An Coimisiún um
Rialáil Cumarsáide
Commission for
Communications Regulation

Proposed Multi Band Spectrum Award

Including the 700 MHz, 2.1 GHz, 2.3 GHz and 2.6 GHz Bands

Response to consultation and further consultation

Reference: ComReg 19/59R

Date: 05/07/2019

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Version history

Document number	Date	Note
19/59	18/06/2019	Original
19/59R	05/072019	Formatting corrections and removal of duplicate text as follows: 1. Removal of Section 9.1.2 (paragraph 9.24 to 9.35) (Duplicate text) 2. Moving of Section 9.3.1 (paragraphs 9.43 to 9.59) to Section 9.1.2 (Formatting correction)

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Overview of Key Proposals

1. ComReg is the manager of the radio spectrum in Ireland. An important part of this function is to assign spectrum rights of use for electronic communications services in a manner that furthers ComReg's statutory objectives including, promoting competition, promoting the interests of users, and ensuring the effective management and efficient use of spectrum in Ireland.

2. This consultation document sets out ComReg's detailed proposals for a multi-band spectrum award to assign rights of use in four spectrum bands which are suitable for mobile and wireless broadband (WBB) services[1]. These spectrum bands are the 700 MHz, 2.1 GHz, 2.3 GHz and the 2.6 GHz bands[2], all of which are harmonised at a European level for the provision of WBB services.

3. In total, ComReg proposes to award 470 MHz of harmonised spectrum rights. This would represent a 46% increase in the harmonised spectrum assigned for the provision of WBB services in Ireland and would significantly enable the market to provide improved services to meet increasing consumer demand for mobile data and new services.

4. In line with its obligation to promote competition, ComReg proposes to award rights to these bands by way of an open, competitive award process where existing operators and potential new entrants can compete for these spectrum rights. Further, and in line with European obligations, ComReg proposes to award the spectrum rights on a technology- and service-neutral basis, meaning that new licensees would be free to deploy equipment that complies with the applicable harmonised standard, be that the 3G, 4G of 5G technologies for mobile, fixed wireless or other uses. ComReg would expect this award to be particularly suitable for enabling advancements in current 4G services and the delivery of new 5G services.

[1] This document also sets out ComReg's response to ComReg Document 18/60, having had regard to the views received from interested parties, recent developments and other relevant material.

[2] The 700 MHz band (703-733 / 758- 788 MHz);
The 2.1 GHz band (1920-1980 / 2110 – 2170 MHz);
The 2.3 GHz band (2300 -2400 MHz); and
The 2.6 GHz band (2500 -2690 MHz);

Proposals for the 700 MHz band

5. In Ireland, the 700 MHz band is currently used for Digital Terrestrial Television (DTT). As outlined in Ireland's National Roadmap on the use of the 700 MHz Frequency Band, published by the Department of Communications, Climate Action and Environment (DCCAE), work to migrate DTT services from the 700 MHz band is being carried out by 2RN, which operates RTÉ's DTT transmission network, and DTT services will cease operation in the 700 MHz band in 2020[3].

6. Given its favourable radio propagation characteristics, the 700 MHz band is a particularly important band for the provision of widespread coverage, including in rural areas and on national transport routes. The 700 MHz band has also been identified as a 5G "pioneer band" for Europe.

7. Noting this importance, and having regard to European obligations concerning this band[4] , ComReg proposals for this band includes making available the entire 60 MHz (i.e. 2×30 MHz) in the duplex portion of this band for award.

8. In considering coverage obligations for the 700 MHz band, ComReg has considered various options, including the use of 'precautionary' and 'interventionist' coverage obligations[5] where:

    - 'precautionary' coverage obligations refer to obligations which do not exceed the levels of coverage that might be expected anyway from well-functioning competition between network operators; and

    - 'interventionist' coverage obligations refer to obligations that can be expected to constrain the commercial choices of network operators and force coverage in excess of competitively-determined levels.

9. As outlined in its draft Regulatory Impact Assessment (RIA) of the various options, ComReg's proposed approach is to set coverage obligations which are precautionary in nature, and are towards the upper end of the range of commercially realistic competitive outcomes. Among other things, this would encourage competition in the award process, thereby underpinning the role of competition in driving coverage, and avoid outcomes where spectrum rights may be unassigned because the coverage obligation was excessive.

10. ComReg's proposed coverage obligations for the 700 MHz band, among other things, would oblige existing licensees to expand their current networks to provide[6]:

[3] https://www.dccae.gov.ie/documents/700MHz%20Roadmap.pdf
[4] EC Decision 2016/687 and EU Decision 2017/899.
[5] See further in ComReg Document 18/103d
[6] The 3 Mbit/s and 30 Mbit/s services identified in these coverage obligation proposals refer to single user throughput services at the cell edge

- a 3 Mbit/s service to 99% of the population and 92% of the geographic area of Ireland;
- a 30 Mbit/s service to 95% of the population, 90% of motorways, and 80% of primary roads; and
- voice calls and a 30 Mbit/s service to 345 specific locations[7], consisting of 40 business and technology parks (including strategic sites), 65 hospitals, 24 higher education campuses, 14 air and sea ports, 160 train and bus stations, and 42 top visitor attraction information points.

11. In relation to 'interventionist' coverage obligations to secure more extensive coverage outcomes than would result from marketplace competition alone, ComReg observes that there may be broader social reasons that would support such an approach and that these would need to be carefully designed, and based on an assessment of the costs and benefits to society of the additional coverage sought.

12. ComReg further observes that 'interventionist' obligations are ideally achieved via a sequential step in a spectrum award or through a separate process. Such mechanisms may provide advantages for the State in ensuring that the societal benefits obtained exceed the costs of any such obligations. The use of a separate process would also allow policy makers the ability to identify what 'precautionary' coverage obligations and competition between network operators would first deliver, retaining the ability for more targeted interventions later if necessary.

Proposals for the 2.1 GHz, 2.3 GHz and 2.6 GHz bands

13. The remaining spectrum bands proposed for award are more suited to providing network capacity, although they could also be used for both capacity and coverage purposes (such as for fixed wireless broadband). ComReg's proposals for these bands are outlined below.

[7] In considering these specific locations ComReg has had regard to the output of the Mobile Phone and Broadband Taskforce which provided a guidance report on the broad categories of locations where mobile services should be available. Based on a ranking of the benefits (economic, societal, safety) of different location categories, it provides the following conclusions:

1) *There is a clear emphasis on the provision of mobile phone coverage at locations where large numbers of people work or spend typical working hours. It should be noted that often people do not live where they work.*
2) *Residential locations and locations where people pass their free time were the next most important type of location.*
3) *Quiet roads, rail lines, cycleways, walking routes and locations where low numbers of people work were considered the lowest priority for mobile phone coverage.*

2.1 GHz band proposals

14. In Ireland, the 2.1 GHz band is currently used to provide 3G services and existing licences in this band run until 2022 and 2027[8].

15. ComReg's proposals for the 2.1 GHz band include:

    - awarding new rights in two "time slices", consisting of 90 MHz (2×45 MHz) in time slice 1[9], and 120 MHz (2×60 MHz) in time slice 2;
    - aligning the expiry dates of the existing 3G licences expiring in 2022 to 15 October 2022 to enable a single commencement date for time slice 1 in the 2.1 GHz band;
    - facilitating the "liberalisation" of all existing 3G rights so as to enable the deployment of 4G and other technologies;
    - a coverage obligation to deploy a specific number of base stations in the band in order to ensure the efficient use of spectrum; and
    - a process to ensure the orderly and timely transition from existing rights to new rights of use.

2.3 GHz band proposals

16. The 2.3 GHz band is widely used for WBB globally, particularly in the Asia Pacific region. In Ireland, this band is unassigned, with the exception of a small portion (2307 MHz – 2327 MHz) which is currently licensed to Eir for its RurTel network which provides universal service obligation (USO) services at a small number of locations in the Donegal, Galway and Kerry regions.

17. ComReg's proposals for the 2.3 GHz band include:

    - making available 100 MHz of spectrum for award;
    - awarding new rights in two time slices, corresponding to the two time slices proposed for the 2.1 GHz band;
    - a coverage obligation to deploy a specific number of base stations in the band in order to ensure the efficient use of spectrum; and
    - proposals to facilitate the continued provision of Eir's RurTel services for a transitional period while alternative services are being deployed.

[8] 2022 for Vodafone and Three, and 2027 for Eir.
[9] Time slice 1 runs to 11 March 2027 to align with the expiry of Eir's existing 3G licence. Time slice 2 commences on 12 March 2027.

2.6 GHz band proposals

18. The 2.6 GHz band is widely used for WBB in Europe and globally. In Ireland, this band is unassigned following the expiry of multichannel multipoint distribution system (MMDS) licences in 2016.

19. ComReg's proposals for the 2.6 GHz band include:

    - making available 190 MHz (2×70 MHz FDD and 50 MHz TDD) of spectrum for award;
    - awarding new rights in two time slices, corresponding to the two time slices proposed for the 2.1 GHz band;
    - a coverage obligation to deploy a specific number of base stations in the band in order to ensure the efficient use of spectrum; and
    - engaging with stakeholders in a timely manner to address co-existence of new services with aeronautical radars operating above the 2.6 GHz band.

Other key aspects of the proposed award

20. The consultation also sets out ComReg's proposals on other key aspects of the Proposed Award, including:

    - licence duration: a proposed duration of 15 years for rights in the 700 MHz, 2.3 GHz and 2.6 GHz bands, and a duration of circa 13 years for the 2.1 GHz band to facilitate a common expiry date for all the bands in this award;
    - award type and format: an open competitive award format based on a combinatorial clock auction (CCA). This award format has previously been used in Ireland for the successful awards of the 3.6 GHz Award in 2016, and the 800 MHz, 900 MHz and 1800 MHz bands in 2012;
    - spectrum fees: proposed spectrum fees (i.e. auction reserve prices and ongoing spectrum usage fees) set at a conservative level based on a benchmarking methodology. This approach encourages competition in the Proposed Award while also discouraging frivolous bidders and, similar to previous spectrum awards, would mean that final prices would ultimately be determined by the bidders in the proposed auction and not ComReg;
    - spectrum competition caps: two sets of spectrum competition caps - one for the sub-1GHz spectrum, and another for total spectrum holdings - to safeguard against extreme asymmetric outcomes in the proposed auction that would be detrimental to competition.

Next Steps

21. ComReg invites input from interested parties on all aspects of the Proposed Award over the next 6 weeks and by 30 July 2019. Considering the complexity of material contained in the document, ComReg has given an additional two weeks over the normal four identified in ComReg's Consultation Procedures.

22. Following receipt and consideration of submissions in response to this consultation, and other relevant material, ComReg intends to publish a response to consultation together with a draft decision for the Proposed Award.

Chapter 1

1 Introduction

1.1 In Document 18/60[10], ComReg considered which spectrum bands should be included in a proposed award of spectrum rights of use suitable for the provision of wireless broadband (both mobile and fixed broadband) services (WBB) (Proposed Award) and outlined its preliminary view that the 700 Duplex, 2.1 GHz, 2.3 GHz and 2.6 GHz bands should be included.

1.2 This document sets out, firstly, ComReg's response to that consultation, having regard to the views received from interested parties to Document 18/60, recent developments and other relevant material, and, secondly, a further consultation on detailed proposals for the design of the Proposed Award.

1.3 In arriving at its proposals set out in this document, ComReg has had regard to the statutory powers, functions, objectives and duties relevant to its management of the radio frequency spectrum (the most relevant of which are summarised in Annex 2). ComReg has also had regard to various European decision documents harmonising the frequency assignments and technical conditions for the availability and efficient use of the spectrum bands proposed for inclusion in the award process (see Annex 4), the responses to Document 18/60, its most recent spectrum strategy statement[11] and its electronic communications services strategy[12].

1.4 In this document, ComReg considers among other issues:

- the key aspects of the spectrum proposed for inclusion in the Proposed Award;
- the type of award mechanism that might be used;
- the proposed approach to setting fees for rights of use that would be assigned on foot of the Proposed Award; and
- appropriate licence conditions including coverage and rollout obligations.

1.5 ComReg is publishing alongside this document:

[10] Document 18/60, "Proposed Multi Band Spectrum Award – Preliminary consultation on which spectrum bands to award", published 29 June 2018
[11] Document 18/118, "Radio Spectrum Management Strategy Statement 2019 to 2021", published 20 December 2018
[12] Document 19/09, ECS Strategy 2019-2021

- a report on the potential design of a spectrum award from its economic and award design consultants, DotEcon, as Document 19/59a (DotEcon Award Design Report);

- a reserve price[13] benchmarking and minimum prices report from DotEcon as Document 19/59b (DotEcon Benchmarking and minimum prices Report);

- a report from its technical consultants, Plum Consulting London LLP (Plum), regarding the potential compatibility and co-existence measures that might be necessary to facilitate the co-existence of future WBB networks in the 2.6 GHz band with aeronautical radars in the 2700 – 2900 MHz (the 2.7 GHz Band), as Document 19/59c (Plum 2.6 GHz Co-existence Report);

- a report from Plum analysing the potential compatibility and co-existence measures that might be necessary to facilitate the co-existence of future WBB networks in the 2.3 GHz with Eir's Rurtel network, and wireless local area networks (WLANs) in the 2.4 GHz band (i.e. Wi-Fi), as Document 19/59d (Plum 2.3 GHz Co-existence Report); and

- a report from its consultants, LS Telcom Ltd (LS Telcom), examining the various network deployment options and spectrum requirements, if any, for any future deployment of Broadband Public Protection and Disaster Relief (BB-PPDR), as Document 19/59e (LS Telcom BB-PPDR Report).

Structure of document

1.6 This document is structured as follows:

- **Chapter 2:** sets out some background information relevant to this consultation process and on the six spectrum bands which ComReg identified in chapter 2 of Document 18/60 for further consideration (i.e. the 700 MHz, 1.4 GHz, 2.1 GHz, 2.3 GHz, 2.6 GHz and 26 GHz bands[14]). It

[13] A reserve price is essentially a price below which spectrum will not be awarded in an auction.
[14] These are defined as:
- the 700 MHz Band (698 – 790 MHz), which comprises the;
  - 700 MHz Duplex (703-733 MHz paired with 758-788 MHz);
  - 700 MHz Duplex Gap (733-758 MHz); and
  - 700 MHz Guard Bands, comprising the
    - 700 MHz Lower Guard Band (694 – 703 MHz); and,
    - 700 MHz Upper Guard Band (788-791 MHz));
- the 1.4 GHz Band (1427 – 1517 MHz), which comprises the:
  - 1.4 GHz Centre Band (1452 - 1492 MHz); and
  - 1.4 GHz Extension Bands (1427-1452 MHz and 1492 – 1517 MHz)
- the 2.1 GHz Band (1920-1980 MHz paired with 2110-2170 MHz), distinct from the Unpaired 2.1 GHz Band (1900 – 1920 MHz)

also provides information on the spectrum options for BB-PPDR the new European Electronic Communications Code (EECC) and Ireland's National Broadband Plan (NBP);

- **Chapter 3:** considers the responses submitted to Document 18/60 on which spectrum bands to include in the Proposed Award, with a view to identifying bands suitable for inclusion in the draft regulatory impact assessment (RIA) in Chapter 4. In addition, this chapter summarises the views of respondents to Document 18/60 on other matters, noting that ComReg's assessment of same may be addressed elsewhere in this document or in a separate ComReg process (e.g. ComReg's Radio Spectrum Management Strategy Statement 2019 to 2021);

- **Chapter 4:** contains a draft RIA of which spectrum bands to include in the Proposed Award, a draft RIA of the type of award process that should be used for same, and an assessment of the preferred options against ComReg's statutory powers, functions, objectives and duties;

- **Chapter 5**: discusses ComReg proposals in relation to the 2.1 GHz Band, including considerations around the liberalisation of existing rights of use in the band and a mechanism for addressing the different expiry dates of existing licences;

- **Chapter 6**: discusses the key aspects of the Proposed Award, including the band plans and licence duration;

- **Chapter 7**: sets out details of the Proposed Award itself, including proposed award type, licence fees and spectrum competition caps;

- **Chapter 8:** details further licence conditions proposed to be attached to rights of use on foot of the Proposed Award, including coverage and rollout, quality of service (QoS), service- and technology-neutrality, and technical conditions related to synchronisation and coexistence;

- **Chapter 9:** considers transition issues that may arise as a consequence of the Proposed Award;

- **Chapter 10:** details how to submit comments in response to this consultation and the next steps in this process.

- **Annex 1:** includes a glossary of terms;

- the 2.3 GHz Band (2300 MHz to 2400 MHz);
- the 2.6 GHz Band (2500 – 2690 MHz); and
- the 26 GHz Band (24.25 – 27.5 GHz).

- **Annex 2:** summarises ComReg's statutory functions, objectives and duties relevant to the management of Ireland's radio frequency spectrum;
- **Annex 3**: sets out ComReg's assessment of the spectrum options for BB-PPDR in the context of the 700 MHz Band;
- **Annex 4**: provides Information on equipment availability, award status in Europe, harmonisation decisions and spectrum availability for the bands considered in Chapter 3 of Document 18/60 for potential inclusion in the Proposed Award;
- **Annex 5**: sets out ComReg's proposals to align the different expiry dates of existing licences in the 2.1 GHz Band in 2022;
- **Annex 6**: sets out a draft RIA informing ComReg's proposal to liberalise existing rights of use in the 2.1 GHz Band and to timing considerations of same.
- **Annex 7**: sets out a draft RIA informing ComReg's proposed coverage obligations for rights of use in the 700 MHz Duplex Band;
- **Annex 8**: details the names and locations of the specific locations which would be included as part of ComReg's proposed coverage obligations for rights of use in the 700 MHz Duplex Band;
- **Annex 9:** sets out a draft RIA informing ComReg's proposed rollout obligations for rights of use in the 2.1 GHz, 2.3 GHz and 2.6 GHz Bands;
- **Annex 10:** sets out a draft RIA informing ComReg's proposed QoS and network availability obligations;
- **Annex 11:** provides a summary of the approach taken to considering the need for a transition mechanism in the 2012 MBSA; and,
- **Annex 12:** sets out the technical licence conditions applicable to the Proposed Bands.

Chapter 2

2 Background Information

2.1 In this Chapter, ComReg sets out some background information relevant to the spectrum bands under consideration in this document, including:

- recent spectrum band developments;
- the connectivity studies published by ComReg in November 2018;
- the broadband public protection and disaster relief (BB-PPDR) spectrum management consideration;
- the adoption of Directive (EU) 2018/172 establishing the European Electronic Communications Code (EECC) in December 2018;[15]
- cybersecurity of 5G networks; and
- Ireland's National Broadband Plan.

2.1 Recent spectrum band information

2.2 In order to reflect developments in the intervening period since June 2018, this section updates[16] the information provided in Chapter 3 of Document 18/60 on each of the spectrum bands under consideration in this document in the context of:

i. the degree of harmonisation;
ii. the availability of spectrum;
iii. equipment availability[17]; and
iv. awards completed in other Member States.

[15] Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code.
[16] More information relevant to the spectrum bands is set out in Chapter 3 and Annex 4 to this document.
[17] Points (i) to (iii) (degree of harmonisation, the availability of spectrum and equipment availability) are three of the four criteria used in Document 14/101 to identify bands suitable for inclusion in the Proposed Award considered in that document.

2.1.1 Degree of harmonisation

2.3 In the intervening period, the European Conference of Postal and Telecommunications Administrations (CEPT) and the European Commission (EC) have continued work to define and update the various technical harmonisation decisions and reports which facilitate the use of spectrum bands for WBB including 5G.[18] In relation to the spectrum bands that were considered in Document 18/60, ComReg notes that for:

- the 2.1 GHz Band, CEPT updated ECC Decision (06)01[19] to enable the use of 5G and Active Antenna Systems (AAS) in this band, and issued Draft Report 72[20], which provides information to the EC to consider in reviewing and updating the existing EC Decision for the 2.1 GHz Band (the 2.1 GHz EC Decision)[21];

- the 2.6 GHz Band, CEPT issued a public consultation on its updates to ECC Decision (05)05[22] to enable the use of 5G and AAS in this band. In addition, Draft Report 72[23] provides information to the EC to consider in reviewing and updating the existing EC Decision for the 2.6 GHz band (the 2.6 GHz EC Decision)[24]; and

- the 26 GHz Band, in July 2018, CEPT adopted ECC Decision (18)06[25] setting harmonised conditions for the introduction of 5G in the 26 GHz Band. In May 2019, EC Implementing Decision (EU) 2019/784 was

[18] CEPT's webpage "Spectrum for wireless broadband – 5G" provides an overview of its activities.
[19] ECC/DEC/(06)01 ECC Decision of 24 March 2006 on the harmonised utilisation of the bands1920-1980 MHz and 2110-2170 MHz for mobile/fixed communications networks (MFCN) including terrestrial IMT, amended on 2 November 2012 and amended on 8 March 2019.
[20] Draft CEPT Report 72, Report from CEPT to the European Commission in response to the Mandate, *"to review the harmonised technical conditions for certain EU-harmonised frequency bands and to develop least restrictive harmonised technical conditions suitable for next-generation (5G) terrestrial wireless systems"* Report A: Review of technical conditions in the paired terrestrial 2 GHz and the 2.6 GHz frequency bands, and the usage feasibility of the 900 MHz and 1800 MHz frequency bands.
[21] 2012/688/EU Commission Implementing Decision of 5 November 2012 on the harmonisation of the frequency bands 1920 - 1980 MHz and 2110 - 2170 MHz for terrestrial systems capable of providing electronic communications services in the Union.
[22] Draft revision of ECC Decision (05)05 Harmonised utilization of spectrum for Mobile/Fixed Communications Networks (MFCN) operating within the band 2500-2690 MHz.
[23] Draft CEPT Report 72, Report from CEPT to the European Commission in response to the Mandate, *"to review the harmonised technical conditions for certain EU-harmonised frequency bands and to develop least restrictive harmonised technical conditions suitable for next-generation (5G) terrestrial wireless systems"* Report A: Review of technical conditions in the paired terrestrial 2 GHz and the 2.6 GHz frequency bands, and the usage feasibility of the 900 MHz and 1800 MHz frequency bands.
[24] Commission Decision 2008/477/EC of 13 June 2008 on the on the harmonisation of the 2 500-2 690 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community.
[25] ECC Decision (18)06 of 6 July 2018, corrected 26 October 2018.

adopted on the harmonisation of the 24.25-27.5 GHz frequency band for terrestrial systems capable of providing WBB ECS in the Union.[26]

2.4 In addition, and as discussed further below, the EECC has now been adopted. It contains a specific obligation in relation to the 26 GHz Band as set out below:

> ***Article 54: Coordinated timing of assignments for specific 5G bands***
>
> *1. By 31 December 2020, for terrestrial systems capable of providing wireless broadband services, Member States shall, where necessary in order to facilitate the roll-out of 5G, take all appropriate measures to:*
>
> *(b) allow the use of at least 1 GHz of the 24,25-27,5 GHz band, provided that there is clear evidence of market demand and of the absence of significant constraints for migration of existing users or band clearance.*

2.1.2 Equipment availability

2.5 Since the publication of Document 18/60 in June 2018, the availability of LTE and 5G capable devices, as reported by the Global mobile Suppliers Association (GSA)[27], has increased in the 700 Duplex, 1.4 GHz Centre Band, 2.1 GHz Band, 2.3 GHz Band, 2.6 GHz Band and the 26 GHz Band. See Chapter 3 and Annex 4 for further details.

2.6 The GSA indicates that there is no equipment available for the 700 MHz Duplex Gap and 700 MHz Guard Bands, or for the 1.4 GHz Extension Bands.

2.1.3 Availability of spectrum

2.7 The availability of spectrum in each of the spectrum bands remains substantially the same as that presented in Document 18/60, noting that:

- as of May 2018, there are 104 point-to-point licences occupying spectrum in the 1.4 GHz Extension Bands (an increase of 1 licence since the publication of Document 18/60); and
- as of May 2019, Eir holds 34 licences (compared with 45 at the time of publication of Document 18/60) in the 2.3 GHz Band (in the range 2307-2327 MHz) for its Rurtel network which, as at December 2018, supports telephony services for 87 customers.

[26] Decision (EU) 2019/784 of 14 May 2019.
[27] www.gsacom.com

2.8 Information on the potential compatibility and co-existence measures that might be necessary to facilitate the co-existence of future WBB networks in the 2.3 GHz Band and 2.6 GHz Band with existing services (Eir's Rurtel network in the 2.3 GHz Band and WLANs in the 2.4 GHz band, and aeronautical radars in the 2.7 GHz band) has been published alongside this consultation in the form of Plum's *2.3 GHz Sharing Analysis* report and its *Compatibility Study in Preparation for the Award of the 2.6 GHz Band*.

2.1.4 Completed spectrum awards in Europe

2.9 Since Document 18/60 was published, a number of relevant spectrum awards have been completed in Europe[28], including:

- On 2 October 2018, in Italy, the Ministry of Economic Development (MISE) announced the results of its multi-band award where a total of 1,275 MHz was made available across frequencies in the 700 MHz (2×30 MHz Duplex and 15 MHz SDL[29]), 3.7 GHz (200 MHz) and 26 GHz (1000 MHz) bands. All but 15 MHz (700 MHz SDL) was assigned;

- In November 2018, France concluded a beauty contest for the award of spectrum in the 900 MHz, 1800 MHz and 2.1 GHz Bands;

- In December 2018, in Sweden, an award for the 700 MHz band was completed. In total, 40 MHz (2×20 MHz) was assigned in the 700 MHz Duplex band, while 20 MHz of 700 MHz SDL was unassigned;

- In December 2018, Finland concluded a beauty contest for the award of spectrum in the 900 MHz, 1800 MHz and 2.1 GHz Bands;

- In February 2019, in Switzerland, ComCom announced the results of its multi-band award where a total of 475 MHz was made available across frequencies in the 700 MHz (2×30 MHz Duplex and 15 MHz SDL), 1.4 GHz (90 MHz SDL), 2.6 GHz (2×5 MHz) and the 3.6 GHz (300 MHz) bands. All but 30 MHz (5 MHz of 700 MHz SDL, 15 MHz of 1.4 GHz SDL and 2x5 MHz in the 2.6 GHz Band) was assigned;

- In March 2019, in Denmark, the Danish Energy Agency (ENS) completed its multi-band award for spectrum rights in the 700 MHz (2×30 MHz Duplex plus 20 MHz SDL), 900 MHz (2×30 MHz) and 2.3 GHz (100 MHz TDD)

[28] All information in this section is sourced from Cullen International (www.cullen-international.com) (a pay subscription website) unless otherwise stated.
[29] Supplementary downlink (SDL).

bands.[30] All spectrum was assigned except for 40 MHz in the 2.3 GHz Band;

- On 5 June 2019[31], in Norway NKOM completed its award of 2×30 MHz in the 700 MHz and 2×15 MHz in the 2.1 GHz Band where all spectrum was assigned, and;

- On 12 June 2019, in Germany, BNETZA completed[32] its multi-band award for spectrum rights in the 2.1 GHz Band (2×60 MHz) and the 3.4–3.7 GHz band (300 MHz).

2.2 The Connectivity Studies

2.10 To assist in the development of proposals for its forthcoming spectrum awards, and in particular its consideration of appropriate coverage obligations, ComReg commissioned three studies on different aspects of providing connectivity in Ireland, including estimated costings to extend mobile coverage to high levels.

2.11 In this context, "connectivity" is the ability of users and their devices to connect and communicate with each other and their networks. This can take different forms, with many different networks and devices being used, increasingly seamlessly, to communicate and consume content and applications.

2.12 In November 2018, ComReg published the results of these studies in the form of the following three reports:

- *"Meeting Consumers' Connectivity Needs"* – a report (Document 18/103b) and accompanying infographic (Document 18/103a) from Frontier Economics Ltd (Frontier) - which provides an overview of the challenges in providing connectivity for consumers in Ireland and outlines actions that can be taken by all stakeholders, including consumers, industry, government and ComReg, to optimise the levels of connectivity given these challenges (Frontier Connectivity Report);

- *"Future Mobile Connectivity in Ireland"* - a report (Document 18/103c) from Oxera Consulting LLP (Oxera), with Real Wireless Ltd - which considers the future mobile connectivity services likely to emerge in Ireland and the estimated costs of providing connectivity to such services at high coverage levels in Ireland (Oxera Connectivity Report);

[30] https://presse.ens.dk/pressreleases/flere-steder-i-landet-kan-se-frem-til-bedre-mobildaekning-2853575
[31] https://eng.nkom.no/topical-issues/news/the-first-5g-auction-in-norway-has-ended
[32] https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2019/20190612_Frequenzauktion.html?nn=265778

- *"Coverage obligations and spectrum awards"* – a report (Document 18/103d) from DotEcon - which considers options as to how appropriate coverage and rollout obligations could be included in future spectrum awards (DotEcon Connectivity Report),

(together the Connectivity Studies).

2.13 In addition, ComReg published an information notice[33] summarising the key messages and recommendations in these studies, noting that:

- good solutions for indoor connectivity include the use of Wi-Fi and native Wi-Fi calling[34] on a fixed broadband connection, and the use of licence-exempt mobile phone repeaters. By ensuring widespread access to high-speed fixed broadband connectivity, the National Broadband Plan (NBP) is clearly critical to the penetration and uptake of Wi-Fi and Native Wi-Fi calling services;

- it seems feasible for the market by itself to increase the availability of 30 Mbit/s mobile broadband (MBB) from current coverage levels to at least 90% of the population (where people live) in the period up to 2025. Achieving this coverage level would also provide significant incidental coverage improvements for other coverage dimensions (geographic, motorway, primary roads), and for the 3 Mbit/s MBB and voice service, increasing this service to above 99% population and above 90% geographic coverage;

- very high levels of 30 Mbit/s MBB coverage on a geographic basis would not be achieved by the market itself as this would require networks to have two to four times as many cell sites as exist today. Reflecting the rural nature of Ireland, this could take many years to achieve if mandated and the overall cost to stakeholders would likely be substantial; and

- policy or regulatory interventions could be used to secure more extensive coverage outcomes that would result from marketplace competition alone. These would need to be carefully designed, and based on an assessment of the costs and benefits to society of the additional coverage sought.

2.14 The matters set out in this consultation document have been informed by the Connectivity Studies and interested parties are encouraged to consider this material.

[33] Document 18/103 - *"Improving connectivity in Ireland – Challenges, solutions and actions."*
[34] Eir and Vodafone have launched native Wi-Fi calling on their networks while Three is the only MNO yet to do so.

2.3 BB-PPDR spectrum management considerations

2.3.1 Background

2.15 As discussed in Document 18/60 and ComReg's Radio Spectrum Management Strategy (Document 18/118)[35], the EC 700 MHz Decision[36] provides flexibility to Member States on the potential uses for the 700 MHz Duplex, the 700 MHz Guard Bands and the 700 MHz Duplex Gap. These potential uses (which are not mutually exclusive) are:

- WBB and BB-PPDR services in the 700 MHz Duplex; and
- BB-PPDR, SDL, Machine to Machine (M2M), and wireless audio programme making and special events (PMSE) services in the 700 MHz Guard Bands and the 700 MHz Duplex Gap.

2.16 In light of this national flexibility, and conscious that there is no national policy decision of the spectrum requirements for BB-PPDR in Ireland, ComReg indicated in Documents 18/60 and 18/118 that it would be engaging with stakeholders to develop clarity on same.

2.17 Since then, ComReg has:

- proposed to set aside 2 × 3 MHz of the 400 MHz band for the provision of future BB-PPDR, specifically in the range 414 – 417 MHz / 424 – 427 MHz[37];
- commissioned LS Telcom to carry out a study on the various network deployment options and spectrum requirements for any future deployment of BB-PPDR in Ireland. The findings of this study are set out in the LS Telcom BB-PPDR Study (ComReg Document 19/59e) and are summarised below; and
- set out its draft spectrum management assessment on the amount of spectrum in the 700 MHz Duplex that should be included in the Proposed Award. This is set out in Annex 3 and is summarised below.

[35] See paragraphs 4.15 to 4.25 of ComReg Document 18/118.
[36] Commission Implementing Decision (EU) 2016/687 of 28 April 2016 on the harmonisation of the 694-790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services and for flexible national use in the EU.
[37] ComReg Document 19/23, "Response to Consultation and Draft Decision on the Release of the 400 MHz Sub-band", published 15 March 2019

2.3.2 Summary findings of the LS Telcom BB-PPDR study

2.18 The LS Telcom Study had three main tasks:

- **Task 1:** Drawing on relevant material from the RSPG, ECC, EU and other relevant information, provide a summary of the key points relevant to BB-PPDR network "deployment options"[38], "spectrum options"[39] and the amount of spectrum likely to be required to operate a BB-PPDR network[40];
- **Task 2:** Having reviewed, considered and summarised the work being carried out in other relevant countries[41], provide key observations and conclusions on the feasibility of different BB-PPDR network deployment options, with a particular focus on approaches in the 700 MHz Band; and
- **Task 3:** In light of the findings from Tasks 1 and 2, consider and provide analysis and observations on the likely spectrum requirements for the provision of BB-PPDR in Ireland, and assess from a spectrum management perspective the relative merits of the various spectrum options available to meet said likely spectrum requirements.

Key Findings of Task 1

2.19 Task 1 of the LS Telcom Study had particular regard to relevant material from CEPT / ECC reports and other technical reports from the TETRA and Critical Communications Association (TCCA).

2.20 Key findings from Task 1 include that:

- there are 3 network deployment options (i.e. Dedicated, Commercial and Hybrid) for consideration in the context of BB-PPDR implementation. Both the Dedicated and Hybrid options require access to dedicated spectrum, whereas the Commercial option relies on access to mobile operators' existing (or future) spectrum holdings. Each of the three deployment options has advantages and disadvantages for each country to consider when assessing its particular requirements;

[38] The three generic deployment options to study were: (i) Commercial, (ii) Hybrid and (iii) Dedicated networks.
[39] In particular this is to consider the harmonised spectrum options set out in the EC 700 MHz Decision and ECC Decision (16)02 as amended.
[40] In particular, this is to draw upon the work done within the ECC/CEPT to reach conclusions and recommendations, noting in particular the rationale and findings of ECC Report 199.
[41] Countries considered include: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Netherlands, Norway, Slovenia, Sweden, Switzerland and the United Kingdom.

- for many years now, CEPT, the International Telecommunications Union (ITU)[42], the EC and European national regulators have been working together to establish harmonised frequency bands for BB-PPDR. Within the concept of "flexible harmonisation" to enable national flexibility to decide how much spectrum and which specific frequency ranges should be designated for BB-PPDR, ECC Decision (16)02[43] (amended on 8 March 2019) sets out harmonised technical conditions for BB-PPDR in three spectrum bands: (i) the 410-430 MHz band, (ii) the 450-470 MHz band and (iii) the 700 MHz Band; and

- from its review of the spectrum requirements for BB-PPDR, according to the work and studies within CEPT (particularly ECC Report 199) and other organisations such as TCCA, LS Telcom observe that 2×10 MHz has been identified as a sufficient amount of spectrum to support BB-PPDR end-user applications with certain usage scenarios and expected type of deployments. The Law Enforcement Working Party (LEWP) model (as used in ECC Report 199) is used again later in Task 3 to consider BB-PPDR spectrum requirements in the Irish context.

Key Findings of Task 2

2.21 Task 2 of the LS Telcom study is based on a study of 15 European countries.[44]

2.22 From this study, LS Telcom firstly note that, across Europe, most Governments are now deciding – or at least studying in earnest - how to move from existing narrowband (mainly Terrestrial Trunked Radio (TETRA)) networks to next-generation public safety/BB-PPDR systems. The particular deployment and spectrum models for these countries – including Ireland - will be determined by a number of factors including, in particular: specific national circumstances, equipment availability, and the wider European context.

2.23 Noting this context, and the findings of the European countries studied, LS Telcom observe that:

- most European Governments have made significant investments in their existing narrowband networks, so it is natural for current BB-PPDR plans to be based on the continued use of these systems until existing network

[42] One notable recommendation of the ITU is ITU-R Report M.2009 which is the broadband radio interface standard for use by public protection and disaster relief operations in some parts of the Ultra High Frequency (UHF) band in accordance with Resolution 646 (Rev WRC-15). This Resolution recognises the use of spectrum in the range 380 – 470 MHz for BB-PPDR as a core harmonised band.
[43] http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCDEC1602.PDF
[44] Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Hungary, The Netherlands, Norway, Slovenia, Sweden, Switzerland and the United Kingdom.

support contracts come to an end or until a fully functioning broadband alternative is in place and approved by the relevant authorities;

- the majority of European countries studied are now considering how commercial networks can form part of the solution for providing next-generation public safety/PPDR services, either on a hybrid or a standalone deployment basis. The main factors that are influencing such views include the increased technical capabilities of commercial networks to provide BB-PPDR services (e.g. with the move to LTE) and cost considerations (i.e. reduced capital and operational costs which otherwise are likely to be substantial);

- the economic costs of deploying PPDR services on a commercial network are significantly lower than the costs of building a dedicated network, noting that there are other non-monetary considerations to also be considered;

- at least 4 European countries – Belgium, Czech Republic, Norway and Slovenia – have already acted to provide core PPDR services over commercial networks in the main 700 MHz band (Band 28), with many more seriously considering this approach. The UK has also decided to provide public safety services over commercial networks without providing additional spectrum, but with investment from Government for additional sites;

- many European countries are still considering, or have not ruled out, a hybrid model – at least in the medium-term – for PPDR service provision;

- focusing on the main 700 MHz Duplex, only Sweden now appears to be considering a possible future assignment of dedicated spectrum for PPDR, with 2x10 MHz yet to be assigned; and

- besides the 700 MHz Duplex, other sub-1 GHz bands (Band 28B (2×3 MHz), Band 68 (2×5 MHz), 410 – 430 MHz and 450-470 MHz) may also be available shortly and are thus being seriously considered for PPDR use.

Key Findings of Task 3

2.24 Task 3 of the LS Telcom Study entailed an assessment of the likely spectrum requirements for BB-PPDR in Ireland, and consideration of the different spectrum options to meet said requirement, including consideration of the alternative uses/opportunity costs of using these spectrum options (including in the 700 MHz Duplex) for PPDR.

2.25 Key findings from Task 3 include that:

- based on a re-running of the LEWP-ETSI Matrix model (as used by CEPT in its studies) suitably adapted for specific circumstances in Ireland, that *"2×6 MHz would be sufficient to support PPDR usage in Ireland, both in Dublin City and County and the rest of Ireland."* ; and

- the 410 – 430 MHz and the 700 MHz option 2[45] (and to some extent 700 MHz option 1[46]) have the most potential in terms of spectrum options for BB-PPDR (see Table 1 below);

Table 1: Summary of LS Telecom's spectrum option assessment

Frequency Band	Equipment availability	Spectrum availability	Alternative uses
410 - 430 MHz (2×3 MHz)	Soon to be a recognised 3GPP band – work item in progress Little equipment ecosystem	2×3 MHz for PPDR proposed	2×3 MHz for Smart Grid proposed ComReg proposes to migrate existing trunked radio licensees to facilitate the allocation of spectrum for BB-PPDR[47]
450 - 470 MHz	A recognised 3GPP band Some equipment available	Band not available given existing usage	Not assessed as spectrum band is unavailable in Ireland
700 MHz Option 1 (2×5 MHz, Band 68)	A recognised 3GPP band No equipment ecosystem yet	Band potentially available for PPDR after March 2020	Alternative users (SDL, PMSE) unlikely to be adversely impacted
700 MHz Option 2 (2×3 MHz, Band 28b)	A recognised 3GPP band Equipment available off-the-shelf	Band potentially available for PPDR after March 2020	Alternative users (M2M/IOT, PMSE) unlikely to be adversely impacted
700 MHz Option 3 (2×5 or 2×10 MHz, Band 28)	A recognised 3GPP band Equipment available off-the-shelf	Band potentially available for PPDR after March 2020	Significant impact for alternative use by wireless broadband.

(green = no significant impediments, yellow = some impediments may exist, red = significant impediments)

- there are a variety of technically viable[48] options available (see Table 2 below) to support the identified requirement of 2×6 MHz of spectrum for PPDR in Ireland, noting that Options D, E and F have significant alternative use impediments:

[45] 733-736 MHz (uplink) / 788-791 MHz (downlink) - 2×3 MHz of spectrum in the 700 MHz Duplex Gap and the 700 MHz Upper Guard Band (3GPP Band 28B)
[46] 698-703 MHz (uplink) / 753-758 MHz (downlink) - 2×5 MHz of spectrum in the 700 MHz Lower Guard Band and the 700 MHz Duplex Gap (3GPP Band 68);
[47] See ComReg Document 19/23
[48] Technically viable options are based on an assessment of equipment and spectrum availability but not considering alternative uses.

- Options A, B, and C, in the case of a Dedicated network, appear to be those which are being most closely considered by those countries examined in Task 2;
- Options D, E and F have significant alternative use impediments, given the importance of the 700 MHz Duplex band for future WBB services and, in particular, for delivering 5G and other services to Ireland's rural communities.

Table 2: LS Telcom's technically viable spectrum options for BB-PPDR in Ireland

Option	Amount of Spectrum	410 – 430 MHz	700 MHz Option 1	700 MHz Option 2	700 MHz Option 3
A	2×6 MHz	2×3 MHz		2×3 MHz	
B	2×8 MHz	2×3 MHz	2×5 MHz		
C	2×8 MHz		2×5 MHz	2×3 MHz	
D	2×8 MHz	2×3 MHz			2×5 MHz
E	2×8 MHz			2×3 MHz	2×5 MHz
F	2×10 MHz				2×10 MHz

2.26 In relation to whether or not some spectrum in the 700 MHz Duplex should be dedicated for PPDR use in Ireland, LS Telcom consider that making available 2×30 MHz for WBB in the Proposed Award would appear to be the best use of the 700 MHz Duplex given the availability of alternative spectrum options for PPDR. Reasons informing this view include that:

- the availability of other viable spectrum options for BB-PPDR in Ireland - namely the 410 - 430 MHz band, and 3GGP Band 28B (2×3 MHz) and 3GPP Band 68 (2×5 MHz) in the 700 MHz Duplex Gap and 700 MHz Guard Bands;
- the importance of the 700 MHz Duplex for 5G rollout;
- the importance of 700 MHz Duplex for rural connectivity across Ireland given its challenging demographics; and
- not making the full 700 MHz Duplex available for award would reduce the spectrum options available for all service providers (e.g. mobile, fixed wireless, etc.) also impairing the potential for new entry.

2.3.3 Summary of ComReg's draft spectrum management assessment

2.27 ComReg has carefully considered the LS Telcom BB-PPDR Study, and other relevant material, in the context of its spectrum management function and the summary findings of this draft assessment are outlined below.

Deployment and spectrum options for BB-PPDR

2.28 Having considered the information in the LS Telcom BB-PPDR report, ComReg firstly observes that there are a wide choice of deployment and spectrum options for BB-PPDR, including the use of commercial networks, the building of a dedicated network, or the use of a hybrid solution.

2.29 From the European countries studied, ComReg observes that:

- the majority of countries are considering how commercial networks can form part of the BB-PPDR solution[49]; and
- while most countries are considering dedicating some spectrum to BB-PPDR, only one country, Sweden, is considering dedicating spectrum in the 700 MHz Duplex for such purposes. Elsewhere, harmonised spectrum in other bands, i.e. 410 - 430 MHz, 450 - 470 MHz and spectrum in 700 MHz Duplex Gap and 700 MHz Guard Bands, are being considered by European countries.

2.30 Cognisant that Ireland has yet to make decisions on its BB-PPDR deployment model, should the Government decide that spectrum is required for BB-PPDR, then ComReg observes that:

- the proposal to make available 2×3 MHz of spectrum in the 410-430 MHz band for BB-PPDR (see ComReg's recent consultation on the 400 MHz band) is a significant step towards meetings Ireland's BB-PPDR spectrum requirements estimate of 2×6 MHz;
    - the propagation characteristics of which are very comparable to that used by the existing TETRA network and as such is suitable for the effective deployment of wide area coverage which could be achieved using existing sites; and

[49] The increased technical capabilities of commercial networks to provide BB-PPDR services (e.g. with the move to LTE) and a consideration of costs, (i.e. reduced capital and operational costs which otherwise are likely to be substantial) are factors influencing such views.

- Nordic Telecom, along with Nokia[50], is developing a LTE network for critical communications in the Czech Republic using spectrum rights in this band; and

- there are technically viable spectrum options for BB-PPDR in the 700 MHz Duplex (Band 28), the 700 MHz Duplex Gap and 700 MHz Guard Bands (Band 68(2×5 MHz) and Band 28B (2×3 MHz)).

    - The impact on alternative uses for some of the above spectrum options appears limited (e.g. limited uptake of the 700 MHz Duplex Gap and 700 MHz Guard Bands for WBB). As outlined in Chapter 3, ComReg does not proposes to include the 700 MHz Duplex Gap or 700 MHz Guard Bands in the Proposed Award, and this spectrum could therefore be potentially available for BB-PPDR uses in the future.

    - However, the negative impacts of reduced availability of spectrum in the 700 MHz Duplex (Band 28) for WBB (i.e. if 2×5 or 2×10 MHz were allocated to BB-PPDR) would be substantial, as outlined below.

The 700 MHz band is an important band for 5G services

2.31 The 700 MHz band is an important band for the widespread provision of 5G services. It is a pioneer band for 5G services in Europe, and its greenfield availability (following the migration of DTT) facilitates the early deployment of 5G services in this band. Other existing spectrum bands have legacy users and operators would need time to transition these bands in order to use such bands for 5G;

The 700 MHz band is particularly important for rural connectivity in Ireland

2.32 The 700 MHz band is an important band for rural connectivity. Given Ireland's challenging demographic characteristics[51], the availability of sub-1GHz spectrum bands, including the 700 MHz band, is particularly important to providing rural connectivity.

[50] https://www.nokia.com/about-us/news/releases/2019/04/17/nokia-and-nordic-telecom-launch-the-worlds-first-mission-critical-communication-ready-lte-network-in-the-410-430-mhz-band/

[51] For example:

- 37% of the population is spread across 95% of the land area;
- of EU member states, Ireland has the highest proportion of population that live in NUTS 3 areas classified as rural at 72%, compared to the EU average of 22%;
- Ireland has an extensive road network (5,306 km of primary and secondary roads and a further 91,000 km of regional and local roads). The road density in Ireland (21 km per 1000 inhabitants) is twice the EU average.

2.33 This importance has been recognised by the European Commission and the Irish Government.

- EU Decision 2017/899 notes that:

  "Spectrum in the 700 MHz frequency band provides both additional capacity and universal coverage, in particular for the economically challenging rural, mountainous and insular areas as well as other remote areas, predetermined in accordance with areas that are a national priority, including along major terrestrial transport paths, and for indoor use and for wide machine-type communications."

- The importance of the 700 MHz band in providing broadband services to rural Ireland has also been noted by the Irish Government:

  "The timely release of this spectrum is a matter of national importance to Ireland as its subsequent use for mobile broadband services will assist in delivering improved network coverage and speed particularly in rural areas."[52]

2.34 Any reduction in the amount of 700 MHz spectrum available for wireless broadband would affect mobile operators' ability to deliver widespread connectivity, noting that:

- Coverage: when used in conjunction with the existing sub-1 GHz bands[53], 2×10 MHz of 700 MHz Duplex would provide a 65% coverage area gain for speeds of 30 Mbit/s;

- Speed: additional sub-1 GHz spectrum (e.g. 2×30 MHz in the 700 MHz Duplex) makes it possible for operators to deploy extra carriers and deliver higher speeds across a wide area; and

- Network costs: While an existing operator without any 700 MHz Duplex spectrum could seek to add capacity in rural areas by deploying additional base stations to its network, the construction of such base stations (as well as extending backhaul links to such sites) is expensive and often costs many multiples of the cost of adding additional spectrum to existing base stations;

[52] Migration of Broadcasting Services for 700 MHz Spectrum Band - Letter of entrustment to RTE. https://www.dccae.gov.ie/enie/communications/publications/Documents/68/Minister's%20Letter%20to%20RT%C3%89%20Chair%20setting%20out%20Act%20of%20Entrustment_Redacted.pdf
[53] See ComReg 18/103c

Reduced spectrum outcomes

2.35 A reduction in the amount of 700 MHz Duplex available for wireless broadband would result in reduced spectrum outcomes for services providers.

- Existing mobile operators: Mobile operators would likely have a preference for 2×10 MHz of spectrum in the 700 MHz band. Therefore, reducing the quantity of 700 MHz spectrum available is likely to have the undesirable effect of constraining supply, particularly given that there is likely to be excess demand for rights of use in the band as observed in awards in other countries. It is also possible that an operator could end up with no 700 MHz spectrum despite participating in the award, as was the case with Hi3G in the recent Swedish award[54].

- Potential new entrants and fixed wireless service providers: These service providers would likely prefer the option that does not further impact their ability to acquire rights of use in the award. Available sub 1- GHz spectrum for the provision of wireless broadband services is already a scarce resource. Further reducing the supply limits ComReg's ability to design an award which facilitates new entry.

Summary view

2.36 In light of the draft spectrum management assessment as set out in Annex 3, ComReg is of the preliminary view that progressing the Proposed Award on the basis of including the full 2×30 MHz of the 700 MHz Duplex would be the most appropriate option in terms of ComReg's spectrum management function and objectives.

2.37 In relation to the other technically-viable deployment and spectrum options available for BB-PPDR, and as noted in ComReg's Radio Spectrum Management Strategy Statement for 2019-2021, ComReg will continue to monitor, investigate and contribute to the spectrum management considerations in respect of spectrum for BB-PPDR.

2.38 In this regard, ComReg notes that:

- it has proposed to make available 2×3 MHz of spectrum in the 410 - 430 MHz band for BB-PPDR and that this represents a significant step towards meetings Ireland's likely BB-PPDR spectrum requirement of 2×6 MHz; and

[54] As outlined in section 4.4.4 of the LS Telcom BB-PPDR Report, in the Swedish 700 MHz award, 2×20 MHz was made available instead of the full 2×30 MHz. As a result, the fourth mobile operator H3G (Three) did not win any 700 MHz spectrum and stated that it would appeal the 700 MHz auction results in the court, accusing PTS of poor regard for competition.

- spectrum in the 700 MHz Duplex Gap and 700 MHz Guard Bands (i.e. Band 68 (2×5 MHz) and Band 28B (2×3 MHz)) could also be made available for BB-PPDR use if required, in line with the flexibility afforded the State in respect of same under the EC 700 MHz Decision.

2.39 ComReg's preliminary view is, however, without prejudice to any future decisions which the State may take in relation to the use of the 700 MHz Band under the EC 700 MHz Decision.

2.4 European Electronic Communications Code

2.40 On 20 December 2018, Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code ("EECC") entered into force.

2.41 The EECC replaces the EU Common Regulatory Framework adopted in 2002 (and amended in 2009) under which ComReg has regulated electronic communications since 2003.

2.42 With some limited exceptions (see Article 124 of the EECC), Member States have until 21 December 2020 to transpose the EECC into national law.[55] Until then, the existing EU Common Regulatory Framework will continue to apply. However, in developing its proposals for the Proposed Award, ComReg is mindful of the EECC.

2.43 ComReg understands that the DCCAE will be responsible for transposition of the EECC and will provide any assistance.

2.5 Cybersecurity of 5G networks

2.44 Undertakings or spectrum rights of use holders are obliged under Regulation 23 of the Framework Regulations to take appropriate technical and organisational measures to manage risks posed to the security of their networks / services and to prevent and minimise the impact of security incidents on users and interconnected networks. Similar obligations are contained in the EECC[56].

2.45 These security obligations continue to apply to operators that win spectrum in the Proposed Award. As networks are rolled out by these operators, a wide range of services could become dependent on 5G networks. This could include energy, transport, banking, health, as well as industrial control systems.

[55] With the exception of Articles 53(2), (3) and (4), and Article 54 (see Article 124).
[56] See Article 40 – Security of networks and services, of the EECC.

2.46 The potential for such services to be dependent on these networks would mean that any systemic and widespread disruption would be particularly serious. With this in mind, the European Commission has initiated a measure to ensure the security of 5G networks across the European Union.

2.47 On 26 March 2019, the European Commission adopted Recommendation 2335 on Cybersecurity of 5G networks (Recommendation 2335) [57] which recommends a common EU approach to the security of 5G networks.

2.48 Recommendation 2335 sets out a number of recommendations for EU Member States including three specific actions plus deadlines for their completion:

- Action 1: Member States, by 30 June 2019, are to assess the cybersecurity risks affecting 5G networks at national level and take necessary security measures.
- Action 2: Member States and relevant Union bodies, by 1 October 2019, are to develop a coordinated Union risk assessment that builds on the national risk assessments.
- Action 3: The "Cooperation Group"[58], by 31 December 2019, is to identify a possible common "Union toolbox", or set of measures to mitigate cybersecurity risks, in particular for 5G networks.

2.49 ComReg is working with and assisting the National Cyber Security Centre (NCSC)[59] which will perform the above three actions on Ireland's behalf.

2.50 In addition, point 4(c) of Recommendation 2335 also provides that:

> *"On the basis of the national risk assessment and review and taking into account ongoing coordinated action at Union level, Member States should:*
>
> *(c) attach conditions to the general authorisation concerning the security of public networks against unauthorised access and ask for commitments from the undertakings participating in any upcoming procedures for granting rights of use for radio frequencies in 5G bands as regards compliance with security requirements for networks pursuant to Directive 2002/20/EC;*

[57] Recommendation C(2019) 2335 - Cybersecurity of 5G networks (Rec. 2335)
[58] The Cooperation Group was established under Directive (EU) 2016/1148 (the Network and Information Systems Directive) to ensure strategic cooperation and the exchange of information among Member States in cybersecurity. It is composed of representative of Member States, the European Commission and the EU Agency for Network and Information Security.
[59] The NCSC is the government computer security organisation in Ireland, an operational arm of the Department of Communications, Climate Action and the Environment.

2.51 Condition 19 of the General Authorisation (03/81R6[60]) and S.I. No. 336/2011[61] already include measures, in respect of ensuring the security of public electronic communications networks against unauthorised access.

2.52 Regarding the common set of measures to mitigate against cybersecurity risks, or the "Union toolbox", this is expected to be known by 31 December 2019. ComReg will consider the output of the Cooperation Group when it is known and any implications that might arise in respect of this award process.

2.6 Ireland's National Broadband Plan (NBP)

2.53 As discussed in the Connectivity Studies, the delivery of the National Broadband Plan (NBP) is an important project in in the overall solution for connectivity in Ireland.

2.54 The NBP is the Government's plan to ensure that all premises in Ireland have access to high speed broadband services. It will ensure that everyone in Ireland will have equal access to a high speed broadband service. In May 2019, the Irish Government approved the appointment of a "Preferred Bidder" for the NBP. This is the final step in the NBP procurement process before a contract is awarded and deployment of the subsidised network begins. [62]

2.55 Details[63] on the NBP include:

- Project Timeline: The rollout will commence in Q4 2019. While the majority of premises will be passed in the initial 5 years the overall rollout will be concluded within 7 years.

- NBP statistics: Approximately 540,000 premises (plus new premises to be built); 1.1 million people (23% population); 56,000 farms (68% of national total of farms); 44,000 non-farm businesses (mostly small and micro); 674 schools. Any new premises built in the intervention area are included approx. 30k;

- The subsidised network is expected to involve: Over 1.5 million poles; over 15,000 km underground ducts; up to 146,000 km new fibre cable; running along 100,000 km of the road network; 150 Mbit/s broadband product

[60] https://www.comreg.ie/publication/general-authorisation-for-the-provision-of-electronic-communications-networks-and-services/
[61] S.I. No. 336/2011 - European Communities (Electronic Communications Networks and Services) (Privacy and Electronic Communications) Regulations 2011 http://www.irishstatutebook.ie/eli/2011/si/336/#
[62] https://www.dccae.gov.ie/en-ie/communications/topics/Broadband/national-broadband-plan/Pages/National-Broadband-Plan-Preffered-Bidder-Announcement.aspx
[63] https://www.dccae.gov.ie/en-ie/news-and-media/press-releases/Pages/Biggest-investment-in-Rural-Ireland-since-Electrification-as-Preferred-Bidder-appointed-to-National-Broadband-Plan.aspx

available for consumers upgraded to 300 Mbit/s by year 6 and 500 Mbit/s by year 10; Up to 1Gbit/s products for businesses, also upgraded to 2 Gbit/s by year 11 and incrementally beyond that; Primarily FTTH will be deployed, with 2% - 5% premises via a high standard wireless connection which will also be upgraded over time.

2.56 As the national regulatory authority in this area, ComReg will have an oversight role in respect of the subsidised network.[64]

[64] https://www.comreg.ie/comreg-ready-to-support-implementation-of-rural-broadband/

Chapter 3

3 Consideration of submissions to Document 18/60

3.1 Introduction

3.1 Eight responses were received to Document 18/60, being from:

- Dense Air Ireland Ltd (Dense Air);
- Eircom Ltd and Meteor Mobile Communications Ltd (eircom group) (Eir);
- Ericsson Ireland (Ericsson);
- ESB Networks Ltd (ESBN);
- Imagine Communications Group Ltd (Imagine);
- Joint Radio Company Ltd. (JRC);
- Three Ireland (Hutchison) Ltd (Three); and
- Vodafone Ireland Ltd (Vodafone)

3.2 Additionally, one subsequent response was submitted to ComReg in advance of the publication of this document. This response was from NERA Economic Consulting (Nera) ("The Nera Report") and was prepared on behalf of, and with the support of, Three.

3.3 This chapter sets outs ComReg's consideration of respondents' views and is structured in terms of:

- matters discussed in Document 18/60; and
- other matters not discussed in Document 18/60, but raised by respondents. E.g. submissions on the award format, licence duration, etc.

3.2 Summary of matters discussed in Document 18/60

3.4 Document 18/60 set out ComReg's preliminary views on which spectrum bands to include in the Proposed Award.

3.5 Chapter 2 of Document 18/60 set out information on a broad range of potential spectrum bands for WBB in order to identify spectrum bands for further consideration in that consultation. This range included spectrum bands for WBB as discussed in previous ComReg consultation processes[65], and those which could be used for the future provision of 5G services.

3.6 The discussion of the latter was based in particular upon information drawn from ComReg's response to consultation on its 26 GHz Spectrum Award 2018[66] and the Radio Spectrum Policy Group's (RSPG)[67] first and second Opinions on the strategic spectrum roadmap for 5G in Europe[68].

3.7 At the conclusion of Chapter 2 of Document 18/60, ComReg identified the 700 MHz, 1.4 GHz, 2.1 GHz, 2.3 GHz, 2.6 GHz and 26 GHz bands as appropriate bands for further consideration.

3.8 Chapter 3 of Document 18/60 outlined band-specific information for each of the above spectrum bands. This information was set out in terms of (i) the degree of harmonisation, (ii) the availability of spectrum, (iii) equipment availability, and (iv) other relevant information including spectrum award plans in other Member States.

3.9 After considering this information, ComReg formed the preliminary view that the Unpaired 2.1 GHz Band should not be considered further because of its lack of harmonisation for WBB and its limited usage.

3.10 The remaining spectrum bands, namely the 700 MHz, 1.4 GHz, 2.1 GHz, 2.3 GHz, 2.6 GHz and 26 GHz bands (called the "Candidate Bands" in Document 18/60), were considered further in Chapter 4 of Document 18/60, which set out ComReg's preliminary assessment as to which of those bands should be included in the Proposed Award.

3.11 This preliminary assessment was carried out substantively by reference to information on the following four relevant criteria, namely: (i) degree of harmonisation, (ii) availability of spectrum, (iii) equipment availability and (iv) propagation characteristics, and other relevant material, such as whether to hold a single or sequential award process for complementary and/or substitutable spectrum bands.

[65] This included Document 14/101, the consultation on ComReg's Radio Spectrum Management Strategy Statement 2016-2018 (Documents 15/131, 16/49 and 16/50) and the consultation on ComReg's strategy statement for Electronic Communications (Documents 16/116, 17/30 and 17/31)
[66] Document 18/12.
[67] The RSPG is a high level advisory group that assists the European Commission in the development of radio spectrum policy.
[68] RSPG16-032 and RSPG 18-005 – available on http://rspg-spectrum.eu/rspg-opinions-main-deliverables/

3.12 For the reasons set out in that preliminary assessment, ComReg formed the preliminary view that:

- the 700 MHz Duplex, 2.1 GHz, 2.3 GHz and 2.6 GHz bands were suitable for inclusion in the Proposed Award; and
- the 700 MHz Duplex Gap and Guard Bands, the 1.4 GHz Band and the 26 GHz Band were not suitable for inclusion.

3.13 ComReg also observed that this would mean that a total of 470 MHz of spectrum would be included in the Proposed Award (with 350 MHz being additional spectrum that is currently not used for WBB) which would result in a 46% increase in harmonised spectrum available for the provision of WBB.

3.3 Matters discussed in Document 18/60 - Views of respondents

3.14 In this section the views of respondents are first set out in terms of their general views on the matters discussed in Document 18/60, and then their specific views on each of the "Candidate Bands" identified in Document 18/60.

3.3.1 General views on matters discussed in Document 18/60

3.15 Eir, while welcoming ComReg's proposals on the spectrum bands for inclusion, added that there are other important issues to resolve, including what the primary purpose or purposes of the award process or processes would be. Eir submits that there appear to be at least three primary purposes: (i) the making available of spectrum for 4G; (ii) releasing new spectrum for 5G; and (iii) dealing with the liberalisation and/or expiry of 3G licences in the 2.1 GHz Band.

3.16 Ericsson welcomed ComReg's proposals noting that these will help realise the full potential of 5G network deployments and enable 5G use cases that will benefit service providers, industries and consumers. Ericsson also observed that, in many use cases, 4G can be deployed today with operators moving to LTE Advanced and 5G New Radio (NR) in the future.

3.17 Dense Air submitted that the evolution towards 5G services concepts depend on "massive densification" of mobile networks and that small cells[69] provide the planned mechanism to provide this densification. Dense Air adds that small cells require dedicated licensed spectrum and that the high spectrum re-use of small cells means that only one channel (e.g. 20 MHz) is typically required to be available in an area for all networks in the mobile ecosystems to benefit.

[69] Dense Air explain that *"small cells operate over a limited area coverage at lower powers an enable high spectrum reuse."*

3.18 Dense Air also supported ComReg's proposals to release spectrum in a multiple band spectrum award (MBSA) as opposed to holding multiple single band awards. In particular, it urged ComReg to award all of the proposed sub 6 GHz bands at the same time because *"…large spectrum award processes enable players like Dense Air to acquire spectrum alongside other MNOs and interested parties"*. It also added that:

> *"when spectrum is auctioned piece meal, in smaller allocations, prices increase which ultimately [sic] eliminate new entrants and reduce competition and innovation."* and
>
> *"Airspan Spectrum Holdings (ASH) entered the Ireland market primarily because the 3.6 GHz spectrum award released 350 MHz simultaneously [sic], and this enabled the existing Irish MNOs, Fixed Wireless and ASH (Dense Air) to all obtain spectrum. In the UK the award of only 190 MHz at 2.3 GHz and 3.4 GHz meant that the four UK MNOs overpaid and inflated the cost of spectrum, which meant a new entrant like ASH (Dense Air) was unable to acquire spectrum at commercially viable cost level."*

3.19 As identified in the band-specific comments below, other respondents also supported the multi-band approach. While Vodafone indicates that its favoured approach is for ComReg to plan for and schedule more than one spectrum award, it also submits that a first award should include the 2.6 GHz Band, the 700 MHz Band and as many other bands as are sufficiently aligned at the European level and are relatively straightforward to implement in Ireland.

3.3.2 The 700 MHz Band

3.20 For the 700 MHz Band, the views of respondents are presented firstly for the 700 MHz Duplex band, and subsequently for the 700 MHz Duplex Gap and 700 MHz Guard Bands.

700 MHz Duplex

3.21 The seven respondents who commented on this band (Dense Air, Eir, ESBN, Imagine, JRC, Three, Vodafone) all agreed with ComReg's preliminary view to include the 700 MHz Duplex in the Proposed Award.

3.22 Two respondents (Vodafone and Eir) provided additional comments as summarised below:

- Vodafone asks that the 700 MHz Duplex be awarded significantly in advance of its availability date of 4 March 2020 in order to allow for planning and preparation. It also stated that if the 700 Duplex is delayed for any reason, then the 2.6 GHz Band should proceed in advance; and

- Eir, in light of what it characterises as *the current situation on 3.6 GHz*[70], asks ComReg to clearly set out what steps it is taking to ensure the availability of the 700 MHz band by 4 March 2020. It states that ensuring availability of appropriate bands and capacity to support 5G is of particular importance to the Irish industry, and that operators require certainty regarding the terms of access to spectrum.

700 MHz Duplex Gap and 700 MHz Guard Bands

3.23 Five respondents commented specifically on the 700 MHz Duplex Gap and 700 MHz Guard Bands.

3.24 Four of these respondents (ESBN, JRC, Three, Vodafone) agreed with ComReg's preliminary view to exclude these bands from the Proposed Award for reasons including that:

- the current status of standardisation of these bands makes them unsuitable for the Proposed Award (Vodafone);
- the diversity of uses for these bands, including use for PPDR services, warrants further detailed analysis to establish the appropriate combination of services for these bands (JRC); and
- these bands have the potential to be used for PPDR (ESBN).

3.25 One respondent (Eir) did not agree with ComReg's proposal to exclude these bands and believes that the 700 MHz Duplex Gap and the 1.4 GHz Centre Band (see below) should be made available for Supplemental Down-Link (SDL) simultaneously with the 700 MHz Duplex. It considers that steps should be taken now in that regard as part of the ongoing process. Further, it suggests that ComReg offered no tangible reason to justify its proposal to *"park SDL spectrum"* despite its availability.

3.3.3 The 1.4 GHz Band

3.26 Seven respondents commented on ComReg's proposal to exclude the 1.4 GHz Band (both the 1.4 GHz Centre Band and 1.4 GHz Extension Bands) from the Proposed Award:

- four respondents agreed with ComReg's proposal to exclude the 1.4 GHz Band from the Proposed Award (ESBN, Imagine, JRC, Three);

[70] In its response to Document 18/60, Eir comments on the transition process for the 3.6 GHz band, stating that it is still waiting, one year from licence issue, for access to the spectrum to be commenced. See section 3.5.5 of this document for further detail and ComReg's assessment of same.

- two respondents (Eir, Vodafone) agreed with part of ComReg's proposal, namely to exclude the 1.4 GHz Extension Bands, but disagreed with the proposal to exclude the 1.4 GHz Centre Band; and

- one respondent disagreed with ComReg's proposal but did not provide any supporting views (Dense Air).

3.27 The views of respondents agreeing with ComReg's proposal to exclude the 1.4 GHz Band (both the 1.4 GHz Centre Band and 1.4 GHz Extension Bands) included that:

- it is preferable to wait until more clarity is available regarding take-up and standardisation of the expanded band (Three);

- the 1.4 GHz Centre Band will not be able to provide additional capacity for mobile networks in the near term and should therefore only be released in the medium term (ESBN)[71]; and

- there is a lack of compelling demand for SDL capability in the 1.4 GHz Centre Band and this band is not complementary to the multi-band award (JRC). JRC added that while this band has been '*given over*' to SDL services in some Member States, services have not being forthcoming and the number of 1.4 GHz SDL devices is low; and

[71] In support of its view, ESBN added that:
- although there are approximately 41 devices operable in band 32 according to GSA, this number is too few for the ecosystem;
- it is not aware of any major equipment manufacturer which plans to include the 1.4 GHz Centre Band in CPE devices in the near future and it believes that there may be issues regarding manufacturing suitable antennas for devices to include 1.4 GHz in addition to other spectrum bands;
- it is not aware of any meaningful existing deployment or planned deployments in the band, despite this spectrum being licensed in the UK, Germany and Italy; and
- it believes that demand for spectrum in the 1.4 GHz Centre Band is a function of the outcome of the Proposed Award, as it is only then that licensees are in a position to understand their demand.

- the incumbent use of fixed links in the 1.4 GHz Extension Bands provide services critical to the operational performance of the National Electricity Grid in Ireland and should be protected (ESBN and JRC).[72]

3.28 Vodafone and Eir disagreed with the proposal to exclude the 1.4 GHz Centre Band (while agreeing with the proposal to exclude the 1.4 GHz Extension Bands) and provided the following views:

- Vodafone, while observing that *"this band is not a high priority"* and recognising that assigning the 1.4 GHz Band in two stages would carry the risk of inefficient assignment due to possible fragmentation, believes there is a larger risk of inefficiency in leaving the 1.4 GHz Centre Band unassigned for an extended period. In support of its view, Vodafone submitted that:
    - there is sufficient standardization of the 1.4 GHz Centre Band to make it useful for adding network capacity; and
    - it would likely take a very considerable time to clear the 1.4 GHz Extension Bands for reassignment given its current incumbent use for a wide variety of users, including the Fire Services etc.; and
- Eir did not provide supporting views, apart from affirming its view that steps should be taken as part of the current process to make the 1.4 GHz Centre Band and 700 MHz Duplex Gap available for SDL.

3.3.4 2.1 GHz Band

3.29 Six respondents commented on ComReg's proposal to include the 2.1 GHz Band, and potentially an "early liberalisation option" for existing rights in this band, in the Proposed Award:

[72] In support of these views:
- ESBN noted that losing access to this spectrum, without a ComReg proposal on where such users would be accommodated, would cause it significant concerns. It asked ComReg to make clear its long term plans for this band in its spectrum strategy document, giving as much visibility as possible to users as well as providing suitable low frequency alternative(s). Further it suggested that, where users of 1.4 GHz fixed links cannot reuse their equipment in alternative bands being made available, a fund should be made available to reimburse affected users;
- JRC submitted that any future consideration of the migration of services from the 1.4 GHz Extension Bands should be subject demonstrable evidence that the 1.4 GHz Centre Band (and other SDL bands) are insufficient to service market demand.

- three respondents (ESBN, Imagine, Vodafone)[73] agreed with ComReg's proposal, although Vodafone's support is contingent on certain matters as outlined below; and

- three respondents did not agree with ComReg's proposals (Eir, Three, and Nera). In summary, Eir and Nera submitted that this band should be renewed for the existing licensees, and Three submitted that this band should be addressed separately from the Proposed Award.

3.30 Vodafone supported the inclusion of the 2.1 GHz Band, provided that its perceived *"complexity issues"* could be resolved without causing an overall delay to the Proposed Award, and especially for the award of the 700 MHz Duplex and 2.6 GHz bands. In particular, Vodafone submitted:

- that some complexity stems from existing 3G rights in the 2.1 GHz Band which presently have four expiry dates ranging from July 2022 to March 2027; and

- that its main concern is that any time slice element of the Proposed Award may contribute to complexity in the design of same and delay the process. Vodafone referenced the 2012 MBSA and submitted that accommodating time slices added considerable complexity to that award and delayed its implementation.

3.31 In relation to the liberalisation of existing licences, Vodafone suggested that it would be possible to construct an "early liberalisation option" to allow some or all the existing licensees the option to convert respective existing rights of use into new "liberalised" rights of use. It submitted that an "early liberalisation option" should aim to have a common start point for all operators with a new assignment in 2022.

3.32 Eir submitted that the 2.1 GHz Band is a band to which licence renewal considerations applied and that a different approach may be required given, among other things, investment considerations. In that regard, Eir:

- stated that *"near term investment in the band would be deterred if future use of this spectrum is determined by an auction, and an existing operator's investments to date would be written off if it is driven out of the spectrum"*;

- suggested that it may be appropriate to *"move away from CCA formats to another format reflective of the more mature market setting"* that

[73] ESBN and Imagine did not submit further supporting views, aside from indicating their support for ComReg's proposal.

recognises the need to channel scarce financial resources to achieve societally beneficial outcomes[74]; and

- noted, for example, the circumstances in France, where the French regulator agreed to extend the spectrum licences of the mobile operators in return for commitments to accelerate mobile coverage and enhance coverage quality.[75]

3.33 Regarding ComReg's rationale for proposing the inclusion of the 2.1 GHz Band, Eir submitted that:

- ComReg's approach should be based on current and prospective circumstances and not on the availability of a previously used auction tool with mechanisms for time slices and liberalisation; and

- ComReg's consideration of substitutability and complementarity of bands overlooks the practical matter that the 2.1 GHz Band is already fully deployed using 3G technology, and this may impact on the ability of an operator to use the band compared to the other spectrum bands (700 MHz, 1.4 GHz, 2.3 GHz or 2.6 GHz) proposed for inclusion.

3.34 Eir further submitted that the approach taken towards the existing 3G licences in the 2.1 GHz Band must address a number of considerations as summarised below.

The *"inherent unfairness"* towards Eir

3.35 Noting the difference (circa 5 years) in 3G licence expiry dates compared to Vodafone and Three, Eir submitted that it would be placed at a disadvantage if fees, determined by an auction, are to be paid upfront at the end of the auction some 8 years (assuming a 2019 award) in advance of actual expiry. It added that its ability to participate in an auction in 2019 is further disadvantaged because it will still be paying off the current 3G licence fee in sizeable annual instalments until 2020 which it maintains places it in a relatively weaker financial position relative to other bidders who have completed their payments.

The rebalancing of Three's *"excessive spectrum holdings"* following its acquisition of O2

[74] Eir's societally beneficial outcomes include investment in new technologies and services and investment in improved coverage delivering quality of service and competitive benefits.
[75] Eir stated that "*the [French] Government will organise a call for tender to assign the 900 MHz, 1800 MHz and 2 GHz licences for a 10-year period without going through an auction process, thus giving up future income. France's mobile telephone operators will spend more than 3 billion euros rolling out a 4G network to ensure there are no coverage gaps by 2020. Each of the major operators will install 5,000 masts and antennas and jointly ensure network coverage along 30,000 km (19,000 miles) of rail tracks.*"

3.36 Eir submitted that, following the acquisition of O2 by H3G, there is a substantial spectrum imbalance between Three and the other MNOs which, if left unaddressed, significantly distorts the competitive landscape. In the context of an administrative assignment of the 2.1 GHz band, Eir submitted that ComReg must ensure that spectrum holdings in the 2.1 GHz band are equalised so that no operator is allowed to maintain an unfair advantage in access to spectrum that will distort competition. Eir also submitted further comments in relation to this view which are considered later in the context of spectrum caps (see Chapter 7).

Ensuring any price paid for liberalisation of Eir's spectrum is fair

3.37 Eir submitted that should it wish to exercise an option to liberalise its 3G licence then any adjustment to licence fees must be determined solely in respect of liberalisation[76], and should not be linked to the behaviour of other entities in an auction process who are seeking to liberalise and renew licences in the same time period that Eir is solely seeking to liberalise an existing licence. It submitted that liberalisation should not be addressed through an auction process.

3.38 Three submitted that matters relating to the liberalisation of existing 2.1 GHz licences and the renewal of the expiring licences should be addressed separately from the award of the new spectrum bands.

3.39 Three did not agree with ComReg's proposal to include the 2.1 GHz Band in the Proposed Award because in its view this (i) would make the award unnecessarily complex, and (ii) would also give an unfair advantage to Eir that would distort competition. In support of this view Three:

- noted that the existing 2.1 GHz licences expire on four different dates, none of which coincides with the availability of the 700 MHz band or the earliest availability of 2.6 GHz or 2.3 GHz spectrum. It submitted that that this could lead to multiple time slices in the Proposed Award (5 or 6) which, in its view, would be unworkable; and

- submitted that Eir has an advantage over other bidders in bidding for 2.1 GHz spectrum because its existing licence does not expire until 2027 - 5 years after the expiry date of the other licences.[77] It further submitted that the presence of these lots (i.e. 3 lots of 2×5 MHz) could also reduce the transparency of the auction, for example, if eligibility points could be "hidden" in bidder-specific lots.

[76] Eir noted that *"it is arguable that liberalisation of an existing licence should not be subject to any increase in licence fees given the benefits it will bring to society through enhanced competition."*
[77] Three states that *"the value placed on lots that can be used in the short term is always going to be higher than the value to buy lots that cannot be utilised for a period of 7 years into the future."*

3.40 Nera, noting legacy issues, submitted that it may be more efficient to assign the band outside of the auction, and further stated that it would likely be better to liberalise the 2.1 GHz band separately from the Proposed Award.

3.41 While Nera outlines a number of spectrum packaging approaches[78] for the 2.1 GHz band if assigned in an auction, and notes its perceived complications with these, Nera also stated that, in its view, a direct assignment has multiple upsides, because it would:

- remove the risks associated with a competitive process, such as the network disruption associated with an operator not securing spectrum for 3G continuity, or failing to win sufficient spectrum to justify investing in the band to deliver 4G/5G;
- remove undesirable complexity from the multi-band award, potentially facilitating a simpler design for the residual spectrum; and
- be highly likely to be the most efficient outcome (or otherwise at least close to the most efficient outcome) given the obvious need for all operators to maintain some 2.1 GHz spectrum rights through the medium term.

3.3.5 Unpaired 2.1 GHz Band

3.42 Two respondents commented on the Unpaired 2.1 GHz Band (Imagine, Vodafone), both of whom agreed with ComReg's proposal to exclude this band from the Proposed Award, with Vodafone noting the lack of standardisation in particular.

3.3.6 2.3 GHz Band

3.43 Six respondents commented on this band. Five respondents (Dense Air, ESBN, Imagine, Three, Vodafone) agreed with ComReg's proposal to include this band in the Proposed Award and one respondent (Eir) did not agree with ComReg's proposal.

3.44 Views provided in support of the inclusion of the 2.3 GHz band include that:

- the band has been awarded in the UK and there have been substantial deployments of the band in other countries (including India, China and

[78] Nera discussed:
- *Short-term and Long-term licences.* ComReg could sell "short-term" licences of 5 years covering the 2x45 MHz available from 2022-27. It could then sell long-term licences (e.g. 20-year duration) for all 60 MHz starting 2027; and
- *Two categories of long-term licence.* Alternatively, ComReg could define two categories of long-term licences, e.g. a 25-year duration starting 2022 for 2x45 MHz and a 20-year duration starting 2027 for 2x15 MHz.

Indonesia) resulting in a broad and extensive ecosystem for the band which facilitates low cost services for both mobile and fixed wireless (Dense Air);

- for bands like 2.3 GHz and 2.6 GHz, the release of additional TDD spectrum would promote the rapid deployment of pervasive 4G LTE and support mass deployment of both standalone and non-standalone 5G networks. This would allow innovative operators using technologies like *Neutral Host*[79] to deliver cost-effective ways to extend and densify existing mobile and fixed wireless networks (Dense Air);

- this band would facilitate operators in economically adding capacity and extending coverage to their own network (Dense Air);

- this band is a sufficiently close substitute to the 2.6 GHz Band and is also sufficiently complementary to the 700 MHz Duplex such that it has value for inclusion in the Proposed Award (Vodafone).

3.45 Eir did not support the proposed inclusion of the 2.3 GHz Band given the current harmonisation status of the band and submitted that consideration should be given to putting the band 'on hold' until a European Commission implementing decision on technical harmonisation had been adopted.

3.3.7 2.6 GHz Band

3.46 All six respondents who commented on this band (Dense Air, Eir, ESBN, Imagine, Three, Vodafone) agreed with ComReg's proposal to include this band in the Proposed Award.

3.47 Views provided in support of its inclusion include that:

- the 2.6 GHz Band is very well-established throughout Europe for MFCN and ECS and has been awarded in the majority of EU Member States (Vodafone);

- customer demand for additional capacity will ensure that this band is efficiently used (Vodafone);

- TDD deployments in 3GPP Band 38 (i.e. 2.6 GHz Duplex Gap) is already happening at scale in other countries, especially North America and Japan. Over 250,000 indoor small cells have been deployed in the USA

[79] Neutral host infrastructure comprises a single, shared network solution provided on an open access basis to all MNOs and is used to resolve poor wireless coverage and capacity inside large venues or other busy locations. Neutral host networks are usually deployed, maintained and operated by a third-party provider and are designed to support the full range of MNO technologies.

and over 20,000 outdoor small cells on poles and/or cable strands (Dense air); and

- there is a mature and well-developed ecosystem for this band (Eir).

3.3.8 26 GHz Band

3.48 Six respondents submitted comments on this band (Dense Air, Eir, ESBN, Imagine, JRC, Three) all of whom agreed with ComReg's proposal to exclude this band from the Proposed Award. No respondents disagreed with ComReg's proposal.

3.49 Views submitted in support of ComReg's proposal include that:

- greater clarity is required on the potential uses and users of the band, equipment development for the band, and its role relative to other mmWave bands (JRC);
- as the 26 GHz Band is a key band for 5G NR (New Radio)[80], the release of this band should be aligned to its release in Europe and beyond (Dense Air);
- there is no benefit in including this band in the same award as sub-6 GHz "non-line-of-sight" bands and it should be released in a separate award instead (Dense Air);
- additional spectrum for 5G capacity above 6 GHz may not be required in the near term (Eir);
- the band will be an important band in the medium term to support new 5G services (Vodafone);
- the current status of standardisation (Vodafone); and
- this band and other 'high bands' are targeted at the densification of 5G networks (Imagine).

[80] 5G New Radio (NR) is the global standard for a unified, more capable 5G wireless air interface. It is intended to deliver significantly faster and more responsive mobile broadband experiences and extend mobile technology to connect and redefine many industrial uses.

3.4 Matters discussed in Document 18/60 - ComReg's assessment of respondents' views

3.4.1 General views on spectrum bands in Document 18/60

3.50 In relation to the general views expressed, ComReg:

- agrees with Eir that ComReg intends, by way of the Proposed Award to, among other things, make spectrum available for 4G and 5G, and to address both the liberalisation of existing rights of use in the 2.1 GHz Band and their expiry;
- notes the comments of Ericsson that the Proposed Award will help realise the full potential of 5G network deployments and enable 5G use cases;
- notes the comments of Dense Air in relation to the potential use of small cells in the "*massive densification*" required for the evolution towards 5G; and
- notes the comments in support of a MBSA, including the Dense Air's view that *"large spectrum award processes enable players like Dense Air to acquire spectrum alongside other MNOs and interested parties"*.

Updated spectrum band information

3.51 Annex 4 of this document sets out information on equipment availability, award status in Europe, harmonisation status and spectrum availability for each of the spectrum bands considered in this document.

3.52 In assessing each of the spectrum bands below, ComReg first sets out below significant developments for the spectrum bands since the publication of Document 18/60.

3.4.2 The 700 MHz Duplex

Updated information – 700 MHz Duplex

3.53 ComReg observes that for the 700 MHz Duplex:

- more 4G and 5G equipment is now available (1,624 4G devices and one (1) 5G device) compared to the 1,211 4G devices reported previously in Document 18/60; and
- this band has now been successfully awarded in a number of additional countries, namely Italy, Switzerland, Sweden, Norway, and Denmark.

ComReg's assessment of respondents' views – 700 MHz Duplex

3.54 Noting this updated information, and the views of respondents who all agreed with ComReg's proposal in Document 18/60 to include this band, ComReg remains of the view that it is appropriate to include the 700 MHz Duplex in the Proposed Award. This is considered further in the draft RIA on spectrum bands set out in Chapter 4.

3.55 Regarding the specific comments made on the 700 MHz Duplex, ComReg notes that:

- the clearance of the 700 MHz Band is proceeding to plan and ComReg has no reason to believe that DTT will not be migrated from the 700 MHz Band on schedule; and
- the proposals set out in this document aim to release the 700 MHz Duplex and other spectrum bands in as timely a manner as practicable.

3.4.3 700 MHz Duplex Gap and 700 MHz Guard Bands

Updated information - 700 MHz Duplex Gap and 700 MHz Guard Bands

3.56 ComReg observes that for the 700 MHz Duplex Gap and 700 MHz Guard Bands:

- there continues to be no equipment available for these bands; and
- while SDL spectrum rights of use in these bands have been assigned in awards in Denmark (20 MHz) and Switzerland (10 MHz), SDL spectrum was also unassigned in the awards of Italy (15 MHz), Sweden (20 MHz) and Switzerland (5 MHz).

ComReg's Assessment of respondents' views - 700 MHz Duplex Gap and 700 MHz Guard Bands

3.57 Of the four respondents who agreed with ComReg's proposal to exclude these bands from the Proposed Award, ComReg notes that their views[81] largely aligned with the information set out in Document 18/60, and that these observations still remain relevant. In this regard, ComReg observes that:

- there continues to be no equipment currently available (see updated spectrum band information above); and

[81] In summary, these are that these bands (i) have unfavourable standardisation and (ii) have the potential to be used for other uses, such as BB-PPDR.

- the LS Telcom Report (Document 19/59e) indicates that these bands are viable spectrum options for the future deployment of BB-PPDR should it be decided to proceed with a hybrid or dedicated model in Ireland.

3.58 Regarding Eir's view that the 700 MHz Duplex Gap should be included because it can be combined with the 1.4 GHz Centre Band for SDL, ComReg notes that:

- Eir's submission does not provide any views to counter ComReg's reasoning in Document 18/60 for excluding this band. Among other things, ComReg's view was informed by the unfavourable equipment availability for the band and its potential to be used for BB-PPDR in the future. As noted above, these considerations remain pertinent and have also been supported by other respondents; and

- the results of recent awards in Europe suggests that demand for SDL rights in the 700 MHz Duplex Gap is weak or at best uncertain. For example, while 20 MHz of SDL spectrum was assigned in Denmark, some or all of this SDL spectrum went unassigned in the Swiss, Swedish and Italian awards.

3.59 In light of the above, ComReg remains of the preliminary view that the 700 MHz Duplex Gap and Guard Bands should not be included in the Proposed Award.

3.4.4 The 1.4 GHz Band

3.60 The 1.4 GHz Band consists of both the 1.4 GHz Centre Band and the 1.4 GHz Extension Bands.

Updated information – the 1.4 GHz Band

3.61 ComReg observes that:

- the 1.4 GHz Centre Band and the 1.4 GHz Extension Bands continue to have different spectrum availability:
    - in Ireland, the 1.4 GHz Extension Bands continue to be used for fixed links and remain unavailable for inclusion in the Proposed Award. As of May 2018, there were 104 existing point-to-point licences in this band - an increase of 1 licence since the publication of Document 18/60; and
    - the 1.4 GHz Centre Band remains unassigned and available for inclusion in this Proposed Award;
- equipment availability varies between the 1.4 GHz Centre Band and the 1.4 GHz Extension Bands:

- 1.4 GHz Centre Band - equipment availability has increased to 83 devices, up from 41 devices as reported in Document 18/60, including handsets from manufacturers such as Apple, Samsung and Huawei; and
- 1.4 GHz Extension Bands - there continues to be no equipment available;

- there remains limited deployment of networks with SDL services using the 1.4 GHz Centre Band:
  - currently there are only three network deployments (Three UK, Vodafone UK and TIM Italy) for SDL in the 1.4 GHz Centre Band[82];
  - SDL network deployments have yet to be launched by other operators in Italy and Germany with spectrum rights in this band (i.e. Vodafone Italy, Vodafone Germany and Telekom Germany – who have all held such rights since 2015[83]); and
- only one country, Switzerland, has awarded spectrum in this band since the publication of Document 18/60. Out of the 90 MHz of spectrum available in its award (i.e. the full 1.4 GHz Band), 75 MHz of spectrum was assigned with 15 MHz remaining unassigned.

3.62 Considering the 3GPP standardisation of spectrum bands for LTE[84] and 5G New Radio (5G NR)[85], ComReg observes that spectrum in the 1.4 GHz Band is also standardised on a FDD or TDD basis as outlined below:

- FDD: 3GPP Band 74 (LTE) and Band n74 (5G NR) in the 1427-1470 MHz / 1475–1518 MHz spectrum band;
- TDD: 3GPP bands 51 and 50 (LTE) and bands n51 and n50 (5G NR) in the 1427-1432 MHz and 1432–1517 MHz spectrum band; and
- SDL: 3GPP bands 32, 75 and 76 (LTE) and bands n75 and n76 (5G NR) in the 1427-1432 MHz and 1432–1517 MHz spectrum band.

[82] Information from the NTS (Networks, Technologies & Spectrum) database on the GSA website Source: https://gsacom.com/gambod-nts-search/
[83] Source “Regulation of the 1427 -1517 MHz band” on Cullen International Source: www.cullen-international.com
[84] Tables 5.5-1 "E-UTRA Operating Bands" of the 3GPP TS 36.101 https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2411
[85] 3GPP TS 38.101 https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3283

3.63 Regarding the use of SDL and while noting that this is in the context of the 2.6 GHz Band, CEPT, when issuing a consultation on its draft revision of ECC Decision (05)05[86] for the 2.6 GHz Band, requested information[87] on the implementation of *"Alternative 2: Supplemental Downlink blocks"* in national authorisations. This was in order to determine if the SDL alternative should be kept in future revisions of ECC Decision (05)05.

ComReg's assessment of respondents' views – the 1.4 GHz Band

3.64 ComReg's assessment set out below considers in turn the 1.4 GHz Extension Bands and then the 1.4 GHz Centre Band. In line with supporting views from a number of respondents, a consideration of the 1.4 GHz Band as a whole forms part of the 1.4 GHz Centre Band assessment.

1.4 GHz Extension Bands

3.65 In relation to the 1.4 GHz Extension Bands, and drawing on the updated spectrum band information provided above, ComReg firstly notes that the 1.4 GHz Extension Bands continue to be used for fixed links in Ireland, and that this usage has increased somewhat since the publication of Document 18/60. This fixed links usage facilitates low-bandwidth links used predominantly by radio broadcasters and utilities, as well as being used for radio link connections in the national electricity grid in Ireland.

3.66 Considering the provisions of the 1.4 GHz EC Decision[88], ComReg observes that this provides that Member States should have national flexibility to use portions of the 1.4 GHz Extension Bands to cater for international military agreements or to respond in a time-limited manner to specific national needs for the continued operation of terrestrial fixed wireless services. The 1.4 GHz EC Decision also emphasises that the technical work undertaken in developing the harmonisation decision has shown that co-frequency operation of mobile and fixed services is not feasible. Where a Member State designates and makes available only a portion of the 1.4 GHz Extension Bands to ECS, Article 2(3)(c) of the 1.4 GHz EC Decision clarifies that, following 1 January 2023, this is subject to the Member State identifying no national demand for wireless broadband ECS.

3.67 Considering the responses submitted to Document 18/60 and the updated spectrum band information above, ComReg observes that there is currently no demonstrated demand for spectrum in the 1.4 GHz Extension Bands. Among other things, ComReg observes that:

[86] See Draft revision of ECC Decision (05)05
[87] See Cover letter to draft revision of ECC/DEC/(05)05
[88] Decision (EU) 2015/750 as amended by Decision (EU) 2018/661 of 26 April 2018.

- from the seven respondents who submitted comments on this band, six agree with ComReg's proposal to exclude this band, while the one respondent (Dense Air) who favours its inclusion did not provide any material in support of its view;
- there is no equipment available for this band; and
- there is limited international deployment of SDL networks despite spectrum having been assigned as long ago as in 2015, in some cases.

3.68 In light of the above, ComReg remains of the preliminary view that the 1.4 GHz Extension Bands should not be included in the Proposed Award.

3.69 In relation to the future use of the 1.4 GHz Extension Bands, ComReg is of the view that any future change of use to this band would need to be carefully assessed and managed. This has also been recognised by a number of respondents to this consultation.

3.70 In this regard, ComReg identified in its Radio Spectrum Management Strategy Statement (Document 18/118) that it will include a work item in the 2019 to 2021 period to continue to monitor developments in the 1.4 GHz band for MFCN and to consider the current and future use of the band in Ireland.

1.4 GHz Centre Band

3.71 In relation to the 1.4 GHz Centre Band, ComReg firstly observes that this band differs from the 1.4 GHz Extension Bands in that the former is currently available for assignment and there is equipment available, including handsets from major manufacturers including Apple, Samsung and Huawei.

3.72 Further, the responses received to Document 18/60 also indicate that there is some support for the inclusion of this band in the Proposed Award with three respondents favouring this. From these however, ComReg notes that only one respondent, Vodafone, provided arguments in support of its view and that these are based on:

- the potential for the 1.4 GHz Centre Band to provide additional network capacity;
- that it would likely take a very considerable time to clear the 1.4 GHz Extension Bands for reassignment given its current incumbent use for a wide variety of users, including the Fire Services etc.; and
- that it would be more efficient to include the 1.4 GHz Centre Band in the Proposed Award, rather than waiting for the 1.4 GHz Extension Bands to become available and award the 1.4 GHz Band as a whole. At the same

time, Vodafone also observes that assigning the 1.4 GHz Band in two stages carries the risk of inefficient assignment due to possible fragmentation.

3.73 On the other hand, ComReg also observes that four respondents (ESBN, Imagine, JRC and Three) did not support the inclusion of the 1.4 GHz Centre Band in the Proposed Award for reasons including that:

- there is a lack of compelling demand for SDL capability in the 1.4 GHz Centre Band. Factors noted by respondents include the low number of devices available, the potential difficulties manufacturing suitable device antennas for 1.4 GHz and other spectrum bands, and the lack of meaningful network deployments internationally despite spectrum being licensed in the UK, Germany and Italy for some time; and

- it is preferable to wait until more clarity is available regarding the take-up and standardisation of the extended band.

3.74 ComReg observes that there is some validity to both of the above viewpoints.

3.75 On the one hand there are factors that suggest that this band could be used in the near future and therefore included in the Proposed Award. These include that:

- spectrum is available in the 1.4 GHz Centre Band;

- equipment (although limited compared to other bands under consideration) is available for the 1.4 GHz Centre Band, and one would expect further availability in the future;

- inter band carrier aggregation is supported between the 1.4 GHz Centre Band and other spectrum bands depending upon the 3GPP release version implemented[89]. While ComReg understands that the devices currently available for the 1.4 GHz Centre Band are limited to operating alongside the 800 MHz band only,[90] this is likely to improve in the future; and

[89] ETSI TS 136 101 release 12 identified that inter band carrier aggregation is supported between the 800 MHz Band (Band 20) and the 1.4 GHz Centre Band (Band 32). In more recent releases other bands that can be carrier aggregated with the 1.4 GHz Centre Band have been added: Release 14: 1800 MHz band (band 3), 2.6 GHz Band (Band 7), Release 15: 2.1 GHz (Band 1), 900 MHz (Band 8), and 3.6 GHz Band (Bands 42 and 43).

[90] For example the Samsung S9 is a LTE Category 18 device that has the capabilities to operate in accordance with the 3GPP Standard Release 13, i.e. where carrier aggregation is possible between 1.4GHz centre band and the 800 MHz Band but not with the other bands identified in the more recent releases.

- this band is harmonised at a European level.

3.76 However, on the other hand, there are factors that suggest that this band may not be used in the near future and that there may, therefore, be little adverse impact to deferring its award at this time. These include:

- the limited nature of SDL network deployments internationally to date, noting that three operators in Italy and Germany Italy (Vodafone Italy, Vodafone Germany and Telekom Germany) have yet to deploy networks with 1.4 GHz capability despite spectrum being assigned to them since 2015;

- the lower availability of network antennas with 1.4 GHz Band capability,[91] and ComReg's understanding that the antennas currently deployed in the Irish mobile networks are not 1.4 GHz Band capable; and

- the award of other spectrum bands in this Proposed Award. Given that ComReg proposes to award 470 MHz of spectrum, of which 350 MHz is greenfield spectrum, mobile network operators may first focus on deployments in those bands given the higher availability of devices and network antennas. Further, ComReg notes that Vodafone, who supported the inclusion the 1.4 GHz Centre Band, also stated that *"this band is not a high priority".*

3.77 Further, not including the 1.4 GHz Centre Band in the Proposed Award could also bring additional benefits in terms of:

- avoiding the risk of inefficiencies associated with assigning the 1.4 GHz Band in two stages; and

- allowing time for further standardisation, equipment and network developments to emerge, noting among other things the wider 3GPP international standardisation for 1.4 GHz Band as outlined above, which also provides for FDD and TDD use.

3.78 In light of the above, the 1.4 GHz Centre Band is put forward for further consideration in the draft RIA on spectrum bands as set out in Chapter 4.

[91] See for example, the low availability of 1.4 GHz (or L-Band) outdoor antenna for mobile communications on the Kathrein website compared to other spectrum bands. https://www.kathrein.com/en/solutions/mobile-communication/products/antennas-accessories/outdoor-antennas/

3.4.5 2.1 GHz Band

Updated information –2.1 GHz Band

3.79 ComReg observes that for the 2.1 GHz Band:

- on 8 March 2019, CEPT updated ECC Decision (06)01[92] to enable the use of 5G and Active Antenna Systems (AAS) in this band;
- in March 2019, CEPT issued a consultation on CEPT Draft Report 72[93], which forms Report A of its draft response to the EC's mandate to review the harmonised technical conditions for certain EU-harmonised frequency bands (including the 2.1 GHz Band) and to develop least restrictive harmonised technical conditions (LRTCs) suitable for next-generation (5G) terrestrial wireless systems;
- LTE equipment availability has increased to 7,706 devices, up from 6,282 devices as reported in Document 18/60; and
- spectrum in this band has been successfully awarded in Norway[94] (2×15 MHz) and Germany (2×60 MHz) [95].

ComReg's assessment of respondents' views –2.1 GHz Band

3.80 ComReg firstly notes that from the six respondents who commented on this band, three respondents (ESBN, Imagine, Vodafone) agreed with ComReg's proposal to include this band in the Proposed Award (although Vodafone's support is contingent on certain matters as outlined in section 3.3.4 above), and three respondents (Eir, Three, and Nera who prepared a report for Three) did not agree with ComReg's proposals.

3.81 ComReg observes that the arguments put forward by respondents can be grouped under the following themes:

1. Perceived complexity concerns of including the band in the Proposed Award;
2. Other concerns of including the band in the Proposed Award;
3. Licence renewal; and
4. Liberalisation of existing 3G Licences.

[92] ECC/DEC/(06)01 ECC Decision of 24 March 2006 on the harmonised utilisation of the bands1920-1980 MHz and 2110-2170 MHz for mobile/fixed communications networks (MFCN) including terrestrial IMT, amended on 2 November 2012 and amended on 8 March 2019
[93] Draft CEPT Report 72
[94] https://eng.nkom.no/topical-issues/news/the-first-5g-auction-in-norway-has-ended
[95] https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2019/20190612_Frequenzauktion.html?nn=265778

1. Perceived complexity concerns of including the band in the proposed award

3.82 Two respondents (Three and Vodafone) submitted that the inclusion of this band may make the Proposed Award unnecessarily complex given that it may lead to the use of multiple time slices (e.g. up to 5 or 6 time slices as suggested by Three).

3.83 In that regard, ComReg observes that:

- DotEcon's recommendations for the 2.1 GHz band (see Chapter 3 of the DotEcon Award Design Report) include aligning the expiry dates of those 3G licence expiring 2022 to that of Vodafone's 3G licence expiry (i.e. 15 October 2022) by grant of interim rights of use to Three to facilitate this co-termination. This would mean that only two time slices would be required and DotEcon considers that the use of two time slices is not "*overly complex and should address Three's concerns."*; and

- DotEcon also notes that *"the proposed approach is less complex than the 2012 MBSA award which also included the use of 'Party-Specific Lots' to facilitate the early liberalisation of the current 900 MHz and 1800 MHz rights of use."*

3.84 As discussed in Chapter 5 of this document (and further detailed in Annex 5), ComReg proposes to adopt DotEcon's recommendation for the 2.1 GHz Band including proposed grant of interim 2.1 GHz rights to Three to enable co-termination of 3G licences expiring in 2022 and thereby enabling the use of only two time slices. ComReg therefore considers that the concerns of Vodafone and Three would be addressed by these proposals and the inclusion of the 2.1 GHz Band would not make the Proposed Award unduly complex.

2. Other concerns of including the band in the Proposed Award

3.85 A number of other concerns were put forward by Eir and Three in relation to the proposed inclusion of the 2.1 GHz Band and these are addressed in turn below.

i. Eir's view that ComReg's approach should be based on relevant circumstances as opposed to the availability of an auction tool

3.86 In relation to Eir's view, ComReg confirms that it considers each award (including which band(s) to include in an award) on its merits having regard to its statutory powers, functions, objectives and duties as well other relevant information. See, among other things, Chapter 5 which sets out further considerations relation to the proposed inclusion of the 2.1 GHz Band.

ii. Eir's view that ComReg's consideration of substitutability and complementarity of bands overlooks the practical matter that the 2.1 GHz band is already fully deployed using 3G technology, and may thus impact the ability of an operator to use this band compared to other greenfield spectrum bands

3.87 ComReg's assessment of the substitutability and/or complementarity of spectrum bands is a forward looking assessment that considers a number of factors including harmonisation status and potential uses, equipment availability, propagation characteristics, and the likely duration of the rights being assigned (i.e. short-term going into medium/long term). In this regard, ComReg observes that the characteristics of 2.1 GHz Band are similar to the other bands in the Proposed Award, including that:

- it is a European harmonised band for WBB services which facilitates the future provision of 3G, 4G and 5G services. Further while the existing licences are licensed for 3G services only, the early liberalisation proposals in this document (see Chapter 5) would also provide for such potential uses in advance of the expiry of existing licences;
- it has considerable 4G equipment availability that is of a similar scale to that in the 2.6 GHz Band and in excess of that for the 2.3 GHz Band;
- it's propagation characteristics are similar to that of the 2.3 GHz and 2.6 GHz bands; and
- the expected duration of rights in the 2.1 GHz Band (see Chapter 6) is of a similar duration to that of the other bands. In that regard, ComReg observes that the overall duration of new licences is likely to be considerably longer than the envisaged duration of any transition issues that may arise due to the existing usage of spectrum rights in the 2.1 GHz Band.

3.88 Chapter 9 of this document sets out ComReg's consideration of the transition scenarios for this award. While the complexity and potential transition times required for any transition in the 2.1 GHz Band would only become fully known following the outcome of the Proposed Award, ComReg observes that this transition is likely to be simpler and potentially quicker than the transition for the 2012 MBSA as the potential for service disruption in this transition is considerably less.

3.89 Annex 11 sets out information on the transition mechanisms used in the 2012 MBSA. This explains that there were two transitions carried out following that award, one in 2013 and the other in 2015, and that both of these were carried out expediently with the 2013 transition being carried out in less than six months.

iii. Eir's view that the 2.1 GHz Band approach needs to address the inherent unfairness to Eir where it believes that it would be placed at a disadvantage if fees, determined by an auction, are to be paid upfront at the end of the auction some 8 years (assuming a 2019 award) in advance of actual expiry of its 3G licence, while still paying 3G licence fees.

iv. Three's view that the 2.1 GHz Band approach would give an unfair advantage to Eir over other bidders, as three lots of 2×5 MHz held by Eir do not expire until 2027, and the presence of these lots could also reduce the transparency of the auction in an uneven way.

3.90 ComReg first observes that Eir and Three hold opposing views on the perceived advantages or disadvantages to Eir from its existing spectrum rights of use in its 3G licence which run until 2027.

3.91 In relation to Eir's claim that it would be disadvantaged by having to pay for new spectrum rights of use commencing in 2027 (i.e. in time slice 2 as discussed in Chapter 5 of this document) which is 8 years in advance (assuming a 2019 award) while still paying licence fees, ComReg notes DotEcon's assessment of same (as set out in Chapter 3 of the DotEcon Award Design Report) including that:

- Eir would not be paying for a licence renewal *per se*, but for new rights of use that would be manifested in a new licence (albeit potentially for the same frequencies) and there is no reason that payments for new spectrum rights in time slice 2 (running beyond the expiry of Eir's current licence) should be treated differently depending on which other spectrum licences they may currently hold. In time slice 2 all bidders are in similar positions with all of the available 2.1 GHz Band spectrum available for award; and

- the payment terms faced by Eir in this situation would be similar to any other operator that was to win 2.1 GHz Band spectrum in both time slices (whether awarded as two separate licences or one continuous licence). I.e. those bidders would also be required to pay in advance for access to the spectrum rights over the period of time slice 2 and at the same time as paying for access over the first time slice.

3.92 In relation to Three's view that Eir would have an unfair advantage because it has three lots of 2×5 MHz which do not expire until 2027, ComReg notes DotEcon's assessment of same (also considered this view in Chapter 3 of the DotEcon Award Design Report[96]) including that:

- it is unclear as to why Three considers Eir to have a particular advantage in bidding for the 2.1 GHz spectrum;
- The lots licensed to Eir up to 2027 would not be available to others until they expired in any case, so Eir does not have an "advantage" with respect to those lots over any other that goes beyond its rights acquired under the current licence and for which it is paying a fee; and
- If Three is instead concerned about the lots associated with Eir's current spectrum when it becomes available from 2027, then again it is unclear why Eir would have an unfair advantage bidding for those lots in the Proposed Award. That is, all bidders would have the opportunity to bid for those lots and, if Eir were to have the highest value for same, there is no reason to believe this would represent an inefficiency or unfairness through distorted valuations.

3.93 In relation to Three's submission that Eir's lots could reduce the transparency of the Proposed Award in an uneven way, DotEcon observes that Three may be referring to the use of party-specific lots (as used in the 2012 MBSA). If so, DotEcon notes that:

- under its current recommendations, there would not be any party-specific lots in the Proposed Award; and
- even in the case that party-specific lots were to be used (which is not proposed), there would be a very low risk of gaming behaviour, especially in auction formats such as the CCA where all bids made at any point in the auction are binding.

[96] DotEcon summarises Three's Claim as follows:

Three claims that the different expiry dates of the current 2.1 GHz licences would "*distort the attractiveness of some of the lots across the range of possible bidders in the long term*". This is because "*an existing licence holder might have an advantage over other bidders for the lots that they hold if the lots do not become available for some time after the award process*". Three highlights that Eir would have a particular advantage because its licences expire seven years after the date of the award, and "*the value placed on lots that can be used in the short term is always going to be higher than the value to buy lots that cannot be utilised for a period of 7 years into the future*".

3.94 ComReg notes and agrees with DotEcon's assessment of the diametrically opposing concerns expressed by Eir and Three, as summarised above. ComReg therefore does not propose to consider them further in this document.

3. Licence renewal/direct assignment

3.95 Two respondents, Eir and Nera (on behalf of Three), submitted that, for the 2.1 GHz Band, licence renewal or a direct award to existing 3G licensees would be a preferable approach for the various reasons as outlined in section 3.3.4 above.

3.96 For the reasons identified in ComReg's draft RIA on the assignment options for the award (see Chapter 4), ComReg does not consider that an administrative assignment process to be appropriate for this award.

4. Liberalisation of existing 3G licences

3.97 Three respondents (Eir, Nera (on behalf of Three) and Vodafone)), provided views on the liberalisation of existing 3G licences which, in summary, are as follows:

- it would be feasible to include a liberalisation option in the Proposed Award with the aim of having a common start point for all operators with new assignments in 2022 (Vodafone); and
- liberalisation should be addressed separately to the award (Eir and Nera); and
- any price to be paid for liberalisation of Eir's spectrum rights must be fair (Eir).

3.98 ComReg's consideration of, and proposals for, the liberalisation of existing 3G licences (including consideration of the above views) is detailed in Chapter 5 of this document and in Chapter 3 of the DotEcon Award Design Report.

3.99 In terms of process, ComReg would highlight for now the following matters:

- as the liberalisation proposals both inform and are informed by the award proposals, it is appropriate to address both matters in the context of the overall consultation process for, and ultimate substantive decisions, on the Proposed Award; and
- at the same time, it should be noted that any liberalisation of existing 3G licences would be given effect to by way of ComReg's power to amend the rights, conditions and procedures concerning rights of use for radio frequencies (see, in particular, Regulation 15 of the Authorisation

Regulations). In that context, any application process for the liberalisation of existing 3G licences would be separate to the application process for the Proposed Award and, under ComReg's proposals, all three existing 3G licensees would be provided the option to apply for liberalisation from a common date.

ComReg's view on the inclusion of the 2.1 GHz Band

3.100 In light of the above, and having particular regard to DotEcon's analysis (as detailed in its Award Design Report) and ComReg's proposals detailed in Chapter 5 (and Annex 5), ComReg remains of the preliminary view that it is appropriate to include the 2.1 GHz Band in the Proposed Award.

3.101 The proposed inclusion of this band is also considered further in the draft RIA on spectrum bands set out in Chapter 4.

3.4.6 Unpaired 2.1 GHz Band

3.102 Two respondents (Imagine, Vodafone) provided comments regarding the Unpaired 2.1 GHz Band and both respondents agreed with ComReg's proposal to exclude the Unpaired 2.1 GHz Band from the Proposed Award (with Vodafone in particular highlighting the lack of standardisation).

3.103 ComReg remains of the preliminary view that the Unpaired 2.1 GHz Band should not be included in the Proposed Award.

3.4.7 2.3 GHz Band

Updated information – 2.3 GHz Band

3.104 ComReg observes that for the 2.3 GHz Band:

- the Plum 2.3 GHz Co-existence Report analyses the potential co-existence obligations that may need to be attached to any rights of use assigned in the 2.3 GHz Band to facilitate co-channel co-existence with Eir's Rurtel network, and adjacent band co-existence with wireless local area networks (WLANs) in the 2.4 GHz band (i.e. Wi-Fi);
- LTE equipment availability has increased to 4,757 devices, up from 3,779 devices as reported in Document 18/60; and
- this band has been awarded in Denmark. Of the 100 MHz available in that award, 60 MHz was assigned and 40 MHz remains unassigned.

ComReg's assessment of respondents' views – 2.3 GHz Band

3.105 Of the six respondents who commented on this band, five respondents (Dense Air, ESBN, Imagine, Three, Vodafone) agreed with ComReg's proposal to include this band in the Proposed Award. ComReg observes that the views submitted by these respondents align with the analysis set out by ComReg in Document 18/60.

3.106 Noting the views of respondents, and the updated information set out above, factors which support the inclusion of the 2.3 GHz Band in the Proposed Award include that this band:

- has a substantial ecosystem of devices;
- has been harmonised at CEPT level and has been awarded in the UK, and most recently in Denmark, albeit that 40 MHz remains unassigned following that award;
- is harmonised for mobile broadband use in the Asia Pacific Telecommunity (APT) and there are substantial deployments in other countries including India, China and Indonesia resulting in a broad and extensive ecosystem; and
- is likely to be considered a sufficiently close substitute to the 2.6 GHz Band and sufficiently complementary to the 700 MHz Duplex such that it is suitable for inclusion in the Proposed Award.[97]

3.107 On the other hand, Eir did not agree with ComReg's proposal and submitted that there is insufficient harmonisation of this band in Europe because the EC has yet to issue an implementing decision on technical harmonisation. While this factor is acknowledged, ComReg does not consider it sufficient to exclude the band from the Proposed Award because:

- this band has nevertheless been harmonised at a CEPT level;
- the characteristics of this band, as outlined above, mean that it is particularly attractive for the deployment of mobile wireless broadband services given its 3PPP standardisation, its deployment in the Asia Pacific region, and its high availability of equipment; and
- this band has now been awarded in two other EU Member States (the UK and Denmark) and it is proposed for award in Sweden.

[97] See Vodafone's submission to Document 18/60 outlined in section 3.3.6 of this document, section 4.4 of Document 18/60 and section 3.2.1 of Document 14/101.

3.108 In light of the above, ComReg remains of the preliminary view that it is appropriate to propose the inclusion of the 2.3 GHz Band in the Proposed Award. This is considered further in the draft RIA on spectrum bands set out in Chapter 4.

3.4.8 2.6 GHz Band

Updated information – 2.6 GHz Band

3.109 ComReg observes that for the 2.6 GHz Band:

- on 11 March 2019, CEPT issued a public consultation on its updates to ECC Decision (05)05[98] to enable the use of 5G and AAS in this band;
- on same date, CEPT also issued a public consultation on Draft Report 72[99], which forms Report A of its draft response to the EC's mandate to review the harmonised technical conditions for certain EU-harmonised frequency bands (including the 2.6 GHz Band) and to develop LRTCs suitable for next-generation (5G) terrestrial wireless systems;
- the Plum 2.6 GHz Co-existence Report provides advice on potential co-existence obligations that might be necessary to attach to any rights of use assigned in the 2.6 GHz Band in order to facilitate adjacent band co-existence with aeronautical radars;
- in Switzerland, 2×5 MHz of unsold spectrum in this band from a previous was included in its recent auction, but remains unassigned; and
- equipment availability has increased across all 3GPP bands for this band, as detailed in Table 3 below.

Table 3: 4G and 5G equipment availability in the 2.6 GHz band

4G Devices May 2018 (18/60)	4G Devices March 2019	5G Devices March 2019
6,974 (B7, FDD)	8,329 (B7, FDD)	1 (n7, FDD)
2,906 (B38, TDD)	3,666 (B38, TDD)	1 (n38, TDD
2,755 (B41, TDD)	3,538 (B41, TDD)	4 (n41, TDD)

(3GPP 4G and 5G NR bands in parenthesis) (source GSA)

[98] Draft revision of ECC Decision (05)05 Harmonised utilization of spectrum for Mobile/Fixed Communications Networks (MFCN) operating within the band 2500-2690 MHz
[99] Draft CEPT Report 72

ComReg's assessment of respondents' views – 2.6 GHz Band

3.110 The six respondents who submitted comments on this band (Dense Air, eir, ESBN, Imagine, Three and Vodafone) all agreed with ComReg's proposal to include this band in the Proposed Award.

3.111 ComReg observes that the views put forward by respondents align with ComReg's analysis set out in Document 18/60, including in particular that the 2.6 GHz Band is a harmonised band with a large ecosystem of available equipment which is particularly suited to the provision WBB services.

3.112 In light of the above, ComReg remains of the preliminary view that it is appropriate to include the 2.6 GHz Band in the Proposed Award. This is considered further in the draft RIA on spectrum bands set out in Chapter 4.

3.4.9 26 GHz Band

Updated spectrum band information - 26 GHz Band

3.113 ComReg observes that for the 26 GHz Band:

- in July 2018, CEPT adopted ECC Decision (18)06[100] which sets the harmonised conditions for the introduction of 5G in the 26 GHz band;
- also in July 2018, CEPT submitted Report 68 on 26 GHz band[101] to the EC to form the basis of ongoing considerations within the Radio Spectrum Committee (RSC) for the development of relevant EC implementing decisions.
- in December 2018, the EECC was adopted and Article 54 of same sets out a specific obligation in relation to 26 GHz Band:

> *Article 54: Coordinated timing of assignments for specific 5G bands*
>
> *1. By 31 December 2020, for terrestrial systems capable of providing wireless broadband services, Member States shall, where necessary in order to facilitate the roll-out of 5G, take all appropriate measures to:*

[100] ECC Decision (18)06 ECC Decision of 6 July 2018 on the harmonised technical conditions for Mobile/Fixed Communications Networks (MFCN) in the band 24.25-27.5 GHz, corrected 26 October 2018
[101] CEPT Report 68 on 26 GHz

(b) allow the use of at least 1 GHz of the 24,25-27,5 GHz band, provided that there is clear evidence of market demand and of the absence of significant constraints for migration of existing users or band clearance.

- on 14 May 2019, the EC adopted Implementing Decision of (EU) 2019/784 on harmonisation of the 24.25-27.5 GHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services in the Union[102] ;

- in October 2018, Italy awarded 1 GHz of spectrum in this band to 5 operators. No other Member State has awarded this band; and

- there is now some 5G equipment available in this band - as of March 2019, information from the GSA indicates that there are 5 such devices.

ComReg's assessment of respondents' views – 26 GHz Band

3.114 Six respondents provided comments on this band (Dense Air, Eir, ESBN, Imagine, JRC, Three) and all agreed with ComReg's proposal to exclude this band from the Proposed Award.

3.115 Noting the updated information above, and the supporting views of respondents as summarised in section 3.3 above, ComReg considers that its preliminary analysis for this band (as set out in section 4.6 of Document 18/60) remains valid. This includes that:

- there remains a lack of clarity on the potential use and the business case for the 26 GHz Band, as well as the appropriate framework for assigning spectrum rights in this band. In this regard, ComReg notes that further clarity is likely to become available over time as other jurisdictions advance their respective 26 GHz award plans, and studies are carried out by BEREC, CEPT and other bodies[103];

- while the standardisation process for the 26 GHz Band has become more developed, there remains very low availability of 5G devices;

- there remains a lack of demand for spectrum rights in this band for 5G purposes. While respondents were generally of the view that this will be an important band in the future, ComReg observes that 5G networks are likely to be first deployed using spectrum in the sub-6 GHz bands and

[102] Decision (EU) 2019/784 of 14 May 2019.
[103] For example, ComReg observes that BEREC has a number of 5G work items on its 2019 work programme https://berec.europa.eu/eng/about_berec/annual_work_programme/

spectrum rights in the 26 GHz band and other 'high bands' would likely be used for the subsequent densification of 5G networks;

- the sub-6 GHz bands proposed in this award are not a close substitute to the 26 GHz band.[104] Instead, close substitutes for the 26 GHz Band, by which to provide 5G services, are more likely to be other mmWave bands[105]. In that regard, ComReg observes that some respondents submitted that spectrum in the 26 GHz Band and other 'high bands' could be used to target the densification of 5G networks; and

- complementarities between rights of use in the 26 GHz Band and the sub-6 GHz bands proposed in this award are unlikely to be sufficiently strong[106], because the value of the latter is unlikely to be enhanced by winning spectrum rights in 26 GHz Band. In particular, the sub-6 GHz bands have particular WBB services and business models/use cases in mind, and the joint award of the 26 GHz Band with sub-6 GHz bands is unlikely to result in the provision of those services either more effectively or at lower cost given the likely different use cases.

3.116 ComReg therefore remains of the view that it is not appropriate to include the 26 GHz Band in the Proposed Award. Instead, ComReg considers that this band should be assigned under a separate, subsequent award process, the timing and other particulars of which would be determined via separate consultation in light of relevant developments.

3.117 In preparation for any such consultation, ComReg will continue to monitor 26 GHz Band developments and also intends to carry out a 5G deployment study in the coming ComReg working year (i.e. during Q3 2019 to Q2 2020). While the scope of that study has yet to be finalised, ComReg currently envisages that this study would consider, among other things:

- the current status of the 26 GHz Band in terms of standardisation, equipment availability, assignments in other jurisdictions, etc.;

- the potential use cases and business case considerations for deployments in the 26 GHz Band; and

- the appropriate licensing framework or frameworks for assigning spectrum in this band in Ireland.

[104] See section 4.6 of Document 18/60.
[105] For example, the 42 GHz and 66-71 GHz bands identified by the RSPG in its second opinion on 5G.
[106] See section 4.6 of Document 18/60.

3.4.10 Summary of ComReg's preliminary view on spectrum bands

3.118 For the reasons outlined above, ComReg is of the preliminary view that:

- the 700 MHz Duplex Gap and 700 MHz Guard Bands, the 1.4 GHz Extension Bands, the Unpaired 2.1 GHz Band and the 26 GHz Band should not be included in the Proposed Award; and
- the 700 MHz Duplex, the 1.4 GHz Centre Band, the 2.1 GHz Band, the 2.3 GHz Band and the 2.6 GHz Band could be included the Proposed Award. These bands are considered further in the draft RIA on spectrum bands set out in Chapter 4.

3.5 Other matters raised

3.119 ComReg notes that respondents raised other matters which were not discussed in Document 18/60.

3.120 The following matters raised by respondents are discussed and addressed in the relevant chapters of this document:

- licence duration (see Chapter 6);
- award design and format (see Chapter 7);
- packaging of lots within an auction (see Chapter 7);
- spectrum fees (see Chapter 7);
- spectrum competition caps (see Chapter 7); and
- coverage (see Chapter 8).

3.121 The following matters are discussed below:

- level of spectrum assignments for mobile services in Ireland;
- assignment considerations for award design;
- technical matters;
- pricing for chained or meshed multi-hop links (60 GHz); and
- 3.6 GHz Transition.

3.5.1 Level of spectrum assignments for mobile services in Ireland

3.122 Two respondents (Nera (on behalf of Three) and Vodafone) provided comments on the level of spectrum assignments for mobile services in Ireland.

3.123 Vodafone submitted that Ireland continues to lag behind its European neighbours with regard to the quantity of spectrum assigned for mobile services. It suggested that having a smaller available spectrum pool has real negative effects for customers in Ireland leading to claims of poorer quality of service as well as higher costs. For these reasons, it submitted that moving quickly to align the quantity of spectrum assigned must be a key consideration in the design of the Proposed Award.

3.124 Nera, on the other hand, submitted that following the Proposed Award there would be plenty of spectrum available in Ireland and presented a figure, reproduced below, comparing the timeline for release of spectrum in Ireland to that of Germany and the UK. Arising from the 2017 release of the 3.6 GHz Award and the Proposed Award, Nera notes that Ireland is advancing towards a relative abundance of mobile spectrum.

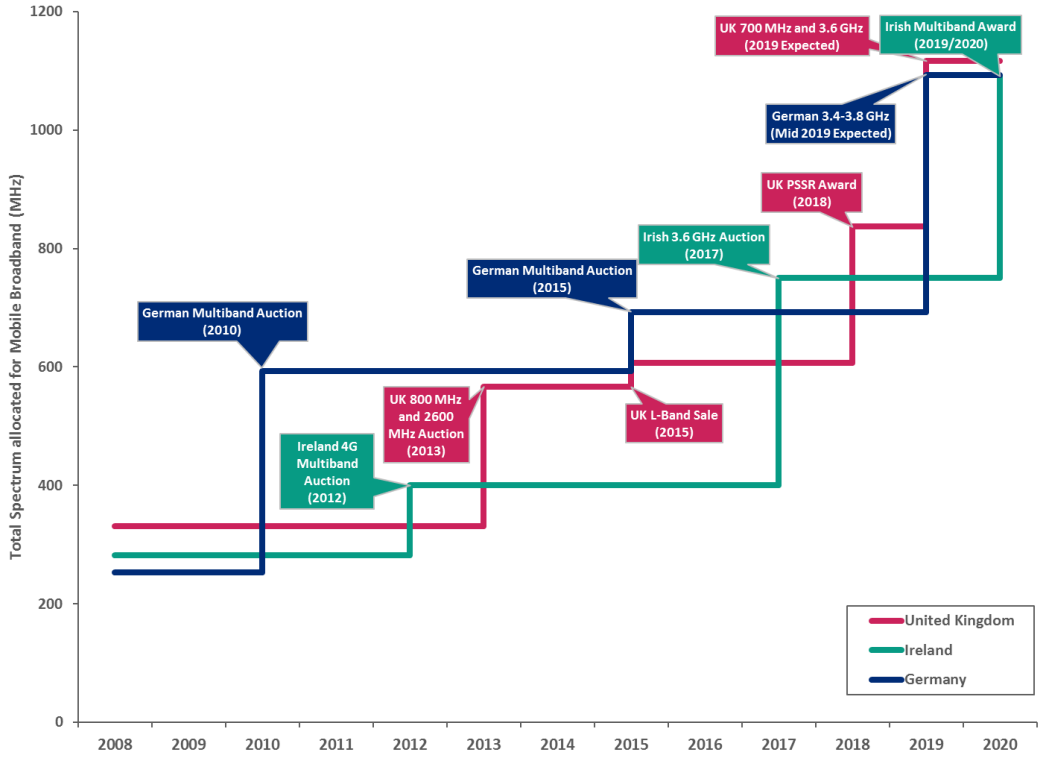

Figure 1: Spectrum allocation timeline in Ireland, United Kingdom, and Germany (source Nera)

3.125 While noting that during the 4G era, Ireland was behind many other European countries in mobile spectrum assignment owing to legacy issues in the release of the 2.6 GHz band[107], Nera submitted that this was arguably less of an issue in Ireland than it would have been in Germany or the United Kingdom, as Ireland has notably fewer dense urban locations, and thus fewer cell sites exposed to early congestion as data use expanded.

3.126 Nera also submitted that ComReg has a well-developed roadmap for release of spectrum over the next five years and, in this regard, it noted the potential future release of spectrum at 1.4 GHz and 26 GHz as identified in ComReg Document 18/60.

ComReg's assessment

3.127 ComReg notes the diverging views of Nera and Vodafone. ComReg agrees that the release of harmonised spectrum in a timely manner is important for Ireland given the significant challenges (including population distribution) for providing mobile connectivity. This is particularly recognised in ComReg's radio spectrum management strategy[108].

3.128 While heretofore it has not been possible to release the 2.6 GHz Band given its legacy use for Multipoint Microwave Distribution Systems (MMDS), the Proposed Award would release 350 MHz of additional spectrum which, as highlighted by Nera, would place Ireland at least on a par with other European countries such as the UK and Germany.

3.5.2 Assignment considerations for award design

Consider award on basis of current circumstance

3.129 Eir submitted that all matters related to this award must be considered on the basis of what it terms *"current circumstances and medium term perspectives"*, taking into account relevant national policy objectives and best practice approaches to addressing such circumstances. In this regard, Eir noted, for example:

- the views of the RSPG that there is no one size fits all in terms of spectrum award designs and that it is important to first establish the objectives for the award (see section 4 of the RSPG Report[109]); and

[107] In Ireland the 2.6 GHz Band was licensed for Multipoint Microwave Distribution Systems (MMDS) services, an ECS service as provided for under EC Decision 2008/477/EC, and was used extensively for the retransmission of television services.
[108] ComReg Document 18/118
[109] RSPG16-004 FINAL: RSPG Report on Efficient Awards and Efficient Use of Spectrum, 24 February 2016

- that BEREC has indicated that it will publish two best practices reports on spectrum authorisation/award procedures and coverage obligations with a view to considering their suitability for 5G during 2018[110], which Eir suggested will also be very relevant to the consideration and establishment of the objectives and design parameters for a potential MBSA.

Reservation of spectrum for FWA use or for new entrants

3.130 Two respondents commented on matters relating to the reservation or 'ring-fencing' of spectrum:

- Vodafone submitted that while the 700 MHz and 2.6 GHz combination may be attractive, any reservation of spectrum for a new entrant would likely lead to inefficiency; and

- Imagine, on the other hand, submitted that it is important that TDD assignments of mid-band spectrum (i.e. 1GHz – 6 GHz)) are 'ring-fenced' for FWA deployment because, in its view, this is where the FWA ecosystem is targeted. Imagine also suggested that this would be important to ensuring that no 'digital divide' develops in 5G deployments and that non-mobile operators have sufficient spectrum to deliver on all 5G use cases and deployment scenarios. Imagine submitted that failure to 'ring-fence' spectrum in the mid-band for FWA use-only could result in hoarding of spectrum by mobile operators and lead to a long-term inability to deliver non-mobile use-cases for 5G.

ComReg's assessment

3.131 In relation to Eir's view that the award needs to be considered on current circumstances, ComReg re-iterates that it considers each award on a case-by-case basis having regard to its statutory powers, functions, objectives and duties, national policy, relevant information and the particular circumstances arising. Throughout this document ComReg provides extensive references to multiple information sources which have informed its proposals, including from:

- international bodies such as the RSPG, BEREC and CEPT;

- international experience, for example relevant spectrum awards as noted in the consideration of spectrum bands above;

[110] Since published, see BoR (18) 235, 6 December 2018, BEREC report on practices on spectrum authorization, award procedures and coverage obligations with a view to considering their suitability to 5G

- national policy- for example, the work of the Mobile Phone and Broadband Taskforce in the context of appropriate coverage obligations; and

- ComReg's expert external advisors, DotEcon, Plum and LS Telcom.

3.132 In relation to the other views set out above, namely the reservation of spectrum for FWA use or new entrants, ComReg notes the respondents' views and refers the reader to the consideration of options in the draft "Assignment Process" RIA as set out Chapter 4 which follows, for ComReg's consideration of these matters.

3.5.3 Technical matters

3.133 Five respondents (Dense Air, Imagine, Nera, Three and Vodafone) commented on a variety of technical matters as summarised below:

- **2.6 GHz Band Plan:** While Vodafone noted that the 2.6 GHz EC Decision allows national discretion on the band plan, it favoured the primary band plan (see Figure 2 below) given what it terms 'pent-up' demand and that handsets are available in the Irish market.

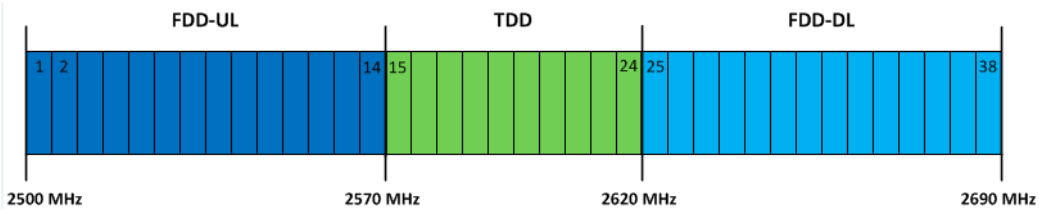

Figure 2: The 2.6 GHz Band showing the primary band plan

- **Guard bands TDD and FDD:** Three requested more information on the guard band requirements between the FDD and TDD blocks in the 2.6 GHz Band.

- **Rurtel in 2.3 GHz Band:** While supporting the inclusion of this band, Three submitted that the industry requires more information on how the matter of Rurtel licences would be addressed.

- **Contiguous spectrum:** Imagine submitted that, where possible, all spectrum should be assigned contiguously to individual operators as fracturing of the spectrum block only leads to inefficient use and sub-optimal deployments.

- **UK technical conditions for 2.3 GHz and 2.6 GHz TDD bands**: Dense Air submitted that, because of the land border between Ireland and the

UK, ComReg should adopt the same TDD technical licence conditions for both the 2.3 GHz and 2.6 GHz Bands that the UK employs.

- **TDD synchronisation:** Nera submitted that within the TDD bands, it may be advantageous to specify a default downlink/uplink ratio (e.g. 3:1) to ensure adjacent users are synchronised as otherwise users must acquire sufficient spectrum rights of use to create their own guard bands.

ComReg's assessment

3.134 ComReg notes the respondents views and refers readers to:

- Chapter 6 for a consideration of matters related the 2.6 GHz band plan and guard bands between FDD and TDD;
- Chapters 6, 7 and 9 for a consideration of RurTel in the 2.3 GHz band;
- Chapter 7 for a consideration of matters related to the packaging of spectrum in terms of lot categories and the assignment of contiguous spectrum where feasible; and
- Annex 12 (technical conditions) for a consideration of matters related to technical conditions, restricted blocks in the 2.6 GHz Band and TDD synchronisation.

3.5.4 Pricing for chained or meshed multi-hop links (60 GHz)

3.135 Dense Air submitted that chained or meshed multi-hop links[111] at 60 MHz (and all spectrum above 39 GHz) should be priced as a single link, as the current pricing regime of €150 per annum per link dominates the total operating costs of mmWave mesh solutions.

ComReg's assessment

3.136 ComReg refers its proposed spectrum action plan for fixed links during the period 2019 to 2021 where it indicated that it will:[112]

> *"Following a call for inputs on the future use of the V-band (57-71 GHz), consider implementing, if required, an appropriate licensing regime to facilitate the future use of this band*;"

[111] Dense Air believes that the designators would be the start and end of the chain where traffic enters and exits the mesh. GPS coordinates would confirm the links were meshed and not individual.

[112] Paragraph 5.10 of ComReg Document 18/118, ComReg's Radio Spectrum Management Strategy Statement 2019 to 2021,

3.5.5 3.6 GHz Transition

3.137 Eir commented on the transition process for the 3.6 GHz Award and submitted:

- it is still waiting, one year from licence issue, for access to the spectrum to be commenced and that it is a significant failing on the part of ComReg that access to the spectrum has not been forthcoming; and
- that this situation cannot persist and ComReg must ensure all transition activity is completed without any further delay.

ComReg's assessment

3.138 In relation to the 3.6 GHz Award transition process, ComReg firstly observes that that the particular circumstances arising for this band are considerably different to that of other bands suitable for mobile services, including the bands being considered for the Proposed Award[113]. In particular, the existing FWALA licensees in the 3.6 GHz Band had local area licences (of which were there 292 before the 3.6 GHz Award) that provided fixed wireless broadband, sometimes in areas where no alternative broadband provider exists.

3.139 Noting these specific circumstances, and the importance of ensuring the efficient use of spectrum as well as maximising benefits to users[114], ComReg's 3.6 GHz Award transition process included binding transition rules (as set out in the Information Memorandum for that award) which provided for the continued provision of existing services while new licensees were deploying their networks. The 3.6 GHz Band Information Memorandum also includes provisions for refunds to new licensees (in respect of both the upfront and ongoing fees) arising from delayed access to new rights of use because of transition.

3.140 Since finalising the 3.6 GHz Award, ComReg has been actively engaging with both existing licensees and new licensees for the purpose of defining local area transition plans which encourages existing licensees to carry out network migration activities with a focus, in particular, of facilitating the proposed roll-out plans of new licensees.

[113] ComReg's consideration of the transition issues associated with the Proposed Award is set out in Chapter 9 of this document.

[114] ComReg established four transition principles to guide transition in the 3.6 GHz Band.
- Minimise the potential for disruption to existing consumer services;
- Introduce liberalised licences as soon as possible not unnecessarily delaying the delivery of future liberalised services;
- Maximise benefits to end users; and
- Ensure the efficient use of spectrum during the transition period.

3.141 Considerable progress has been made in the orderly transition of the 3.6 GHz Band. For instance, from the 292 Transition Service Areas (TSAs) of existing licensees at the start of transition, data as at 22 May 2019 currently indicates that:

- 87 TSAs (30%) have been cancelled;
- 164 TSAs (56%) have been modified (in frequency or area); and
- 41 TSAs (14%) remain unaltered.

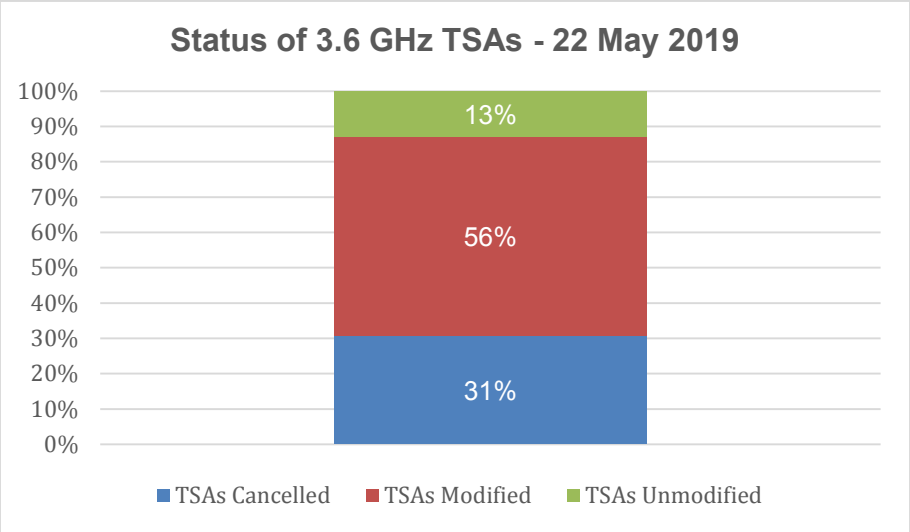

Figure 3: Status of 3.6 GHz band TSAs

3.142 Furthermore, this progress has facilitated the commencement of spectrum rights for all new 3.6 GHz Band licensees to varying degrees.[115] The specific details of the spectrum rights assigned are set out on the 3.6 GHz Award webpage, and ComReg notes that currently circa 60% of the overall spectrum rights have now been assigned.[116]

3.143 ComReg's overall aim is to complete the 3.6 GHz Award transition process in an orderly and timely manner, and ComReg will continue to actively engage with both existing licensees and new licensees in this regard.

[115] For example, on 1 October 2018, Eir was issued spectrum rights for each region in its 3.6 GHz Band licence. Additional 3.6 GHz Band spectrum rights were commenced for Eir on 7 January 2019.
[116] https://www.comreg.ie/industry/radio-spectrum/spectrum-awards/3-6ghz-band-spectrum-award/

Chapter 4

4 Draft Regulatory Impact Assessments

4.1 Introduction

4.1 In Chapter 3 of this document, ComReg set out its preliminary view that he 700 MHz Duplex, 1.4 GHz Centre Band, 2.1 GHz, 2.3 GHz and 2.6 GHz bands should be considered further in a Regulatory Impact Assessment (RIA).

4.2 This chapter sets out ComReg's draft RIAs on:

- which, if any, of the 700 MHz Duplex, 1.4 GHz Centre Band, 2.1 GHz Band, 2.3 GHz Band and 2.6 GHz Band should be included in the Proposed Award; and
- in light of the preferred option arising from the Spectrum for Award RIA, how best to assign the rights of use in the relevant band(s).

4.3 The chapter concludes with a preliminary assessment of the preferred option arising from the two draft RIAs (the "Preferred Option") against ComReg's relevant statutory functions, objectives and duties (including the application of regulatory principles).

4.2 RIA Framework

4.4 In general terms, a RIA is an analysis of the likely effect of a proposed new regulation or regulatory change, and, indeed, of whether regulation is necessary at all. A RIA should help identify the most effective and least burdensome regulatory option and should seek to establish whether a proposed regulation or regulatory change is likely to achieve the desired objectives, having considered relevant alternatives and the impacts on stakeholders. In conducting a RIA, the aim is to ensure that all proposed measures are appropriate, effective, proportionate and justified.

Structure of a RIA

4.5 As set out in ComReg's RIA Guidelines[117], there are five steps in a RIA. These are:

- Step 1: Identify the policy issues and identify the objectives.

[117] See Document 07/56a – Guidelines on ComReg's approach to Regulatory Impact Assessment – August 2007.

- Step 2: Identify and describe the regulatory options.
- Step 3: Determine the impacts on stakeholders.
- Step 4: Determine the impacts on competition.
- Step 5: Assess the impacts and choose the best option.

4.6 In the following sections, ComReg identifies the specific policy issues to be addressed and relevant objectives for the Proposed Award (i.e. Step 1 of the RIA process). This results in the identification of two fundamental policy issues which are then considered in two separate RIAs following Steps 2 to 5 above of ComReg's RIA process.

4.7 Before moving on to Step 1 of the RIA, ComReg first makes some relevant observations below on the stakeholders involved and on ComReg's approach to Steps 3 and 4.

Identification of stakeholders and approach to Steps 3 and 4

4.8 The focus of Step 3 is to assess the impact of the various regulatory options on stakeholders. A precursor to the subsequent steps in the RIA, therefore, is to identify the relevant stakeholders. Stakeholders consist of two main groups:

i. consumers (for the purposes of this draft RIA, consumers include both business and residential consumers), and
ii. industry stakeholders.

4.9 There are a number of key industry stakeholders in relation to the matters considered in this chapter:

- existing service providers who have spectrum rights of use in the bands being considered for inclusion in the award (2.1 Licensees[118]);
- Mobile Virtual Network Operators (MVNOs);
- parties who currently provide services using other spectrum rights (licensed or licence-exempt) for whom the spectrum being considered for inclusion in the Proposed Award may be of particular interest to satisfy existing and potential demand (e.g. mobile network operators (MNOs) or other fixed wireless access providers (FWA Providers);

[118] Meteor Mobile Communications Ltd, Three Ireland Hutchison Limited, Vodafone Ireland Limited.

- potential new entrants who do not currently provide any services using spectrum in the State. This group may include companies that are already otherwise engaged in the electronic communications sector in the State, in other Member States or further afield (New Entrants); and

- economic or industrial sectors who have the potential to change business models for MNOs relative to the current marketplace, (largely standardised services) with differentiation limited to pricing.[119]

4.10 The focus of Step 4 is to assess the impact on competition of the various regulatory options available to ComReg. In that regard, ComReg notes that it has various statutory functions, objectives and duties which are relevant to the issue of competition. See Section 4.5, 'Assessment of Preferred Option against ComReg's other relevant functions, objectives and duties' below.

4.11 Of themselves, the RIA Guidelines and the RIA Ministerial Policy Direction[120] provide little guidance on how much weight should be given to the positions and views of each stakeholder group (Step 3), or the impact on competition (Step 4). Accordingly, ComReg has been guided by its statutory objectives which it is obliged to seek to achieve when exercising its functions. ComReg's primary statutory objectives in managing the radio frequency spectrum for ECN/ECS, as outlined in Annex 2, include:

- the promotion of competition;

- contributing to the development of the internal market; and

- the promotion of the interests of users within the Community.

4.12 In this document, ComReg has adopted the following structure in relation to Step 3 and Step 4 – the impact on industry stakeholders is considered first, followed by the impact on competition, followed by the impact on consumers. This order does not reflect any assessment of the relative importance of these issues but rather reflects a logical progression. In particular, a measure which safeguards and promotes competition should also, in turn, impact positively on consumers. In that regard, the assessment of the impact on consumers draws substantially upon the assessment carried out in respect of the impact on competition.

[119] Study on Implications of 5G Deployment on Future Business Models No BEREC/2017/02/NP3 A report by DotEcon Ltd and Axon Partners Group.
[120] See Policy Direction Number 6 in Annex 2

Identify the policy issues and identify the objectives (Step 1)

Policy issues

4.13 As noted at the beginning of this Chapter, a number of bands could reasonably be considered for inclusion in the Proposed Award (the Candidate Bands) including:

- Bands which are currently unused in Ireland:
    - The 2.6 GHz Band is unused and available for use.[121]
    - The 2.3 GHz Band is largely unused and available for use[122].
    - The 1.4 GHz Centre Band is available for use.
- Bands whose rights of use are due to expire before the proposed award.
    - RTÉ is Ireland's public service broadcaster, and is the current licence holder for Licences for Digital Terrestrial Television Multiplexes using 700 MHz rights of use.
    - It has now been established that the 4 March 2020 is the date by which DTT services are to be migrated from the 700MHz Duplex in Ireland and the date from which the 700MHz Duplex is to be available for the provision of ECS/WBB services.
- Bands whose rights of use are due to expire after the Proposed Award. In particular, existing rights of use in the 2.1 GHz Band begin to expire in 2022. For example,
    - Three's "A licence" expires on 24 July 2022, and its "B Licence" expires on 1 October 2022;
    - Vodafone's rights of use expire on 15 October 2022; and
    - Eir's rights of use expire on 11 March 2027.

4.14 ComReg is of the view that there are two primary policy issues to be considered in the Proposed Award:

a) which, if any, of the above bands should be included in the Proposed Award; and

[121] Licences issued in the 2.6 GHz Band for MMDS expired in full on 18 April 2016;
[122] There are currently 34 licences issued to Eir in the 2.3 GHz Band under S.I. 370 of 2009 (Radio Links) and all licences are within the frequency range 2307-2327 MHz

b) in light of (a) how best to assign rights of use in the Proposed Award.

4.15 In relation to (a), for the reasons set out below, ComReg believes that there are certain bands, namely the 2.6 GHz and 700 MHz Duplex bands, which are clearly suitable for inclusion in the Proposed Award (and favoured by respondents to Document 18/60) and that there is no need to considering their inclusion separately in this draft RIA. Instead, this draft RIA only considers the potential inclusion of the other Candidate Bands noted above alongside the 2.6 GHz and 700 MHz Duplex bands in the Proposed Award.

2.6 GHz Band

4.16 As noted in Document 18/60, ComReg believes that there are good reasons for including the 2.6 GHz Band in the Proposed Award. In particular:

- it is harmonised at both EU and CEPT level, with the 2.6 GHz EC Decision requiring that all Member States designate and subsequently make available on a non-exclusive basis the 2.6 GHz Band for terrestrial systems capable of providing ECS;
- there is a very strong device ecosystem for this band (see Annex 4);
- it is widely used in other Member States for the provision of WBB including International Mobile Telecommunications (IMT)[123];
- it is available for immediate assignment; and
- all respondents to Document 18/60 supported the inclusion of this band.

4.17 Therefore, ComReg is of the preliminary view that the 2.6 GHz Band is clearly suitable for inclusion in the Proposed Award, particularly when combined with the 700 MHz Duplex discussed below, and should therefore be included in all options discussed in this draft RIA.

700 MHz Duplex

4.18 The 700 MHz Duplex is the only Candidate Band capable of providing wide area coverage that is available for release in the proposed time period.[124] It is highly complementary to the 2.6 GHz Band (and other Candidate Bands) as its

[123] The 2.6 GHz Band is the second most used spectrum band for LTE and LTE-Advanced services worldwide (count of networks using each spectrum band to deliver commercial services). Source: LTE Frequency Bands Worldwide – January 2019 Global mobile Suppliers Association – GSA

[124] The 1.4 GHz Centre Band offers similar propagation characteristics to sub-1 GHz spectrum, when paired with low frequency spectrum (such as 700 MHz spectrum. This additional capacity would supplement a basic coverage layer provided by spectrum below 1GHz. However, this band does not provide wide area coverage in its own right.

inclusion provides interested parties with the opportunity to obtain rights of use to coverage and capacity spectrum in the same award which provides coverage and capacity capabilities and greater opportunities for new entry.

4.19 At the time of publication of Document 14/101, there was still some uncertainty around the timing of availability of the 700 MHz Duplex for inclusion in an award. However, as noted in Chapter 3, circumstances have materially changed since Document 14/101, in particular:

- the 700 MHz Duplex has since been harmonised for providing WBB ECS[125]:
- it has been established that 4 March 2020 is the date by which the 700 MHz Duplex will be available in Ireland;[126] and
- as of January 2019, the GSA identified 1,450 devices[127] capable of operating in this band[128].

4.20 Further, and subsequent to the publication of Document 14/101, ComReg commissioned Frontier Economics to conduct a Cost Benefit Analysis (Frontier CBA) on the release of the 700 MHz Duplex.[129] This analysis concluded that the network cost savings to all MNOs (should they secure such spectrum in an award) to be of the order of €89 million in the base case scenario and between €50m and €150m, respectively, in the low and high demand scenarios, arising due to the network cost savings as a result of requiring fewer base stations. This would also improve the performance of networks[130], ultimately to the benefit of consumers.

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[125] See Chapter 2 and also Annex 3 ComReg's consideration of the use of the 700 MHz Duplex for BB-PPDR.

[126] In that regard, ComReg notes that the Minister for Communications, Climate Action and Environment in a letter of entrustment to RTE to provide for the migration of Broadcasting Services from the 700 MHz band noted that "*The timely release of this spectrum is a matter of national importance as its subsequent use for mobile broadband services will assist in delivery of improved network coverage and speed particularly in rural areas*."
https://www.dccae.gov.ie/en-ie/communications/publications/Pages/Migration-from-700-MHz-Spectrum-Band.aspx

[127] GSA – GAMBoD – LTE devices

[128] Note that this figure has increased since the publication of Document 18/60, where the GSA in May 2018 reported that 1,211 devices where available in the 700 MHz Duplex, (Band 28).

[129] Frontier Economics, 'A cost benefit analysis of the change in use of the 700 MHz radio frequency band in Ireland', published June 2015.
https://www.comreg.ie/publication/a-cost-benefit-analysis-of-the-change-inuse-of-the-700-mhz-radio-frequency-band-in-ireland/

[130] 700 MHz Duplex spectrum could be used to increase network performance in two different ways.
- it may enable larger blocks of contiguous sub-1GHz spectrum which could be used to significantly increase performance; and
- operators could increase performance in parts of their networks by increasing capacity, and thereby reducing utilisation.

4.21 The Frontier CBA also described wider economic and societal benefits that would likely result from the assignment of the band, including consumer welfare benefits in the form of improved and/or lower cost services and increased demand for mobile services stimulated by greater network capacity. For example, an Oxera Report commissioned by ComReg and published in November 2018 notes that from mid-2020, the commercial extension of a mobile network is likely to switch to a focus on extending higher-speed connectivity (e.g. minimum 30Mbit/s population coverage) partly because 700 MHz Duplex rights of use become available, which will also more readily enable three-band Carrier Aggregation[131] (a key technology that will reduce the cost of extending high-speed connectivity).[132][133] In effect, these gains could not be realised absent the assignment of 700 MHz Duplex rights of use and no additional alternative rights of are currently available to support such potential gains.

4.22 Accordingly, ComReg is of the view that the 2.6 GHz and 700 MHz Duplex bands are clearly suitable for inclusion in the Proposed Award and should therefore be included in all options discussed in this draft RIA.

4.23 In light of the above, ComReg is of the view that the two primary policy issues to be addressed are:

a) whether to include the 1.4 GHz Centre Band, 2.1 GHz Band and/or 2.3 GHz band (Candidate Bands) with the 2.6 GHz and 700 MHz Duplex bands in the Proposed Award (the **"Spectrum for Award RIA"**); and

b) in light of (a) how best to assign rights of use in the Proposed Award (the **"Assignment Process RIA"**).

4.24 These two important policy issues, while related, are sequential in nature and are each in turn considered under Steps 2 to 5 of the RIA process below. However, before doing so, it is relevant to note the objectives ComReg is seeking to achieve with the Proposed Award.

Objectives

4.25 The focus of this draft RIA is to assess the impact of the proposed measure(s) (see regulatory options below) on industry stakeholders, and on competition

[131] Carrier Aggregation of 2×10MHz of 700MHz spectrum, 2×10MHz of 800MHz spectrum, and 2×10MHz of 900MHz spectrum

[132] Section 5.5.1, Oxera,'Future mobile connectivity in Ireland', Published November 2018. https://www.comreg.ie/publication/future-mobile-connectivity-in-ireland/

[133] The anticipated switch to 30Mbit/s connectivity is also a product of the fact that the costs of providing 3Mbit/s coverage for the last few percentage points of population rises exponentially. Given this, an MNO would be able to cover a significant proportion of the population with 30Mbit/s for the same cost as expanding 3Mbit/s.

and consumers. In that way, it allows ComReg to identify and implement the most appropriate and effective means to assign spectrum rights of use, while still allowing ComReg to achieve its objectives of:

- assigning liberalised rights of use in the 700 MHz Duplex and 2.6 GHz Band in line 700 MHz EC Decision (EU 2016/687)) and 2.6 GHz EC Decision (2008/477/EC);
- assigning liberalised rights of use in one or more the Candidate Bands, if appropriate, in line with relevant EC Decisions;
- promoting competition and ensuring that there would be no distortion or restriction of competition in the electronic communications sector;
- encouraging efficient investment in infrastructure, promoting innovation and ensuring the efficient use and effective management of the radio frequency spectrum;
- providing further clarity on the likely availability of spectrum for release in other relevant bands; and
- promoting the interest of economic development of the State and electronic communications sector.

4.26 ComReg also aims to design and carry out this assignment process in accordance with its broader statutory objectives (set out in Annex 2), including, but not limited to, the promotion of competition in the electronic communications sector.

4.27 ComReg's other overarching objectives are to contribute to the development of the internal market and to promote the interests of users within the Community. ComReg also notes that, in achieving its objectives, its ultimate aim is to choose regulatory measures which maximise the benefits for consumers in terms of price, choice and quality.

4.3 The 'Spectrum for Award' RIA

4.28 As noted in the previous section, ComReg is of the preliminary view that the 2.6 GHz and 700 MHz Duplex bands are clearly suitable for inclusion in the Proposed Award and should therefore be included in all options discussed in this draft RIA. The 2.6 GHz and 700 MHz Duplex bands are therefore hereafter referred to as the "**Primary Bands**". Accordingly, this draft RIA assesses each of the remaining Candidate Bands in terms of the impact their inclusion, or otherwise, would have on stakeholders, competition and consumers. ComReg then forms a preliminary view on which bands should be included in the

Proposed Award.

Identify and describe the regulatory options (Step 2)

4.29 An assessment of the Primary Bands and each of the remaining Candidate Bands together leads to a large number of potential individual options. However, ComReg notes that it is unnecessary to assess each and every potential combination of bands as a separate option for the purposes of this draft RIA, because the arguments for and against including each Candidate Band with the Primary Bands is essentially the same for any other potential combination of that Candidate Band with other Candidate Bands. Therefore each option below, following Option 1, considers the addition of a particular spectrum band and assesses whether the inclusion of that spectrum band is appropriate in light of the objectives referred to above. In that regard, Option 1 is assessed against other options which provide for the inclusion of additional bands.

4.30 In light of the preceding discussion, and having regard to responses received to Document 18/60, ComReg has identified the following regulatory options for consideration in this draft RIA:

- **Option 1 -** Assign rights of use for 700 MHz Duplex and 2.6 GHz Band only.
- **Option 2 -** Include the 2.3 GHz Band in any award process assigning rights of use in the 700 MHz Duplex and 2.6 GHz Band.
- **Option 3 -** Include the 2.1 GHz Band in any award process assigning rights of use in the 700 MHz Duplex and 2.6 GHz Bands.
- **Option 4 -** Include the 1.4 GHz Centre Band in any award process assigning rights of use in the 700 MHz Duplex and 2.6 GHz Bands.

Impact on industry stakeholders, competition and consumers (Steps 3 and 4)

4.31 The focus of this section of the draft RIA is to assess the impact of the aforementioned regulatory options on:

i. industry stakeholders[134] (being existing stakeholders and potential new entrants);

ii. competition; and

[134] Some of the comments below regarding the possible views of certain stakeholders are based on assessment of what ComReg considers to be stakeholder's likely views. Stakeholders are, of course free to be more explicit on their actual views in the response to this consultation.

iii. consumers.

4.32 Prior to carrying out this analysis, ComReg first briefly sets out some background information concerning developments in the demand for spectrum in Ireland. Such developments are relevant when considering the likely attitudes of industry stakeholders and consumers to the inclusion of certain spectrum bands in the Proposed Award. ComReg notes that it intends to further develop this draft RIA in light of feedback from respondents to this consultation.

Demand for spectrum

4.33 Consumer demand for mobile broadband has grown significantly in recent years. Total mobile traffic has grown nearly 13 times[135] since the 2012 Multi-Band Spectrum Award (2012 MBSA) when 3G was expanded across the country using UMTS 900 and 4G was launched in Ireland. Further, ComReg recently commissioned Frontier Economics to publish a new mobile data traffic forecast to enable better network planning by operators and assist stakeholders to keep pace with consumer demand for services (Document 18/35).[136] Frontier forecasts that demand for mobile data in Ireland will grow at an average of 32% per year up to 2022 with growth rates of above 40% per year in the period up to 2020.[137] Similarly, LTE fixed wireless broadband is forecast to grow by 26% per year through to 2022.[138]

4.34 Frontier separately notes that there are many factors increasing demand for data including that:[139]

- devices are becoming increasingly sophisticated;
- consumers are using more heterogeneous and sophisticated software and applications on their devices;
- broadband networks are increasingly used by consumers to watch content that would previously have been transmitted over traditional TV networks; and
- business applications continue to drive demand.

4.35 These drivers are all described in more detail in Section 2.2 of the Frontier Report on meeting consumers' connectivity needs. [140]

4.36 Demand for spectrum exists to satisfy requirements in both rural and urban areas, and a mix of spectrum bands is typically required for optimal network configuration and where possible to facilitate new entry. While mid frequency

[135] ComReg Quarterly Reports – Q1 2013 – Q4 2018.
[136] Implementing Action 33 of the Mobile Phone and Broadband Taskforce.
[137] Document 18/35, Mobile Data Traffic Forecast in Ireland, published 27 April 2018.
[138] https://www.rcrwireless.com/20180425/5g/fixed-wireless-broadband-to-grow-30-in-2018_tag41
[139] Section 2.2, Document 18/103b.
[140] Meeting Consumers' Connectivity Needs a report from Frontier Economics, Document 18/103b

spectrum has greater capacity capabilities compared to low frequency spectrum, the latter offers substantial coverage benefits and is more cost-effective in providing 'capacity in the coverage layer' for mobile data services. The 700 MHz Duplex is likely to be central to providing mobile coverage in rural areas and along terrestrial routes where the capacity requirements are typically less. Ireland is one of the most rural countries in the EU 28[141] and the 700MHz Duplex is likely to be of most interest in Ireland in terms of providing or improving mobile coverage, given that its strong propagation qualities support more cost-effective approaches to the coverage of distributed and rural populations.[142]

4.37 Capacity is also likely to be an issue particularly in urban and suburban areas where populations are becoming increasingly concentrated. Population growth is projected to be greatest in and around the major cities and Dublin in particular. For example, since the 2012 MBSA, the population of Dublin has grown by around 100,000[143] and is forecast to grow by 300,000 in the period up to 2040.[144] Further, around 90,000 persons (net) travel to work in Dublin from outside and another 70,000 (net) travel to work into the other cities from outside areas. The five urban areas combined accounted for 41% of all daytime workplace destinations (excluding mobile workers).[145] This increasing density of population, particularly in urban areas, will put pressure on the capacity of existing networks, whether mobile or fixed.

4.38 MNOs already have significant spectrum portfolios with 750 MHz currently assigned for WBB in Ireland. However, given the data forecasts described above, additional spectrum rights across different bands are likely to be required in the future, and respondents to this consultation process have indicated as much (see discussion in Chapter 3). In light of the above characteristics and developments, demand for suitable radio spectrum in Ireland is likely to be high.

4.39 ComReg sets out below a comparative analysis of each of the four regulatory options outlined above, in terms of their impact on stakeholders, competition and consumers.

4.3.1 Impact on Industry Stakeholders

4.40 As noted above, industry stakeholders can be broadly split between those operators that are currently active in the electronic communications sector and potential new entrants to the electronic communications sector in the State.

[141] Section 4.1.1 Document 18/35, Mobile Data Traffic Forecast in Ireland, published 27 April 2018.
[142] See Section 2.4, Document 18/103c 'Future Mobile Connectivity in Ireland a report from Oxera Consulting LLP, with Real Wireless Ltd.'
[143] Census 2016.
[144] ESRI, 2018, 'Prospects for Irish Regions and Counties: Scenarios and Implications' Research Series Number 70.
[145] Census of Population 2016 – Profile 6 Commuting in Ireland.

4.41 ComReg notes that each of the regulatory options below involves additional spectrum being made available for assignment to existing operators or new entrants. Therefore, before assessing each of the options, ComReg sets out below the main reasons why operators, all else being equal, would prefer options which make available additional spectrum rights of use.

Benefits of additional spectrum to stakeholders

Fixed Wireless

4.42 While the Candidate Bands above 1 GHz are often used for the provision of capacity on mobile networks, these bands can also be used by a fixed wireless network to deliver coverage and capacity[146]. For example, Plum notes:

"*the CPE antennas used in fixed networks are also directional and are mounted externally, typically on a rooftop or other elevated position. Once again the antenna gain leads to an increase in the tolerable path loss, but there is also a further benefit in that there is a much higher probability of a line of sight path between the base station and antenna than would be the case for a mobile network, where user terminals are often shielded by buildings, trees and other clutter. This means that a reliable service can be provided over much larger distances than would be the case for a mobile network, especially in an urban or suburban environment*".[147]

4.43 In terms of the coverage range for the Candidate Bands, propagation loss increases with the frequency. While there are propagation differences between the 2.1 GHz Band, 2.3 GHz Band[148] and 2.6 GHz Band, these are not significant and are typically treated the same for network planning studies.[149]

4.44 The addition of any of these bands would give additional capacity and coverage benefits to existing Fixed Wireless Access (FWA) operators. For example, based on its previous analysis, Plum[150] recommended that 100 MHz[151] is

[146] For example, DotEcon notes that frequencies above 1 GHz may be attractive for fixed wireless providers, for which capacity and throughput can be achieved using bands with larger amounts of contiguous spectrum. See Chapter 2, of the DotEcon Award Design Report.
[147] Document 15/140d - Technical advice by Plum Consulting concerning potential rights of use in the 3.6 GHz band Updated Report 3: Analysis of the potential spectrum requirements for NGA services.(p53).
[148] FDD assignments can cover a wider coverage area. Assuming same transmit power, the main reason for reduced coverage is that the uplink device power is used part of the time for TDD but continuously for FDD.
[149] Report ITU-R M.2292-0 (12/2013) - Characteristics of terrestrial IMT-Advanced systems for frequency sharing/ interference analyses – Table 3.
[150] Document 15/75, A Report for ComReg, Technical advice concerning potential sub-national rights of use in the 3.6 GHz band. Report 3: Analysis of the potential spectrum requirements for NGA services.
[151] The 100 MHz uses an infrastructure density comparable to one of today's mobile cellular networks, and Plum state that this amount of spectrum utilising LTE-A could serve up to 30% of all

necessary to provide a high speed (30 Mbit/s or more) broadband service with similar contention levels to existing cable services and a similar infrastructure density to existing wireless services. The 2.3 GHz Band provides FWA operators with the opportunity to increase existing holdings closer to or beyond 100 MHz and compete to a greater extent with existing fixed services.

4.45 Fixed Wireless is a consumer's fixed broadband solution in the home and the download requirements are significantly higher per user compared to mobile. For example, monthly data usage per FWA is around 102 GB per month compared to around 6 GB and 23 GB for smartphone and dongles, respectively.[152] In February 2019, Imagine announced plans to deploy approximately 325 sites and provide fixed wireless services across large parts of the country. [153]Therefore, depending on FWA subscriptions in a particular area, the need for additional spectrum for such purposes could increase in the future.

Mobile and Fixed Wireless

4.46 Assigning available substitutable spectrum in a single award rather than in one or more sequential awards would, among other things, better facilitate the planning of spectrum portfolios to address growth in data traffic and, in turn, enhanced services by successful participants in the Proposed Award. Operators typically have three options when increasing capacity on their networks:

1. deploy more spectrum on existing base stations;
2. add more bases stations increasing the geographic reuse of spectrum; and/or
3. increase spectrum efficiency (i.e. increasing the throughput capacity of each MHz of spectrum).

4.47 Increased spectral efficiency is generally achieved through on-going technological advancements and operators are generally dependent on equipment manufacturers and handset upgrades to provide for same.[154] More generally, the capacity available to provide MBB services depends on the

broadband subscribers in a typical suburban area and up to 50% of all subscribers in more rural areas.

[152] ComReg Quarterly Reports, Q4' 2018.

[153]https://www.irishtimes.com/business/technology/imagine-plans-300m-wireless-broadband-network-1.3792296?mode=sample&auth-failed=1&pw-origin=https%3A%2F%2Fwww.irishtimes.com%2Fbusiness%2Ftechnology%2Fimagine-plans-300m-wireless-broadband-network-1.3792296

[154] As technology standards are improved and refined the effective capacity of different technologies improves. However, even if new LTE releases are deployed in the network there may be a lag in the user adoption of handset technology with the latest LTE releases. Therefore operators typically do not rely on such developments to increase capacity, particularly in the short run.

amount of spectrum assigned to an operator and the number of base stations in its network. Once the existing capacity is fully used, operators must, in the absence of suitable additional spectrum, add more base stations to their network to address congestion.[155] This allows radio spectrum to be reused for multiple simultaneous transmissions within the cell area.

4.48 However, the construction of base stations deploying more radios and antennas as well as extending additional backhaul links to new sites is expensive and typically costs substantially more (in the order of multiples) than adding additional spectrum rights to existing base stations.[156] Therefore, depending of course on the relative cost of spectrum in a competitive award, operators are likely to prefer the release of additional spectrum in order to reduce costs of providing additional capacity. Further, with advances in radio technology, including the use of higher bandwidth channels (such as the 2×20 MHz channels available with LTE) and the use of carrier aggregation, having a larger spectrum holding allows an MNO to offer higher headline speeds and sustain higher actual speeds.[157]

4.49 The release of additional bands also provides greater opportunity for carrier aggregation across bands which makes more efficient use of spectrum by combining two or more bands into a single channel. Carrier aggregation can combine spectrum both within a single band and across multiple bands. The resulting higher peak data rates give users a richer mobile broadband experience and improved service coverage.

Option 1 v Option 2 (inclusion of the 2.3 GHz Band with the Primary Bands)

4.50 While stakeholders are likely to be in favour of Option 1, some stakeholders may also prefer the inclusion of the 2.3 GHz Band in light of the benefits of additional spectrum described above. ComReg first sets out information on the band and then assesses how that information would likely inform the views of stakeholders:

- the inclusion of the 2.3 GHz Band (and other bands) would provide additional spectrum and also more contestable spectrum to different

[155] This is done by deploying more radio towers/antennas and shrinking the reach of each tower by reducing the radiated power of its radio transmissions. This allows radio spectrum to be reused for multiple simultaneous transmissions within the geographic area. Thus by subdividing cells, the amount of traffic that a Hz of spectrum can carry within an overall geographic area (measured by bps/km^2) is increased.

[156] For example, the estimate networks costs in the Oxera Report (Document 18/103c Section A.2.4.10) indicates a difference in capex costs. For a new site the estimated capex cost is €250,000, compared to €10,500 for upgrading a site.

[157] The actual speeds depend upon a number of factors including the device capability, the network capability, the network capacity available (and congestion) and the RF quality of the connection.

potential users;

- the inclusion of the 2.3 GHz Band would provide the opportunity to acquire additional TDD (unpaired) spectrum rights to address asymmetric traffic flows and more effectively manage increased capacity from end users.[158] For example:
    - overall average traffic asymmetry ratio (Uplink (UL)/ Downlink (DL)), which is currently dominant (from 1/4 to 1/9) in favour of DL is expected to increase in favour of DL (from 1/7 to 1/10 or more) due to growing demand for audio-visual content[159]; and
    - the 2.3 GHz Band could be used to deliver extra capacity primarily in the DL direction for more densely populated areas providing better flexibility for operators.

- unlike SDL[160] bands, 2.3 GHz TDD spectrum can accommodate both uplink and downlink, and can be used in its own right independent from other frequencies;
- of the 104 smartphones tested by ComReg as part of its handset testing[161], 65 handsets support the 2.3 GHz Band, including the most popular Apple and Samsung devices;
    - the technical conditions for the 2.3 GHz Band are harmonised in Europe by CEPT and there are significant deployments outside of Europe[162] resulting in availability of equipment and a strong device ecosystem[163];
- beamforming is of particular interest for LTE-TDD because the same frequency is used in the downlink and uplink, whereas FDD requires two separate communications channels. The 2.3 GHz Band is the lowest frequency band suitable for highest capacity 8T8R (8 Transmit 8 Receive) beamforming[164][165]; and

[158] The use of TDD spectrum provides operators the flexibility to adjust its uplink-downlink ratio to account for more downlink capacity once any uplink requirements are satisfied in line with traffic asymmetry. This flexibility is not available with FDD.
[159] https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2370-2015-PDF-E.pdf
[160] SDL (Supplemental Downlink) is a mobile broadband system, which by means of base station transmitters in a network uses unpaired spectrum in the downlink direction to provide supplemental downlink capacity.
[161] Mobile Handset Performance – Data, Document 18/82, published 19 September 2018.
[162] Including China, the Asia Pacific region, Africa and Australia.
[163] As at Jan 2019 the GSA identify that the 2.3 GHz Band (Band 40) has 4,449 devices available. Source: https://gsacom.com/
[164] https://www.huawei.com/en/press-events/news/2017/10/Huawei-5G-Oriented-Full-Band-4T4R
[165] Award of the 2.3 and 3.4 GHz spectrum bands Annexes to the statement, Ofcom.

- the EC has drafted an implementing decision based on CEPT Report 55. However, the adoption of this decision was deferred and the matter has not yet been revisited by the ECs Radio Spectrum Committee.

4.51 Given the above, ComReg outlines below stakeholders' likely preferences.

MNOs

4.52 ComReg notes that, in response to Document 18/60, Three and Vodafone supported the inclusion of the 2.3 GHz Band in the Proposed Award.[166] However, Eir did not agree and submitted that consideration of this band should be put on hold until an EC implementing decision on technical harmonisation had been adopted.

4.53 In relation Eir's view, ComReg notes that the lack of an EC harmonisation decision should not be a significant concern given deployments outside of Europe. Indeed, the band already has a significant device presence on the Irish market.

FWA operators

4.54 ComReg firstly notes that, in response to Document 18/60, Imagine supported the inclusion of the 2.3 GHz Band in the Proposed Award.

4.55 FWA operators generally are likely to prefer the inclusion of the 2.3 GHz Band because:

- it would provide 100 MHz of additional suitable LTE-TDD[167] spectrum, which could be used in addition to 3.6 GHz LTE-TDD and/or 2.6 GHz TDD spectrum;
- the 2.3 GHz Band would be considered an important 'coverage band' in the provision of fixed wireless services which is likely to be able to provide additional capacity benefits and end user benefits due to the suitability of the band for beamforming in the future; and

[166] Vodafone supports the inclusion of the 2.3 GHz Band as it is a sufficiently close substitute to rights of use in the 2.6 GHz Band and also sufficiently complementary to rights of use in the 700 MHz Duplex.

[167] Of particular importance has been the development and take up of TD-LTE designed to maximise the use of spectrum in the most efficient way to deliver higher bandwidth services. Derived from fixed wireless protocols and standards, TD-LTE uses the same channel for downloading and uploading data where the spectrum resources are assigned proportionally to reflect and cater for normal broadband usage where the primary requirement is downloading data.

- it would provide for the possibility of carrier aggregation[168] with the 3.6 GHz Band[169] and/or 2.6 GHz Band in the future[170] for MNOs and Fixed Wireless operators.

New Entrants/Other Operators

4.56 The assignment of 700 MHz Duplex and 2.6 GHz rights of use under Option 1 would facilitate potential new entry to the mobile telecommunications market by providing a spectrum portfolio suitable for both cost-effective wide-area coverage and capacity in higher density areas. New entrants are also likely to prefer the inclusion of the 2.3 GHz Band because the availability of more substitutable spectrum in the same award increases the opportunity for a new entrant to be assigned rights of use.[171]

4.57 Other operators would also likely prefer the inclusion. For example, Airspan (which obtained rights in the 3.6 GHz Award) has used 2.3 GHz Band LTE-TDD small cell and small cell backhaul solutions in conjunction with mobile operators[172] outside Ireland, and its outdoor 4G LTE-Advanced base station equipment all support the 2.3 GHz Band.[173]

4.58 In light of the above, industry stakeholders (with the exception of Eir) would likely prefer the inclusion of the 2.3 GHz band in the Proposed Award.

Option 1 v Option 3 (Inclusion of 2.1 GHz Band with the Primary Bands)

4.59 ComReg acknowledges the concerns expressed by some respondents to Document 18/60 on the complexity of including the 2.1 GHz Band in the Proposed Award. These are considered separately in Chapter 5 and detailed further in Annex 5. The following analysis focuses upon more general considerations concerning the potential inclusion of the 2.1 GHz Band and should be read in the context of the subsequent discussion and specific proposals for the 2.1 GHz Band in Chapter 5.

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[168] Carrier aggregation is a key feature of LTE-Advanced (LTE-A) which enables carriers at multiple frequencies to be used together to provide improved data rates for users of 4G networks.
[169] https://www.ericsson.com/en/news/2017/4/australian-achievement-nbn-hits-record-in-gigabit-lte
[170] More generally, operators are likely to prefer carrier aggregation of bands with similar propagation characteristics. Carrier aggregation of bands with similar propagation characteristics offer better and more consistent quality of service for a given level of coverage because there is less likely to be a coverage mismatch between bands leading to inconsistent Quality of service and lower speeds at cell edge, as the impact of one or more of higher frequency bands falls out of coverage. Carrier aggregation of certain bands can be an effective means of overcoming poor speeds for users located at cell edge. The 2.1 GHz Band, 2.3 GHz Band and 2.6 GHz Band are likely to be relevant in this regard.
[171] This is a point raised by Dense Air in its submission to Document 18/60.
[172]https://www.airspan.com/press-release/afrimax-vodafone-group-deploys-airspans-lte-network-architecture-in-zambia/
[173] https://www.airspan.com/airharmony/

4.60 While stakeholders are likely to support Option 1, some stakeholders (particularly MNOs, but also FWA operators[174]) may also prefer the inclusion of the 2.1 GHz Band in light of the benefits of additional spectrum described above. In that regard, 2.1 GHz Band is currently used with the 800 MHz, 900 MHz and 1800 MHz bands to provide mobile services, and could be considered highly complementary to the 700 MHz Duplex, given the similarities between the 700 MHz Duplex and the 800 MHz and 900 MHz bands.

4.61 The 2.1 GHz Band is likely to be primarily of interest to existing 2.1 GHz licensees (i.e. MNOs).

MNOs

4.62 The 2.1 GHz Band is one of two bands (the other being UMTS in 900 MHz) currently used to provide 3G services. MNOs are likely to continue operating 3G services in future, before refarming to enable provision of 4G and/or 5G services, and therefore should continue to require the band for the provision of 3G services beyond licence expiry (Vodafone's and Three's licences expire in 2022). For example:

a) 2G and 3G networks are still required to deliver voice calls across the country;

b) 3G networks are required to provide data services where 4G services are not currently provided; and

c) a large number of consumers still have 3G handsets[175].

4.63 However, this requirement is reducing and MNOs are likely to repurpose 2.1 GHz rights to provide 4G and ultimately 5G services over the duration of any new 2.1 GHz Band rights. For example:

- in relation to (a), the introduction of VoLTE will reduce the need for 3G networks to provide voice and Vodafone and Three have already announced their intention to rollout VoLTE in the next 12 - 24 months[176];

- in relation to (b), the continued rollout of 4G services by all operators will reduce the reliance on 3G networks for data over time; and

[174] For example, Imagine expresses support for the inclusion of the 2. 1GHz Band.
[175] By the end of Q3 2018, 50.0% of mobile subscribers were categorised as 4G network users, 36.6% were using 3G networks with the remaining 13.4% of subscribers using 2G networks only.
[176]https://www.irishtimes.com/business/retail-and-services/revenue-slips-10-at-mobile-operator-three-1.3176901

- in relation to (c), while 3G still accounts for around 37% of all subscriptions, this has fallen from nearly 70% in 2014, allowing such customers to be migrated from 3G to 4G.

4.64 Further, 3G services are also provided using 900 MHz spectrum, thus providing MNOs greater options in relation to providing 3G connections than in the 2.1 GHz band. It is likely that 3G spectrum will gradually be repurposed to provide 4G and 5G[177] services as the above developments intensify, with 3G networks potentially retiring over the duration of any new 2.1 GHz rights of use. For example, KPN in the Netherlands recently announced its intention to shut down 3G mobile voice/data network services by January 2022[178]. Similarly, Telenor will start phasing out 3G networks from 2019.[179] Finally, EE in the UK has refarmed some of its 2.1 GHz spectrum to provide 5 band carrier aggregations in certain areas.[180]

4.65 3G services will not, however, cease overnight. Rather, the reliance on such networks will reduce over time and across different geographic areas. The inclusion of the 2.1 GHz band in the Proposed Award would provide operators additional flexibility to evolve their networks in line with market developments and technology rollouts. For example, additional rights of use beyond expiry would allow repurposing to occur at a pace consistent with market developments (i.e. any operator that did not win additional rights of use would have to significantly reduce the capacity of its 3G networks on expiry).

4.66 In light of the above, all MNOs agree that 2.1 GHz rights of use need to be assigned significantly in advance of the expiry of existing licences:

- Vodafone submitted that if the issues around complexity can be resolved, it would favour including the 2.1 GHz Band in the Proposed Award;

- Eir favours new 2.1 GHz rights of use, but considers it may be inappropriate for the 2.1 GHz Band to be included in the Proposed Award, particularly if it were based on an auction[181] (see Assignment Option 2B below); and

[177] ECC has tasked ECC PT1 to review the existing ECC Decisions for the 2.1 GHz (ECC Decision (06)01) with a view to adapt the harmonised regulatory framework in these existing frequency bands to account for 5G. ECC PT1 has conducted technical analysis for the 2.1 GHz Band in Draft ECC Report 298. https://cept.org/ecc/topics/spectrum-for-wireless-broadband-5g
[178] https://overons.kpn/nl/nieuws/2018/kpn-gaat-in-2022-stoppen-met-3g-netwerk
[179] https://www.teliacompany.com/en/news/news-articles/2g-and-3g-networks-to-retire--norway-first-out/
[180] https://rethinkresearch.biz/articles/five-carrier-aggregation-sees-ee-refarming-3g-spectrum-for-lte/
[181] In that regard, Eir submitted that *"near term investment in the band would be deterred if future use of this spectrum is determined by an auction, and an existing operator's investments to date would be written off if it is driven out of the spectrum"*.

- Three favours new 2.1 GHz rights that would be assigned through an administrative award process directly to MNOs (see Assignment Option 2B below).

4.67 More generally, other stakeholders would likely consider the 2.1 GHz Band as substitutable to the 2.3 GHz Band and 2.6 GHz Bands as it has comparable propagation characteristics and is capable of providing additional capacity (or coverage).

4.68 Therefore, subject to concerns regarding award complexity being appropriately addressed (see Chapter 5), industry stakeholders would, on balance, likely prefer that the 2.1 GHz Band be included in the Proposed Award.

Option 1 v Option 4 (Inclusion of 1.4 GHz Centre Band with the Primary Bands)

4.69 While stakeholders are likely to be in favour of Option 1, some stakeholders may also prefer the inclusion of the 1.4 GHz Centre Band in light of the benefits of additional spectrum described above. ComReg first sets out information on the band that then assesses how that information would likely inform the views stakeholders.

Use of Band

4.70 The 1.4 GHz Centre Band is harmonised for the use of SDL which, as the name suggests, aims to provide additional downlink capacity to networks where the downlink resource is constrained due to asymmetry in data flows. As this band has no uplink capabilities, it needs to be used alongside another band/s and as such would be complementary to it.

4.71 The 1.4 GHz EC Decision allows the potential for the 1.4 GHz Centre Band to obtain a similar coverage footprint as sub-1 GHz spectrum bands when paired with low frequency spectrum such as the 700 MHz Duplex and 800 MHz[182], where this additional capacity would supplement a basic coverage layer provided by spectrum below 1GHz. While specific information on the deployments of SDL networks is limited, it appears initially that the band would be used as a complement to coverage bands such as the 800 MHz band and then at a later point to the 1800 MHz band[183], 2.6 GHz Band, 2.1 GHz Band,

[182] This arises because the uplink, which is the limiting factor for coverage, is only carried on the low frequency, while the 1400 MHz frequency is only used for the downlink. The 1.4 GHz EC Decision allows that the in block EIRP can be increased from 68 dBm/5MHz for specific deployments, for example for the aggregated use of spectrum within the 1.4 GHz band and spectrum in lower frequency bands..

[183] Insert range if not identified before 1 710 – 1 785 / 1 805 – 1 880 MHz

900 MHz[184] band and 3.6 GHz band[185]. ComReg understands that the devices currently available for the 1.4 GHz Centre Band are limited to operating alongside the 800 MHz band only.[186] As noted below, devices that even have this capability have limited availability in their own right.

Device support of the 1.4 GHz Centre Band

4.72 There are currently 83 devices capable of operating in 1.4 GHz Centre Band.[187] These devices are not all currently available in Ireland and some of the devices that are available are expensive, high-end devices (e.g. iPhone XR). While the increase in new devices indicates the development of a device ecosystem, operators are unlikely to be able to effectively use this band to any significant degree until a critical mass of users are able to receive the frequency on their device.

4.73 In that regard, ComReg recently tested 71 of the latest mobile handsets available on the Irish market in order to replicate the mobile user experience by measuring the receive performance for data and the antenna sensitivity patterns of mobile handsets.[188] A total of 107 phones currently available on the Irish market were tested across both voice and data tests.

4.74 A further analysis of these 107 handsets (104 smartphones) shows the following.

- 90 handsets support the 2.6 GHz Band;
- 65 handsets support the 2.3 GHz Band; and
- 7 handsets support the 1.4 GHz Centre Band.

4.75 This assessment shows that both the 2.3 GHz Band and 2.6 GHz Band are well supported across smartphones currently available on the market. In particular, both bands are supported across Samsung and Apple devices which account for around 60% of the market.[189] Devices that do not support these bands tend to be older generation 'pay as you go' devices that are typically associated with

[184] Insert range if not defined earlier 880 – 915 / 925 – 960 MHz
[185] ETSI TS 136 101 release 12 identified that inter band carrier aggregation is supported between the 800 MHz Band (Band 20) and the 1.4 GHz Centre Band (Band 32). In more recent releases other bands that can be carrier aggregated with the 1.4 GHz Centre Band have been added: Release 14: 1800 MHz band (band 3), 2.6 GHz Band (Band 7), Release 15: 2.1 GHz (Band 1), 900 MHz (Band 8), and 3.6 GHz Band (bands 42 and 43).
[186] For example the Samsung S9 is a LTE Category 18 device that has the capabilities to operate in accordance with the 3GPP Standard Release 13, i.e. where carrier aggregation is possible between 1.4GHz centre band and the 800 MHz Band but not with the other bands identified in the more recent releases.
[187] See Annex 4, sourced from https://gsacom.com/gambod/
[188] Mobile Handset Performance – Data, Document 18/82, published 19 September 2018.
[189] Mobile Consumer Experience, Document 17/100a, slide 32.

low data users. However, it is clear that the availability of handsets which support the 1.4 GHz Centre Band is much lower.

Support for 1.4 GHz Centre Band on existing base stations

4.76 ComReg understands from an assessment of the apparatus specified in MNO licences that the base station equipment (base transceiver station and antennas) are primarily multi-band and cover existing bands, such as the 800 MHz, 900 MHz, 1800 MHz, and 2.1 GHz bands, but also the 700 MHz Duplex, 2.6 GHz Band, and to a lesser extent the 2.3 GHz Band. However, existing base station equipment does not appear to cover the 1.4 GHz Centre Band. If so, an operator assigned 1.4 GHz Centre Band rights would therefore likely need to install additional/new specialised antenna equipment in order to use such rights.[190]

Future harmonisation of the band

4.77 While the 1.4 GHz Centre Band is harmonised for use as SDL[191] in Europe, as outlined in Chapter 3, the 1.4 GHz Band (i.e. the Centre Band and the Extension Bands) is also standardised on both a TDD and FDD basis for both LTE and 5G standards[192]. Further, and while noting that this is in the context of the 2.6 GHz Band, CEPT, when issuing a consultation on its draft revision of ECC Decision (05)05 for the 2.6 GHz Band, requested information[193] on the implementation of "Alternative 2: Supplemental Downlink blocks" in national authorisations. This was in order to determine if the SDL alternative should be kept in future revisions of ECC Decision (05)05. Noting the above, and the limited deployment of SDL networks to date (see Chapter 3), it is possible that the harmonisation status of this band may emerge as a topic for consideration.

4.78 Given the above, ComReg outlines below stakeholders' likely preferences.

MNOs

4.79 First, and as identified in Chapter 3, Eir and Vodafone disagreed with ComReg's proposal in Document 18/60 to exclude the 1.4 GHz Centre Band, whereas Three agreed with the proposed exclusion of this band. The reasons informing these views, and ComReg's assessment of same, are set out in Chapter 3 and they are not repeated here.

[190] https://www.kathrein.com/en/solutions/mobile-communication/products/antennas-accessories/outdoor-antennas/

[191] SDL is a mobile broadband system, which by means of base station transmitters in the network, uses unpaired spectrum in downlink to provide a supplemental downlink capacity to carry comprehensive data requirements. SDL provides additional downlink capacity to networks where the downlink resource is constrained due to the asymmetry in data

[192] http://www.3gpp.org/

[193] See Cover letter to draft revision of ECC/DEC/(05)05

4.80 Second, while stakeholders are generally likely to prefer additional substitutable spectrum in the same award process, there is some uncertainty on future plans for the band and additional uncertainty as to whether any rights awarded would be used efficiently in the years following the Proposed Award.

4.81 In relation to the latter issue, and as noted above, existing base station equipment would not appear to cater for the 1.4 GHz Band. If so, the process of upgrading sites to include 1.4 GHz Centre Band capability is unlikely to happen prior to the rollout of other Candidate Bands as operators would presumably prefer to capitalise on the more ready deployment of the other Candidate Bands. In its Mobile Termination Rate consultations and draft model, ComReg observed that an asset life of 8 years is used for base station equipment. Therefore, depending on the asset life of existing base station equipment it could be a number of years before operators would be incentivised to upgrade such assets to take make use of 1.4 GHz Centre Band rights.

4.82 Further, some operators may wish to defer assignment of 1.4 GHz Centre Band rights of use if they do not have an immediate need for same as this would allow them to observe developments and make preparations for any future award. This would allow operators to deploy using rights of use assigned in the other bands, which are largely compatible[194] with their existing networks (i.e. no significant equipment upgrades are required), and then assess the need for 1.4 GHz Centre Band spectrum. In the meantime, in order to increase capacity on its network, an MNO would likely use 2.3 GHz Band and 2.6 GHz Band which can be of immediate use on a significant portion of existing base stations.

4.83 Finally, even if MNOs upgraded their networks to support the 1.4 GHz Centre Band, it is only supported on 7 handsets, which have only recently become available and correspond to high-end expensive handsets and can only be used with 800 MHz. Further, while consumer handsets typically tend to be around 2-3 years old, around 10% are over 5 years old, rising to 20% in rural areas where the 1.4 GHz Centre Band could also be used. Assuming all new phones on the market would have 1.4 GHz Centre Band capability it will likely take at least 3 years of handset churn until a sufficient number of subscribers have compatible devices and over 5 until all areas, particularly rural areas, are capable of benefiting from the band to any significant degree. It would take longer again before all consumer handsets compatible with the 1.4 GHz Band could operate alongside the full range of spectrum holdings (i.e. bands other than 800 MHz). In that regard, Three agrees that it is preferable to wait until more clarity is available regarding take-up and standardisation of the 1.4 GHz Band.

[194] Depending on the particular operator and base station, existing equipment may not be compatible with 2.3 GHz in certain areas.

4.84 Alternatively, MNOs may prefer to include the 1.4 GHz Centre Band and/or other SDL spectrum in the Proposed Award. At least 40 MHz of rights of use (1.4 GHz Centre Band) is available for assignment and 83 devices are capable of operating in 1.4 GHz Centre Band.[195] Stakeholders may prefer to be assigned rights of use as part of this award in order to guard against capacity constraints that may arise in the future or in the event of significant delays in refarming the 1.4 GHz Extension Bands For example, Eir would prefer the inclusion of SDL spectrum more generally by including the 1.4 GHz Centre Band and the 700 MHz Duplex Gap.

Fixed Wireless Providers

4.85 Fixed Wireless Providers are likely to be indifferent about the inclusion of the 1.4 GHz Centre Band. For example, in response to Document 18/60, Imagine agreed with ComReg's proposal not to include the 1.4 GHz Centre Band in the Proposed Award.

4.86 While the 1.4 GHz Centre Band has recently been added by 3GPP to be carrier aggregated with the 3.6 GHz band, it is likely to take time before fixed wireless equipment becomes available. Given the current rollout plans of existing Fixed Wireless Providers, the 1.4 GHz Centre Band is unlikely to be of any real benefit. It does not offer any uplink possibilities which is likely to be more important for Fixed Wireless Providers given the higher upload requirement from fixed broadband services.

4.87 Further, the available capacity (40 MHz) is relatively small and any rights of use assigned to a Fixed Wireless Provider would likely be small (if a band-specific spectrum cap were applied).While the 1.4 GHz Centre Band has the potential to offer a similar coverage footprint to a sub-1 GHz deployment[196] this is only possible when paired with low frequency spectrum, such as the 800 MHz band, which may be less relevant to Fixed Wireless operators given the typical network configuration for fixed wireless as described above.[197] Pairing with 3.6 GHz would provide additional capacity within the coverage area of the 3.6 GHz spectrum but not beyond this.

Other Operators/New entrants

[195] https://gsacom.com/gambod/ report as per March 2019 that there are 83 devices in band 32 increasing from 41 in May 2018

[196] This arises because the uplink, which is the limiting factor for coverage, is only carried on the low frequency, while the 1400 MHz frequency is only used for the downlink. The 1.4 GHz EC Decision allows that the in block EIRP can be increased from 68 dBm/5MHz for specific deployments, for example for the aggregated use of spectrum within the 1.4 GHz band and spectrum in lower frequency bands

[197] While not implausible, DotEcon are of the view that there is unlikely to be demand from fixed wireless operators for the 700 MHZ band as the limited amount of contiguous spectrum in the sub-1 GHz bands makes it less attractive for providing services that require higher capacity links.

4.88 The 1.4 GHz Centre Band would likely be a low priority for potential new entrants. While a new entrant would be able to rollout a new network and provision for 1.4 GHz Centre Band from the outset, consumer handsets would still lag significantly behind and those handsets are only compatible when the 1.4 GHz Centre Band is used in conjunction with the 800 MHz band (which is not available to a new entrant). A potential new entrant's first priority would be to obtain a mixture of coverage and capacity / performance bands, noting that the 1.4 GHz Centre Band can only be used with existing rights of use.

4.89 Other operators such as Airspan are unlikely to be interested in the 1.4 GHz Centre Band. In response to Document 18/60, Airspan noted that it is not focused on "macro" bands like 700 MHz and the 1.4 GHz Centre Band. For example, the 1.4 GHz Centre Band is not operational on its outdoor [198] or Pico[199] base station equipment. Notwithstanding, Airspan preferred the inclusion of the 1.4 GHz Band in the Proposed Award.

4.90 In line with the responses received to Document 18/60, stakeholders are likely to have contrasting views on the inclusion of the 1.4 GHz Centre Band. Notwithstanding, the inclusion or otherwise would not appear to significantly benefit or compromise any individual operators network plans. For example, while Vodafone would prefer to include 1.4 GHz Centre Band in this award, it notes that the band is not a high priority and its value is less than other bands.

4.91 Therefore, ComReg is of the preliminary view that, on balance, some industry stakeholders would prefer not to include the 1.4 GHz Centre Band in the Proposed Award and others would prefer that this band be assigned at a later date.

Impact on Competition

4.92 Before assessing each of the options under this heading, ComReg sets out some relevant information below on the interaction between spectrum awards and competition.

[198] https://www.airspan.com/airharmony/.
[199] https://www.airspan.com/wp-content/uploads/2017/02/AirSynergy-Product-Spec-Sheet.pdf

4.93 A key objective in designing and carrying out this award process is to encourage the efficient use and ensure the effective management of the radio frequency spectrum in order to promote competition and maximise the benefits for consumers in terms of price, choice and quality. In that regard, ComReg briefly explains how the release of additional spectrum rights in the same award typically encourages efficient assignment and use of spectrum which, in turn, should promote competition on the relevant downstream markets to the benefit of consumers. The impact on consumers is assessed separately after this section.

4.94 There are important competition and efficiency reasons for including substitutable and complementary spectrum in the same award process. Where demand for spectrum in different bands is interdependent (substitutable and/or complementary), a joint award for such spectrum reduces the risk of an award participant being assigned rights of use in some but not all of its preferred bands, and provides an opportunity for different types of award participants (with potentially different intended uses and technologies) including potential new entrants to participate in an award.

4.95 In particular, it increases the ability of award participants to express a full suite of preferences, thereby enhancing the efficiency of the award outcome which, in turn, has a positive impact on competition. If spectrum in different bands are substitutable or complementary, the demand for spectrum in a particular band (and the value placed on this spectrum) may be affected by the availability and price of spectrum in other bands. For example, in an open award process, bidders can observe the relative prices of spectrum in different bands and change valuations and consequent demand for spectrum across those bands in response to these emerging relative prices. Even a sealed bid award can provide for efficient outcome if bidders express their preferences over a sufficiently large number of packages so that all combinations of lots that might potentially be relevant in the efficient assignment are included.

4.96 The ability of operators to compete for different packages of spectrum promotes competition in downstream markets as they are likely to have different requirements across the various bands and would be able to differentiate themselves from rivals downstream, to a greater or less extent, depending on the rights of use that are ultimately assigned. As a result, depending on whether additional bands are included or not may affect the efficiency of the assignment across bidders. By providing a mix of interdependent bands in the same award it increases competition during the award as bidders with similar uses cases are likely to compete for the same spectrum bands across different quantities.

4.97 An appropriate mix of spectrum across different bands provides flexibility to adapt to changes in, among other things, technologies, demand from end-users and market developments. As noted by DotEcon, access to additional spectrum should tend to reduce the long-run marginal costs to MNOs of expanding network capacity, which in turn should have pro-competitive benefits that should be passed on to consumers.[200] This has clear advantages in terms of promoting spectrum use and related services, and in turn intensifying competition in downstream markets. It also provides a good opportunity to acquire significant bandwidth of contiguous spectrum and therefore promote entry and the development of new services for consumers. This benefit is particularly pronounced given the growth in consumer demand for wireless data services and the consequent increased demand for wireless broadband spectrum.

4.98 In contrast, where substitutable or complementary spectrum is awarded in separate and consecutive award processes, operators' valuations of spectrum in different bands will necessarily be based on the expected price of substitutable and complementary spectrum to be awarded in subsequent processes, rather than the actual valuation (if assigned in the same award). However, bidders would likely be incorrect in their expected valuations as it would be based on the expected price and availability of substitutable and complementary spectrum to be awarded in the future. If expectations with regard to future prices or availability are incorrect then a sequential process may lead to an inefficient assignment of spectrum.

4.99 This is likely to have impacts on downstream competition if a bidder's expectations about price and consequently the spectrum it would receive in a future award are incorrect. If a bidder's ability to compete in downstream markets is dependent on spectrum assigned across different bands, which are awarded sequentially, then there is a risk that bidders who would have been able to deliver a particular set of services for a given mix of spectrum cannot because its views on what it would have been assigned across different awards was incorrect.

4.100 The appropriate release of harmonised spectrum bands in the past has proven to be successful in promoting competition and facilitating the delivery of services to end-users. It also lowers the risk of artificial scarcity in an award where substitutable and complementary spectrum bands are available for release. As there is demand to use this spectrum for the provision of more advanced WBB services, leaving it to remain fallow for a period of time without clear reason would, ostensibly at least, not be an efficient use of that spectrum and would not therefore promote competition in the WBB sector.

[200] DotEcon Report, Document XX/YY, p 38.

4.101 Finally, the joint award of interdependent spectrum would increase the potential for new entry on account of the mix of spectrum above and below 1GHz and g the increased supply of contestable spectrum rights.

Option 1 v Option 2 (Inclusion of 2.3 GHz Band with the Primary Bands)

4.102 In light of the above discussion, ComReg is of the preliminary view that the inclusion of 2.3 GHz Band would promote competition both within the Proposed Award and in downstream broadband markets. In summary:

- all frequencies are potentially available for release (subject to further information on Rurtel) at the time of the Proposed Award;
- the band is likely to be of interest to a wide range on interested parties (i.e. MNOs, FWA Providers and other operators):
    - it has similar propagation characteristics to the 2.6 GHz Band and other Candidate bands and is harmonised for WBB or MFCN services;
    - it provides TDD spectrum that can be used to account for asymmetric traffic flows;
    - there is a large existing ecosystem of handsets and existing network equipment can accommodate 2.3 GHz Band to a greater or less extent; and
    - additional TDD rights are likely to be of interest to FWA operators;
- its inclusion would provide more contestable spectrum for incumbents and new entrants and would provide increased opportunities for bidders to compete and switch between various spectrum bands, promoting competition during the Proposed Award; and
- its inclusion would encourage new entry and promote competition between operators acquiring a portfolio of spectrum.

4.103 Accordingly, ComReg is of the preliminary view that the inclusion of the 2.3 GHz Band in the Proposed Award would have a positive impact on competition. Further, this preliminary view is indifferent as to whether any of the other Candidate Bands were also included in the Proposed Award.

Option 1 v Option 3 (Inclusion of 2.1 GHz Band with the Primary Bands)

4.104 In general terms, the inclusion of the 2.1 GHz band would provide similar benefits to competition as the inclusion of the 2.3 GHz Band as described above.

4.105 The inclusion of the 2.1 GHz Band would also allow for the timely determination of the future of this band beyond the expiry of existing licences. As noted above, the 2.1 GHz Band is currently used to provide 3G services across the State. If either Vodafone or Three were assigned no or reduced 2.1 GHz rights of use in an award process carried out in 2020, they would have circa two years to address any transition activities arising from same, and to consider network upgrades to 4G more generally.

4.106 Alternatively, new rights in the 2.1 GHz Band could be assigned in a separate award process following the Proposed Award (the former of which would also require a detailed consultation process in advance of this separate award process[201]). In this scenario, ComReg firstly observes that there presumably would remain the potential for Vodafone and/or Three to be assigned no or reduced 2.1 GHz rights. However, as the consultation process for this separate award may not conclude until close to the expiry of existing licences in 2022, then there would be less time before licence expiry for measures to be undertaken by an existing licensee to adjust their network to the outcome of this separate award (including obtaining no spectrum or less spectrum than presently held).

4.107 In contrast, the inclusion of the 2.1 GHz Band in the Proposed Award would allow MNOs to better plan the rollout of LTE2100 by providing earlier certainty around what 2.1 GHz rights they would have in the long term. In that context, any rollout of LTE 2100 prior to 2022 (Three and Vodafone) without visibility of their long term 2.1 GHz holdings may involve significant investment uncertainty and could result in inefficient investments.

4.108 In that regard, the inclusion of 2.1 GHz Band would promote efficient investment and innovation in new and enhanced infrastructures by facilitating any network refresh and rollout programme in an efficient manner by permitting it to avoid what would otherwise be inefficient investment costs.

4.109 Accordingly, ComReg is of the preliminary view that the inclusion of the 2.1 GHz Band in the Proposed Award would have a positive impact on competition. Further, this preliminary view is indifferent as to whether any of the other Candidate Bands were also included in the Proposed Award.

Option 1 v Option 4 (Inclusion of 1.4 GHz Centre Band with the Primary Bands)

4.110 The inclusion of the 1.4 GHz Centre Band would, on its face, provide similar benefits to competition as the inclusion of the 2.3 GHz Band as described above. However, there are a number of issues that separate the 1.4 GHz Centre

[201] ComReg has statutory obligations to appropriately consult on any such award process which would mean that any such award process would unlikely take place significantly in advance of current licence expiry dates.

Band from other Candidate Bands in terms of suitability for inclusion in the Proposed Award. These have already been set out in detail above (in the section considering the views of stakeholders on this band), but are summarised below.

4.111 For example, it is questionable whether the 1.4 GHz Centre Band is suitable for release at this time. In particular, there is uncertainty over a number of issues that could result in the inefficient assignment and use of the band, thereby reducing competition and benefits to consumers, including:

- it is possible the current harmonisation status of the 1.4 GHz Centre Band for SDL in Europe may be reviewed and modified[202], noting the limited deployments of SDL in the 1.4 GHz Centre Band to date, and the 3GPP standardisation of the 1.4 GHz Band (i.e. Centre Band and Extension Bands) which also provides for both a FDD and TDD band plan;

- It is unlikely that operators would realistically use the 1.4 GHz Centre Band to any great extent in the years following the Proposed Award[203]. In order for an operator to effectively use additional spectrum it requires both base stations and end user devices to transmit and receive the relevant frequencies:

    - in the period following 2020 there is likely to be limited base station equipment or end user devices to facilitate the efficient use of the 1.4 GHz Centre Band;

    - operators are likely to focus on the deployment of other spectrum bands first, noting that the other Candidate Bands are widely deployed globally by networks and are implemented across a large number of handsets[204];

- In the absence of substantial demand for this band, one could artificially stimulate demand by making it available at a relatively low minimum price. However, this could result in the premature award of spectrum rights which may inefficiently displace or restrict valuable future uses.

4.112 Conversely, there would appear to be a number of reasons for delaying the

[202] While noting that this is in the context of the 2.6 GHz Band, CEPT, when issuing a consultation on its draft revision of ECC Decision (05)05 for the 2.6 GHz Band, requested information on the implementation of "Alternative 2: Supplemental Downlink blocks" in national authorisations. This was in order to determine if the SDL alternative should be kept in future revisions of ECC Decision (05)05

[203] Further, ComReg understands that current antenna systems are not designed / optimised to operate in the 1.4 GHz Band, as such dedicated equipment may be needed.

[204] See Table Annex 4 on device availability per band

release of this band. For example:

- greater certainty about the long term band plan would likely be available in the years following the Proposed Award;
- operators should be in a better position to use the 1.4 GHz Centre Band to deliver services as:
    - 1.4 GHz Centre Band capability can be added to existing networks in line with the end of the asset life of existing equipment; and
    - users device will have greater 1.4 GHz Centre Band capability as consumers replace older devices over time;
- the proposed inclusion of the 2.3 GHz Band (100 MHz) and the 2.6 GHz Band (190 MHz) should be sufficient to satisfy any capacity constraints[205] that may arise in the medium term, and the absence of the 1.4 GHz Centre Band would be unlikely to create any artificial scarcity concerns that could compromise competition in the Proposed Award;
- it would be difficult to determine appropriate rollout obligations to ensure the efficient use of the spectrum given uncertainty about when user and base station equipment is likely to be rolled out to sufficient levels.

4.113 In light of the above, ComReg is of the view that, while the 1.4 GHz Centre Band is available for use and a device ecosystem is beginning to develop, effective management of the radio frequency spectrum in order to promote competition would be better facilitated by awarding the band in a separate and subsequent process.

Impact on Consumers

4.114 It can be assumed that what is good for competition is, in general, good for consumers because increased competition between wireless service providers brings benefits to customers in terms of price, choice and quality of services.

4.115 As outlined previously, consumer demand for WBB has grown significantly in recent years and is expected to continue growing over the coming years. The spectrum bands under consideration in this draft RIA are all suitable for the provision of such services which should increase consumer welfare. ComReg notes that each of the bands assessed below involves additional spectrum being made available for assignment to existing operators or potential new

[205] Noting also that the assignment of the 700 MHz Duplex, while particularly suited for rural deployments, would provide additional capacity wherever it's deployed in addition to the other bands already providing capacity.

entrants. In that regard, ComReg sets out below the main reasons why consumers would likely benefit from the assignment of additional spectrum rights of use.[206]

Benefits of additional spectrum to consumers

4.116 The avoided costs from using additional spectrum to meet rising demand for mobile broadband rather than investing in additional base stations should lead to lower prices. In competitive markets, it is expected that network cost savings would partly be passed onto consumers in the form of improved and/or lower cost services.

4.117 The cost of improving network performance (e.g. increasing average user speeds) without new spectrum may be so high that it is unprofitable to attempt to do so. Hence, the speeds and quality of service that an operator offers in practice are likely to be partly determined by how much spectrum it acquires. The deployment of additional spectrum enables considerably higher user data rates and supports a greater number of users, all of which will substantially enhance the user experience. This includes faster download speeds and the ability to support a greater number and variety of users. These benefits are consistent across all options below that assign additional rights of use

Option 1 v Option 2 (Inclusion of 2.3 GHz Band with the Primary Bands)

4.118 As noted above, the inclusion of the 2.3 GHz Band in the Proposed Award would, on balance, have a positive impact on competition, which in turn should benefit consumers. There are other reasons why the addition of this band should benefit consumers. For example, the benefits to consumers in terms of higher quality and speeds as described above.

4.119 In addition to the benefits of additional capacity for MNOs, the 2.3 GHz Band provides a large amount of contiguous spectrum suitable for providing fixed wireless services across a large area. For example, like the 3.6 GHz band, the 2.3 GHz Band might be viewed as a 'performance' band for fixed wireless services, increasing the availability of suitable spectrum for fixed wireless operators and increasing the prospects of new entry.

4.120 The band also provides increased opportunity for operators to manage asymmetric data flows in the future. High quality and high resolution audio-visual services are important drivers for increased downlink data rates, whereas user generated content, including sharing of social media and/or video calling is the main driver for increased uplink data rates.

4.121 Smartphones are increasingly becoming 'creation' devices that upload or share

[206] Subject to appropriate competition caps.

content with other uses. Features such as high quality cameras for video and photos along with sophisticated software and hardware capabilities allow digital processing and advanced online gameplay[207] all of which use uplink capacity. Similarly, users are uploading information from mobile devices to cloud services and sharing photos via social networks making upload capacity increasingly important on a per GB basis even if the downlink/uplink ratio is increasing. Therefore, consumers are likely to favour options which provide operators with flexibility, where it is needed, as this would likely lead to improved performance of applications/services which require additional uplink capacity.

4.122 In light of the above, ComReg is of the preliminary view that including the 2.3 GHz Band in the Proposed Award would, on balance, be more beneficial for consumers than not.

Option 1 v Option 3 (Inclusion of 2.1 GHz Band with the Primary Bands)

4.123 As noted above, the inclusion of the 2.1 GHz Band in the Proposed Award should, on balance, have a positive impact on competition, which in turn should be to the benefit of consumers. Also, the inclusion of the 2.1 GHz band would, at a minimum, likely retain the benefits already provided to consumers through the use of the band. Importantly, as noted above, the inclusion of the 2.1 GHz Band in the Proposed Award would, compared to a separate and subsequent award, provide MNOs with earlier certainty about future 2.1 GHz holdings and thus a longer period to reorganise their 3G networks in a timely manner prior to the expiry of existing rights of use.

4.124 In addition to the benefits of including additional capacity in the Proposed Award, the inclusion of the 2.1 GHz Band would facilitate operators liberalising 2.1 GHz rights of use earlier than would otherwise be the case giving MNOs the choice to deploy more advanced technologies to cater to changing consumer demands. This would provide operators with the opportunity to rollout 4G services using the 2.1 GHz Band up to two years (Vodafone and Three) and seven years (Eir) earlier than what would be possible under existing licence conditions. As noted by DotEcon, "*Applying an early liberalisation option on the current 2.1 GHz licences would mean that (where efficient), the spectrum could be used earlier for the provision of services other than UMTS. This may bring about significant benefit for consumers and potential cost savings for operators*

[207] The data requirements for games can often be significant as uplink and downlink will have to be synced with unnoticeable latency to ensure appropriate performance. The uplink requirements are likely to increase as games become cloud based in the future. For example, Microsoft are developing a game streaming network to unlock console gaming on any device and the service will work across Xbox, PCs, or phones.
http://telecoms.com/490215/microsofts-cloud-gaming-ambitions-set-to-further-test-network-capacity/

by facilitating transition to more spectral efficient technologies." [208]

4.125 In light of the above, ComReg is of the preliminary view that including the 2.1 GHz Band in the Proposed Award is, on balance, more beneficial for consumers than not.

Option1 v Option 4 (Inclusion of 1.4 GHz Centre Band)

4.126 As noted previously, the inclusion of this band in the Proposed Award is unlikely to have much if any impact on stakeholders or competition. Conversely, there appear to be good reasons for delaying the release of this band in terms of encouraging the efficient use and ensuring the effective management of the radio frequency spectrum. On that basis, ComReg is of the preliminary view that excluding the 1.4 GHz Centre Band from the Proposed Award and instead assigning it in a separate future award process is, on balance, more beneficial for consumers.

4.3.2 The 'Spectrum for Award' RIA: Preferred Option (Step 5)

4.127 In light of the above, ComReg is of the preliminary view that including the 700 MHz Duplex, 2.6 GHz Band, 2.3 GHz Band and 2.1 GHz Bands in the Proposed Award (i.e. Options 2 and 3 together) ("Award Bands") is the preferred option in terms of the impact on stakeholders, competition and consumers.

4.4 The 'Assignment Process' RIA

4.128 As noted earlier, Step 1 of the RIA (Policy Issues and Objectives) is common to both the 'Spectrum for Award' RIA and the 'Assignment Process' RIA.

4.129 Before setting out the specific options under review in this draft RIA, ComReg first sets out some background information regarding different ways in which spectrum rights can be assigned and some key characteristics of these assignment mechanisms. ComReg does not favour any one process for assigning new rights of use of spectrum as a matter of principle; it decides the most appropriate process in each individual case. In this regard, there are two main ways by which to award new rights of use.

1. **Administrative Assignment**: the regulator determines who obtains spectrum, how much they obtain and the location of the frequencies within the band, and the price paid; or

2. **Competitive market mechanism**: the interaction of bidders during the award determines who wins the spectrum and the price paid, subject to objective and transparent rules set *ex ante* by the regulator

[208] DotEcon Award Design Report p 22.

(e.g. an auction).

4.130 Each process will typically have its particular advantages and disadvantages and one process may, on balance, be found to be the most suitable in light of the particular factual matrix, including the characteristics of the spectrum to be assigned, the types of rights of use to be awarded and the anticipated demand for the spectrum.

4.4.1 Background Information

4.131 An administrative assignment can take many forms depending on the specific issues that need to be addressed. For example, it could:

- involve the administrative grant of spectrum to certain operators (such as incumbents), the reservation of spectrum for particular groups (such as new entrants) or the reservation of spectrum for other purposes;
- involve a comparative award (or "beauty contest") if there are particular objectives in mind;
- also take the form of an extension or renewal of an existing licence or an administrative assignment of spectrum to particular operators, for a particular period of time; or
- involve simple granting of licences where uses are not incompatible, for instance in relation to point to point links.

4.132 Administrative approaches are likely to be most beneficial where there is no competition for a large amount of spectrum. Administrative awards, however, rely on the regulator making decisions, with the intention of promoting the efficient use of spectrum, where such decisions could be made with significant information asymmetries. This approach raises concerns that regulators may pick the incorrect technologies, services or licensees.

4.133 Spectrum auctions are designed to incentivise bidders to express their willingness to pay for spectrum rights, and aims to assign the available rights of use of spectrum to the bidders who value it the most. An appropriately designed auction extracts information regarding bidders' willingness to pay for the rights of use of spectrum thereby enabling an assignment to the bidders who value the spectrum most.

4.134 By ensuring that those bidders who value the spectrum the most obtain the rights being offered, auctions should result in an efficient outcome in terms of

assignment.[209] Using an auction to assign spectrum mitigates the risk of the regulator making incorrect decisions, as a result of not having access to all relevant information, which could have long standing negative effects on the relevant market/s. Moreover, auctions provide a transparent and non-discriminatory mechanism to allocate rights of use of spectrum relatively quickly and this mitigates the risk of prolonged challenges to the outcome of the allocation process.

4.135 Auction formats however are silent on the type of services that should be provided by the winning bidders. Where spectrum for award that is currently being used to provide certain existing services is assigned to an operator who utilises the spectrum to provide unrelated services, there is a danger consumers reliant on existing services would be left unserved. Where this occurs additional measures to protect consumers may be necessary (e.g. transition measures).

4.136 ComReg has previously expressed views on the assignment of spectrum rights by auction or administrative award[210] and has most recently articulated this in its Electronic Communications Strategy Statement: 2017 – 2019.[211]

4.137 In particular, in Document 15/140 ComReg identified a number of outcomes that a regulator would need to determine in any spectrum award *irrespective of the assignment format adopted*:

1. Which electronic communications networks/services, using which technologies, are going to be the ones most likely to provide the greatest end-consumer benefits over the proposed duration of the rights being awarded?

2. Which of all the interested providers of the ECN/ECS (and using potentially different technologies) identified in (1) are going to be the ones most likely to provide the greatest end-consumer benefits over the duration of the rights being awarded and should, therefore, be issued said rights?

3. Determination of the quantum of spectrum rights in each of the proposed bands that should be assigned to each provider identified in (2).

[209] Each bidder's valuation of spectrum should be dependant on the value it believes it can derive from the use of the spectrum and is therefore a good proxy for the overall economic value likely to be generated from such use.
[210] Chapter 3, Document 14/101, ComReg (2014) 'Spectrum Award – 2.6GHz Band with possible inclusion of 700 MHz, 1.4, 2.3 and 3.6 GHz Band; Chapter 3 of Document 15/70,ComReg (2015) 'Consultation on Proposed 3.6 GHz Band Spectrum Award'; and Chapter 3 of Document 15/140, ComReg (2015) 'Response to consultation and draft decision on proposed 3.6 GHz band spectrum award' (page 32)
[211] Document 17/31 at paragraph 5.49.

4. Determination of which part of the band those spectrum rights identified in (3) should be located.

4.138 The award outcomes are less relevant where demand is unlikely to exceed supply over the duration of the rights being awarded. Administrative assignments are likely to be appropriate in such circumstances as each of the award outcomes can be established through the demands of interested parties. In this situation, there is less risk of the regulator assigning the spectrum in a manner which would result in its inefficient use, since all competing requirements can be provided for.

4.139 However, where demand is potentially greater than supply, ComReg, in an administrative assignment process, would have to make an administrative determination on each of the award outcomes listed above. ComReg is of the preliminary view that demand for the new rights of use in one or more of the proposed bands is likely to exceed supply as described in the draft Spectrum Award RIA ('Demand for Spectrum') and these award outcomes are likely to be central to the Proposed Award.

4.140 Readers are referred to Document 15/140 for a detailed discussion on each of the award outcomes.

4.4.2 Identifying the options

4.141 In light of the above, there are two broad regulatory options available to it for the purposes of assigning rights of use in the 700 MHz Duplex, 2.6 GHz Band, 2.3 GHz Band and the 2.1 GHz Band:

- assign some or all spectrum rights of use by administrative assignment; or
- assign some or all spectrum rights by way auction.

4.142 The responses to Document 18/60 and the subsequent Nera Report (commissioned by Three) express the view that it is appropriate to consider both an auction and/or an administrative assignment as an assignment process for the Proposed Award. Further, two distinct categories of administrative assignment were suggested.

4.143 **First,** Nera submits in relation to the 2.1 GHz Band that there is a strong case for an administrative award of 2.1 GHz rights directly to MNOs with 2×20 MHz assigned directly to each operator. ComReg considers this proposal under Assignment Option 2B below.

4.144 **Second**, Eir submits that it is time to move away from CCA formats to another format reflective of the more mature market. In that regard, it notes the experience in France where the regulator agreed to extend spectrum licences

(giving up future income) to MNOs for ten years in return for firm commitments to enhance 4G coverage[212]. ComReg notes a number of pertinent points in relation to the French award that could inform a potential option in this draft RIA:

- the award procedure was a beauty contest open to any interested market player. The procedure was the result of an agreement between the French government and the mobile operators in January 2018[213][214];
- coverage obligations applied to licences that were due to expire in the period up to 2021 and 2024[215]:
    - 900 MHz (2×30 MHz)[216] – obligation to increase density of 900 MHz sites to enhance availability of voice and SMS services;
    - 1800 MHz (2×65 MHz)[217] - coverage of main roads and regional railway connections and applicants could include additional commitments for commuting trains; and
    - 2 GHz bands (2×90 MHz)[218] - commitments to improve indoor mobile coverage and/or to provide fixed broadband services in remote areas;
- Only the four existing MNOs applied for licences.

4.145 ComReg also observes that:

- the French assignment process was an administrative assignment, with provision for it to become an auction if there were was excess qualified demand; and

[212] The main obligations for the new licensees in the French award are to improve and increase access to mobile networks: to cover areas with no or very poor coverage and to enable access to mobile broadband everywhere. The tender document also included specific obligations to improve mobile connectivity on main roads, from regional railway connections and indoor. Applicants could also propose additional coverage commitments in the 1800 MHz and 2 GHz bands. Source: Cullen International.
[213] https://www.cullen-international.com/product/documents/FLTEFR20180005
[214] If more than four applicants (number of MNOs) had qualified for a band, the selection would have been based on:
- a single round sealed bid auction for the 900 MHz band;
- commitments for better coverage inside trains for the 1800 MHz band; and
- commitments for better indoor coverage for the 2 GHz band.

[215] https://www.cullen-international.com/product/documents/FLTEFR20180005
[216] Free Mobile has 2×10 MHz rights of use until 2030.
[217] Free Mobile has 2×15 MHz rights of use until 2030.
[218] Orange, SFR and Free all have 2×10 MHz rights of use expiring in 2030.

- auction processes previously run by ComReg (e.g. 2012 MBSA and 3.6 GHz Award) would, if there was no excess demand, have degenerated to administrative assignment at the reserve price.

4.146 Accordingly, it appears that there is little difference at the level of principle between the two approaches.

4.147 ComReg notes that the only rights of use available for reassignment in Ireland are 2.1 GHz rights of use. However, it is unlikely that Eir is referring to this band with respect to improving 4G coverage. Alternatively, it would appear that Eir may be suggesting that rights of use to the 700 MHz Duplex should be assigned to the MNOs in return for certain unspecified coverage obligations. [219] ComReg observes that such obligations would appear to be 'Interventionist' and considers this proposal under Assignment Option 2A below.

4.148 ComReg therefore considers that three regulatory options are available to it:

- **Assignment Option 1**: Assignment of all available spectrum using a competitive, open, transparent auction format; or
- **Assignment Option 2:** Assignment of some or all available spectrum band by administrative assignment. In particular:
  - ***Assignment Option 2A*:** Assignment of 2×10 MHz of 700 MHz Duplex rights of use to each MNO by administrative assignment in return for interventionist coverage obligations.
  - ***Assignment Option 2B*:** Assignment of 2×20 MHz of 2.1 GHz rights of use to each MNO by administrative assignment in return for fees that reflect the market value.

4.149 ComReg notes that each option is not mutually exclusive and that the overall preferred option could involve one or more of the above options.[220] In that regard, ComReg assesses each Option individually and determines the overall preferred option at the end of this draft RIA.

[219] DotEcon (Document 18/103d) distinguish between precautionary and interventionist coverage obligations:
- Precautionary coverage obligations - where the obligations do not exceed the levels of coverage that might be expected anyway from well-functioning competition between network operators;
- Interventionist coverage obligations - which can be expected to constrain the commercial choices of network operators and force coverage in excess of competitively determined levels

[220] For example:
- Assignment Option 1 only (i.e. assign all rights of use by auction);
- Assignment Option 1 and Assignment Option 2B (i.e. assign rights of use to 2.1 GHz administratively and the remaining rights of use by auction)
- Assignment Options 1 and Assignment Option 2A (i.e. assign rights of use to 700 MHz Duplex administratively and the remaining rights of use by auction)

4.150 The following sections of the draft 'Coverage RIA' consider the impact of the aforementioned regulatory options on:

i. industry stakeholders (being existing operators and potential new entrants)

ii. competition, and

iii. consumers.

4.151 ComReg intends to further develop this draft RIA in light of feedback to this consultation.

Determining the impact on industry stakeholders

4.152 There are a number of key industry stakeholders in relation to the matters considered in this chapter:

- existing mobile operators (Vodafone, Three and Eir);
- existing FWA operators including:
  - licensees with spectrum rights of use in the 3.6 GHz band (e.g. Imagine);
  - parties which currently provide fixed wireless services using other licensed (10.6 GHz) or unlicensed (5.8 GHz) spectrum;
- other providers (small cell operators e.g. Dense Air[221]);
- potential new entrants (e.g. an MVNO or entirely new entrants to mobile or fixed wireless services);
- economic or industrial sectors who have the potential to change business models for MNOs relative to the current marketplace, (largely standardised services) with differentiation limited to pricing[222] .

Impact on stakeholders

4.153 A stakeholder that submitted an award proposal is likely to prefer the option that most closely reflects that proposal. Otherwise, stakeholders are likely to prefer an option which would offer the greatest amount of contestable spectrum (so as to provide the greatest chance of obtaining spectrum rights). ComReg assesses each of the 3 regulatory options in turn.

[221] Dense Air provides wireless-based solutions for both 'network densification' and 'network extension' by providing 'Small Cells as a Service'.
[222] Study on Implications of 5G Deployment on Future Business Models No BEREC/2017/02/NP3 - A report by DotEcon Ltd and Axon Partners Group.

MNOs

4.154 MNOs have submitted a variety of different views in relation to the assignment process for the Proposed Award.

4.155 Vodafone supports the use of an auction as the most appropriate assignment process for this award. For example, it recently noted "*in principle the assignment of spectrum though open transparent auction processes has facilitated the roll-out of competitive mobile networks and we believe (will) be the best solution to meet customer demand for increased capacity and new technologies in the future*."[223] Similarly, in response to Document 18/60, it generally expressed support for an auction to assign rights of use to the bands under assessment.

4.156 Notwithstanding, it may prefer a form of administrative assignment suggested by Nera (commissioned by Three) and/or Eir. In particular, it may prefer the administrative assignment of 700 MHz Duplex (Assignment Option 2A) and 2.1 GHz rights of use (Option 2B) whereby each MNO would receive 2×10 MHz and 2×20 MHz.

- In relation to Assignment Option 2B, Vodafone may prefer such an assignment as it would increase its 2.1 GHz holdings by an additional 2×5 MHz. However, the current spectrum asymmetry would only apply for less than two years and Vodafone may prefer to compete for all long term rights of use across all the Award Bands. For example, in response to Document 18/60, Vodafone noted that if all issues related to the 2.1 GHz Band can be resolved sufficiently without causing overall delay, it would favour including the 2.1 GHz Band in the Proposed Award.

- In relation to Assignment Option 2A, while Vodafone may prefer to be assigned an additional 2×10 MHz (700 MHz Duplex), such an assignment would retain the existing asymmetry of sub-1 GHz holdings until 2030 at the earliest. In contrast, the competition caps proposed (see Chapter7) would provide Vodafone with the opportunity to be assigned 2×15 MHz 700 MHz Duplex compared with 2×10 MHz for Three. Accordingly, an administrative assignment of 2×10 MHz rights of use would deny Vodafone the opportunity to reduce the existing sub 1 GHz spectrum asymmetry vis-à-vis Three.

4.157 Therefore, in line with its previously stated views, Vodafone is likely to prefer an appropriately designed auction because this would provide it and other operators with an equal opportunity to access all available spectrum rights of use.

[223] Response to Document 18/74 – Draft Spectrum Strategy Statement.

4.158 In response to Document 18/74, Three expressed support in general for the use of auctions. However, it cautioned that the auction mechanism and rules must be chosen to suit the award, and that ComReg should "*start from fresh*" and consider all options for the award mechanism. Similarly, in recent correspondence submitted with its Nera Report, Three also expressed support for the use of auctions but expressed a view that ComReg should switch to a simpler, better adapted format (see Chapter 7 for discussion on preferred format). ComReg notes the following:

- in relation to the 2.1 GHz Band, Three is likely to prefer Assignment Option 2B given its support for its Nera Report;
- in relation to Assignment Option 2A, Three may prefer an administrative assignment of 2×10 MHz of 700 MHz Duplex rights of use since this would also be the maximum it could obtain under the proposed competition caps (meaning it would retain its sub 1 GHz spectrum advantage over Vodafone until 2030 at the earliest);
- however, Assignment Option 2A would also involve interventionist obligations. In that regard, ComReg notes Three's view that onerous coverage obligations should be a separate and distinct stage from the assignment of spectrum.[224] In particular, the Nera Report expressed caution against attaching onerous obligations as this would create artificial scarcity of "clean" spectrum and may distort bidding across the whole auction.

4.159 Overall, it would appear that Three would prefer a combination of Assignment Option 1 and Assignment Option 2B, whereby 2.1 GHz rights of use are assigned administratively and all remaining rights of use are assigned by way of auction.

4.160 Eir provided a variety of views which depend on the band in question; however, it would appear to favour the administrative assignment of both the 700 MHz Duplex and 2.1 GHz Band:

- in relation to the 700 MHz Duplex, Eir is likely to prefer Assignment Option 2A as this best represents its submission to Document 18/60;

[224] Three Nera Report Briefing Note to ComReg 15 January 2019,

- in relation to Assignment Option 2B, in its response to Document 18/60, Eir submitted that "ComReg must ensure that spectrum holdings in the 2100MHz band are equalised so that no operator is allowed to maintain an unfair advantage in access to spectrum that will distort competition". Therefore, Eir is likely to prefer the administrative assignment of 2×20 MHz to each MNO.

4.161 Overall, it would appear that Eir would prefer a combination of all Assignment Options (Assignment Option 1 and Assignment Option 2A and Assignment Option 2B) whereby 2.1 GHz and 700 MHz Duplex rights of use are assigned administratively, and remaining rights of use assigned by way of auction.

Fixed Wireless Providers

4.162 Assignment Options 2A and 2B are unlikely to be favoured by FWA operators as both options would assign spectrum rights of use directly to MNOs. FWA operators would likely prefer Assignment Option 1 over Assignment Option 2A or 2B as it would provide for the assignment of all available spectrum rights on a service and technology neutral basis and would give all operators an equal opportunity to access spectrum up to and including on a national basis. The administrative award of some, or all, of the Award Bands for mobile would exclude other providers (e.g. FWA operators) entirely or reduce the quantum of spectrum available to FWA operators and could cause the cost of any residual spectrum rights of use to artificially increase.

4.163 In that regard, ComReg notes that Imagine believes that CCA is a suitable mechanism for the auction and assignment of the proposed bands given the recent experience of the CCA auction process for the 3.6 GHz band .[225]

4.164 Therefore, ComReg is of the preliminary view that Fixed Wireless Providers would likely prefer Assignment Option 1 (Auction).

New Entrants/Other operators

4.165 Potential new entrants would likely prefer an assignment process which best facilitates new entry (which could be either an administrative assignment or auction). While new potential entrants would likely prefer a reservation of spectrum made solely for new entrants, they may, depending on the options available, also prefer an open, transparent competitive award format for all available spectrum. In terms of the 3 regulatory options, new entrants are likely to prefer Assignment Option 1, as they would be given an equal opportunity to access spectrum according to their valuation of the spectrum, as expressed by their willingness to pay (i.e. there would not be any direct assignments to

[225] Imagine response to Document 18/60.

existing MNOs).

Impact on competition

4.166 The impact on competition is assessed at two levels which are interconnected:

- competition during the award process, where bidders/applicants compete with each other in order to be assigned spectrum rights; and
- downstream retail competition between winning bidders and other market participants in affected downstream markets. The promotion of competition at this level is a primary goal of the Proposed Award because competition at retail level is ultimately what drives consumer benefits, such as in terms of price, quality and choice of the relevant services.

Competition during the award process

4.167 At a general level, subject to the award process preventing highly asymmetric outcomes (to safeguard downstream retail competition), the more intense the competition in an assignment process (the greater the level of participation), the higher the likelihood that the spectrum usage rights will be awarded to those operators that value it the most, and who are incentivised to use the spectrum most efficiently and compete most vigorously in the downstream retail market.

Administrative assignment

4.168 ComReg assesses Assignment Options (Option 2A and 2B) below.

Assignment Option 2A and 2B

4.169 First, any form of assignment which excludes certain users from participating in the award process reduces the level of competition within the award process. The more extensive the restriction, in terms of the possible assignment outcomes which it precludes, the more likely it is that the actual optimal assignment outcome is precluded from arising. Indeed, the request for a reservation of the band for a particular use/user in the first place suggests that more than one type of user would have participated in the award absent such reservation and/or there is an unwillingness to pay the fees that may have arisen from a more open award process.

4.170 Options 2A and 2B would result in extensive restrictions given that rights of use would be assigned directly to MNOs (noting that a less extensive restriction would be to allocate to a particular use). In particular, both options would exclude all other potential bidders for rights of use, including new entrants[226], FWA operators and/or small cell providers:

- under Assignment Option 2B, 2.1 GHz rights of use would be assigned directly to the three MNOs and there would be no competition to determine the most efficient use(s), user(s) or quantum of spectrum between same[227]. Any competition between bidders would be limited to determining frequency positions within the band. For example, Three is currently positioned at opposite[228] ends of the band and a reduction in rights of use to facilitate an increase of 2×5 MHz in the other two MNOs would likely result in preferences across the different positions with the band; and

- under Assignment Option 2A, 700 MHz Duplex rights of use would also be assigned directly to the three MNOs and there would also not no competition to determine the most efficient use(s), user(s) or quantum of spectrum between same. There could be some limited competition for additional coverage commitments in return for additional spectrum above a minimum requirement.[229] In terms of frequency locations, any competition for specific positions within the 700 MHz band would likely be marginal as new rights of use in a "greenfield" spectrum band are unlikely to generate significant competition for positions in the band;

[226] It would be possible In the French award, if more than four applicants (number of MNOs) would have been qualified for a band, the selection would have been based on:
- a single round sealed bid auction for the 900 MHz band;
- commitments for better coverage inside trains for the 1800 MHz band; and
- commitments for better indoor coverage for the 2 GHz band.

[227] Further, the quantum of spectrum between the MNOs would be fixed (i.e. split. equally) where (i) symmetric holdings are not required for effective competition (see Competition Caps Section 7.7), (ii) it may be more efficient for some MNOs to hold more or less spectrum and/or (iii) conversely, differences in quantum may allow an operator to adopt differentiated strategies/services (e.g. a small operator with a relatively large amount of spectrum in a band/s to provide higher speeds/capacity so as to grow market share).

[228] Three currently holds two separate licences to use radio spectrum in the 2100MHz band for the provision of 3G services. This situation arose following the acquisition by Three Group of Telefonica Ireland in 2014. Three is licenced to use 6 blocks in total, however they are divided into two groups of three at opposite ends of the band, given the spectrum blocks in Three's 2.1 GHz licence were not contiguous with the spectrum blocks in Telefonica's licence.

[229] In the French award, applicants could include additional commitments for commuting trains using 2.1 GHz Band. Applicants could also propose during the beauty contest commitments to improve indoor mobile coverage and/or to provide fixed broadband services in remote areas.

- In relation to other forms of administrative assignment, the lack of transparent procedures in an administrative award limits the extent of competition within the award. Specifically:
    - applicants may be unable to respond to specific commitments made by competing applicants and even where they can, the potential lack of effective objective selection criteria may make it difficult for competing applicants to determine the effectiveness of the offers (in terms of the outcome) they make; and
    - applicants may be exposed to substitution risks and be unable to increase or decrease their requirements in response to alternative rival requirements, particularly where some applicants may be indifferent between one or more bands. In this way competition between bands and during the award would be restricted.

4.171 Further, the administrative assignment of one or more bands could reduce competition for other bands that would be available in open competition. For example, suppose a potential new entrant had a minimum package requirement of 2×5 MHz - 700 MHz Duplex; 2×10 MHz - 2.1 GHz Band; 2×10 MHz - 2.6 GHz Band; and 2×10 MHz- 2.3 GHz Band. Under Assignment Option 2A or Assignment Option 2B, a new entrant would be unable to acquire sub 1 GHz rights of use and may not compete for any of the remaining rights of use that would have been subject to open competition. In effect, MNOs would benefit from the administrative assignment of rights of use in the 700 MHz Duplex and 2.1 GHz bands in Assignment Options 2A and 2B, and the resulting reduction in competition for spectrum in the remaining bands. Even where a new entrant could apply under an administrative assignment process, it would be difficult for such an entrant to meet with interventionist coverage obligations in the 700 MHz Duplex for example absent any existing network.

4.172 In relation to fees, under Assignment Option 2A, the assignment of 700 MHz Duplex rights of use would be provided in return for interventionist coverage obligations. However, under Assignment Option 2B, Three suggests that the price be set at market value. In that regard, it is difficult for ComReg to make an accurate assessment of a market price that reflects the opportunity cost of the spectrum rights. This is exacerbated by the fact that usage fees, if any, prescribed under Assignment Options 2A or 2B would be unlikely to encourage licensees to return unused or underused spectrum if they do not reasonably reflect the opportunity cost of the reserved use. Therefore, absent a suitable fee structure, the assignees would have little incentive to consider that the frequencies administratively assigned to them might be more efficiently used by other users. Accordingly, under these options long-term competition could be restricted because there would be less of an incentive to return the spectrum

over the duration of the licence to allow alternative users provide services.

4.173 In addition, whereas auctions rely on binding bids to elicit credible information from bidders as to the value they attach to spectrum as a basis for an efficient outcome, no such incentives for truthful revelation exist in the case of an administrative award. This is because parties involved would have an incentive to overstate the services delivered (and/or the value of same) from the use of the spectrum. In that context, ComReg prefers winners of spectrum rights to seek to use them efficiently based on economic incentives, rather than by potentially having to resort to sanctions/litigation to compel compliance with commitments made in seeking an administrative assignment.

4.174 Moreover, if spectrum rights have been assigned at below the "*opportunity cost*", there may have been some other bidders who would have been prepared to pay more. This could be inefficient as the spectrum is not assigned at the highest value amongst alternative uses.

4.175 Any administrative determination of fees is not straightforward, and could lead to inefficient use and or distortions to competition since:

- prices that are set too low could lead to unfair competition with others who are paying more for their similar rights of use of spectrum; or
- prices that are set too high could lead to scarce spectrum (a valuable public resource) being unused, or under-used.

4.176 Further, the administrative determination of fees could lead to disputes where licensees disagree with the level of fees set administratively by the regulator. For example:

- EE challenged Ofcom's 2015 decision to set new annual licence fees in the UK. The Court of Appeal quashed Ofcom's decision and, as a result, fees reverted back to a lower level which had applied for many years[230]; and
- In light of the above ruling, Vodafone lodged legal proceedings against Ofcom to reclaim the fees it considers have been overpaid. A ruling in the High Court in May 2019 found in favour of Vodafone against Ofcom over the issue.[231]

4.177 In relation to interventionist coverage commitments associated with Assignment Option 2B, ComReg discusses, in detail, its views in relation to appropriate

[230] https://www.ft.com/content/6ab98d6a-cf85-11e7-b781-794ce08b24dc
[231] https://www.ft.com/content/e4a22ff4-78be-11e9-be7d-6d846537acab

coverage obligations in Chapter 8. ComReg observes that Assignment Option 2A would appear to involve a symmetric obligation across all three operators given Eir's suggestion of 2×10 MHz each. However, as noted by DotEcon[232], applying interventionist coverage obligations symmetrically could reduce participation and competition in spectrum awards. Among other things, there may be operators (either existing MNOs or potential new entrants (if permitted)) unable to meet such an obligation and, if so, imposing the obligation on all MNOs might prevent some parties participating altogether when it might have been socially optimal for them to be awarded spectrum. Alternatively, an administrative award with a symmetric obligation (where one operator is provided 2×10 MHz in return for coverage commitments) might not be favoured by certain MNOs if only one operator would be assigned rights of use directly with the remainder assigned by auction.

4.178 Further, because there is a limited field of potential suppliers of coverage, this would likely weaken competition and lead to sub-optimal coverage outcomes. In particular, the administrative procurement of coverage would require the regulator to assess the costs associated with providing coverage and there would be significant questions about the extent to which each operator would be capable of extending services to a determined level. Such an assessment across competing operators would require, at a minimum, detailed information about existing networks and expectations about how such operators would rollout services in the future. For example, bidders may have different net costs of providing additional coverage where smaller networks may be less able to partially offset the costs of improved coverage or quality of service. In that regard, some bidders may be better able to meet coverage requirements than others, leading to reduced competition and potentially poor value for money in the provision of better coverage.

4.179 It would therefore be very difficult for the regulator to make an accurate assessment of what additional coverage would be required above what would be delivered on a commercial basis and there is a risk that spectrum would be assigned inefficiently if coverage obligations were not met. This approach also creates perverse incentives by creating a risk of applicants exaggerating future business cases to boost their chances of being assigned spectrum directly. In this way, certain operators could be able to distort competition within the award and gain additional rights of use that are not reflected in underlying efficiency and ability to deliver additional coverage efficiently.

Assignment Option 1 (Auction)

4.180 Auctions typically take a service and technology neutral approach allowing all credible bidders to compete for the same spectrum rights. As such, they can be

[232] Coverage obligations and spectrum awards a report from DotEcon Ltd, Section 2.6.

beneficial in terms of:

- removing the burden on the regulator to make complex judgements (based on incomplete/imperfect information) in relation to assigning the spectrum and the suitable level of fees. In particular, auctions are better at eliciting relevant information about the value (and efficient assignment) of the spectrum that is likely not available to the regulator. E.g. the value that different undertakings place on those rights of use, in light of the potential different uses (and networks/technologies for same) and business cases for same etc, over the lifetime of the rights of use;

- incentivising bidders to reveal information about their preferences and valuation of spectrum through their willingness to pay also enables rights of use to be assigned to the bidders who value them most, and who are, in turn, sufficiently incentivised to use the spectrum most efficiently and compete vigorously in the downstream retail market/s'

- ensuring that all potential acquirers of the spectrum rights can compete on an equal basis for all available spectrum, and not artificially on the basis of any measures designed to favour incumbency for example;

- promoting competition during the award and allowing bidders to switch back and forth across complementary and/or substitutable bands in response to the evolution of prices and valuations of other bidders. In that regard, it is desirable to allow bidders to switch between different bands as the award process progresses as the choices made by bidders are not static and likely vary depending on the choices made by other bidders.

- allowing the market to determine the specific frequency assignments for each winning bidder, which should promote efficient assignments based on information about bidders' preferences that would otherwise not be available to the regulator. In that regard, ComReg notes that in previous similar awards, preferences existed across different parts of the bands as evidenced by the assignment bids received in the last three spectrum awards (26 GHz band – 2017[233], 3.6 GHz band– 2016[234] and 2012 MBSA[235]).

[233] Vodafone paid an additional price of €200,000 for specific frequency assignments. https://www.comreg.ie/publication/results-of-the-26-ghz-spectrum-award-2018/
[234] For example, Vodafone paid and additional price of € 230,012 for specific frequency assignments.https://www.comreg.ie/publication/results-3-6-ghz-band-spectrum-award-2/
[235] For example, Meteor, Telefonica and Vodafone paid €89,136, €300,058 and €2,109,275 for specific frequency assignments. https://www.comreg.ie/?dlm_download=frequency-arrangements-and-results-of-the-multi-band-spectrum-award-process

4.181 In relation to fees, where demand for spectrum is likely to be greater than supply, the use of a market mechanism for assignment[236] (such as a well-designed auction with prices set on the basis of opportunity cost[237]) can help to:

- establish the efficient assignment of spectrum amongst bidders, based on bidders' willingness to pay (which can be expected to reflect the economic value they are able to generate); and
- establish the opportunity costs of the assignment, setting suitable spectrum usage fees at a level that represents market value (and could be considered fair) and encourages the winning bidder(s) to utilise the spectrum more efficiently, including incentivising the return of unused or underused spectrum to the regulator; and
- significantly reduce the risk of subsequent challenges on the level of fees required to provide for optimal use because the final prices also represent the level at which winners are willing to pay for the spectrum rights;

4.182 Separately, auctions can be designed so that, if there is an excess of spectrum over the aggregate demand from all bidders in the first round, they degenerate into a simple administrative assignment. This has been the case with a number of ComReg's previous auctions.

4.183 Coverage obligations should not exceed the levels of coverage that might be expected anyway from well-functioning competition between network operators and therefore should not impact competition within an auction. However, where coverage in excess of competitively determined levels is required (as would seem to be suggested by Eir under Option 2A)[238] auctions can lead to certain unavoidable distortions, including that:

- such obligations may exacerbate asymmetries between bidders, in that some bidders may be more able to meet the obligations than others (indeed some bidders may not be able to deliver such coverage obligations at all);
- such obligations could create an opportunity for an operator to exploit its relatively strong position in competing for a coverage lot to leverage its

[236] Wherever spectrum is scarce, this implies that there is an 'opportunity cost' associated with distributing the spectrum to particular uses and users.
[237] Efficient spectrum assignment generally requires rights of use to be assigned to those users able to make the best economic use of it, and for the users of the assigned spectrum to make use of it in the way that generates the greatest social benefit.
[238] Eir refer to the French example where rights of use were assigned with an agreement to accelerate mobile coverage without going through an auction and the State giving up future income. The foregone auction revenue reflecting the cost to network operators of meeting the obligation to extend coverage.

cost advantage to obtain more spectrum; and,

- it is possible that the winner of a coverage lot gets a discount on spectrum in return for a coverage level it would have provided anyway (i.e. an undue benefit).

4.184 In contrast, auction formats offer flexibility and, depending on the willingness to pay for additional coverage, DotEcon advises that there are options for how such obligations might be provided which would ensure that distortions of the spectrum award process are kept to a minimum. For example, DotEcon states that "*Auctions offer considerable flexibility to resolve some of these problems. Although seldom used to date, auctions have the potential to explore award of alternative levels and forms of coverage obligation depending on their relative cost*."[239] In particular, and depending on the particular circumstances, it may be possible to split the award of spectrum and the procurement of a coverage improvement into two stages within an award process or to procure a coverage obligation in an entirely separate process from spectrum either before or after the award of spectrum. This would usefully allow bidders to compete on the basis of providing coverage rather than making bids in order to receive spectrum rights of use.

4.185 Therefore, and for the reasons stated above, Assignment Option 2 (Auction) would, in ComReg's view, better promote competition within the award process (even where "interventionist"-type coverage obligations are required).

Competition in downstream markets

Administrative Assignment (Options 2A and 2B)

4.186 The various EC Decisions[240] relating to the proposed bands requires a service and technology neutral approach be applied.

4.187 In that regard, ComReg firstly recalls that Options 2A and 2B would involve the direct grant of equal spectrum rights of use to incumbent MNOs.

4.188 Whilst only granting spectrum rights of use to specific parties or category of parties, such as MNOs (or other operators), could be appropriate if the supply of spectrum is likely to exceed demand for same, doing so where there is the potential for demand to exceed supply (such as this proposed award), runs the risk of the assigned spectrum being used inefficiently and/or distorting

[239] Coverage obligations and spectrum awards a report from DotEcon Ltd, published November 2018.

[240] For example:

- EC Decision 2008/477/EC of 13 June 2008 ("2.6 GHz EC Decision");
- (EU) 2016/687 of 28 April 2016 ("700 MHz EC Decision").

downstream competition.

4.189 In that regard, ComReg observes that over the duration of the rights of use the basis for competition could change or shift from the data rates and prices offered by the different platforms towards converged services and content demanded by end-users. Additionally, in terms of technology both mobile and FWA operators are converging in terms of transmission standards, with both sectors moving towards adoption of LTE technology and in the future to 5G standards. In such circumstances, Options 2A and 2B would deny rights of use to other operators (FWA operators or small cell operators) and/or new entrants[241]. This would place such bidders who may have the potential to provide a more efficient and differentiated range of services at a disadvantage by reducing the overall amount of spectrum in the award or even exclude them altogether from certain bands. This could act as a barrier to innovation, entry and/or expansion if such applicants were excluded from applying for some or all spectrum. Certain applicants might use spectrum rights of use less efficiently than others would have (had they succeeded in acquiring it), particularly in light of the convergence of services and technologies in the future.

4.190 In addition, ComReg cannot rule out the possibility of new entry across any of the relevant downstream markets. For example the 3.6 GHz Award resulted in one incumbent FWA Provider (Imagine), three MNOs and a new small-cell operator obtaining spectrum rights of use. Furthermore, ComReg notes that the acquisition of Telefónica Ireland by Hutchison 3G[242] contains a commitment to offer divestment spectrum[243] to the Upfront[244] (or Second MVNO[245]) and any such MVNO may wish to be assigned additional rights of use as part of the proposed award process. Assigning rights of use to incumbents would deny such entrants or any other new entrant the opportunity to acquire additional rights of use in the proposed bands. Similarly, reserving spectrum rights of use for new entrants could raise competition issues in the future if such an entrant was the Upfront MVNO.

4.191 Second, ComReg further observes that even the administrative assignment to incumbents has the potential to create inefficient outcomes. For example, as Options 2A and 2B would involve the assignment of a symmetric quantum of rights to the incumbents, they necessarily preclude asymmetric outcomes which

[241] Potential new entrants who do not currently provide any services using spectrum in the State
[242] Case No COMP/M.6992 HUTCHISON 3G UK / TELEFONICA IRELAND.
[243] The Divestment Spectrum available is:
(a) 2×5 MHz of 900 MHz spectrum in Time Slice 2 (13 July 2015 to 12 July 2030);
(b) 2×10 MHz of 1800 MHz spectrum in Time Slice 2 (13 July 2015 to 12 July 2030); and
(c) 2×10 MHz of 2100 MHz spectrum for the remainder of the licence period until 24 July 2022.
[244] The Upfront MVNO is Virgin Mobile which currently has around [✂[redacted]] customers and [✂[redacted]] market share. – ComReg Quarterly Reports.
[245] The Second MVNO 'ID Mobile' ceased offering services in April 2018 and no other MVNO has entered the market since. https://www.comreg.ie/id-mobile-ceasing-services/

may have been more efficient in terms of better promoting competition. As noted in Chapter 7, ComReg observes that asymmetric outcomes may be compatible with a diversity of operators engaging in effective downstream competition provided the asymmetry is not too extreme.

4.192 More generally, an assignment of spectrum to less efficient operators under an administrative assignment could lead to reduced competition and, consequently, lower quality services being offered by less efficient operators and higher prices from more efficient operators offering improved services. If such an award process fails to deliver an efficient outcome there may well be a negative impact on downstream competition. Therefore, there is a risk that applicants seeking to provide services to consumers may be awarded less spectrum than would be efficient, or none at all, while less efficient operators are awarded all, or excessive rights of use.

4.193 In relation to more interventionist coverage commitments envisaged under Option 2A, the extent to which an obligation could be delivered by each incumbent mobile operator would likely depend on a number of factors including existing network densification and rights of use already assigned. Since it is more cost effective to add spectrum (compared to densifying the network) any decisions taken by a regulator could distort competition by assigning comparable rights of use to MNOs who have been slower or less efficient compared to competing networks.[246] Options 2A and 2B could also compromise efficient investments already made and also create investment distortions in the future if incumbents have an expectation that future rights of use will be assigned to them exclusively.

4.194 Further, ComReg notes DotEcon's advice that applying interventionist obligations asymmetrically (i.e. only to a subset of network operators, or to just one) helps to avoid inefficient duplication of networks in rural areas, where the demand density is low and natural monopoly conditions are likely to apply due to strong scale economies in very lightly loaded networks. In that context, ComReg observes that should interventionist obligations be appropriate, then an auction format would be capable of providing for such outcomes while also assigning rights of use efficiently and preventing distortions to competition.

Assignment Option 1 (Auction)

4.195 Under an Option 1, all existing operators (fixed and mobile) and potential new entrants would be afforded the same opportunities to compete for, acquire, and use spectrum rights (subject to any competition caps). As such, an auction

[246] The availability of spectrum, demand for throughput, cost of denser networks and more spectrally efficient radio systems together result in an optimum configuration at any point in time. As spectrum is finite but network density is variable it is important that operator are incentivized to use it efficiently. Very low cost would incentivize inefficient use.

would, firstly, avoid issues around having to make any *ex-ante* determinations as to the most efficient users or service providers, particularly where the regulator does not have perfect information.

4.196 Auctions can entail the risk that bidders may try to reduce or distort the competitiveness of the auction in order to restrict the total number of winning bidders and so gain a competitive advantage (e.g. by preventing new entry or foreclosing access to spectrum required by incumbents to maintain or enhance existing services) and/or to reduce the amounts paid by winning bidders. This could restrict the number of undertakings capable of providing downstream retail services which, in turn, could reduce competition in the provision of those services. As a result, consumers could have less choice and some services may be of relatively low quality, because the service providers lack sufficient spectrum to provide services.

4.197 However, auctions can also include measures designed to safeguard and promote competition in downstream markets to the ultimate benefit of end users. For example, the use of competition caps to prevent extreme asymmetric outcomes and minimum prices to reduce incentives for bidders to engage in strategic behaviour during an auction to decrease the eventual price(s) paid[247]. This includes tacit collusion during an auction and arrangements entered into before an auction begins and which are aimed at reducing competition between bidders.[248] Other measures to reduce collusion include having a carefully designed information policy.

4.198 In relation to interventionist coverage obligations envisaged under Option 2A, auctions can also be designed to be flexible enough to allow for market testing of coverage obligations at different levels and of different forms and ensuring that value for money is obtained in the provision of coverage (i.e. a winning bidder delivers the maximum amount of coverage relative to other competing bidders and that it is awarded only if the cost of doing so is not too high). As noted by DotEcon[249], it is possible to procure a coverage obligation in an entirely separate process either before or after an award of spectrum. Because the provision of coverage is based on a bidder's private valuation of delivering that coverage (rather than the value of the spectrum), as opposed to an assessment by the regulator, the extent to which such obligations are delivered upon is higher as a bidder's private valuation would be based on the costs of delivering that coverage.

4.199 Therefore, and for the reasons stated above, Assignment Option 1 would, in

[247] Note also that minimum prices that are too high might have a negative impact on competition if smaller participant/new entrants are discouraged from participating, so there is a balance as discussed in Chapter 7 below.
[248] See Section 4.3 DotEcon Report 17/85a.
[249] Document 18/103d, Coverage obligations and spectrum awards a report from DotEcon Ltd, Section 5.2.

ComReg's view, better promote downstream competition.

Impact on consumers

4.200 Generally, consumers will prefer the option which has the greatest potential to promote competition, thereby maximising the long term benefits to consumers in terms of choice, price, and quality. They are also likely to favour options which avoids or minimises any significant disruption to existing services.

Assignment Option 2 (Administrative assignment)

4.201 The administrative assignment of spectrum rights of use is likely to be beneficial to consumers where sufficient spectrum is available to satisfy all possible licensees and services, and those services are made available to consumers on an equal basis. Similarly, short term assignments may be beneficial in order to prevent significant disruption to existing services[250] [251] or to facilitate the efficient assignment of longer term rights of use[252]. However, as noted above, demand is likely to exceed supply in the present case, and an administrative assignment to certain MNOs (or indeed any other operator) under Option 2A and 2B would deny such spectrum to other potential providers of services, including potentially more efficient providers of services, that consumers may be interested in receiving (e.g. fixed wireless broadband).

4.202 Consumers would likely be negatively impacted if the administrative assignment of spectrum resulted in restricting other potential services. Options 2A and 2B runs the risk of assigning rights of use to MNOs when an assignment to alternative operators would have been the more efficient and more beneficial outcome to consumers. This could, among other things, impact on competition and potentially delay the introduction of more advanced mobile data services. Any negative impact of the administrative assignment of rights of use would fall on consumers[253] and even a relatively small negative effect could result in a substantial aggregate loss over the duration of the new rights of use. Further, fees set administratively may not provide appropriate incentives for operators to uses spectrum efficiently over the duration of the spectrum rights. Such a scenario could be damaging where an operator does not returned unused rights of use when it would have done so if the fees were set appropriately (denying access to other licensees who could deliver services).

[250] Interim 1800 MHz Rights of Use for the period 1 January 2015 to 12 July 2015 Consultation and Draft Decision, published April 2014.
[251] ComReg observes that the potential for service continuity issues to arise can also be addressed by non-award measures, such as the proposed transition arrangements and rules outlined in Chapter 9.
[252] See Chapter 5 for issues arising in the 2.1 GHz.
[253] Such effects could include higher prices and less choice than might otherwise have been available; and poorer quality services than might have been achieved with a more efficient spectrum assignment.

4.203 In relation to interventionist coverage obligations, the potential to deliver on commitments made in terms of coverage, rollout or investment ultimately affects the delivery of services to consumers and an effective ex ante mechanism to enforce the commitments made by applicants is difficult to achieve under Option 2A. In contrast, under Option 1, the use of binding bids ensures that bidders are committed to the bids they make, incentivising the delivery of services from the use of the assigned spectrum. Further, where commitments on coverage are made by incumbents in return for spectrum rights of use, such coverage, or a portion of it might ultimately have been provided absent such an assignment, and better coverage outcomes could have been obtained for consumers through a specific coverage procurement process after the competitive assignment of rights of use.

Assignment Option 1 (Auction)

4.204 As noted above, auctions are more likely to have a positive impact on downstream retail competition. By extension, this should benefit consumers through providing better choice, quality and pricing of services. By opening up the opportunity to obtain rights to use to all interested parties, an auction provides for a broader range of outcomes, including for differentiated services and/or technologies to be delivered in a timely manner.[254] It would also reduce risk of challenge from unsuccessful applicants as to the evaluation process and / or outcome of a beauty contest (as to insufficient transparency, objectivity, due diligence, etc.) and delays resulting with such challenges. In contrast to an administrative assignment, the use of binding bids in an auction ensures that bidders are committed to the bids they make, incentivising the delivery of services from the use of the assigned spectrum.

4.205 Further, as noted above, auctions can also be used to procure additional coverage where required. Coverage outcomes are likely to be greater through a competitive process as bidders are able to price the anticipated cost to network operators of meeting the obligation to extend coverage. This in contrast to the administrative determination of coverage where there is the potential for winner(s) of the coverage requirement to obtain spectrum rights in return for a coverage level it would have provided anyway, delivering less coverage than would have be obtained in a more competitive process.

4.206 In light of the above, auctions offer the following benefits, relative to an administrative assignment:

- all of the bands would be offered to all bidders and non-incumbents would not be restricted from participating;

[254] Consumers are more likely to gain access to the services in a timely manner, as the market mechanism in option 2 reduces the likelihood of challenge from dissatisfied bidders (which may delay the ultimate delivery of services to consumers).

- an auction better ensures that spectrum rights are assigned to those who most value those rights, and who are therefore best incentivised to maximise consumer welfare by using their assigned spectrum efficiently;
- an auction is more likely to ensure that none of the bidders are dissatisfied with the outcome, thereby minimising the prospect of delays due to litigation etc;
- an auction can assign spectrum more efficiently and also cater for interventionist coverage obligations without compromising the efficient assignment and creating distortions to competition; and
- an auction should therefore have the most positive impact on downstream retail competition and should therefore promote the interests of consumers in terms of the choice, price, and quality of electronic communications services.

4.207 ComReg therefore is of the preliminary view that consumers would likely prefer Assignment Option 1 over Assignment Options 2A and 2B.

4.4.3 Preferred option

4.208 This assessment has considered the impact of the various options from the perspective of industry stakeholders, as well as the impact on competition and consumers, and should aid stakeholders' understanding of the relative merits of the alternative assignment formats.

4.209 For the reasons outlined in this draft RIA, ComReg's preferred option is to make available the relevant spectrum rights using an appropriate auction format.

4.4.4 Overall Preferred Option

4.210 In light of the preceding two draft RIAs, ComReg is of the preliminary view that spectrum rights of use in the 700 MHz Duplex, 2.1 GHz, 2.3 GHz and 2.6 GHz bands should be assigned by way of an open, appropriate competitive auction format ("Overall Preferred Option").

4.211 In Chapter 7 of this document, ComReg considers a number of different types of competitive auction formats for the Proposed Award.

4.212 The following section assesses the Overall Preferred Option against ComReg's other relevant functions, objectives and duties.

4.5 Assessment of Preferred Option against ComReg's other relevant functions, objectives and duties

4.213 The draft RIAs considered a number of options potentially available to ComReg within the context of the RIA analytical framework as set out in the ComReg's

RIA Guidelines (i.e. impact on industry stakeholders, impact on competition and impact on consumers). It necessarily also involved an analysis of the extent to which various options would serve to facilitate ComReg in achieving certain statutory objectives in the exercise of its functions. In particular, it involved an analysis of the extent to which the various options would serve to promote competition and ensure that there would be no distortion or restriction of competition in the electronic communications sector, whilst at the same time encouraging efficient investment in infrastructure, promoting innovation and ensuring the efficient use and effective management of the radio frequency spectrum. This would enable ComReg to ensure that users would derive maximum benefit in terms of choice, price and quality.

4.214 In this section, ComReg assesses the Overall Preferred Option in the context of other statutory provisions relevant to the management of Ireland's radio frequency spectrum (which are summarised in Annex 2 of this document). It is not proposed to exhaustively reproduce those statutory provisions here. However, set out below is a summary of all statutory provisions which ComReg considers to be particularly relevant to the management and use of the radio frequency spectrum with an assessment (to the extent not already dealt with as part of the draft RIAs) of whether, and to what extent, the Overall Preferred Option accords with those provisions. In carrying out this assessment, ComReg has highlighted below some of the relative merits / drawbacks which would arise if it was to select some of the alternative options assessed under the draft RIA above.

4.215 For the purposes of this section, the statutory provisions which ComReg considers to be particularly relevant to the management of the radio frequency spectrum in the State are grouped as follows:

- general provisions on competition;
- contributing to the development of the internal market;
- to promote the interest of users within the Community;
- efficient use and effective management of spectrum;
- regulatory principles;
- relevant Policy Directions and Policy Statements; and
- general guiding principles (in terms of spectrum management, setting of fees and licence conditions):
    - Objective justification;
    - Transparency;

- Non-discrimination; and
- Proportionality.

General Provisions on Competition

4.216 There is a natural overlap between the aims of the draft RIAs and an assessment of ComReg's compliance with some of its statutory obligations and, in particular, one of its core statutory objectives under section 12 of the 2002 Act of promoting competition by, among other things:

- ensuring that users derive maximum benefit in terms of choice, price and quality;
- ensuring that there is no distortion or restriction of competition in the electronic communications sector;
- encouraging efficient use and ensuring effective management of radio frequencies;
- ensuring that elderly users and users with special social needs derive maximum benefit in terms of choice, price and quality; and
- ensuring that, in the transmission of content, there is no distortion or restriction of competition in the electronic communications sector.[255]

4.217 There are also other various statutory provisions requiring ComReg generally to promote and safeguard competition in the electronic communications sector including:

- Regulation 16(2) of the Framework Regulations which requires ComReg to apply objective, transparent, non-discriminatory and proportionate regulatory principles by safeguarding competition to the benefit of consumers and promoting, where appropriate, infrastructure based competition;
- Regulation 9(11) of the Authorisation Regulations which requires ComReg to ensure that competition is not distorted by any transfer or accumulation of rights of use for radio frequencies;
- Article 4 of Directive 2002/77/EC (Competition Directive) which requires ComReg to refrain from granting exclusive or special rights of use of radio frequencies for the provision of electronic communications services; and

[255] The final two statutory obligations were introduced by Regulation 16 of the Framework Regulations.

- General Policy Direction No. 1 on Competition (2 April 2004) which requires ComReg to focus on the promotion of competition as a key objective, including removing barriers to market entry and supporting new entry (both by new players and entry to new sectors by existing players).

4.218 Based on the draft RIAs, ComReg's preliminary view is that the Overall Preferred Option is the one that would best safeguard and promote competition to the benefit of consumers.

Contributing to the development of the Internal Market

4.219 In achieving the objective of contributing to the development of the Internal Market, another of ComReg's core statutory objectives under section 12 of the 2002 Act, ComReg considers that the following factors are of particular relevance in the context of this award process:

- the extent to which the Overall Preferred Option would enable ComReg to ensure that harmonisation of the use of radio frequency spectrum across the EU is promoted, consistent with the need to ensure its effective and efficient use and in pursuit of benefits for the consumer such as economies of scale and interoperability of services, having regard to all decisions and measures adopted by the European Commission in accordance with the Radio Spectrum Decision[256] (Regulation 17 of the Framework Regulations);

- the extent to which the Overall Preferred Option would encourage the establishment and development of trans-European networks and the interoperability of pan-European services, in particular by facilitating, or not distorting or restricting, entry to the Irish market by electronic communication services providers based or operating in other Member States; and

- in order to ensure the development of consistent regulatory practice and the consistent application of EU law, the extent to which ComReg has had due regard to the views of the European Commission, BEREC and other Member States in relevant matters, in selecting an option and considering any regulatory action required by ComReg in respect of such an option.

Promoting harmonised use of radio frequency spectrum across the EU

4.220 In relation to the first factor identified above, for the reasons set out in the draft 'Spectrum for Award' RIA, it is ComReg's preliminary view that the Overall

[256] Decision No. 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the EU.

Preferred Option would result in the award of harmonised spectrum rights of use in the selected bands which are suitable for the provision of advanced WBB services. In this regard, the Overall Preferred Option is consistent with and promotes the objectives of the relevant harmonisation decisions of the European Commission which emphasise the suitability of this band for WBB services.

Encouraging the establishment and development of trans-European networks and the interoperability of pan-European Services

4.221 ComReg notes the overlap between this objective and the objective of promoting competition in the provision of ECN/ECS. Encouraging the establishment and development of trans-European networks requires that operators from other Member States seeking to develop such networks are given a fair and reasonable opportunity to obtain spectrum rights of use required for such networks and, particularly, access to critical spectrum rights of use. Accordingly, options which would restrict or distort competition or otherwise unfairly discriminate against potential entrants (such as through administrative assignment of rights of use to critical spectrum to incumbent operators) would not, in ComReg's view, satisfy the requirements of this objective.

4.222 In this regard, ComReg refers to the 'Spectrum for Award' draft RIA and its preliminary finding that the Overall Preferred Option is likely to be preferred by new entrants. This is because the Overall Preferred Option would not involve an administrative assignment of valuable spectrum rights that is more likely to favour incumbents simply by virtue of their incumbency, with the associated disincentives for potential participation by undertakings from other Member States in the proposed award process. Such an approach would also be in line with service- and technology-neutrality requirements by not preferring existing services and technologies by virtue of incumbency.

Promoting the development of consistent regulatory practice and the consistent application of EU law

4.223 In relation to this aspect of contributing to the development of the internal market, ComReg continues to cooperate with other National Regulatory Authorities ("NRAs"), including closely monitoring developments in other Member States to ensure the development of consistent regulatory practice and consistent implementation of the relevant EC harmonisation measures and relevant aspects of the Common Regulatory Framework.

4.224 For instance, ComReg has had clear regard to international developments in the context of:

- promoting the provision of WBB services;

- considering whether to include other potential bands in the award process;
- harmonisation developments and equipment availability in relation to the potential candidate bands;
- licence durations for spectrum rights in the selected bands; and
- licence fees (and benchmarking in particular).

4.225 Furthermore, ComReg will continue to have regard to international developments as appropriate. In the present case, ComReg considers that the Overall Preferred Option is consistent with the approaches taken by and being considered in other Member States.

Promote the interest of users within the Community

4.226 The impact of the Overall Preferred Option and other options on users from a more general perspective and in the context of ComReg's objective to promote competition has been considered in the context of the above draft RIAs and it is not proposed to consider this matter any further.

4.227 ComReg also observes that the majority of measures set out in Section 12(2)I(i) to (vii) of the 2002 Act, aimed at achieving this statutory objective, are more relevant to consumer protection, rather than to the management of the radio frequency spectrum.

Efficient Use and Effective Management of Spectrum

4.228 Under section 10 of the 2002 Act, it is one of ComReg's functions to manage the radio frequency spectrum in accordance with a Policy Direction under section 13 of the 2002 Act. Policy Direction No. 11 of 21 February 2003 requires ComReg to ensure that, in managing spectrum, it takes account of the interests of all users of the radio frequency spectrum (including both commercial and non-commercial users) (see discussion on this policy direction below). Importantly, in pursuing its objective to promote competition under section 12(2)(a), ComReg must also take all reasonable measures to encourage efficient use and ensure effective management of radio frequencies. Section 12(3) of the 2002 Act also requires that measures taken with regard to encouraging the efficient use and ensuring the effective management of radio frequencies must be proportionate.

4.229 Regulation 9(11) of the Authorisation Regulations also provides that ComReg must ensure that radio frequencies are efficiently and effectively used having regard to section 12(2)(a) of the 2002 Act and Regulations 16(1) and 17(1) of the Framework Regulations.

4.230 In relation to Policy Direction No. 11, the draft RIAs set out above take into account the interests of all users of the radio frequency spectrum (and assesses the extent to which such interests are consistent with ComReg's own statutory obligations), both commercial and non-commercial. ComReg is of the view that the Overall Preferred Option is one that would safeguard and promote those interests.

4.231 In addition, the preferred spectrum assignment process (an auction) best facilitates efficient new entry, and encourages an efficient use of spectrum by those successful in the proposed assignment process. This is because an auction would ensure that, subject to reasonable constraints inherent in the design of an auction (e.g. spectrum competition caps), those who value the spectrum rights the most will win same and, because of these financial incentives, are the most likely to use the spectrum efficiently.

4.232 In that light, ComReg is of the view that the Overall Preferred Option complies with the obligations contained in the above statutory provisions. ComReg is also of the view that the alternative spectrum and assignment options considered would fail to satisfy the above provisions to the same extent, if at all.

Regulatory Principles

4.233 Under Regulation 16(2) of the Framework Regulations, ComReg must, in pursuit of its objectives under Regulation 16(1) and section 12 of the 2002 Act, apply objective, transparent, non-discriminatory and proportionate regulatory principles by, amongst other things:[257]

- promoting regulatory predictability by ensuring a consistent regulatory approach over appropriate review periods; and
- promoting efficient investment and innovation in new and enhanced infrastructures, including by ensuring that any access obligation takes appropriate account of the risk incurred by the investing undertakings and by permitting various cooperative arrangements between investors and parties seeking access to diversify the risk of investment, whilst ensuring that competition in the market and the principle of non-discrimination are preserved.

Regulatory Predictability

4.234 ComReg notes that it places importance generally on promoting regulatory predictability and, as illustrated below, has complied with this principle in carrying out the current process.

[257] Some of those principles listed in 16(2) are not listed here because they are either dealt with elsewhere in this chapter or were considered by ComReg as not being relevant to the Proposed Award.

4.235 In the present context, ComReg considers the following objectives to be of particular importance to achieving the aims of this regulatory principle:

- promoting regulatory predictability in relation to availability of spectrum rights to other users of spectrum by applying an open, transparent, and non-discriminatory approach to spectrum release; and
- promoting regulatory predictability by, to the extent appropriate, taking a consistent approach to the award of spectrum in Proposed Award as that taken in other recent spectrum awards.

4.236 In relation to the first objective, ComReg notes that the Overall Preferred Option ensures that the rights of use to the proposed harmonised bands are made available. This would give the market the utmost transparency and predictability in terms of the availability of those rights. The alternative of potentially delaying the award of rights of use in these bands would not, in ComReg's view, contribute to the promotion of regulatory predictability.

4.237 In relation to the second objective, ComReg considers that the alternative options would not promote regulatory predictability due to the inherent uncertainties attached to administratively determining key parameters such as spectrum assignments and fees, particularly in the context of competing demands from stakeholders, imperfect information and the lengthy duration of the spectrum rights at issue. Rather, relying on a full market based mechanism (with objective, transparent, non-discriminatory and proportionate rules) to assign rights of use in a large amount of valuable spectrum across a range of bands better promotes regulatory predictability. In that regard, relevant industry stakeholders (e.g. MNOs, FWA operators etc.) are becoming increasingly familiar with competitive auction processes and the use of such processes should contribute to regulatory predictability.

4.238 In addition, ComReg considers that the Overall Preferred Option – which, amongst other things, facilitates potentially significant variations in demand characteristics through the inclusion of TDD and FDD spectrum to accommodate uplink and downlink capacity requirements, and would incorporate appropriate spectrum caps informed by this consultation to facilitate advanced WBB service provision while avoiding extreme outcomes – would better minimise the risk of award participants failing to win their desired spectrum assignments for reasons other than competitive tension within the award.

4.239 In light of the above, ComReg is of the view that the Overall Preferred Option complies with the regulatory principle of promoting regulatory predictability.

Promoting Efficient Investment and Innovation in New and Enhanced Infrastructures

4.240 ComReg considers that the Overall Preferred Option is consistent with the aims of this regulatory principle because it:

- has the capacity to facilitate a fully competitive release of the selected bands at the earliest possible opportunity. Providing clarity around the availability of these bands as soon as possible ensures that winners of rights of use are appropriately incentivised to efficiently invest in new and enhanced infrastructures, to deploy new technologies and to provide advanced WBB services to end users, while avoiding the potential costs, uncertainties and inefficiencies associated with a delayed release of such rights; and

- would give participants the scope to bid according to their own valuation of the spectrum rights, based on their own business plans and market and financial positions, and thus to invest efficiently.

Relevant Policy Directions and Policy Statements

4.241 ComReg has taken due account of the Spectrum Policy Statement issued by the then DCENR in September 2010 and its Consultation on Spectrum Policy Priorities issued in July 2014. ComReg notes that the core policy objectives, principles and priorities set out therein are broadly in line with those set out in the 2002 Act and in the Common Regulatory Framework and, in turn, with those followed by ComReg in identifying the Overall Preferred Option.

4.242 Section 12(4) of the 2002 Act requires ComReg, in carrying out its functions, to have regard to policy statements, published by or on behalf of the Government or a Minister of the Government and notified to it, in relation to the economic and social development of the State. Section 13 of the 2002 Act requires ComReg to comply with any policy direction given to ComReg by the Minister as he or she considers appropriate to be followed by ComReg in the exercise of its functions.

4.243 ComReg considers below those Policy Directions which are most relevant in this regard (and which have not been considered elsewhere in this chapter).

Policy Direction No.3 of 21 February 2003 on Broadband Electronic Communication Networks

4.244 This Policy Direction provides that:

> *"ComReg shall, in the exercise of its functions, take into account the national objective regarding broadband rollout, viz, the Government wishes to ensure the widespread availability of open-access, affordable, always-on broadband infrastructure and services for businesses and*

citizens on a balanced regional basis within three years, on the basis of utilisation of a range of existing and emerging technologies and broadband speeds appropriate to specific categories of service and customers."

4.245 The purpose of this Policy Direction was to ensure that the regulatory framework for electronic communications plays its part in contributing to the achievement of the Government's objectives regarding the rollout of broadband networks.

4.246 ComReg is cognisant of the fact that the three year objective described in this policy direction has now expired. In any case, ComReg is of the view that the Overall Preferred Option is aligned with the objectives of the Programme for Government. For example, it would promote the introduction of advanced WBB services in the selected bands at the earliest possible date and it complements other schemes such as the Mobile Broadband Taskforce aimed at improving broadband infrastructure and services for businesses and citizens.

4.247 In addition, the Overall Preferred Option should result in a greater competitive tension than in the case of an administrative assignment, and it can be expected to positively impact on downstream retail competition in the deployment, or augmented deployment, of enhanced services in terms of bandwidth.

4.248 Furthermore, ComReg considers it unlikely that some form of administrative assignment of spectrum in the place of a competitive award procedure would incentivise the roll out of broadband infrastructure by recipients to the same extent as the Overall Preferred Option, if at all.

Policy Direction No.4 of 21 February 2003 on Industry Sustainability

4.249 This Policy Direction provides that:

"*ComReg shall ensure that in making regulatory decisions in relation to the electronic communications market, it takes account of the state of the industry and in particular the industry's position in the business cycle and the impact of such decisions on the sustainability of the business of undertakings affected*."

4.250 The purpose of this policy direction is to ensure that any regulatory decisions take due account of the potential impact on the sustainability of industry players, in particular in light of the business cycle at the time such decisions are taken[258].

[258] In the context of the Proposed Award, the business cycle for services in the 3.6 GHz Band is more than likely entering a new phase where the existing services and technologies are likely to be surpassed by the introduction of advanced services via new technologies (e.g. via LTE) due to the increasing consumer demand for more WBB capacity. Transition measures are proposed in this award process to facilitate the existing licensees in transitioning to these new services and technologies (see Chapter 7 in this regard).

4.251 ComReg observes that this policy direction concerns the sustainability of the industry as a whole rather than just the position of individual players. Notwithstanding, in its draft RIAs above, ComReg has considered the impact of its award proposals in the context of all industry stakeholders, including different types of industry stakeholders. ComReg considers that an open auction which facilitates greater participation on a non-discriminatory basis facilitates the sustainability of the industry as a whole.

4.252 This Policy Direction is clearly relevant in terms of those costs that industry must bear which are, to some extent, within the control of ComReg, for example, the nature and extent of any minimum prices in the Proposed Award and the related issue of the duration of spectrum rights of use. ComReg has regard to this policy direction in devising its proposals in relation to licence duration and minimum prices.

Policy Direction No.11 of 21 February 2003 on the Management of the Radio Frequency Spectrum

4.253 This Policy Direction provides that:

> "*ComReg shall ensure that, in its management of the radio frequency spectrum, it takes account of the interests of all users of the radio frequency spectrum*."

4.254 The purpose of this policy direction is to ensure that ComReg achieves an appropriate balance between the interests of various users of the radio frequency spectrum, in particular, the respective interests of commercial and non-commercial users.

4.255 In carrying out the above draft RIAs, ComReg has considered the Overall Preferred Option in light of the interests of various categories of industry stakeholders and consumers.

4.256 ComReg is of the view, therefore, that it has complied with this requirement in carrying out the above draft RIAs and that the Overall Preferred Option is the one that best serves the interests of all users of the radio frequency spectrum and strikes an appropriate balance where those interests may conflict.

General guiding principles (in terms of spectrum management, licence conditions and setting of licence fees)

4.257 ComReg notes that it is required to comply with the guiding principles of objectivity, transparency, non-discrimination and proportionality in carrying out its functions under the 2002 Act and the Common Regulatory Framework. In relation to the current process, ComReg considers that these principles are most relevant in terms of its functions concerning spectrum use and management, attaching conditions to rights of use and the setting of licence fees.

4.258 In relation to spectrum management and use, ComReg notes that:

- Regulation 11(2) of the Authorisation Regulations requires that ComReg grants rights of use for radio frequencies on the basis of selection criteria which are objective, transparent, non-discriminatory and proportionate; and
- the regulatory principle set out in Regulation 16(2) of the Framework Regulations requires ComReg in pursuing its objectives to apply objective, transparent, non-discriminatory and proportionate regulatory principles by, amongst other things, ensuring that, in similar circumstances, there is no discrimination in the treatment of undertakings providing electronic communications networks and services.

4.259 ComReg notes that the above guiding principles are Irish and EU law principles that ComReg abides by generally in carrying out its day to day regulatory functions.

4.260 ComReg is of the view, having regard to the applicable legislation and legal principles, its draft RIAs and other analyses, its expert advice and reports, and the material to which it has had regard, that the Overall Preferred Option is objectively justified, transparent, proportionate and non-discriminatory.

Chapter 5

5 Issues concerning the proposal to include the 2.1 GHz Band

5.1 Introduction

5.1 In Document 18/60, ComReg considered the 2.1 GHz Band for inclusion in the Proposed Award. ComReg noted that while there are benefits to including the band in the Proposed Award, certain issues arising from the different expiry dates of the four existing 3G licences (three of which expire at different dates in 2022 and the fourth in 2027) would need to be addressed in order for the band to be included.

5.2 ComReg noted that similar issues arose in the 2012 MBSA and it should be possible to apply a similar approach in respect of the 2.1 GHz Band in the Proposed Award and that this could include the potential use of:

- measures to align the expiry dates of the three licences expiring in 2022 which would reduce the staggered availability of the band to two dates (e.g. a common date in 2022 and 11 March 2027);
- "time periods" for new rights of use in the 2.1 GHz Band, so as to accommodate the staggered availability of spectrum in this band in 2022 and 2027;
- an "early liberalisation option" to allow some or all the existing licensees the option to convert, via the Proposed Award, its respective existing rights of use into new "liberalised" rights of use; and
- "relocation" rebates to provide for any additional relocation expenses that would be incurred by existing licensee/s earlier than expected, noting that such earlier relocation may be necessary in order to enable the assignment of contiguous spectrum rights.

5.3 In Document 18/60, ComReg identified its preliminary view that the 2.1 GHz Band should be included in the Proposed Award.

5.4 This chapter considers the issues arising from the potential inclusion of the 2.1 GHz Band in the Proposed Award and how ComReg proposes to address them. In forming its views, ComReg has considered the responses to Document 18/60 and the views of its expert economic advisors, DotEcon.

5.5 The remainder of this chapter is set out as follows.

- Responses to Document 18/60 relating to the 2.1 GHz band;
- Overview of existing 2.1 GHz licences;
- Proposed licence period alignment and use of “time slices”;
- Time slices in other bands; and
- Early liberalisation of existing 2.1 GHz licences.

5.2 Responses to Document 18/60 relating to the 2.1 GHz Band

5.6 In light of the assessment of respondents’ views in relation to the 2.1 GHz Band in Chapter 3, this chapter only addresses respondents’ views relevant to the above issues (i.e. perceived complexity arising from the proposed inclusion of the 2.1 GHz Band, “time slices“ and liberalisation), which are summarised below:

- Vodafone was supportive of including the band provided issues around complexity in the award design were addressed. In particular, Vodafone stated that:
    - accommodating time slices in the 2012 MBSA delayed the implementation of the award because of the added complexity; and
    - it is possible to allow existing licence holders the option to convert, via the Proposed Award, their existing rights of use into new liberalised rights of use and that such an *“option should aim to have a common start point of all operators with a new assignment in 2022”*;
- Eir submitted that any fees paid by Eir for the liberalisation of its current licence must be determined solely in respect of liberalisation and not linked to the activity of other potential bidders in an auction; and
- Three did not in favour the inclusion of the 2.1 GHz Band and submitted that the potential for a large number of time slices would make the Proposed Award unnecessarily complex and would also introduce an unfair advantage for Eir that would distort competition.

5.7 In the following sections ComReg sets out its preferred approach in relation to the assignment of 2.1 GHz rights of use and, in doing so, addresses the various issues raised by respondents to Document 18/60 in relation to the 2.1 GHz Band.

5.3 Background - Current 2.1 GHz Licences

5.8 The frequency range 1920 -1980 MHz and 2110 – 2170 MHz consists of 60 MHz of paired spectrum and is currently licensed in Ireland for the provision of Universal Mobile Telecommunications System (UMTS or 3G). Three, Vodafone and Eir are currently assigned rights of use in the band. The current licences do not share a common expiry date which creates certain issues that are addressed below. Three's and Vodafone's licences expire on different dates in 2022 while Eir's licence expires in 2027. An overview of the expiry of current licences is provided in Table 4 below.

Table 4: Details of current licences in the 2.1 GHz Band

Licence Holder	MHz	Expiry
Meteor Mobile Communications Ltd	2×15 MHz	11 March 2027
Three Ireland Hutchison Limited	**A Licence** 2×15 MHz **B Licence** 2×15 MHz	**A Licence** 24 July 2022 **B Licence** 1 October 2022
Vodafone Ireland Limited	2×15 MHz	15 October 2022

5.4 Proposed 2.1 GHz licence period alignment

5.9 Clearly, a key issue to be addressed is the different dates of expiry for the current 3G licences and the corresponding commencement of new 2.1 GHz rights. There are three key periods to consider:

- up to 15 October 2022 when Vodafone's and Three's licences will have expired but on different dates;
- 16 October 2022 to 11 March 2027 (when Eir's licence expires); and
- 12 March 2027 until the envisaged expiry date of all new licences.

Up to 15 October 2022

5.10 In respect of the first period, Three's A Licence expires on 24 July 2022, its B Licence expires on 1 October 2022, and Vodafone's licence expires on 15 October 2022. These different expiry dates in 2022 raise two key issues:

- **Issue 1:** A large number of time slices would potentially be needed to account for the different expiry dates which would add unnecessary complexity to the Proposed Award;

- **Issue 2:** If unaddressed, the different expiry dates of Three's and Vodafone's current licences would create some uncertainty over the commencement date for new 2.1 GHz rights of use. For example:

    - if the commencement date of new rights of use coincides with the expiry dates of Vodafone's existing rights of use, this creates a potential issue regarding the continuity of services in the band for Three[259]; and

    - If the commencement date of new rights of use coincides with the expiry dates of Three's existing rights of use, it would not be possible for those rights to commence before Vodafone's expired, unless Vodafone cleared its frequencies early.

5.11 Given the two issues above, DotEcon identified two options[260] for consideration:

1. Prolong Three's existing 2.1 GHz rights of use (both the A and B License) so that they expire at the same time as Vodafone's licence (15 October 2022). This could be achieved by issuing new 'interim' rights of use. New 2.1 GHz rights of use would begin on 16 October 2022; or

2. Allow for any new 2.1 GHz rights of use awarded to Three to start immediately on expiry of its current licences on 24th July 2022 and 1 October 2022.

5.12 DotEcon advises that Option 1 is preferable for two reasons:

- it would allow for a common commencement date for new rights of use following the expiry of Vodafone's and Three's current licences;

- In the case of a reallocation of specific frequencies across existing licensees (and potentially with new licensees in the band), there would be a single point at which the operators would transition from using their old frequencies into the new band plan; and

[259] If Three were to be awarded rights of use in the band, there could be a period between the expiry of its current licence and the start of the new licence. In such an event, Three would have to either temporarily suspend services in the band or migrate them to another band until such time that the new licence commences

[260] There are other options that could be considered for maintaining service continuity, such as allocating different start dates to different frequencies (to align with current expiry dates) or making the spectrum available for award in short-term time slices. However, these all have the potential to create significant award design complexity, perverse bidding incentives and consumer disruption.

- it would avoid the risk of disruption to Three's 3G services by ensuring that its rights of use would not expire prior to the commencement of any new 2.1 GHz rights of use it acquired in the Proposed Award;

5.13 In addition, DotEcon observes that Option 2 would require complex rules over when new rights of use could commence in practice. For example, if Three was to win new rights to the frequencies currently used by Vodafone, it would not be possible for those rights to commence before Vodafone's expired, unless Vodafone were willing to clear the frequencies early.

5.14 Having regard to DotEcon's analysis, ComReg is of the preliminary view that Option 1 is preferable because the same outcome can be achieved (i.e. co-termination) but without the additional complexity entailed with Option 2.

5.15 ComReg therefore proposes that:

- Three should be provided the option of applying for interim rights of use, the detailed proposals for which are set out in Annex 5; and
- the commencement date of new 2.1 GHz rights of use (for those frequencies currently held by Vodafone and Three) would be 16 October 2022.

16 October 2022 to 11 March 2027

5.16 For this period, Eir's existing 2.1 GHz rights of use expire on 11 March 2027, at which point those rights of use (2×15 MHz) will become available for reassignment. New rights of use for the spectrum currently assigned to Eir would commence on 12 March 2027. These rights of use would run from 12 March 2027 until the expiry of all rights of use in all of the proposed bands (See Chapter 6).

5.17 DotEcon advises that the proposed inclusion of 2.1 GHz Band necessitates the use of "time slices" to enable the assignment of the full 2×60 MHz and to also allow Eir the opportunity to obtain new 2.1 GHz rights beyond the expiry of its existing rights.

5.18 ComReg agrees with DotEcon's analysis on the issue. In particular, because it would avoid the inefficiencies that would arise from re-awarding the spectrum currently licensed to Eir in a separate award after 2027 and, instead, would allow Eir to bid for new 2.1 GHz rights of use and rights in other substitutable bands in the same award process.

5.19 In light of the above, and having regard to DotEcon's analysis, ComReg is of the preliminary view that:

- two time slices are necessary in order to provide for the inclusion of the entire 2.1 GHz Band in the Proposed Award;
- Time Slice One should run from 16 October 2022 to 11 March 2027; and
- 2×45 MHz of 2.1 GHz Band rights would be available in Time Slice One.

12 March 2027 until licence expiry

5.20 ComReg notes DotEcon's observation that all new 2.1 GHz rights for the period from 12 March 2027 (i.e. the full 2×60 MHz) could be given the same expiry date – which would also be the same expiry date for new rights in all of the other Award Bands. ComReg agrees with DotEcon that this approach would be beneficial for effective long-term spectrum management and future efficient assignment and use of spectrum because *"…future licence re-award or renewal would be simplified and there would be greater flexibility to reconfigure spectrum holdings across licensees."*

Summary of ComReg's proposal for 2.1 GHz licence period alignment and use of "time slices"

5.21 In summary, ComReg proposes:

- that Three should be provided the option of applying for interim rights of use to effectively prolong its existing 2.1 GHz rights of use (Licence A and Licence B) so that both licences expire at the same time as Vodafone's licence (15 October 2022) (the detailed proposals for which are set out in Annex 5);
- to make available new 2.1 GHz rights for those expiring in October 2022 (i.e. 2×45 MHz) for the period 16 October 2022 to 11 March 2027 (to coincide with Meteor's current licence expiry) ('Time Slice One'); and
- to make available new 2.1 GHz rights of use for the full 2×60 MHz available in the 2.1 GHz band, for the period 12 March 2027 until a common expiry date[261] ('Time Slice 2').

[261] See Chapter 6 for ComReg's proposals for licence duration.

5.22 ComReg observes that its proposals would reduce the number of time slices required to two, which should satisfactorily address the concerns raised by Vodafone and Three regarding potential award complexity. In that regard, ComReg further observe that this proposed approach would be less complex than the 2012 MBSA which also involved the use of 'Party-Specific Lots' to facilitate the early liberalisation of the current 900 MHz and 1800 MHz rights of use. Additionally, this proposal would result in a common start date for new licences removing any potential disruption to services that otherwise might arise.

5.5 Whether "time slices" should be applied to any of the other Award Bands

5.23 In light of the approach identified above in respect of the 2.1 GHz Band, and given the likely substitutability between rights in the 2.1 GHz, 2.3 GHz and 2.6 GHz bands, DotEcon recommend that rights in the 2.3 GHz and 2.6 GHz bands also be awarded in two time slices (aligned as much as possible with those set out above for the 2.1 GHz spectrum). In particular, DotEcon consider that *"[t]his would allow for maximum flexibility over switching between the higher frequency lots within the award, which should help to facilitate an efficient assignment."*

5.24 At the same time, DotEcon do not recommend applying two time slices to rights in the 700 MHz Band because:

- the difference in propagation characteristics and likely uses of the sub-1 GHz and supra-1 GHz bands mean that they are more likely to be complements;
- switching between them is less likely to be relevant than between the 2.1 GHz, 2.3 GHz and 2.6 GHz bands, where despite value differences across bands bidders are more likely to switch in response to changes in relative prices;
- it would maintain simplicity for the Proposed Award where possible.

5.25 On the basis of the above, DotEcon recommend the following two time slices for the available 2.1 GHz, 2.3 GHz and 2.6 GHz spectrum:

- Time Slice 1 – which would run from the start date of the 700 MHz, 2.3 GHz and 2.6 GHz licences until 11 March 2027; and
- Time Slice 2 – which would run from 12 March 2027 until a common licence expiry date for all rights of use awarded (see Chapter 6 on licence duration in this regard).

5.26 Having carefully considered the issues, ComReg agrees with DotEcon's analysis and recommendations as outlined above. ComReg also notes that only applying time slices to the 2.1 GHz Band could create substantial substitution risks[262] by restricting the ability of bidders to switch demand between substitutable bands in response to changes in prices.

5.27 Figure 4 below illustrates ComReg's time slice proposals for each of the Award Bands.

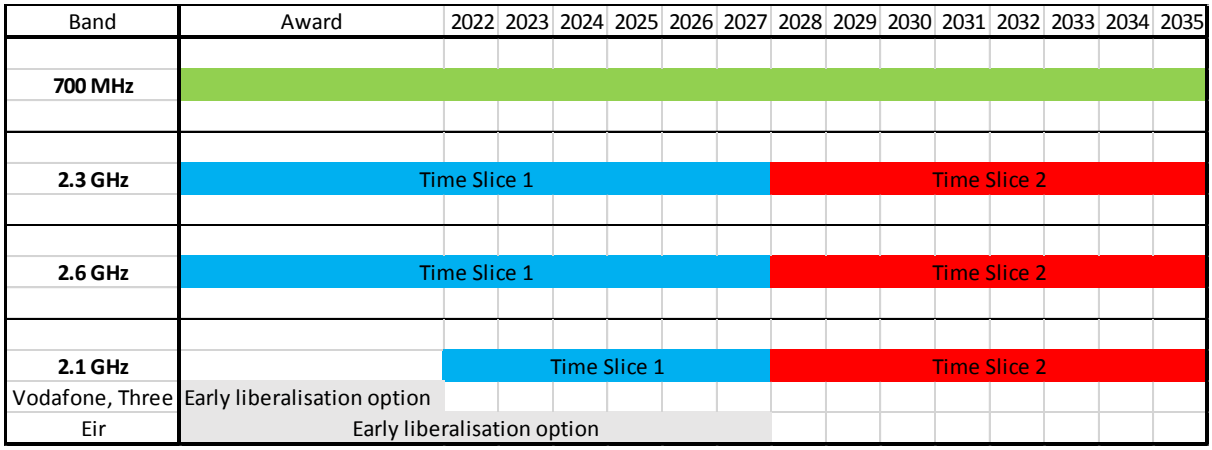

Figure 4: Proposed Time Slices

5.6 Early liberalisation

5.6.1 Background – Document 18/60

5.28 In section 4.5 of Document 18/60, ComReg, among other things:

- recognised that the benefits of including the 2.1 GHz Band (in any joint award of the 2.3 GHz and 2.6 GHz Bands) will be affected by the ability of the Proposed Award to appropriately address the issues arising from the different expiry dates of the four existing 3G licences;
- recalled that similar timing issues arose in respect of the assignment of the 900 MHz and 1800 MHz bands in the 2012 MBSA and observed that it should be possible to apply a similar approach in respect of any inclusion of the 2.1 GHz Band in the Proposed Award; and
- noted that this could, among other things, include the "potential use of an "early liberalisation option" to allow some or all the existing licensees the option to convert, via the Proposed Award, its respective existing rights of use into new "liberalised" rights of use".

[262] For example, it would mean that spectrum usage rights of use in the 2.1 GHz Band would be subject to two time periods while rights of use in the other bands would have one time period.

5.6.2 Background – benefits to liberalisation and statutory framework

5.29 As generally noted by DotEcon, liberalisation of existing 2.1 GHz licences would provide benefits to licensees and end-users including:

- at a time when 3G services would seem likely candidates to be phased out before 2G (which might be in use for some time to support roamers and GPRS machine-to-machine services), the ability to re-farm the spectrum currently used for 3G might prove particularly beneficial[263];
- the spectrum could be used earlier for the provision of services other than UMTS, and it could therefore provide additional capacity for new 5G services, or for existing technologies (4G) at a time when operators need to manage their spectrum use for developing and expanding new services whilst also maintaining legacy networks for current services;
- potential cost savings for operators by facilitating transition to more spectral efficient technologies; and
- it would also be in line with the requirements of ECC Decision 2012/688/EU.

5.30 ComReg agrees with DotEcon's observations.

5.31 Whilst the issue of liberalisation is being considered in the context of the present consultation (because ComReg's award proposals both inform, and are informed by, the issue of liberalisation), ComReg would clarify that any liberalisation of existing licences would be given effect to by way of an amendment of the rights/conditions of the rights of use held under those licences. In that connection, ComReg is obliged to, among other things:

- ensure that any such amendments are only made in objectively justified cases and in a proportionate manner[264];
- in the context of its objective of the promotion of competition, ensure that there is no distortion or restriction of competition in the electronic communications sector;
- in pursuit of its objectives, apply objective, transparent, non-discriminatory and proportionate regulatory principles, including:

[263] Nera highlights that the expiry dates of 2.1 GHz licences are not aligned with the commercial timetable for 3G switch-off, so without liberalisation the 2.1 GHz spectrum may not be well used in the final years of the licence terms.
[264] Regulation 15 of the Authorisation Regulations.

- ensuring that, in similar circumstances, there is no discrimination in the treatment of undertakings providing ECN and ECS; and
- safeguarding competition to the benefit of consumers.

5.32 In that context, and whilst existing licensees in response to Document 18/60 were generally supportive of liberalisation, ComReg recalls the different views of same licensees in response to Document 14/65. See the non-confidential versions of these submissions which are being published alongside this document, the DotEcon Award Design Report and Annex 6 for further details.

5.33 ComReg also observes that there are two key periods with regard to any liberalisation of current 2.1 GHz licences in which issues relevant to the above statutory framework need to be considered:

- the period up to the expiry of Vodafone and Three's licences on 15 October 2022, based on ComReg's proposal to provide Three the option to obtain interim 2.1 GHz rights of use; and
- 16 October 2022 - 11 March 2027, being the period in which Eir's existing licence remains valid, but following the expiry of Vodafone's and Three's existing licences.

5.6.3 Structure of ComReg's preliminary assessment

5.34 Having regard to the above context, ComReg's preliminary assessment is structured in terms of the following key issues:

i. whether some or all of existing 2.1 GHz rights of use should be liberalised;

ii. if so, the timing of any such liberalisation; and

iii. whether any fees should apply to any such liberalisation.

5.35 ComReg's preliminary assessment has been informed by DotEcon's consideration as set out in its Award Design Report (see section 3.3).

5.6.4 Issue 1 and 2: whether existing 2.1 GHz rights of use should be liberalised and, if so, the timing of any such liberalisation

5.36 ComReg considers issue 1 and 2, including relevant views from respondents to Documents 14/65 and 18/60, in the context of its draft RIA set out in Annex 6 and readers are referred to same.

5.37 By way of high level summary, the following 3 regulatory options are considered in this draft RIA:

- **Option 1:** Do not liberalise any 2.1 GHz rights of use prior to expiry of same;
- **Option 2A:** Provide the option for all existing licensees to liberalise some or all existing 2.1 GHz rights of use from the time of the substantive decisions concerning the present Proposed Award; and
- **Option 2B:** Provide the option for all existing licensees to liberalise some or all existing 2.1 GHz rights of use following the assignment of new rights of use in the proposed frequency bands in the Proposed Award.

5.38 Based on its draft RIA, ComReg is of the preliminary view that **Option 2A** would be the more appropriate option in the context of its statutory framework, including being objectively justified and proportionate.

5.6.5 Issue 3: whether any fees should apply to liberalisation

5.39 This issue is considered in the context of:

- background and general observations;
- the period up to the expiry of Vodafone and Three's licences on 15 October 2022 (assuming ComReg's proposal to provide Three the option to obtain interim 2.1 GHz rights of use); and
- 16 October 2022 - 11 March 2027, being the period in which Eir's existing licence remains valid, but following the expiry of Vodafone's and Three's existing licences.

Background and general observations

5.40 ComReg firstly recalls that it may impose fees for spectrum rights of use for ECS which reflect the need to ensure the optimal use of such rights of use.[265]

5.41 In the context of whether or not additional payments for liberalisation of existing spectrum rights would be required, ComReg notes the following from DotEcon's Award Design Report:

[265] Regulation 19 of the Authorisation Regulations.

- reasons for requiring additional payments on liberalisation are to ensure that operators pay a fair price for being assigned a valuable resource (and, in particular, to incentivise the efficient and optimal use of that valuable resource) and avoid creating potential distortions to competition; and

- everything else being equal, the expectation would be that liberalising licences would expand the range of technologies that can be used and so increase the value of the spectrum rights. If an appropriate fee for liberalisation were not charged, an existing licensee would also experience a windfall gain. This could be problematic if such gains accrued unequally across operators, leading to competitive distortions.

5.42 ComReg agrees with these general observations.

Period up to 15 October 2022

5.43 First, ComReg notes DotEcon's assessment on this issue including that:[266]

- for the time period up to 15 October 2022, the available evidence suggests that it is not necessary to apply any additional fees for liberalising the existing 2.1 GHz rights of use because the fees paid (or to be paid in the case of Eir) under the current licence terms are likely to be above the current market price of 2.1 GHz spectrum rights;

- In particular:

    - The benchmarking exercise[267] gives an estimated current market price of spectrum in the 2.1 GHz band in the region of €0.33/MHz/pop for a 15-year licence;
    - however, the 2.1 GHz awards in Ireland in 2002 and 2007 yielded prices in the range of 0.42 – 0.77 €/MHz/pop[268];
    - on this evidence, the market price of liberalised 2.1 GHz spectrum is likely to be less than the fees for the current 3G licences that were set in 2002/2007; and

[266] Page 25 of ComReg document 19/59a.
[267] ComReg Document 19/59b
[268] Depending on the type of licence and time of award. Note also that these benchmark data points are for licences including a 5 MHz TDD lot alongside the paired spectrum. The achieved prices were:

- 0.417 €/MHz/pop for the 2x15 MHz A licence (which had restricted coverage) and 5 MHz TDD awarded to Hutchison in 2002;
- 0.772 €/MHz/pop for the 2x15 MHz B licence and 5 MHz of TDD spectrum awarded to each of Vodafone and O2 in 2002; and
- 0.559 €/MHz/pop for the 2x15 MHz licence and 5 MHz of TDD spectrum awarded to Eircom (Meteor) in 2007.

- As operators are already potentially paying above current market price estimates for liberalised spectrum, there appears to be no justification for requiring further payment.

5.44 DotEcon also highlight practical difficulties seeking to set appropriate fees for liberalising licences in this period including that:

- it is not possible to create a mechanism into the Proposed Award for establishing a market price (as in the 2012 MBSA) because there are no equivalent generic liberalised 2.1 GHz rights being made available within the process for this time period to use for comparison (i.e. all the spectrum in the band is assigned for this period); and
- whilst useful for setting reserve prices, there would be significant uncertainties involved in seeking to use benchmarking for setting market prices, including for estimating the market price of liberalised licences lasting only two years or less.

5.45 In addition, DotEcon consider that liberalisation in the period up to 15 October 2022 should not create any issues regarding distortion of competition because all existing licensees would be treated the same with regard to the opportunities for liberalising their current rights of use.

5.46 Having carefully considered DotEcon's assessment, including its current benchmarking results for 2.1 GHz rights, ComReg does not propose to apply any additional fees for any liberalisation of existing 2.1 GHz licences for the period up until 15 October 2022.

Period from 16 October 2022 until 11 March 2027

5.47 First, the issue of liberalisation for this period is only relevant to Eir because only it holds existing rights in this period.

5.48 Second, unlike the period up 15 October 2022 and assuming its proposal for time slices is adopted, ComReg observes that there would be generic liberalised 2.1 GHz rights being made available in the Proposed Award for the period 16 October 2022 until 11 March 2027 (i.e. the 2×45 MHz currently assigned to Vodafone and Three but proposed to co-terminate on 15 October 2022). Given this, a market mechanism similar to that used in the 2012 MBSA could, in principle, be applied in the Proposed Award to determine the fees for any liberalisation of Eir's rights in the period 16 October 2022 until 11 March 2027.

5.49 However, and as observed by DotEcon, it would not appear reasonable or appropriate to enable a situation where Eir could avail of an option to liberalise its licence for the period up to 15 October 2022 but could then choose (via a mechanism in the award process) whether or not to also liberalise its licence for the remaining period of 16 October 2022 – 11 March 2027 (i.e. to have the 3G-only technology restriction that currently applies to its licence re-instated). This is because:

- it would likely strongly disincentivise Eir in making use of the liberalisation freedom in the earlier years (and including the benefits from same);
- it would reapply the technology restrictions which the EC 2.1 GHz Decision seeks to remove; and
- it would not encourage the efficient use of spectrum or promote efficient infrastructure investment.

5.50 Given the above, ComReg agrees with DotEcon that that if Eir availed of any liberalisation option for its existing licence for the period up to 15 October 2022, then its licence would need to remain liberalised for the period 16 October 2022 – 11 March 2027. That is, any choice by Eir to liberalise its existing licence would necessarily be for the entire residual term of its licence.

5.51 In the context of any fees for liberalisation of the second period, ComReg firstly recalls that DotEcon's benchmarking output suggests that the price of new liberalised 2.1 GHz spectrum is likely to be less than the current 3G licence fees that were set in 2002/2007. However, as there would be generic liberalised 2.1 GHz rights being made available in the Proposed Award for this period and, further, noting that benchmarking provides estimates of current market value, DotEcon observe the possibility for prices for new 2.1 GHz rights in the Proposed Award (in Time Slice 1) to rise beyond the level of the current fees.

5.52 Whilst DotEcon consider this scenario as unlikely, there is nevertheless the potential for distortions to competition in the event that Eir's licence was liberalised over the period from 16 October 2022 until 11 March 2027 (with no additional fee over its current licence fee) *and* other operators paid fees for liberalised 2.1 GHz rights over the same period in excess of Eir's current licence fee.

5.53 In that regard, ComReg notes Eir's submissions including that:

- should it wish to exercise an option to liberalise its 3G licence any adjustment to licence fees *"must be determined solely in respect of liberalisation"*;

- *"it is arguable that liberalisation of an existing licence should not be subject to any increase in licence fees given the benefits it will bring to society through enhanced competition"*; and
- *"however if the regulator deems it appropriate that a fee must be levied then this should not be linked to the behaviour of other entities in an auction process who are seeking to liberalise and renew licences in the same time period that eir is solely seeking to liberalise the existing licence."*

5.54 ComReg also observes that DotEcon does not agree with Meteor's argument because:

- *"…in the case it became necessary to charge liberalisation fees, it would be very difficult to determine suitable fees without looking at the prices paid by others for equivalent spectrum in the award, as these prices would represent the best available estimate of the fair market price of the liberalised spectrum"*; and
- *"Indeed, if Meteor were to win 2.1 GHz rights in the award that followed on from its current licences, it would (if its current licences had been liberalised) be acquiring equivalent rights to those (if any) awarded to other MNOs over the full time period."*

5.55 On balance, ComReg considers DotEcon's assessment to be more persuasive for the reasons provided.

5.56 In light of the above, the following section outlines the proposed methodology to determine whether any additional fees would be required for any liberalisation of Eir's existing licence in the period 16 October 2022 until 2027 and, if so, the amount of any such fees.

Methodology to determine any additional fee for any liberalisation of Eir's existing licence in the period 16 October 2022 until 2027

5.57 As set out in its Award Design Report, DotEcon advise:

- the ideal mechanism to determine any liberalisation fees would be based on the extent to which the prices achieved in the award for new 2.1 GHz rights in Time Slice 1 lots exceeded the current fees being paid by Eir;
- if package bidding is used for the Proposed Award, then there may not be an explicit price for the 2.1 GHz lots that can be used as a basis for the liberalisation fees, because winning bidders would each pay a single price for a package of lots that potentially includes spectrum from multiple bands/lot categories; and

- that a reasonable solution might be to use the final clock prices to provide an approximation of the relative price per lot for each of the various lot categories, which could then be used to approximate the prices paid by winning bidders for new 2.1 GHz spectrum rights awarded. DotEcon state that this would in turn give a price point for assessing the extent to which prices achieved in the auction for new 2.1 GHz spectrum rights have exceeded current fees, and the level of additional charges that would be appropriate for liberalisation[269]; and
- although it would be possible to use bidding data (especially losing bids) to create more refined estimates of the market price of spectrum bands within a combinatorial auction, they do not recommend this approach because:
    - they consider it important that any process for determining the amount of any additional charges is transparent and only uses public data; and
    - they do not think that the benefits of using more sophisticated methods of estimating the market price of particular bands are appropriate, as they would cut across ComReg's approach to confidentiality of bid data.[270]

5.58 In light of these considerations, DotEcon then identified the following process to determine whether any additional charges would be paid by Eir for liberalising its current 2.1 GHz licence in the period 2022-2027.

1. Calculate the average 2×5 MHz Lot

- Sum the prices paid by each winning bidder to obtain total revenue for the award.
- For each lot category, multiply the final clock price for the category by the number of lots in that category awarded in the auction.
- Generate the proportion of the total revenue associated with each lot category; this gives an estimate for the auction revenue associated with each of the two 2.1 GHz lot categories.

[269] DotEcon also observe that the "use of final clock process is similar to the approach taken by ComReg for calculating refunds and adjustments to licence fees for the 3.6 GHz licences awarded in 2016 in the event of delayed access to the spectrum." See Section 2.4.7 of ComReg Document 16/71.
[270] In that regard, DotEcon note that in the 2012 MBSA, ComReg kept confidential the bid amounts of winning bidders and also losing bids; this was to improve bidding incentives, as this information is likely be highly informative about bidders' valuations and bid ceilings.

- For the 2.1 GHz Band in each of the two time slices, divide the corresponding estimate of associated auction revenue by the number of lots in the category sold to give an average auction price per lot.

- Add these together to give an average auction upfront price for a 2x5 MHz lot (running for the full duration over both time slices).

2. Calculate an equivalent price for a 2x5 MHz block including SUFs

- Add the discounted sum of SUFs for a 2x5 MHz licence (again for the maximum possible licence term) for spectrum in the 2.1 GHz band to the average auction price to give a total price for a 2x5 MHz lot in the award; this is the 'current market price' of 2.1 GHz licences.

- Calculate an equivalent price for a 2x5 MHz block of 2.1 GHz spectrum using the discounted fees (SAFs and SUFs) for Eir's current 2.1 GHz licences, adjusting for inflation and differences in licence duration.

3. Assess whether any additional liberalisation fees are required and, if so, the amount of such fees.

- Use the difference between the current market price and the equivalent price to assess the extent to which prices for new 2.1 GHz licences have exceeded Eir's fees for its current licence.

- If the market price for liberalised rights of use exceeds the existing price for an unliberalised price, annuitise the difference (using a real discount rate of 7.13% per annum[271]) to give a per year difference between the value of a liberalised licence and the current fee level for an unliberalised licence.

- Multiply the per year price difference by the number of 2x5 MHz lots Eir chooses to liberalise (e.g. three) and take the present discounted value (using a real discount rate of 7.13% per annum) over the years for which the early liberalisation is applicable. This is then the one-off premium payable for early liberalisation during the time period 16 October 2022 – 11 March 2027.

[271] The discount rate used (7.13%) is based on the estimates provided for the mobile sector WACC in ComReg, 2014, Cost of Capital, Document 14/136 and D15/14

5.59 Having considered DotEcon's analysis and recommended approach, ComReg is of the preliminary view that the suggested methodology would be appropriate in present circumstances and also observes that this process is similar to the approach taken by ComReg for calculating refunds and adjustments to licence fees for the 3.6 GHz licences awarded in 2017 in the event of delayed access to the spectrum.

Chapter 6

6 Key aspects of the Proposed Award Spectrum

6.1 This chapter discusses key aspects of the spectrum rights in the Proposed Award and in particular:

- the proposed grant of a limited number of individual rights of use in respect of the "Proposed Bands", where such individual rights would be national in scope;
- the proposed band plans and compatibility considerations; and
- the proposed duration of the spectrum rights that would be awarded.

6.2 While the above issues will ultimately inform the conditions that would be attached to the spectrum rights that would be awarded (discussed in Chapter 8 below), certain aspects of these issues are discussed here as they also inform the discussion of the award type and format which follows in Chapter 7.

6.1 Limited number of individual rights on a national basis

6.3 In accordance with Regulation 9(2) of the Authorisation Regulations, ComReg proposes to grant individual rights of use for radio frequencies in respect of each of the Proposed Bands because this is necessary to, among other things:

- avoid harmful interference;
- ensure technical quality of service; and
- safeguard the efficient use of the spectrum proposed for inclusion in the award process.

6.4 Further, ComReg considers that limiting the number of individual rights of use for radio frequencies in respect of each of the Proposed Bands is appropriate, having regard to Regulation 11 of the Authorisation Regulations because:

- The finite amount of spectrum in each of the Proposed Bands means that individual rights of use in respect of same are necessarily limited in nature;
- The proposed minimum block size of 2×5 MHz (FDD) and 5 MHz (TDD) is the smallest possible having regard to relevant technical harmonisation decisions as discussed in section 6.2 (band plans) below;

- ComReg is giving due weight to the need to maximise benefits for users and to facilitate the development of competition, including in the context of:
    - the coverage/roll-out and quality of service conditions proposed to be attached;
    - the proposed grant of both complementary and substitutable spectrum rights, which should, among other things, facilitate new entry;
    - the proposed competition caps; and
    - the potential for wholesale access (MVNO) conditions to be attached to 700 MHz Duplex rights of use.
- The proposed grant of these limited number of individual rights by way of an open, competitive auction process would in general terms constitute the application of objective, transparent, non-discriminatory and proportionate selection criteria; and
- Interested parties are being provided an opportunity to provide their views on these matters.

6.5 Unlike its 2012 MBSA, ComReg's recent 3.6 GHz Award included national and sub-national rights of use.

6.6 In the present matter, however, ComReg proposes that the rights of use in respect of each of the Proposed Bands should be for the entire State[272]. This proposal is informed by a number of factors including that:

- the Proposed Bands are identified by the International Telecommunications Union ("ITU") for International Mobile Telecommunications ("IMT")[273] which, together with technical harmonisation standards[274], have resulted in large numbers of mobile devices being available for use in these bands, making them particularly suitable for the deployment of mobile broadband networks, which are typically deployed across the whole State;

[272] This is without prejudice to ComReg applying certain restrictions / coordination mechanisms on the geographic deployment of services with an aim to ensuring the compatibility between new and existing services.
[273] At the International Telecommunications Union (ITU) level the Proposed Bands have been identified for International Mobile Telecommunications (IMT), 700 Duplex (Article 5.317A), 2.1 GHz Band (Article 5.388), 2.3 GHz and 2.6 GHz Bands (Article 5.384A)
[274] At a regional level such as at CEPT level and EC level in Europe.

- where these bands have been awarded by other Member States they have been awarded almost universally at a national level[275]; and

- the particular factors which informed ComReg's approach in its 3.6 GHz Award[276] do not arise for this award process. In particular:

    iv. the previous licensing scheme in the 3.6 GHz Band entailed local area licences with a radius of 20km leading to many local single area licensees, but where the majority of the existing users of the band prior to the 3.6 GHz Award were regional operators;

    v. while both mobile and fixed wireless broadband were identified as the likely uses of the 3.6 GHz Band in Ireland, ComReg observed that mobile would be of particular benefit in urban hotspot areas while fixed wireless would be particularly suited to rural deployments; and

    vi. considering (i) and (ii) above, there were benefits in terms of both spectrum efficiency and competition to proceed with a dynamic and scalable national and regional award.

6.7 In relation to bullet (i), ComReg notes that of the Proposed Bands, only the 2.1 GHz Band has existing deployments and these are licensed on a national basis.

6.8 In relation to bullet (ii), fixed wireless and mobile deployments are likely to be across the whole State and not limited to specific urban/rural areas.

6.9 In relation to bullet (iii), and in light of the above factors, there do not appear to be any clear benefits in terms of spectrum efficiency or competition with the approach taken in the 3.6 GHz Award in the present case, and particularly given the additional complexity for ComReg and potentially for bidders such an approach would entail.

[275] 700 MHz Duplex awarded nationally in all European countries including: France, Germany, Finland, Italy and Switzerland; 2.1 GHz Band has been awarded nationally in all Member States (MS); 2.3 GHz Band: of the Member States, the UK and Denmark has completed the award of spectrum in the band and has done so on a national basis.. 2.6 GHz Band: All other Member states have awarded national licences with the exception of Spain, where it awarded part of the spectrum on a regional /local basis.
[276] ComReg Document 15/70, available at www.ComReg.ie

6.2 Band plans and compatibility considerations

6.10 This section discusses the band plans and compatibility considerations for each of the Proposed Bands. Block Edge Masks (BEMs) are implemented as technical conditions to ensure coexistence between neighbouring networks and for the protection of other services and applications in adjacent bands. The technical conditions proposed for each of the bands discussed in this section are set out in Annex 12 of this document.

6.11 As a general point, and in the interests of ensuring the efficient use of spectrum, ComReg does not propose to implement guard bands between assignments, be that on a FDD, TDD or other mode basis. Instead licensees should ensure compatibility with neighbouring licensees within their own spectrum assignments. This ensures spectrum efficiency and maximises the quantum of spectrum available for use.

6.2.1 700 MHz Duplex

700 MHz Duplex - Band Plan

6.12 The 700 MHz EC Decision[277] defines the band plan for 700 MHz Duplex portion of the 700 MHz Band and relevantly specifies:

- channelling arrangements of 2×30 MHz in the paired frequency range of 703-733 MHz and 758-788 MHz;
- block sizes of multiples of 5 MHz, where the lower frequency limit of an assigned block shall be aligned with, or spaced at, multiples of 5 MHz from the band edge of 703 MHz; and
- that the mode of operation shall be Frequency Division Duplex (FDD), the duplex spacing of which shall be 55 MHz with:
    - terminal station transmission (FDD uplink) located in the lower frequency band 703-733 MHz; and
    - base station transmission (FDD downlink) located in the upper frequency band 758-788 MHz.

6.13 The 700 MHz EC Decision also sets out technical conditions for the spectrum blocks. While these are discussed further in Annex 12 below, for present purposes, ComReg notes that the 700 MHz EC Decision sets substantially the same technical conditions for each block.

[277] General parameters Annex of EU Decision (EU) 2016/687

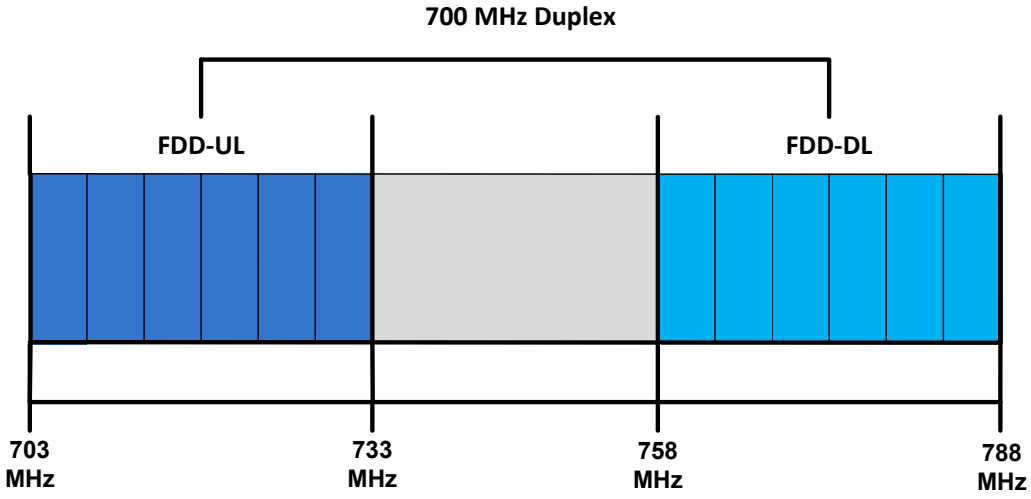

Figure 5: The 700 MHz Duplex Band Plan

700 MHz Duplex – Compatibility considerations

In-band considerations

6.14 The existing primary use of the 700 MHz Duplex is for Digital Terrestrial Television ("DTT")[278] and, in Document 17/23[279], ComReg provided an update on the migration of DTT to below the 700 MHz Band.

6.15 In particular, ComReg identified that in December 2016 the Minister for Communications Climate Action & Environment entrusted[280] RTÉ with the task of migrating its DTT network and services from the 700 MHz band, in sufficient time to meet Ireland's planned DTT migration dates which are:

- 4 September 2019 for commencing a simulcast of DTT services on the old and new radio frequencies[281]; and
- 4 March 2020 for ending the simulcast of DTT services and completing the full migration of DTT to below the 700 MHz Band.

[278] The 700 MHz band is also currently available for certain Programme Making and Special Events (PMSE) services, including wireless microphones. ComReg sets out the guidelines for radio licensing for PMSE use in Ireland in ComReg Document 08/08R. At the time of the proposed award ComReg will update this document to reflect the outcome of the 700 MHz spectrum award. This will provide clarity to operators of PMSE services as to the spectrum that will be available to them for their services.
[279] Progress Update on DTT Migration to below the 700 MHz Band: International Coordination Of Ireland's DTT Spectrum Plan. Available at www.comreg.ie
[280] Letter of Entrustment of 15 December 2016 from the Minister DCCAE to RTÉ, available at www.DCCAE.ie
[281] The Letter of Entrustment of 15 December 2016 explains that the period of simulcast is being provided to allow for appropriate information, and if necessary, assistance to be given to DTT households prior to the final cessation of DTT services in the 700 MHz Band.

6.16 2RN[282] has begun the process of installing the new transmission equipment required to migrate RTÉ's DTT network from the 700 MHz Band. This work is on-track and expected to be completed prior to 4 September 2019. On 4 March 2020, all DTT transmissions in the 700 MHz Band are expected to cease operation.

6.17 As 700 MHz Duplex rights will only be allowed to commence from after the full migration of DTT to below the 700 MHz Band, there will be no in-band compatibility issues between MFCN and DTT.

Out-of-band compatibility

6.18 The services adjacent to the 700 MHz Duplex are as follows:

- Lower adjacent services: DTT services will continue to operate in the frequency range 470 – 694 MHz. i.e. separated by 9 MHz from the lowest frequency of the 700 MHz Duplex (703 MHz); and
- Upper adjacent services: MFCN services currently operate in the frequency range 791 MHz - 821 MHz. i.e. separated by 3 MHz from the highest frequency of the 700 MHz Duplex (698 MHz).

6.19 While CEPT was developing the least restrictive technical conditions ("LRTC") for the 700 MHz band plan, which are set out in the form of Block Edge Masks ("BEMs"), the necessary compatibility studies were conducted to ensure coexistence between any deployments in the 700 MHz Band and adjacent services. Specifically, CEPT Report 53[283] states that:

"The BEMs have been developed to protect other MFCN blocks (including the option for SDL), as well as other services and applications in adjacent bands."

6.20 Therefore, the protection of the upper and lower adjacent services is captured as part of the LRTC, specifically via the BEMs, for the 700 MHz Duplex.

6.21 In conducting the compatibility studies, CEPT set out a number of assumptions. For the protection of DTT, the BEM was established based on[284]:

[282] 2RN built and operates the DTT transmission network in Ireland. 2RN is a wholly-owned subsidiary company of RTÉ although it operates independently of RTÉ and fully at commercial arms' length.
[283] CEPT Report 53, available at www.ecodocdb.dk
[284] Note 1 of CEPT Report 53, page 8, available at www.ecodocdb.dk

- *"… broadcasting using DVB-T2 and derived for an MFCN system with a bandwidth of 10 MHz for a DTT-MFCN centre frequency separation of 18 MHz (assuming an 8 MHz TV channel, 9 MHz guard band and a 10 MHz MFCN bandwidth)."*

- *"If administrations wish to allow the deployment of MFCN on a national basis with a bandwidth greater than 10 MHz and in case an unwanted emission power higher than -42 dBm/8MHz is generated in the band below 694 MHz, they should consider:*

    - *either implementing the greater MFCN bandwidth starting at a frequency higher than 703 MHz so that the required limit of unwanted emission power is still met; and/or*

    - *applying mitigation techniques."*

6.22 Without prejudice to ComReg's proposals on spectrum competition caps, ComReg envisages addressing the issue arising from any potential spectrum block greater than 2×10 MHz in the following manner:

- If a bidder won greater than 2×10 MHz but less than 2×30 MHz, then a constraint would be imposed on any assignment round spectrum options for that bidder that would exclude the lowest frequency block (i.e. starting at 703 MHz); and

- If two bidders won greater than 2×10 MHz (i.e. each bidder won 2×15 MHz) in the "main stage", then:

    - the assignment round would determine which bidder obtained the lowest frequency block; and

    - that bidder with the lowest frequency block would be prevented, by way of a licence condition, from deploying a channel bandwidth greater than 2×10 MHz starting at 703 MHz unless it can demonstrate that it can meet the unwanted emission power of -42 dBm/8MHz .[285];and,

- For completeness, if one bidder won all 2×30 MHz, that bidder would be prevented, by way of licence condition, from deploying a channel bandwidth

[285] In light of the ability to transfer or lease 700 MHz Duplex rights (as provided for in the Article 2 of Decision (EU) 2017/899, but subject to the proposed spectrum transfer and lease regime in Ireland as discussed in Chapter 8 of this document), then it would also appear prudent to apply this restriction to all future holders of the lowest frequency block (or the lowest frequency block generally).

greater than 2×10 MHz starting at 703 MHz unless it can demonstrate that it can meet the unwanted emission power of -42 dBm/8MHz.

6.23 ComReg notes that the Danish Energy Agency has previously implemented a similar mitigation solution.[286]

6.2.2 2.1 GHz Band

2.1 GHz Band Plan

6.24 The 2.1 GHz EC Decision[287] establishes the frequency arrangements for the 2.1 GHz Band and specifies that:

> *"The duplex mode of operation **shall** be Frequency Division Duplex (FDD). The duplex spacing **shall** be 190 MHz with terminal station transmission (FDD uplink) located in the lower part of the band starting at 1920 MHz and finishing at 1980 MHz and base station transmission (FDD downlink) located in the upper part of the band starting at 2110 MHz and finishing at 2170 MHz."* (***emphasis added***)

6.25 The EC has issued a mandate to CEPT to review the harmonised technical conditions for certain EU-harmonised frequency bands, including the 2.1 GHz Band, and to develop LRTCs suitable for next generation (5G) terrestrial wireless systems. As discussed in Chapter 3, ComReg observes that:

- in March 2019, CEPT issued a public consultation on Draft Report 72[288], which forms Report A of its draft response to the EC's mandate to review the harmonised technical conditions for certain EU-harmonised frequency bands (including the 2.1 GHz Band) and to develop LRTCs suitable for next-generation (5G) terrestrial wireless systems.

6.26 ComReg is following this work and intends to establish the band plan and technical conditions in line with any amendments to the 2.1 GHz EC Decision.

6.27 While the 2.1 GHz EC Decision also sets out technical conditions for the spectrum blocks (which are discussed in Annex 12 below), for present purposes, ComReg would highlight that the 2.1 GHz EC Decision allows for the same technical condition to be applied for each block.

[286] See "Public Consultation for the Danish award of spectrum in the 700 MHz, 900 MHz and 2300 MHz bands", available at: https://ens.dk/.
[287] EC Implementing Decision 2012/688/EU
[288] Draft CEPT Report 72, available at www.cept.org

6.28 Figure 6 below details the 120 MHz of spectrum in the 2.1 GHz Band considered as part of the Proposed Award [289].

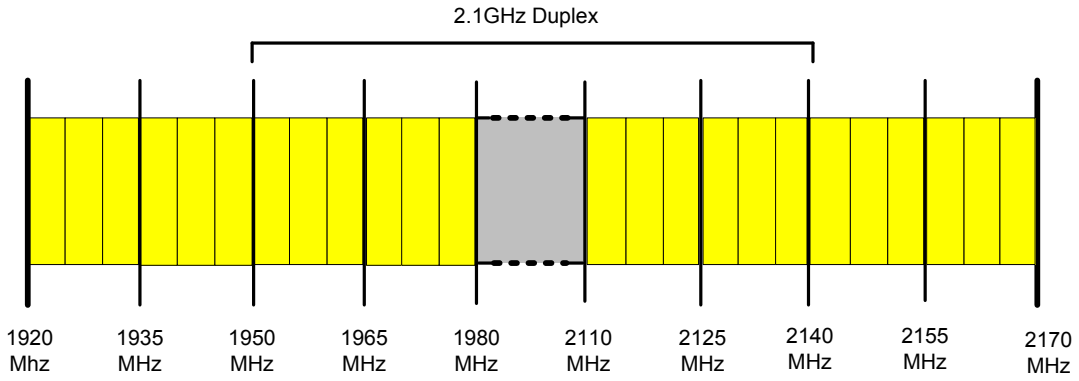

Figure 6: The 2.1 GHz Band Plan

2.1 GHz Band - Compatibility Considerations

In-band Compatibility

6.29 The 2.1 GHz Band is currently licensed to Three, Vodafone and Eir and used exclusively for 3G UMTS, and the technical conditions facilitate in-band compatibility between the licensees.

Out-of-band compatibility

6.30 The adjacent services to the 2.1 GHz Band are as follows:

- Lower adjacent services: one operator, Three, is licensed to operate in the frequency range 1910-1915 MHz (TDD). This right of use will expire on 01 October 2022. i.e. prior to the proposed commencement of new rights of use in the 2.1 GHz band.

[289] For reasons discussed in Chapter 3 the Unpaired 2.1 GHz Band (1900-1920 MHz) is not being considered for inclusion in the Proposed Award.

- Upper adjacent services: the frequency range 1980-1995 MHz and 2170-2200 MHz is designated for use by the complementary ground component of mobile satellite services. There are two licences issued in the band, both of which expire on 13 May 2027. The mitigation measures required for coexistence of these services are detailed in ECC Reports 197[290] and 233[291] as well as block edge mask defined in CEPT report 39[292].

6.31 The 2.1 GHz EC Decision identifies a discretionary guard band of 300 kHz to provide protection to adjacent bands, in addition to the defined BEM.

6.32 The provision in the 2.1 GHz EC Decision to allow for these guard bands was informed by studies in 1999 which considered the assumed out-of-band emission of UMTS services at that time. In practice, many administrations (including Ireland) did not implement these guard bands when assigning rights of use in the 2.1 GHz Band.

6.33 More recently, the ECC reported that measurements of LTE and UMTS equipment indicate that the out-of-band emissions are 30 dB below the levels assumed in the studies in 1999.[293] In addition, the recent amendment to ECC/DEC/(06)01[294] (the "2.1 ECC Decision") contains a new band plan which removes the option for the 300 kHz guard bands at both ends of the band and defines 5 MHz blocks within the band.

6.34 Having regard to the above, and given that the BEMs identified in the 2.1 GHz EC Decision and 2.1 GHz ECC Decision are established to ensure coexistence with systems in adjacent bands, ComReg is of the view that the BEM defined in the 2.1 GHz EC Decision, without the discretionary guard bands, should provide adequate protection against adjacent band interference.

[290] ECC Report 197, available at www.ecodocdb.dk
[291] ECC Report 233, available at www.ecodocdb.dk
[292] CEPT Report 39, available at www.ecodocdb.dk
[293] ECC(19)042_Minutes of the 50th ECC meeting
[294] ECC Decision (06)01, available at www.ecodocdb.dk

6.2.3 2.3 GHz Band

2.3 GHz Band Plan

6.35 While a band plan for the 2.3 GHz Band has not been harmonised by way of an EC decision, ComReg recognises the work in the Radio Spectrum Committee ("RSC") regarding drafts of an EU decision on the 2.3 GHz Band[295]. These drafts are based on the work from CEPT, namely ECC Decision (14)02[296] (the "2.3 GHz ECC Decision"). ComReg expects that, should an EC decision be adopted in the future, it would take into consideration the work within CEPT and, in particular, the LRTC detailed in the 2.3 GHz ECC Decision.

6.36 In the absence of an EC decision for the 2.3 GHz Band, ComReg proposes to implement the LRTC outlined in the 2.3 GHz ECC Decision[297].

6.37 The 2.3 GHz ECC Decision specifies the following frequency arrangements:

- a frequency range of 2300 – 2400 MHz;
- TDD mode of operation; and
- block sizes of multiples of 5 MHz (i.e. 20×blocks of 5 MHz (100 MHz)).

6.38 ComReg notes the implementation of this band plan as described in the 2.3 GHz ECC Decision has been adopted in other European countries, specifically in the UK[298] and Denmark[299].

6.39 While the 2.3 GHz ECC Decision also sets out technical conditions for the spectrum blocks (which are discussed further in Annex 12 below), in the following sections, ComReg addresses issues arising from the following:

- In the lower end of the 2.3 GHz Band, Eir holds a number of licences in the range 2307-2327 MHz for its RurTel Network (blocks 2 to 6 in Figure 7 below (2305 -2330 MHz)); and
- The two uppermost 5 MHz blocks in the band (2390-2400 MHz) are adjacent to WLAN's operating above 2400 MHz (blocks 19 and 20 in Figure 7 below).

[295] See Radio Spectrum Committee Documents (e.g. RSCOM 15-08 and RSCOM15-09) available at https://circabc.europa.eu/
[296] ECC Decision Of 27 June 2014 On Harmonised Technical And Regulatory Conditions For The Use Of The Band 2300-2400 MHz For Mobile/Fixed Communications Networks (MFCN) (ECC/Dec/(14)02), available at www.ecodocdb.dk
[297] Dense Air in its response to Document 18/60 stated ComReg should adopt the same TDD technical licence conditions for the 2.3 GHz Band that Ofcom employs. See Chapter 3.
[298] Ofcom Information Memorandum on The award of 2.3 and 3.4 GHz spectrum bands, available at www.ofcom.co.uk
[299] The Danish Agency 800 MHz, 900 MHz and 2300 MHz Auction Information Memorandum, available at www.ens.dk

6.40 The 2.3 GHz Band Plan and the above two uses above are illustrated in the Figure 7 below:

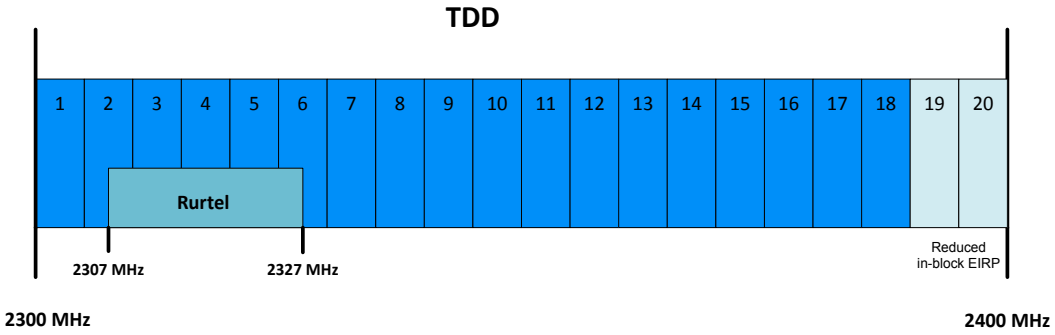

Figure 7: The 2.3 GHz Band Plan

2.3 GHz - Compatibility considerations

In-band compatibility

6.41 In October 2018, ComReg commissioned Plum to conduct analysis relating to the potential compatibility between future MFCN base stations and (a) the existing RurTel network[300] and (b) the adjacent channel WLAN networks.

6.42 Plum's report, entitled "2.3 GHz Sharing Analysis", is published alongside this document as Document 19/59d ("Plum 2.3 GHz Co-existence Report").

(a) Background – Eir's RurTel network

6.43 The existing user of the band is Eir for its Rurtel service (operating in the paired frequency range 2307-2327 MHz and 2407-2427), which is a point-to-multipoint system used to provide fixed telephony services in areas of counties Galway, Kerry and Donegal as part of Eir's Universal Service Obligation ("USO").

6.44 The RurTel technology delivers voice-only services to consumers in rural Ireland who do not have access to an alternative fixed telephony service.

6.45 ComReg has been engaging with Eir to better understand the nature and scope of the RurTel network (so as to inform the compatibility analysis) and also Eir's current activities and overall plans to migrate the RurTel customers to alternative platform/s.

[300] Plum modelled the RurTel network based on the assumptions which are outlined in Appendix A of the Plum 2.3 GHz Co-existence Report.

6.46 The extent of the RurTel network, which is dated, has decreased over time. In 2012, the RurTel network consisted of 52 licences[301]. As at June 2019, there were 34 such licences (a reduction of 18 licences or 35%). ComReg also understands that this reduction is due to the decommissioning of RurTel stations as notified by Eir.

6.47 The total number of active RurTel customers is now just 87, being comprised of[302]:

- 2 active customers in the area of Kerry, who are supported by 6 licences. ComReg understands that this consists of 8 repeater stations and 2 customer stations;
- 8 active customers in the area of Galway, who are supported by 7 licences. ComReg understand that this consists of 5 repeater stations and 6 customer stations with; and
- 77 active customers in the area of Donegal who are supported by 21 licences. ComReg understands that this is more complex network consisting of a number of repeater stations and customer stations.

Summary of the Plum 2.3 GHz Co-existence Report on Rurtel

6.48 Plum models the interference from MFCN base stations ("BS") into RurTel BS receivers based on three assumed received power levels at the RurTel BS receiver[303]. Specifically, the three power levels are -45 dBm (maximum), -62 dBm (median) and -94.5 dBm (minimum)[304]. In the modelling, the composite interference areas surrounding RurTel BS receivers were determined.

6.49 For the **co-channel case**, Plum concludes that:

> *"the results from the co-channel interference analysis show large areas within which the deployment of MFCN base stations is likely to exceed the assumed RurTel BS interference thresholds. Within the calculated interference areas as depicted in Figure 2.1 and Appendix B [of the 2.3 GHz Plum Study and extracted below as Figure 8], the deployment of MFCN BSs may require coordination between MFCN operators and Eir to minimise the risk of interference"*

[301] Note that Rurtel is a point-to-multipoint system and its licence can include more than one link.
[302] Information received from Eir in response to a letter from ComReg seeking technical information on Rurtel network, dated 3 December 2018.
[303] Limited information is available on the receiver performance of the RurTel receivers. As such, a low medium and high received power level was assumed.
[304] Described in Appendix A.3, Table A.2 of the study.

Based on Plum's findings, ComReg observes that it may be required to establish a coordination process for the deployment of MFCN covering all the composite interference levels shown in Figure 8 below to facilitate co-channel co-existence with the Rurtel network.

6.50 In the case of **adjacent channel coexistence** between adjacent MFCN blocks and Rurtel, Plum states, in summary:

"Although there is uncertainty regarding the RurTel receiver performance, installed antenna systems and actual link budgets, adjacent channel co-existence between MFCN (below 2305 and above 2330 MHz[305]) and RurTel (operating in the band 2307-2327 MHz) is likely to be feasible in practice for most deployment scenarios without the need for any coordination."[306]

Based on Plum's findings, ComReg does not envisage any adjacent block compatibility issues between MFCN and Rurtel.

RurTel Coordination Area

6.51 Considering Plum's findings summarised above, the large coordination areas for the deployment of MFCN (covering all the composite interference levels shown in Figure 8 below) would have a significant impact on the potential rollout of any future MFCN services in this band. In this regard, ComReg proposes to implement "coordination areas" derived from these composite interference contours, for the areas of Galway, Kerry and Donegal until such time that Eir fully migrates its RurTel network from the 2.3 GHz band.

6.52 In these areas, any MFCN deployment would require coordination with Eir to ensure coexistence with its RurTel network, noting that these areas would reduce in the event of full migration of any individual area (as opposed to a single link).

[305] The harmonised frequency arrangements in Annex 1 of the 2.3 GHz ECC Decision identify that there are 20 blocks of 5 MHz starting at 2300 MHz to 2400 MHz.
[306] Plum 2.3 GHz Co-existence Report, page 12

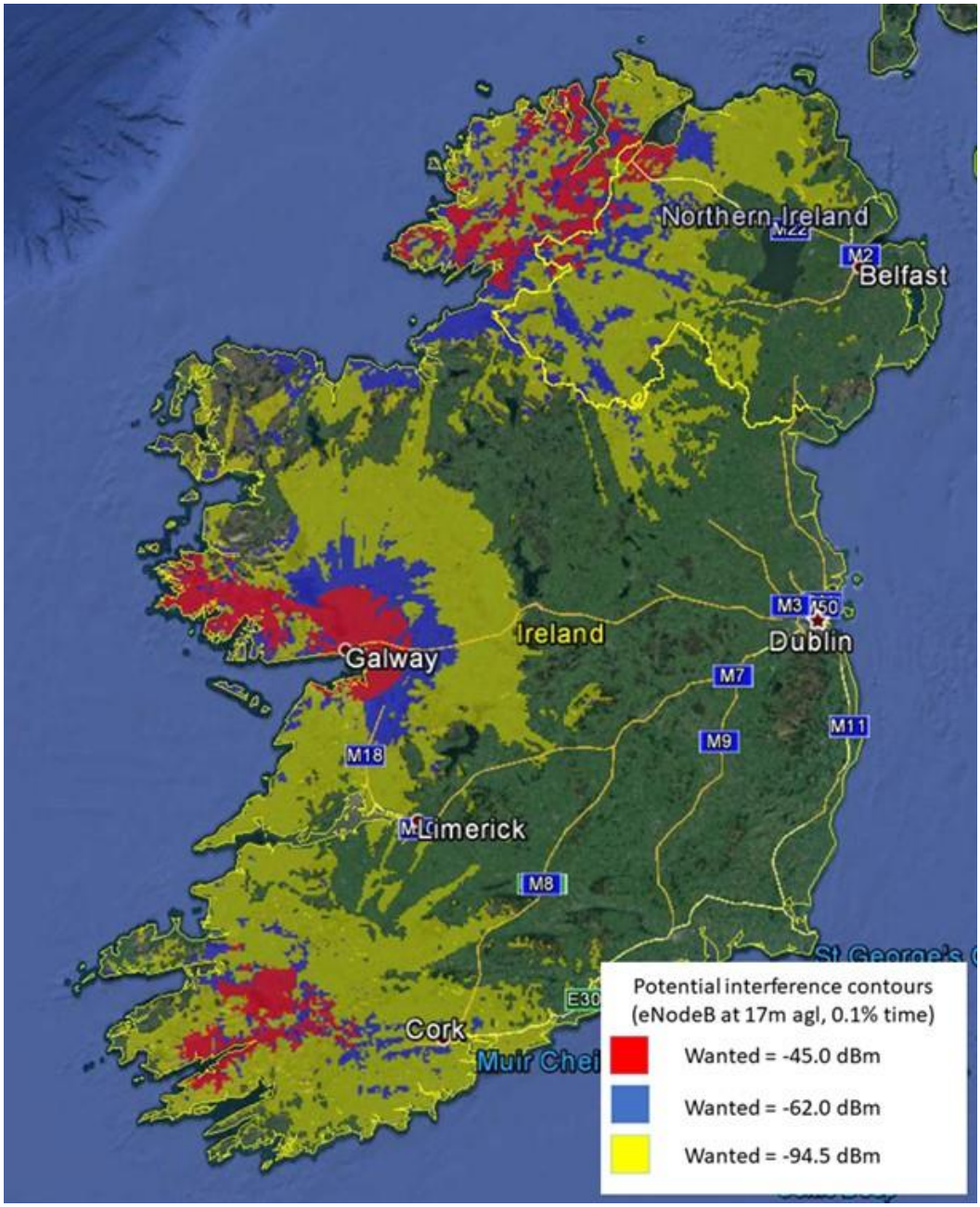

Figure 8: RurTel Coordination Areas based on Composite Interference Contours Calculated for all RurTel BS Receivers (0.1% of time)

6.53 Below ComReg provides its general observations on the current extent and licensing arrangement for Eir's RurTel network.

The current extent of, and licensing arrangements for, Rurtel[307]

6.54 ComReg clearly recognises the importance of the voice services currently being received by customers of the RurTel network, given that they are in rural areas of the State and also do not presently have access to an alternative fixed telephony service, and particularly in the context of ComReg's objective to promote the interests of users, including by ensuring that all users have access to a universal service.

6.55 For the avoidance of doubt, however, this does not mean:

- that Eir can or should be the only provider of these voice services going forward; or
- that Eir's continued provision of such services is required to be provided using its existing rights of use in the 2.3 GHz Band.

6.56 In that regard, ComReg would also highlight its other relevant statutory obligations including to promote competition, such as by:

- ensuring that users derive maximum benefit in terms of choice, price and quality; and
- encouraging the efficient use of radio frequencies and ensuring the effective management of same.

6.57 In that context, it is also apparent to ComReg that prolonged continuation of the existing situation is unlikely to constitute the efficient use of the relevant spectrum, given *inter alia*:

- the considerable quantum of spectrum currently occupied by this network together with the very small number of customers of the network;
- the alternative uses for this spectrum (e.g. wireless broadband) and the substantial number of consumers in the identified co-ordination areas who would otherwise benefit from such alternative uses using this spectrum;
- that there are a number of technologies that are capable of delivering enhanced services to existing RurTel customers, including FWA with VoIP technology, mobile-based services (with a fixed repeater/ fixed cellular solution if required), and point-to-point links (in other bands);

[307] ComReg notes that this section provides information related to Three's request in its response to Document 18/60 where it identifies that industry requires more information on how the Rurtel licences would be discontinued"

- that Eir has a range of alternative spectrum holdings with which to deploy such technologies so as to provide such enhanced services to existing RurTel customers (and other customers in these areas); and
- as discussed in Chapter 2, ComReg acknowledges that the rollout of NBP will commence in Q4 2019 and could have a significant impact on the availability of new alternatives services in rural areas. The timeframe of which is indicated as 5 years for the majority of premises and the overall rollout will be concluded within 7 years.

6.58 In ComReg's view, when the above matters are taken together, this means:

- freeing the encumbered spectrum for the alternative uses (e.g. WBB) to the benefit of all consumers in the proposed co-ordination areas;
- by providing Eir with real incentives to vacate this spectrum in a timely, efficient and orderly manner;
- whilst also ensuring that the remaining RurTel customers maintain access to voice services during this transition period (whether from Eir or any other service provider).

6.59 In that context, ComReg has been engaging with Eir to better understand the nature and scope of the RurTel network (so as to inform the compatibility analysis above) and also Eir's current activities and overall plans to migrate the RurTel customers to alternative platform/s.

6.60 In that regard, ComReg refers to the correspondence between it and Eir including correspondence from Eir[308] dated 3 December 2018 in which it stated:

> *"surveys are to be carried out to investigate the feasibility of providing alternative fixed voice solutions (e.g. Fixed Cellular Service) for the few remaining customers active on the Kerry and Galway RurTel systems. If it is feasible to migrate all of the active customers to an alternative fixed voice solution then the systems would be decommissioned following customer migration. A similar exercise would then be conducted for Donegal."*

6.61 ComReg will continue this engagement with Eir and is hopeful that Eir will proactively implement alternative solutions for its RurTel customers in a timely fashion so as to not unduly impact upon the design and/or implementation of the Proposed Award, and the efficient use of spectrum (and benefits to all consumers from same) going forward.

[308] ComReg intends to publish this correspondence shortly

6.62 Nevertheless, ComReg recognises that the extent and timing of Eir's migration activities going forward will have a bearing on the Proposed Award (and the longer term efficient use of the relevant spectrum), and these matters, including the requirement for any coordination process, are further considered in the context of Frequency Generic or Frequency specific Lots and Fees (Chapter 7) and Transition (Chapter 9).

Out-of-band Compatibility

(a) WLAN

6.63 The 2.3 GHz ECC Decision:

- defines a BEM for applications in the 2.3 GHz Band; and
- provides that the reduced in-block EIRP limit applicable between 2 390 – 2 400 MHz and additional baseline BEM out-of-band EIRP limits applicable above 2 403 MHz would be sufficient to enable adjacent band coexistence between MFCN and WLANs[309].

6.64 ComReg commissioned Plum to assess the feasibility of adjacent band sharing between potential MFCN stations in the 2.3 GHz Band and Wireless Local Access Networks (WLANs) operating within the 2.4 GHz band.

6.65 In its report, Plum highlighted studies commissioned by Ofcom examining the same issue and notes Ofcom's conclusions that the number of affected devices is low and, in many cases, potential co-existence issues could be mitigated by, for example, in-device filtering and dual band capabilities already deployed in many WLAN devices.

6.66 In summary, Plum states that "*..it is our view that in implementing the specific limits outlined in ECC Decision (14)02 for the protection of WLAN devices, adjacent band coexistence between MFCN and WLANs is feasible without additional implementation measures from ComReg.*"

[309] It is noted that the derived BEM does not take into account coexistence with other incumbent services inside the band 2300-2400 MHz

6.67 In light of the above, and noting that other Member States that have, or intend to, award this band have included the measures identified in the 2.3 GHz ECC Decision (e.g. Denmark[310], Sweden[311]), ComReg is of the view that no requirements beyond the introduction of restricted blocks between 2 390 – 2 400 MHz are needed to enable effective adjacent band sharing between MFCN and WLANs.

6.2.4 2.6 GHz Band

2.6 GHz Band Plan

6.68 The 2.6 GHz EC Decision[312] sets out a band plan consisting of 190 MHz of spectrum in the frequency range of 2 500 MHz to 2 690 MHz.

6.69 The EC has issued a mandate to CEPT to review the harmonised technical conditions for certain EU-harmonised frequency bands, including the 2.6 GHz Band, and to develop LRTCs suitable for next generation (5G) terrestrial wireless systems. As discussed in Chapter 3, ComReg observes that:

- on 11 March 2019, CEPT issued a public consultation on its updates to ECC Decision (05)05[313] to enable the use of 5G and AAS in this band;
- on same date, CEPT also issued a public consultation on Draft Report 72[314], which forms Report A of its draft response to the EC's mandate to review the harmonised technical conditions for certain EU-harmonised frequency bands (including the 2.6 GHz Band) and to develop LRTCs suitable for next-generation (5G) terrestrial wireless systems;

6.70 ComReg is following this work and intends to establish the band plan in line with any amendments to the 2.6 GHz EC Decision.

6.71 The band plan set out in the 2.6 GHz EC Decision is illustrated in Figure 9 below (the "2.6 GHz Primary Band Plan") and comprises:

- 2×70 MHz paired arrangement in the frequency ranges of 2 500-2 570 MHz and 2 620-2 690 MHz ("2.6 GHz FDD Duplex"); and
- 50 MHz unpaired arrangement in the frequency range 2 570-2 620 MHz ("2.6 GHz Duplex Gap") – which can be used for TDD or other modes compatible with the technical conditions of the 2.6 GHz EC Decision.

[310] Information Memorandum on 700 MHz, 900 MHz and 2300 MHz Auction. Available at www.ens.dk.
[311] Consultation of proposals for the allotment in the 2.3 GHz and 3.5 GHz bands, available at www.pts.se.
[312] EC Decision 2008/477/EC, available at www.eur-lex.europa.eu
[313] Draft revision of ECC Decision (05)05 Harmonised utilization of spectrum for Mobile/Fixed Communications Networks (MFCN) operating within the band 2500-2690 MHz
[314] Draft CEPT Report 72

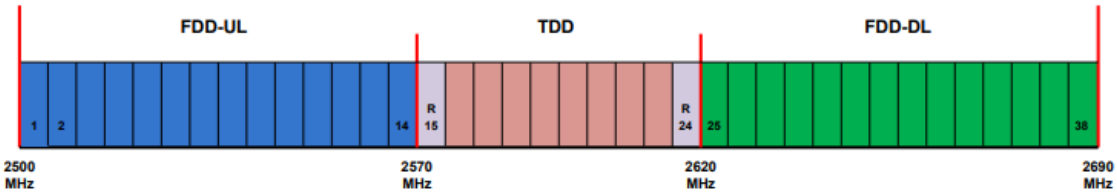

Figure 9: 2.6 GHz Primary Band Plan

6.72 In the 2.6 GHz Primary Band Plan restricted blocks would be required where FDD and TDD spectrum blocks are adjacent to one another. The 2.6 GHz EC Decision sets out the in-block levels and BEM for the restricted blocks in the ranges 2 570 – 2 575 MHz and 2 615 – 2 620 MHz. This is detailed further in Annex 12.

6.73 The 2.6 GHz EC Decision alternatively allows the use of the 2.6 GHz FDD Duplex sub-bands (i.e. 2 500–2 570 MHz and 2 620 – 2 690 MHz), in part or in full, for TDD.[315] Any such use (which is to be decided at a national level) is required to be in equal parts in both the upper part of the band starting at 2 690 MHz (extending downwards) and the lower part of the band starting at 2 570 MHz (extending downwards).

6.74 In relation to this national discretion, ComReg observes that a number of factors indicate that the 2.6 GHz Primary Band Plan would be more appropriate[316].

6.75 First, the majority of Member States have adopted the 2.6 GHz Primary Band Plan.

6.76 Second, in its Award Design Report published alongside this document, while DotEcon, firstly notes that it may be possible to include flexibility within the award process to allow the market to determine the combination of FDD and TDD spectrum that is assigned, it observes, however, that this would add significant complexity to the award (for stakeholders and for the regulator). DotEcon therefore advises against such an approach unless there were very good reasons to believe that it would improve the efficiency of the spectrum assignment.

6.77 Third, ComReg would highlight the following additional matters:

[315] Or other modes compatible with the technical conditions of the 2.6 GHz EC Decision.
[316] In its response to ComReg Document 18/60, Vodafone states that it favours the primary 2.6 GHz band plan. See Chapter 3.

- according to the GSA, the device ecosystem utilising the 2.6 GHz Primary Band Plan is greater than for the alternative band plan[317];
- ComReg is proposing to also make the 2.3 GHz Band available (comprising 100 MHz of TDD rights), which has a stronger device ecosystem[318] and may be more attractive to potential users than the alternative band plan;
- absent assigning the entire band for TDD, the alternative band plan may be less spectrally efficient because of the need to introduce additional restricted blocks to ensure compatibility between TDD and FDD blocks, limiting the extent of deployments in those blocks;[319]
- as the 2.6 GHz Primary Band Plan has been adopted in the UK[320], the adoption of the alternative band plan in Ireland would create frequency coordination issues in deploying services along the border to account for interference between FDD and TDD networks[321];
- although ComReg did not discuss this issue in Document 18/60, the respondents which nevertheless commented on this issue (Dense Air, Three and Vodafone) indicated that the primary band plan should be used; and
- the draft of CEPT Report 72[322] identifies that national TDD flexibility has not been implemented in CEPT countries[323] and recommends that the introduction of MFCN in this band be based on the 2.6 GHz Primary Band Plan.

6.78 In light of the above, ComReg is of the preliminary view that the 2.6 GHz Primary Band Plan should be adopted, subject to any amendments to the 2.6 GHz EC Decision on foot of the CEPT mandate previously discussed.

[317] Specifically, 7,938 and 3,434 devices operating in the 2.6 GHz FDD Duplex (Band 7) and 2.6 GHz Duplex Gap (band 38) respectively, compared to 3,300 in band 41 (i.e. TDD across the whole 2.6 GHz Band.
[318] Notably the device ecosystem for the 2.3 GHz Band is greater for the alternative band plan in the 2.6 GHz band, 4449 versus 3300.
[319] See annex to the 2.6 GHz EC Decision where restricted blocks are required between FDD and TDD blocks.
[320] Ofcom 800 MHz and 2.6 GHz combined award, available at https://www.ofcom.org.uk
[321] ComReg notes that, Dense Air in its response to Document 18/60 that it believes that because of the land border between Ireland and the UK, ComReg should adopt the same TDD technical licence conditions for both the 2.3 GHz and 2.6 GHz bands that Ofcom employs
[322] Draft CEPT report 72 on Report A in response to EC Decision, available at www.cept.org is under public consultation until 26 April 2019 and is due for completion by 02 March 2020.
[323] ECO Report 03 on the licensing of mobile bands in Europe presents the most recent information available to the European Communications Office (ECO) on the licensing of the mobile frequency bands in CEPT countries, available at https://www.efis.dk/views2/report03.jsp

6.79 Given this:

- restricted blocks will be required where FDD and TDD spectrum blocks are adjacent to one another; and
- the in-block levels and BEM identified in the 2.6 GHz EC Decision for the restricted blocks (in the ranges 2 570 to 2 575 MHz and 2 615 to 2 620 MHz) will apply, which are detailed further in Annex 12.

2.6 GHz Band - Compatibility Considerations

In-band compatibility

6.80 As the previous use of the 2.6 GHz Band (for Multichannel Multipoint Distribution Services (MMDS)) ceased in April 2016, no in-band coexistence issues arise.

Out-of-band compatibility

6.81 In October 2018, ComReg commissioned Plum to examine the compatibility and coexistence of incumbent aeronautical radar services in the 2 700 MHz to 2 900 MHz band ("2.7 GHz Band") with MFCN base stations operating in the 2.6 GHz Band. This considered both the international and national context.

6.82 As aeronautical radar services operate in the 2.7 GHz Band in many European countries, Plum first assessed three benchmark countries (France, Belgium and the UK) to understand the approaches taken to protect existing radar services from MFCN interference.

6.83 The studies[324] examined the implication of three types of interference namely, blocking, intermodulation and unwanted spurious emissions.

6.84 In the case of blocking and intermodulation, in all three benchmark countries studied, it was found that implementation of additional filtering at the radar was required to mitigate potential interference issues.

6.85 In the case of minimising the impact of mobile base station transmitter unwanted emissions (spurious emissions), an approach based on defining a power flux density (pfd) limit at the radar receiver location was used.

6.86 Plum also conducted a study of the potential interference situation in the context of any future deployment in the 2.6 GHz Band and aeronautical radar services in Ireland.

[324] As an additional step to this study, in cooperation with the IAA, ComReg/Plum expects to conduct field measurements for adjacent channel coexistence to better inform the above recommendations.

6.87 In respect of blocking and intermodulation, Plum recommends that additional filtering at the radar would be required. ComReg agrees with this recommendation and is engaging with relevant stakeholders with a view to implementing same in a manner that would minimise the duration for which additional out-of-band pfd limits would apply.

6.88 In relation to spurious emissions, Plum recommends that an approach similar to that used in the benchmark countries be adopted and suggests that an out of band (pfd) limit at the radar receiver location of -145 dBW/m^2/MHz per operator be employed, in addition to the filtering identified above.

6.89 In addition, and recognising the safety of life aspect of aeronautical radar services, Plum recommends that a coordination zone be applied for any MFCN deployments within 1km of an aeronautical radar site.

ComReg proposals

6.90 In light of the approaches taken in the benchmark countries and the analysis and recommendations from Plum, ComReg proposes to implement mitigation measures recommended by Plum (which may be updated following field measurements) in its 2.6 GHz report to ensure coexistence between aeronautical radars operating in the 2.7 GHz band and new MFCN base stations in the 2.6 GHz band.

6.91 For operators in the 2.6 GHz band, ComReg proposes:

- installation of filters at the aeronautical radar to protect against blocking and intermodulation caused by MFCN base stations;
- imposing a pfd limit on out-of-band emissions of -145 dBW/m2/MHz on MFCN base stations per operator at the radar antenna to address the impact of MFCN spurious emissions;
- that if MFCNs are deployed before filters are installed at the aeronautical radar, an additional out of band pfd limit of -83 dBW/m^2 be imposed to address the impact of blocking and intermodulation effects at radar receivers during the transition period (to be defined)[325]; and
- a coordination zone of 1 km around the aeronautical radar to provide additional protection from MFCN base stations.

[325] Following successful installation of radar filters, this limit on MFCN base stations will no longer be required to protect radar services.

6.92 Observing that the first mitigation measure (i.e. installation of filters at the aeronautical radar) would be particularly effective in addressing coexistence issues, ComReg is actively engaging with the IAA and other relevant stakeholders with a view to implementing this mitigation measure in a manner that minimises the duration of which an additional out-of-band pfd limit of -83 dBW/m^2 would need to be imposed.

6.3 Licence duration

6.3.1 Introduction

6.93 This section outlines ComReg's proposals regarding the appropriate duration of individual rights of use for the spectrum bands under consideration for inclusion in the proposed award. The section is structured as follows:

- Background;
- Rights of use of definite or indefinite duration;
- Appropriate duration vis-à-vis investment amortisation having regard to international and Irish practice and other material; and
- ComReg's proposal regarding licence duration.

6.3.2 Background

6.94 Regulation 9(6) of the Authorisation Regulations provides that:

> *"Rights of use for radio frequencies shall be in force for such period as the Regulator considers appropriate having regard to the network or service concerned in view of the objective pursued taking due account of the need to allow for an appropriate period for investment amortisation."*

6.95 Regulation 9(6) transposed the requirement set out at the third sub-paragraph of Article 5(2) of the Authorisation Directive (Directive 2002/20/EC) into Irish law.

6.96 As noted in Chapter 2, the EU Common Regulatory Framework is being replaced by the European Electronic Communications Code (EECC) which took effect in December 2018 and, with some limited exceptions, must be transposed into national law by 21 December 2020. ComReg is mindful of the relevant provisions of the EECC.

6.3.3 Rights of definite or indefinite duration

6.97 ComReg has received and considered consultation input on the issue of definite or indefinite duration of licences on a number of occasions over recent years. For example, in Document 15/70, ComReg addressed submissions on this issue in the context of the 3.6 GHz Award. In Document 16/49, ComReg addressed submissions on this issue in the context of its 2016-2018 Spectrum Strategy Statement. ComReg has consistently taken the view that rights of finite duration are consistent with its statutory functions, objectives and duties.

6.98 In January 2019, ComReg received, on behalf of Three, the Nera Report, in which it asserts the benefits of indefinite licences including:

- that incentives to invest further in the spectrum diminish towards the end of a licence of finite duration;
- that indefinite licences provide operators with greater certainty over their long-term spectrum holdings and create stronger incentives for secondary trading; and
- that a system for default renewal of licences could alleviate this problem, citing the approach adopted by the Federal Communications Commission (FCC) in the US and Ofcom.

ComReg's assessment

6.99 ComReg remains aware of the claimed benefits of indefinite licence durations (including licences of considerably longer duration than have been granted to date, and "rolling licences" and variants thereof).

6.100 These matters, including the matters raised most recently in the Nera Report, have been extensively and repeatedly addressed by ComReg in previous consultation processes. For the sake of completeness, however, some of the key points arising from ComReg's analysis again are summarised below.

6.101 First, licences of finite duration allow a spectrum manager to maintain the co-ordination of important spectrum bands because among other things:

- they ensure that there are no long-term barriers to releasing bands in line with international harmonisation measures, which is particularly important where international harmonisation is necessary to introduce new and innovative services to a spectrum band;
- they ensure that the desired change in line with international harmonisation can be brought about without perverse incentives emerging for incumbent firms to hold out strategically with a view to gaining more rent;

- they provide a sufficiently flexible approach to address future co-ordinated approaches that may be taken to particular spectrum bands at an EU-wide level; and

- in light of the above factors, they better promote competition, spectrum efficiency and the internal market.

6.102 Second, ComReg considers the arguments regarding the uncertainty associated with periodic re-release of spectrum to be overstated and not to accord with the likely economic incentives of incumbent operators facing such a situation because:

- reducing investment towards the end of a licence of finite duration may actually encourage outside firms to enter on the basis that the incumbent firms would be signalling that their substantial advantages of incumbency would not be sufficient to allow them to outbid their likely competitors in an auction;

- once sufficiently long, licences of finite duration allow licence holders sufficient time to obtain a return on investment in line with the expected life-cycle of the technology deployed;

- incumbent firms are competing with each other on the retail market and any loss in network quality (arising from reduced or non-investment) could translate to worse outcomes on the retail market. Hence, they will all be strongly motivated to maintain their network quality or risk losing customers (and customer groups that value network quality highly); and

- with indefinite licences there would not be the same incentive to fear new entry and hence investment rates may fall, once a stable market equilibrium emerges.

6.103 Third, ComReg notes that indefinite licences could include provisions under which a licence can be revoked (for instance, in specific circumstances and/or with a minimum notice period as suggested by some interested parties). ComReg notes the uncertainty, delay and potential litigation that could be associated with a spectrum manager seeking to recover spectrum rights via such measures.

6.104 In addition, licences of finite duration are wholly compatible with the EU Common Regulatory Framework (and the new EECC). Finally, ComReg observes that the weight of spectrum management practice in Europe (including in the BEREC and RSPG reports referred to below) and more broadly for the relevant spectrum bands has been and continues to be for licences of finite duration.

6.105 In light of the above, ComReg proposes to grant licences of finite duration for the rights of use the subject of the proposed award.

6.3.4 Appropriate duration vis-à-vis investment amortisation having regard to relevant international and Irish experience and practices

6.106 Recalling section 12(5) of the 2002 Act[326], ComReg sets out below relevant European and Irish experience and other material to inform consideration of the appropriate duration for rights of use to the spectrum bands proposed for award.

European experience

6.107 In its 2016 report on Efficient Awards and Efficient Use of Spectrum, the RSPG observed that most Member States issue licences for a specific duration, usually around 15-20 years.[327]

6.108 In its 2018 report, BEREC found that, of the 106 awards reported by 13 competent authorities, the most commonly reported licence duration was 15 years, with 10 competent authorities awarding 15 year licences at least once.[328]

6.109 The duration of licences issued and currently proposed for a number of European countries for the bands under consideration for this award are set out in Table 5. Only licences issued since the introduction of the EU Common Regulatory Framework in 2002 are considered.

[326] "In carrying out its functions, the Commission shall have regard to international developments with regard to electronic communications networks and electronic communications services, associated facilities, postal services, the radio frequency spectrum and numbering"
[327] 2016 RSPG Report on Efficient Awards and Efficient Use of Spectrum, RSPG16-004 FINAL.
[328] 2018 BEREC report on Practices on Spectrum Authorisation, Award Procedures and Coverage Obligations with a View to Considering their Suitability to 5G, BoR (18) 235. See, in particular, section 5.1.

Table 5: Duration of Rights of Use in other European Countries[329]

Spectrum Band	Licence Duration
700 MHz	Duration from 14.9 years to indefinite duration (UK)
2.1 GHz	Duration from 8 years to 22.5 years
2.3 GHz	Rights to this band have only been awarded in two countries: indefinite duration in the UK (2018) and 23 years in Denmark (2019[330])
2.6 GHz	Duration from 15 years to indefinite duration (UK).

Ireland

6.110 As can be seen from Table 6 below, ComReg has generally issued mobile and wireless broadband licences for 15 years.

Table 6: Mobile and WBB licence durations in Ireland

Year	Spectrum Bands	Licence Duration
2017	3.4-3.8 GHz auction	15 years
2012	800, 900 and 1800 MHz	2.5 years / 15 years
2002/2007	3G 2100 MHz	20 years
1996/2000	GSM 900 MHz	15 years
2000/2001	GSM 1800 MHz	15 years

6.111 An exception to this was the 3G mobile licence award process (2.1 GHz band) where 20 year licences were issued. This was in keeping with a wider trend throughout the EU at that time where 3G mobile spectrum licences were longer than those awarded under other award processes.

[329] Source: Cullen International
[330] https://ens.dk/sites/ens.dk/files/Tele/information_memorandum_-_updated_feb_2019.pdf

6.112 Given that licence durations adopted for other bands similar to those forming part of the Proposed Award can be instructive, ComReg notes:

- as a coverage band, the 700 MHz band has similar characteristics to the 800 MHz and 900 MHz bands, both of which were awarded in 2012 with finite rights of use of 15 years duration (for time slice 2); and
- the higher frequency 2.1 GHz, 2.3 GHz and 2.6 GHz bands have similarities to the 1800 MHz band, the latter of which was awarded in 2012 with finite rights of use of 15 years duration (for time slice 2).

6.113 ComReg observes that the above licence durations of 15 to 20 years are considerably greater than the duration of assets lives of mobile network equipment which is considered to be about 8 years.[331] Further, ComReg is not aware of any material changes which suggests that longer amortisation periods would be required now for newer technologies that may be deployed in the bands under consideration, compared to those currently used.[332]

6.114 In light of the above, ComReg observes that the weight of relevant spectrum management practice in Europe has been for durations of between 15 to 20 years. ComReg further observes that such durations are similar to those which have been adopted by ComReg.

6.115 In addition, European practice in setting durations for the 700MHz, 2.1 GHz and 2.6 GHz bands does not appear to suggest that longer durations are required for the promotion of innovation or efficient investment, including by allowing for an appropriate period for investment amortisation.

[331] For example, an asset life of 8 years is used for the vast majority of mobile network elements in the mobile termination model. See Table 21 of the "Mobile Termination Rates - Deloitte MTR Model Specification for Ireland Public Final Report" (Document 16/09a).

[332] See, for example, article entitled "Vodafone UK claims 5G could be the end game" , in which Vodafone UK CTO Scott Petty is reported as stating:

"Myth one is site densification. The idea that you have to have more sites for 5G over 4G. That is just not true for the way we are deploying 5G, which is using mid-band spectrum and low-band spectrum. You can build a fantastic 5G network with the same number of base stations."

The article further states: "He said US operators had little to no access to mid-band and low-band spectrum, meaning they were relying on mmWave, which was fast, but not far reaching in terms of coverage."

Available at: https://www.mobileworldlive.com/featured-content/home-banner/vodafone-uk-claims-5g-could-be-the-end-game/

6.116 Based on the preceding material, ComReg's preliminary view is that a duration of between 15 to 20 years appears reasonable, with the weight of European practice[333] and recent Irish practice for similar bands (i.e. 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands) supporting a duration of 15 years.

6.3.5 ComReg's proposal regarding licence duration

Assumptions

6.117 This section discusses a number of licence duration options, based on the following assumptions:

- a possible commencement date for rights of use in the 700 MHz, 2.3 GHz and 2.6 GHz bands of 1 December 2020[334];
- ComReg's proposal to grant new interim 2.1 GHz rights to Three which would co-terminate with Vodafone's existing 3G spectrum rights on 15 October 2022 (as outlined in Chapter 5);
- ComReg's proposal for the 2.1 GHz Band to be awarded in two time slices (as outlined in Chapter 5):
    - TS1: running from 16 October 2022 to 11 March 2027; and
    - TS2: running from 12 March 2027 until a common expiry date for all rights in the Proposed Bands;
- ComReg's proposal to offer liberalisation of existing rights in the 2.1 GHz Band to the three existing 3G licensees from the time of ComReg's substantive decisions on the proposed award and following application:
    - For Three and Vodafone, liberalisation would apply to the end of their respective 2.1 GHz Band spectrum rights, i.e. until 15 October 2022 (as outlined in Chapter 5);
    - For Meteor, liberalisation would apply to the end of its existing 3G spectrum rights, i.e. to 11 March 2027 (as outlined in Chapter 5); and
- in the context of the effective management and efficient use of spectrum (and all other things being equal) that:
    - co-termination of rights of use within a band is more preferable than not; and

[333] See, for example, BEREC, 2018, BEREC Report on Practices on Spectrum Authorisation, Award Procedures and Coverage Obligations with a View to Considering their Suitability to 5G, BoR (18) 235. See, in particular, section 5.1.
[334] See information on Ireland's 700 MHz roadmap as published on the DCCAE website, at: www.DCCAE.gov.ie

- co-termination of rights of use being jointly awarded is also more preferable than not.

Options

6.118 Assuming a 15 year duration and that all rights in the Proposed Bands should co-terminate, and that the earliest availability of unassigned 2.1 GHz rights is 16 October 2022, this would suggest the following 2 options:

1. 15 years for rights in the 700 MHz, 2.3 GHz and 2.6 GHz bands (possibly commencing on 1 December 2020) and adjusted to a corresponding *shorter* duration for new 2.1 GHz rights. Specifically:

   - 700 MHz, 2.3 GHz and 2.6 GHz band rights commencing 1 December 2020 and fully expiring 30 November 2035, i.e. an overall period of 15 years; and

   - new 2.1 GHz rights commencing on 16 October 2022 (i.e. beginning of TS1 for the 2.1 GHz band) and fully expiring 30 November 2035, corresponding to an overall period of approximately 13 years and 1.5 months; or

2. 15 years for new 2.1 GHz rights commencing on 16 October 2022 and adjusted corresponding longer duration for 700 MHz, 2.3 and 2.6 GHz band rights. Specifically:

   - new 2.1 GHz rights commencing 16 October 2022 and fully expiring on 15 October 2037, i.e. an overall period of 15 years; and

   - 700 MHz, 2.3 and 2.6 GHz band rights commencing 1 December 2020 and fully expiring 15 October 2037, corresponding to an overall period of approximately 16 years and 10.5 months.

6.119 For the sake of completeness, ComReg notes that another approach could have been to provide for 15 years for new 2.1 GHz rights commencing in TS2 (i.e. with an expiry date of 11 March 2042) with adjusted corresponding longer durations for 700 MHz, 2.3 GHz and 2.6 GHz band rights.

6.120 As between Options 1 and 2 above, ComReg considers Option 1 to be preferable in light of the previous discussion about the suitability of 15 years duration, including that this would be consistent with the approach in the 2012 MBSA (for the similar 800 MHz, 900 MHz and 1800 MHz bands). In addition, ComReg does not consider the shorter durations for new 2.1 GHz rights under Option 1 to be inconsistent with Regulation 9(6) of the Authorisation Regulations because:

- firstly, ComReg is proposing to offer existing licensees the option to have their existing 2.1 GHz rights liberalised from the period of ComReg's substantive decision on the proposed award until 15 October 2022 (for Three and Vodafone) and until 11 March 2027 for Eir. Further, ComReg is proposing to offer liberalisation without any additional spectrum fees (subject to the potential spectrum liberalisation fee mechanism for Eir for Time Slice 1). In this context, all such liberalised rights could be considered "new" rights of use[335] and, when coupled with the ability to aggregate same with new 2.1 GHz rights in proposed Time Slice 1 and 2, would provide effectively the same duration (and regulatory predictability) as rights in the 700 MHz, 2.3 GHz and 2.6 GHz bands (indeed, slightly longer);

- secondly, it is plausible that some existing licensees would continue to use some or all of their liberalised 2.1 GHz spectrum rights to provide existing 3G services for some time. If so, and given that all licensees would have the benefit of the entirety of their existing duration and that the equipment is already deployed, then an existing licensee who wins new rights can immediately benefit from use of that spectrum (i.e. monetise) without any need to deploy new equipment (and corresponding period for amortisation);

- thirdly, even where existing licensees deploy new technologies (e.g. LTE), this is likely to be at existing 2.1 GHz sites where a substantial proportion of the CAPEX (e.g. site acquisition, antennae, power, backhaul etc.) has already been amortised.[336]

ComReg's proposal

6.121 In light of the above, ComReg is of the preliminary view that Option 1 would be appropriate for the proposed award.

6.122 An indicative commencement date for spectrum rights in the 700 MHz, 2.3 GHz and 2.6 GHz bands will be provided in due course when further information on the expected timings of the Proposed Award becomes known. It is ComReg's intention that spectrum rights in these bands are commenced as soon as practicable following the completion of the Proposed Award.

[335] In the 2012 MBSA, existing 900 MHz and/or 1800 MHz which were liberalised via the "early liberalisation option" in that award were effectively treated as new rights of use.
[336] Indeed, ComReg observes that this may also apply to the 700 MHz, 2.3 GHz and 2.6 GHz bands.

Chapter 7

7 Award Type and Format

7.1 Introduction

7.1 On the basis of the draft 'Assignment' RIA set out in Chapter 4 ComReg is currently of the view that an auction mechanism is the most appropriate mechanism by which to assign rights of use in the Proposed Award.

7.2 There are a number of different auction formats and various design elements that can be applied to assign rights of use. It is therefore necessary to evaluate what considerations should be taken into account for the Proposed Award and in that light determine what auction characteristics, in this specific case, would best meet with ComReg's statutory objectives (See Annex 2).

7.3 In that regard, this chapter is structured as follows:

- views of respondents to Document 18/60
- considerations for the Proposed Award;
- the preferred auction format;
- packaging of available spectrum;
- frequency generic or frequency specific lots;
- competition caps; and
- fees.

7.2 Views of respondents to Document 18/60

7.4 Three respondents (Imagine, Nera (on behalf of Three) and Vodafone) submitted views on the award format that could be used for assigning the spectrum bands proposed in Document 18/60.

7.5 Imagine contends that a Combinatorial Clock Auction (CCA) is a suitable mechanism for the auction and assignment of this spectrum. This is based on its recent experiences of the 3.6 GHz Award in Ireland[337].

7.6 Vodafone believes that many of the principle issues surrounding auctions have been consulted on a number of times and suitable formats are now well established.

[337] See https://www.comreg.ie/publication/results-3-6-ghz-band-spectrum-award-2/

7.7 Nera suggests that ComReg should consider following the trend amongst European regulators that previously used the CCA format of switching to a simpler format. In support of this view Nera notes that:

- aggregation risk is unlikely to be a major concern for MNOs in this auction;[338]
- a major downside of the CCA is that it is known to incentivise aggressive bidding, potentially above intrinsic valuations for spectrum, in situations where winning bidders are setting each other's prices and fear paying more than rivals. Nera believes that such a scenario is plausible in Ireland, where the prospects for non-MNO participation are uncertain;
- package bid auctions, such as the CCA, are typically implemented with a second price rule and that this can lead to grossly asymmetric price outcomes for bidders winning the same spectrum, and that such price asymmetry can be unfair. Nera believes that price differences in past Irish CCAs have fortuitously been smaller, but non-trivial. In contrast, clock auctions produce symmetric price outcomes for all spectrum in a category, which is consistent with the notion of a market price; and
- the use of package bidding increases complexity for bidders. In complex settings, such as a multiband award, the number of possible packages that a bidder needs to evaluate may be very large and the efficiency of the final allocation crucially depends on bidders' ability to identify the right packages to bid for.
- Nera suggests a clock or SMRA (Simultaneous, Multi-Round Ascending Auction) format would be suitable for this award, including:
    - a SMRA with generic lots as used in Germany since the late 1990s,
    - a multi-unit clock auction where again there are a number of variants of this format, including: a Simple Clock Auction (SCA) as used in the Swiss 5G multiband auction and Austrian multi-region 3.6 GHz auction; or an Enhanced Clock/SMRA as will be used in the Australian 3600 MHz auction.

7.8 In relation to packaging of each of the spectrum bands, Nera:

- suggests that for the 700 MHz band, and if ComReg decides to adopt lots of 2×5 MHz, then it could consider allowing operators to specify a

[338] Nera states that "Operators may benefit from protection against winning too little spectrum in any one band (e.g. only 2x5 MHz at 700 MHz or blocks of less than 20 MHz in a higher band), but do not face meaningful aggregation risk for larger quantities."

"minimum spectrum requirement" (MSR) of 2 lots in the 700 MHz band. Nera submits that while the minimum unit of demand is 2×5 MHz, operators may have a strong preference for a block of at least 2×10 MHz to provide sufficient capacity to justify investment in a third sub-1 GHz band.

- notes that for the 2100 MHz band, the packaging of lots is not obvious as operators may prefer blocks of 2×20 MHz or more while some operators currently hold spectrum rights of use for 2×15 MHz. Overall, Nera notes that blocks of 2×5 MHz would allow the market to explore all options.

7.9 suggests that the approach for 2300 MHz TDD, 2600 MHz FDD and 2600 MHz TDD should be to sell all the available spectrum rights of use in 20 MHz blocks

7.10 Nera also comments on the information policy for auctions noting that this is a key feature of almost all auctions using the SMRA, clock and CCA designs. Nera suggests that a good option would be for the auctioneer to disclose aggregate demand by band at the end of each round on an anonymous basis. This approach provides a good balance between promoting transparency and price discovery on the one hand, while limiting scope for strategic bidding because (with 3 or more bidders) no one bidder can have certainty regarding the level of demand from individual rivals. Nera observes that this is the policy adopted by ComReg in previous auctions.

7.11 These responses are considered in determining the preferred award format below.

7.3 Considerations for the Proposed Award

7.12 The DotEcon Award Design Report identified and examined a number of suitable auction formats for assigning rights of use across the bands under consideration. These auction formats assessed by DotEcon include:

- simultaneous multiple-round ascending (SMRA) auction;
- simple clock auction (SCA);
- combinatorial clock auction (CCA);
- sealed bid combinatorial auction formats (SBCA); and
- combinatorial multiple-round ascending auction (CMRA).

7.13 It is not proposed to fully repeat DotEcon's discussion and analysis of these formats. Rather, stakeholders are encouraged to review the mechanics of each auction format as set out in the DotEcon Report which accompanies this

consultation.

7.14 In order to assess which of the aforementioned auction formats is best suited to the Proposed Award, it is necessary to consider a number of risks outlined by DotEcon as likely to arise, and determine which auction format best mitigates those risks while ensuring spectrum is awarded to those users who value it the most. ComReg notes that the preferred award format would be the format that best mitigates or eliminates these risks given the circumstances particular to this award. The main risks associated with the Proposed Award are:

- aggregation risks;
- gaming opportunities;
- strategic demand reduction;
- inefficiently unsold lots;
- substitution risks;
- bidder information deficits; and
- complexity.

7.3.1 Aggregation risks

7.15 Aggregation risk refers to the risk that bidders may only partly satisfy their demand for certain spectrum at a particular price. Aggregation risk arises in scenarios where there are complementarities across lots (i.e. where the value of a particular lot is higher if the bidder wins certain other lots).[339]

7.16 In this award, DotEcon notes that aggregation risk is likely to be a significant concern, and could arise due to:

1. complementarity of lots within a given band, if the bidder places a greater value (per MHz) on greater bandwidth (this includes the possibility that the bidder may require a minimum bandwidth in order to be able to deploy services using the spectrum, but also includes the possibility that a bidder may wish to use multiple channels with bandwidth exceeding that of single lots);

[339] A simple example of this is where a bidder has a minimum spectrum requirement that exceeds the size of an individual lot, so that the bidder only places any values on the spectrum won if it can acquire multiple lots to achieve this minimum spectrum requirement. In this case, the bidder is not interested in a single lot, so any auction process that exposes the bidder to the risk of winning a single lot creates an 'aggregation risk' for the bidder. More generally, where the value that a bidder places on a combination of lots exceeds the sum of the value it places on the individual lots in that combination, then any auction process that determines winning bids for the different lots independently will create aggregation risks for the bidder, in that the bidder cannot bid for the combination with any guarantee that if it wins any lots it will win all of the lots in the combination.

2. complementarity of lots across different bands, where bidders may wish to acquire a combination of frequencies in different bands (e.g. low frequencies to provide wide-area coverage, and high frequency to provide additional capacity in high-traffic areas; or in order to provide support to a wider range of terminals); and/or
3. complementarity of lots across the two time slices, where bidders may wish to acquire rights of use covering the full duration of Time Slice 1 and time slice 2, but would place a disproportionally lower value on having rights of use for only one time slice.

7.17 Aggregation risk may arise because bidders need a certain minimum amount of spectrum which they can only achieve by winning multiple contiguous lots in any given band of interest. Where bidders require more bandwidth than that provided by a one or more lots, then even where a bidder is assigned spectrum across multiple bands, it can be exposed to the risk of winning below its minimum spectrum requirement in any of those bands, in which case it may be restricted in its ability to provide its services efficiently (or at all), and the spectrum it wins could be worth less to the bidder than the price paid.

7.18 Increasing the lot size (as noted by Nera) (e.g. by using 20 MHz lots instead of 5 MHz) could help to mitigate this form of aggregation risk, but will necessarily reduce flexibility in the auction in terms of potential outcomes, and could also create asymmetries amongst bidders to the extent that this might only be a suitable building block for some but not all bidders and would deny other bidders the opportunity to build packages incrementally using a smaller block size (e.g. Vodafone obtained 105 MHz rights of use in urban areas in the 3.6 GHz Award and, a block size of 20 MHz in the 3.6 GHz Award could have precluded the entry of Airspan).

7.19 Aggregation risk may also arise when it is beneficial to acquire a portfolio of spectrum in more than one band, i.e. if there are complementarities across bands. For example, if a bidder requires both coverage (e.g. 700 MHz) and higher frequency spectrum (e.g. 2.6 GHz) to launch or run services efficiently (i.e. the value of spectrum in one band is dependent on winning spectrum in the other), that bidder could face the risk of overpaying for the spectrum it wins if it only acquires rights of use in one band but not the other.

7.20 Finally, it is likely that there will also be strong synergies arising from having access to the spectrum over the course of both time slices, with bidders likely to require rights of use for the full proposed licence duration, exposing them to aggregation risks. An award that resulted in some bidders obtaining rights of use in one Time Slice but not the other could create distortions to competition and disruption to consumers.

7.21 In relation to Nera's[340] view that aggregation risk is unlikely to be a major concern for MNO's who require larger quantities of spectrum and therefore is not a risk in this award, ComReg notes the following:

- The Proposed Award is not designed solely with MNO's in mind and ComReg has to consider the possibility of alternative bidders who may not have need for the larger quantities of spectrum that may be required by MNOs. For example, in the 3.6 GHz Award (2017):
    - Imagine was assigned 60 MHz in all rural regions; and
    - Airspan was assigned 15 MHz in all urban regions.

  In particular, as noted in the draft 'Spectrum for Award' RIA, the availability of TDD spectrum rights of use in this award is likely to be of interest to FWA operators.
- While existing MNOs have current spectrum holdings that would reduce the impact of not obtaining their minimum requirements, this is not true of all bidders, particularly new entrants. In that regard, while ComReg does not propose to include specific measures to promote new entry (e.g. spectrum reservation) it is also conscious that it should not preclude or discourage entry through the choice of an auction format or specific auction design features that might expose entrants to greater risks.
- The risk of winning rights of use in one Time Slice but not the other is likely to be of particular concern in this award for all bidders.

Therefore, ComReg is of the preliminary view that aggregation risk needs to be considered in determining its preferred auction format.

7.22 DotEcon notes that the issue of aggregation risk is removed by accepting package bids, where bidders can bid for packages of lots with a single bid amount for each. Therefore, the issue of aggregation does not arise in auctions such as the SBCA, SCA, CMRA or CCA, where bidders are guaranteed that, if they win any spectrum, this will correspond to an entire package of lots that they have bid on. In this way bidders can bid for packages without the risk of winning only a subset of the lots included in that package (unless they explicitly submit a separate package bid for that subset). Package bidding provides flexibility for bidders with different requirements to compete on a level playing field.

[340] As noted in Chapter 3, Nera is prepared on behalf of, and with the support of, Three

7.23 Conversely, in a standard SMRA auction, bidders bidding on a combination of lots may be exposed to the risk of ending up being the standing high bidder for some but not all of the lots on which they wished to win. In this case, bidders may be 'stranded' on a subset of the combination of lots they wanted (see Annex B.1. of the DotEcon Report). For this reason, DotEcon considers that SMRA auctions are not suitable where aggregation risks are likely to be significant.

7.24 DotEcon notes that addressing aggregation risks in an SMRA, through the use of special provisions, is not straightforward. While a number of measures might somewhat mitigate aggregation risk (e.g. allowing bidders to withdraw bids)[341], none of these methods can fully eliminate aggregation risk without increasing the risk that some lots may go inefficiently unsold, or creating significant additional complexity in the Proposed Award. Furthermore, where such provisions include the possibility for bidders to withdraw standing high bids, this raises questions about whether a bidder is committed to the bids made and the obligations applying to the spectrum on which the bid was placed. As a result, provisions to mitigate aggregation risks are usually coupled with restrictions or penalties designed to maintain the integrity of the auction,[342] which might introduce impediments or costs for bidders willing to switch across aggregations of lots (e.g. bidders considering switching between several lots in one band and several lots in a different band).

7.25 It is possible to use pre-defined packages in a SMRA format, which would constitute individual lots that can be offered alongside the individual lots that form the package. Bids for pre-packaged lots would then be in competition with bids for individual lots, as it is not possible to assign both pre-packaged lots and their constituent lots. However, given the large quantity of spectrum available across multiple bands where a large number of packages are potentially suitable for bidders it would not be possible to list all possible packages, and thus this approach is only reasonable when a limited number of pre-packaged lots are offered. DotEcon does not recommend the use of such an SMRA format.

7.26 First, this approach would require ComReg to determine how to pre-package lots, which requires specific information about demand that may not be available to ComReg. Second, this approach only offers a partial mitigation, as any

[341] For instance, the SMRA with an 'augmented switching' format allows withdrawals only in the event that a bidder places a new bid (as opposed to increasing a bid on a lot it is already bidding on) for each withdrawal that it makes.

[342] For example, allowing for the withdrawal of bids in a SMRA auction mitigates aggregation risks. However, allowing bidders to withdraw bids might also allow for strategic bidding that may distort the auction outcome. Therefore, there are usually restrictions on the number of withdrawals allowed and often also financial penalties if a withdrawal then leads to a lot not being sold.

bidders seeking any additional complementary lots not included in a pre-packaged lot would still be exposed to aggregation risk in relation to combining the pre-packaged lots with additional lots. As a result, limiting package bids to those pre-package lots specified by ComReg is less flexible with respect to allowing different types of users to specify the combinations of lots they want.

7.27 Finally, ComReg notes Nera's suggestion that ComReg should allow bidders to specify a "minimum spectrum requirement" of 2 lots in the 700 MHz band in order to eliminate the specific risk in a SMRA that a bidder could win 2×5 MHz when it wants at least 2×10 MHz. However, a minimum requirement reduces competition in the award and bidders would be unlikely to set such a requirement as they would be unlikely to rule out being assigned 2×5 MHz of important coverage spectrum over nothing. In any event, such concerns are addressed entirely through the use of package bidding.

7.28 More generally, ComReg notes that while minimum spectrum requirements[343] (such as those used in Australia) mitigates aggregations risks, it does not remove it in the same way as package bidding. In particular, if bidders have a minimum spectrum requirement above the level set in an award it would remain exposed to aggregation risks. Similarly, this would not mitigate aggregation risks across bands or time slices. Multiple 'spectrum requirements' across bands, time slice and bandwidth would create excessive complexity.

7.29 Further, introducing minimum spectrum requirements raises questions (especially for other bands) about what the appropriate level should be, particularly given the variety of different uses and users. Furthermore, such a rule is unnecessary if the auction format supports package bidding, which deals entirely with any aggregation risks.

7.30 Therefore, for the reasons set out above, ComReg is of the preliminary view that an SMRA would expose bidders to significant aggregation risks and is unlikely to be suitable for the Proposed Award.

7.3.2 Gaming Opportunities

7.31 Gaming opportunities refer to all opportunities for bidder behaviour aimed at acquiring spectrum at a price below what would have been paid had the auction been run in a competitive manner, at acquiring more spectrum than they would have acquired had the auction been run in a competitive manner or at compromising competition during the award and/or competition downstream. Strategic demand reduction is discussed separately below. This section refers to gaming behaviour which typically includes tacit collusion, signalling,

[343] For example, a minimum spectrum requirement of four lots means that an applicant who sets an minimum spectrum requirement cannot have demand fall to two or three lots for that product.

predatory pricing and/or price driving.

7.32 DotEcon advises that sealed bid auctions are robust against gaming and tacit collusion.[344] Of the awards described above, the SBCA offers the greatest level of protection against gaming opportunities because a single sealed bid ensures bidders cannot signal to each other about their intentions during the auction and therefore ensures that no information is made available with which to invoke gaming.

7.33 Alternatively, DotEcon advises that the SMRA is vulnerable to a range of gaming strategies, especially when bidding is for multiple lots across various lot categories (as is the case in the proposed award). Since bids in the SMRA are only binding if they become standing high bids, it is possible for bidders to bid for lots in categories they do not want simply to drive up the prices for competitors before switching into lot categories they do wish to acquire at a relatively low risk, especially if withdrawal of standing high bids is allowed.[345] Various forms of predatory bidding and tacitly collusive behaviour are possible under an SMRA due to the high level of transparency associated with reporting standing high bids. With bids being placed on individual lots, there is scope (depending on the information policy adopted) for signalling (which could facilitate collusion) and targeting of particular competitors (which could facilitate predatory strategies aimed at denying spectrum to specific competitors).

7.34 Aggregation risks, or provisions aimed at mitigating aggregation risks (i.e. bid withdrawals), may further increase the scope for gaming strategies aimed at reducing competition. For example, it may be possible to strategically use withdrawals to distort the auction process, and even where withdrawal penalties are imposed, the cost associated with penalties might be offset by the benefits obtained from gaming. DotEcon advises that concerns about the potential for tacit collusion in scenarios of limited competition can be mitigated by setting reserve prices as close as possible to the expected final auction prices and limiting transparency. Such reserve prices may also reduce the incentives to engage in gaming more generally. However, setting higher reserve prices entails a greater risk of regulatory failure due to choking off demand and creating inefficiently unsold lots.

7.35 In a clock auction, lots are offered in categories, so that bidders can specify the number of lots they wish to acquire in each category, but not target specific lots. This reduces the scope for signalling and/or targeting specific lots. Bidders will typically be given aggregate demand information, without specific details about the specific bids made by competitors. This aggregate information can facilitate price discovery, but the limited transparency also helps to minimise the scope

[344] DotEcon Award Design Report, p52. Section 7.1.2
[345] DotEcon Award Design Report P56. Annex B1.

for bidders conditioning their bids on the specific behaviour of one or more rivals so as to sustain a tacitly collusive outcome (since it is difficult to establish information about the bidding behaviour of individual bidders).

7.36 The SCA, however, can provide opportunities for price driving or vexatious bidding when there are multiple lot categories. As bids made in rounds that are not in the final round are discarded, bidders can place bids for lot categories they do not want in order to drive up prices for competitors, before switching away to bid only for the lots they are interested in. Bidders may only engage in such strategies if they can be relatively confident that the auction will not end in the round in which they make a price-driving bid, so that they will be able to withdraw their demand in the following round. However, bidders may be able to overstate their demand for lot categories in high demand when making price-driving bids in other categories, in order to reduce the risk that the auction will end in that round.

7.37 It is possible to reduce the scope for this behaviour to some degree by expanding the SCA to use a combinatorial closing rule that considers all bids placed in the auction so far; however, this brings the process closer to a CMRA, but without the additional flexibility that would allow bidders to make additional bids below round prices.[346]

7.38 In a CCA, winners and prices are determined in a similar way as in a SBCA, using all bids submitted in the auction (including all bids submitted in every clock round as well as in the supplementary bids round). Since all bids are potentially winning bids, a bidder that bids for lots it does not want in order to drive prices faces the risk that it ends up winning those lots, and the potential for vexatious bidding in this way is therefore more limited under the CCA than with the SCA.

7.39 The activity rules in the CCA also reduce the scope for strategic bidding, by limiting the bids that bidders can make in light of choices made by bidders in earlier clock rounds – these activity rules have been designed to discourage bids for unwanted packages, as doing so could lead to a situation in which bidders cannot express their preferences in the supplementary bids round. DotEcon also notes that the CCA is more robust to tacit collusion, as the supplementary bids round has a sealed bid component that provides an opportunity for bidders to deviate from any tacit agreement in the supplementary bids round without the risk of retaliation by competitors.[347] In effect, the CCA

[346] The simpler approach (relative to using a CMRA) of considering all clock bids when determining the winning outcome may be a reasonable approach for relatively simple awards with a limited number of lot categories if we can reasonably assume that marginal valuations for additional lots are decreasing, and where bidders may be willing to switch across bands at a lot level, rather than switching their demand for several lots at once. However, this is not the case with the present award.

[347] DotEcon Award Design Report, p35.

provides additional assurance that the full range of bids for particular packages are based on the competitive interaction of bidders rather than signalling or other tacitly collusive outcomes.

7.40 The CMRA is somewhat between a SCA and a CCA. In a CMRA bidders can submit a clock bid (called headline bid in the CMRA) along with additional bids (which would be the equivalent of supplementary bids in a CCA, but capped at prevailing round prices). At the end of each round, all the bids received so far are taken into account, in order to determine whether it is possible to achieve the highest possible value with a bid from each bidder who remains active in the auction (i.e. who still bids for lots at clock prices). This increases the risks associated with making bids for unwanted packages (for instance to drive prices) relative to when bidding in a SCA, as any bids made may become winning bids.

7.41 Furthermore, a bidder's losing bids have a smaller impact on the price paid by competitors, as these are not calculated on the basis of opportunity costs, but rather are set using a 'pay-your-bid' rule; therefore, the impact of losing bids on prices is limited to how these may affect clock prices, which may reduce incentives to bid for unwanted packages – however, unlike in a CCA, bidders may be unable to neutralise earlier bids by increasing their bids for other packages, as bids are always capped by round prices. However, as noted by DotEcon,[348] the CMRA is subject to the problems associated with the pay-your-bid rule, where bidders may try to shade (i.e. bid below their true valuation) the bids they consider more likely to win with a view to maximising their surplus (i.e. the difference between their valuation and the price paid).

7.42 In relation to price driving (Nera refers to aggressive/spiteful bidding), auctions that emulate a second price rule (including open auctions that seek to establish prices via an iterative process) are theoretically more susceptible to price driving[349] as bidders could overstate demand and valuations for incremental spectrum, in an attempt to increase the prices other bidders have to pay. For example, a CCA could theoretically offer price driving opportunities when bidders can switch between lot categories, as it allows bidders to bid for lot categories it does not want simply to increase the price for competitors. However, as noted previously by DotEcon[350], while theoretically susceptible it relies on unrealistic assumptions about the information that one bidder has about the likely valuations and bidding strategy of other bidders. In practice, the

[348] DotEcon Award Design Report, p42.

[349] Such strategies are not easily implemented in a sealed bid award although are theoretically possible if information on the valuation other bidders have for certain packages is available.

[350] Document 15/140 (Para 5.28 – 5.32) and Document 15/140a (Para 80 -86).

risk associated with price driving strategies is more related to whether bidders have sufficient information about their competitors' likely demand/valuations, so that they can be relatively assured that they will not win with price-driving bids.

7.43 DotEcon previously advised[351] that the likelihood of such strategies being used would depend less on the auction format, and more on the degree of information certain bidders have about other bidders' demand and the perceived benefits of increasing the prices paid by other winners, than to the auction format used. For example, if a bidder has information about the actual demand of other bidders, then it could bid to push prices close to the point where demand from competitors would be choked off, regardless of whether the auction format is 'pay as you bid' or opportunity cost pricing.

7.44 In its latest report, DotEcon reiterates its view that price-driving strategies are risky in a CCA, as if bidders make a wrong assessment of their competitors' demand, they could win with price-driving bids, and therefore end up with an unwanted package or winning at a price that exceeds their valuation. Thus, while the CCA may provide incentives to bid for packages that the bidder does not expect to win, the risk associated with price-driving should have a desirable disciplinary effect and discourage such behaviour.[352]

7.45 In that regard, ComReg considers the risk of price driving in a CCA format to be low and, observes that such a risk could also arise in all other auction formats.

7.3.3 Strategic Demand Reduction

7.46 Strategic demand reduction can occur when bidders seeking multiple lots benefit from strategically reducing their demand at prices that are lower than their valuation for additional lots. Specifically, a bidder may reduce its demand early with the aim of keeping final prices low and achieve a higher surplus than it might expected if it were to compete for a larger package (even if the bidder would prefer the larger package at prevailing prices).

7.47 In auction formats that establish a single (or similar) price per lot in each category, bidders can benefit from reducing their demand early, as continuing to compete for larger packages may result in excess demand and a consequential increase in the prices. The incentives to engage in strategic demand reduction arise whenever a bidder can moderate the quantity demanded to benefit from reducing competition within the auction and secure a smaller quantity than wanted, but at a much better price, and may be stronger for bidders who expect to eventually have to reduce demand in response to

[351] Para 81 – Document 15/140a

[352] DotEcon Award Design Report, Document 19/59a, p34.

price increments.

7.48 Such behaviour might lead to inefficiencies in the assignment of spectrum if bidders who place the highest value on additional lots reduce demand too early, as it would have been efficient for such bidders to win additional lots. This could weaken competition in downstream markets[353] or lead to inefficiently unsold lots, if a bidder drops demand by too much, taking the auction from a situation of excess demand to one of excess supply. Therefore, strategic demand reduction could have an important impact in the delivery of end user services if bidders end up with less spectrum rights of use that would have been the case in an efficient assignment or the award ends with unsold lots.

7.49 ComReg is of the preliminary view that strategic demand reduction is potentially a material issue for this award for a number of reasons, including:

- there is a large amount of spectrum available and bidders would likely require multiple substitutable lots allowing bidders greater opportunity to obtain sufficient spectrum (although less than optimal) without having to compete strongly;
- bidders seeking capacity spectrum are likely to be more flexible in relation to the total bandwidth they acquire, which means that they may have greater scope for reducing demand with the prospect of being able to acquire spectrum at a lower price, even if this may not lead to an outcome where the optimal level of additional capacity is provided at the lowest possible cost; and
- the risk of strategic demand reduction is greater in low participation scenarios (which is typically the situation in spectrum auctions, due to the large investment required for potential spectrum users), especially when one or more bidders can act unilaterally to bring the auction to a close at lower prices.

7.50 Research[354] has shown that strategic demand reduction incentives are strong in uniform price auctions such as the SCA and the SMRA where all lots in a category have a common (or similar) price per lot. As noted by DotEcon, since winning bidders pay the amount of their winning bids, there may be a benefit from curtailing demand to acquire fewer lots than the bidder would wish to

[353] Strategic demand reduction could lead to less competitive downstream markets as having less capacity may increase marginal costs (increasing retail costs downstream) and reduce incentives to compete.

[354] For example, see Ausubel, Lawrence M., and Peter Cramton. "Demand reduction and inefficiency in multi-unit auctions." (2002); Goeree, Jacob K., Theo Offerman, and Randolph Sloof. "Demand reduction and preemptive bidding in multiunit license auctions." Experimental Economics 16.1 (2013): 52-87; and Kagel, John H., and Dan Levin. "The winner's curse and public information in common value auctions." The American economic review (1986): 894-920.

acquire at the prevailing round prices, in order to keep prices below market-clearing prices (i.e. the price at which there would be no excess demand).[355] In such formats, when bidders pursue multiple lots, competition for additional lots will drive the price for all substitutable lots. As a result, bidding for additional lots increases the price that the bidder will need to pay if it eventually settles for fewer lots, so bidders have an incentive to settle for fewer lots at lower prices. The incentive for reducing demand early can be lowered by setting minimum prices relatively close to expected end prices, and limiting the transparency of the procedure where applicable. However, this increases the risk of choking off demand by setting minimum prices too high.

7.51 As noted by DotEcon, the downside of any auction that uses a pay-as-your-bid rule (including a CMRA) is that it may be subject to strategic demand reduction as bidders have an incentive to strategically reduce demand early to prevent competition from increasing prices.[356] However, the risk of strategic demand reduction in a CMRA is significantly less compared to other pay-as-your-bid formats as it allows bidders to make bids for alternative packages (e.g. for fewer lots) at a lower price per lot. As a result, bidders can maintain alternative bids in parallel with which they can compete for larger and smaller packages, at different prices.

7.52 Incentives to strategically reduce demand are mitigated in a SBCA, as this format does not impose linear pricing. In particular, if a second price rule is used, then final prices[357] are determined by the bids made by rival bidders rather than the bidder's own bids, so understating demand affects the chances of winning, but may only affect the actual price that the bidder would need to pay if it wins in some cases.[358] Therefore, the second-price rule mitigates incentives for strategic demand reduction. In particular, if a bidder competes for a larger amount of spectrum in line with its preference and does not win, this does not drive up the cost of acquiring a smaller package. A CCA mitigates incentives to strategically reduce demand in the same way as in a SBCA using a second price rule.

7.53 Given the above, ComReg is of the preliminary view that the CCA and the SBCA best deal with concerns surrounding strategic demand reduction.

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[355] DotEcon Award Design Report, p56.

[356] DotEcon Award Design Report, Document 19/59a, Section 7.2.4.

[357] Final prices are set at the lowest hypothetical bid amount with bidders could have still won that lot or package of lots.

[358] In particular, this will only lead to a reduction in price when the bidder that is part of a winning coalition of bidders needs to share the opportunity cost of outbidding competitors. In this case, marginally reducing the bid amount might lead to a lower price. However, establishing how much to reduce bids is difficult in practice, as it is difficult to predict when bidders may be part of a winning coalition, whilst at the same time reducing bids may also lead to the bidder not winning with that bid.

7.3.4 Inefficiently unsold lots

7.54 Unsold lots do not necessarily represent an inefficient outcome from an auction. However, if bidders have increasing returns for additional lots and such lots remain unsold, this would represent an inefficient outcome. Lots go inefficiently unsold if one or more bidders would have wished to acquire them at a price which is at least their reserve price. The harm arising from inefficiently unsold lots will be greater if the lots would have been used by bidders to provide services to consumers.

7.55 Inefficiently unsold lots are more likely to arise where a large amount of spectrum is available, as is the case in this award. Therefore, ComReg is minded to adopt appropriate measures to prevent same.

7.56 DotEcon advises that the main problem with the SCA is that it could result in inefficiently unsold lots when some lots are complementary, as is likely to be the case in this award. [359] This arises because the clock auction imposes a uniform price per lot for all winners, regardless of the number of lots that each winner might receive. In particular, if bidders have a minimum requirement of multiple lots, or at least some bidders have increasing returns for additional lots, then demand can fall abruptly from one round to another (with one or more bidders dropping multiple lots in one step) taking the auction from a situation in which there is excess demand to one of excess supply. In this case the auction would end with unsold lots which could have potentially been awarded (at a lower price). For example, there may be some bidders that have already reduced their demand or exited the auction (due to prices rising beyond their valuations) that would have been prepared to buy the lots that go unsold, but at a lower price per lot than final auction prices.

7.57 There are adjustments that can be made to the SCA that would reduce this risk, such as allowing for exit bids and/or use of a combinatorial closing rule as currently proposed in the 400 MHz award.[360] However, DotEcon notes that exit bids may not resolve this problem when there are complementarities between lots or when the available lots are offered in multiple categories, and that in these cases combinatorial auction formats are more appropriate.[361]

7.58 Further, ComReg notes that the SCA variants suggested by Nera suffer from the risk of inefficiently unsold lots and strategic demand reduction. The suggestion that provision could be made for a second stage auction in case

[359] DotEcon Award Design Report, p62.

[360] Document 19/23,'Response to Consultation and Draft Decision on the Release of the 400 MHz Sub-band', published 15th March 2019.

[361] Document 18/89a, p42.

some lots go unsold is not an appropriate solution. In particular, the provision of a follow up stage for unsold lots could create a negative incentive for bidders to strategically withhold demand during the auction in the hope of securing some lots at a low price in the first stage and then bidding for additional spectrum (that remained unsold) on the same or more preferable terms as those offered in the auction in a follow-up process.[362] Given that the proposed spectrum is particularly important for the delivery of end user services, any harm arising from inefficiently unsold lots would likely be high in this award, so ComReg believes that the preferred auction format should minimise the likelihood of such scenarios.

7.59 While the risk of unsold lots is lower with the SMRA auction – due to the notion of standing high bids – there are circumstances where this risk also may arise, in particular when withdrawal of standing high bids is allowed. For example, suppose a bidder with synergistic valuations across multiple lots withdraws one or more of its standing high bids because the other lots it needs have become too expensive. If no further bids are received for the lots with withdrawn standing high bids, those lots might go unsold even if other bidders would have wanted to acquire them at a lower price (but can no longer do so because the price is too high or they have already lost eligibility to bid for those lots).

7.60 Even if withdrawals are not allowed, such lots might be assigned, but possibly inefficiently, as it is not clear that the standing high bidder on a lot might be that who places the highest value on the lot on a standalone basis. Therefore, while the risk of inefficiently unsold lots in a SMRA is low, it is higher relative to alternative formats such as the CCA, SBCA or CMRA, and is also linked to a risk that lots that would have otherwise gone unsold might not be assigned to the bidder who values them most, and possibly at a price that exceeds the bidder's valuation for the lots, which in turn might distort bidding incentives.

7.61 DotEcon advises that the risk of inefficiently unsold lots is avoided through the use of the combinatorial auctions that do not impose linear pricing[363], such as the CMRA, CCA and SBCA. These formats allow bidders to submit multiple bids that reveal the structure of their demand for spectrum at different prices. Winners (and prices) are established taking into account the whole range of bids submitted, with the consequence that (if bidders reflect their full demand profiles in their bids) lots will only remain unsold if there is no additional value that can be achieved by assigning them.

[362] See also Section 7.6 'Unsold lots'.

[363] DotEcon Award Design Report, p60.

7.62 However, an open award is likely to better protect against the risk of inefficiently unsold lots. Because of the large number of lots there is a possibility that bidders would not to be able to submit bids for every single package of interest – in this sense there is a greater risk of an inefficient outcome (potentially with inefficiently unsold lots) associated with the one-shot SBCA process relative to auctions with an open stage that allow bidders to gather information about where their demand might fit in with other bidders and which packages to focus their bids on.

7.63 Nera submits that the use of a CCA can lead to grossly asymmetric price outcomes for bidders winning the same spectrum and such price asymmetry can be grossly unfair. First, ComReg notes that bidders paying comparable amounts is not an objective of the Proposed Award. Rather, one of its main objectives set out in its statutory framework is to ensure the efficient assignment and use of the radio spectrum. Second, uniform pricing, as suggested by Nera, may not be compatible with an efficient assignment because bidders (in a limited field of potential bidders) have incentives to keep prices down (see Strategic Demand Reduction below). Further, a uniform price (i.e. the same per lot price for all bidders) may result in lots going unsold unnecessarily or being assigned inefficiently to a bidder who is not the bidder that values them most, simply because in some cases it is impossible to achieve an efficient outcome with uniform prices when there are complementarities between lots.

7.64 By comparison, the CCA and opportunity cost pricing provides bidders with incentives to compete for additional spectrum and provides strong incentives for bidders to make bids that reflect their actual relative valuations for the different packages that bidders consider they could win. Further, allowing for the possibility of asymmetric prices does not preclude outcomes with symmetric prices. For instance, the 3.6 GHz Award used a CCA with a second price rule and we note the views of Nera that the 3.6 GHz Award was competitive, resulting in a "fair market price" of € 0.04 per MHz per capita.

7.65 Given the above, ComReg is of the preliminary view that open combinatorial auctions that do not require a uniform price per lot (i.e. CCA and CMRA) provide the most effective mitigation for the risk that lots might go inefficiently unsold in the proposed award.

7.3.5 Substitution Risks

7.66 Substitution risks arise when a bidder or bidders view an alternative package of lots as substitutes, but cannot express their relative preference between these alternative packages. DotEcon notes that substitution risk occurs where bidders are exposed to the risk of winning a combination of lots that is not their preferred

one given final auction prices.[364] Substitution risks can result in a bidder obtaining a package that it is not its preferred one given the final auction prices, and may also lead to inefficiently unsold lots, if bidders who would want to acquire these lots were simply unable to express their willingness to do so through their bids. Efficiency requires that the lots available are assigned in line with relative valuations. Typically, an efficient outcome can be provided if at the final prices each bidder prefers the package it has been assigned (including the possibility of an empty package) over any of the packages assigned to any other bidders at a given set of prices.

7.67 As noted in the various EC Decisions[365] and the Radio Spectrum Policy Group opinion on Wireless Broadband[366], all of the bands proposed to be included in this award have been identified as candidates for the provision of wireless broadband. In that regard, there is likely to be scope for substitution across bands. Therefore, ComReg is of the preliminary view that substitution risks are likely to be an important consideration in this award.

7.68 In open auction processes, substitution risks can be mitigated by allowing bidders to switch between packages of lots in response to price changes, so that bidders can seek their preferred package at prevailing prices. Conversely, there is a risk of an inefficient outcome if bidders cannot switch between substitutable packages. However, in this regard it is important to acknowledge that bidders may want to switch between combinations of lots rather than individual lots. In this case, allowing switching on a lot-per-lot basis (as in a SMRA) may not be sufficient to mitigate switching risks – instead, bidders would need to be able to switch their demand between different packages.

7.69 Indeed, in relation to the SMRA, DotEcon advises that determining standing high bids on each lot independently of other lots exposes bidders to substitution risks.[367] This arises because standing high bids remain valid and committing unless they are overbid in a subsequent round, and a bidder may be "stuck" as the standing high bidder on one or more lots when they would prefer to switch their demand to an alternative package. There are some measures to reduce switching impediments in SMRA auctions,[368] however, these do not fully remove switching impediments, whilst at the same time may increase the scope

[364] DotEcon Award Design Report, p65.
[365] EC Decision 2008/477/EC and EC Decision 2012/688/EU.

[366] Radio Spectrum Policy Group Report on Spectrum for Wireless Broadband and Broadcasting in the Frequency Range 400 MHz to 6 GHz

[367] DotEcon Award Design Report, p52.

[368] For example, the SMRA can be modified to allow bidders to withdraw standing high bids (potentially with limits on the number of withdrawals allowed, and/or only in the event that a bidder places a new bid for each withdrawal that it makes).

for strategic behaviour and gaming (e.g. by allowing bidders to hide demand by bidding on unwanted lots and then switching demand later in the auction).

7.70 A further issue that affects both the SMRA and the SCA is that traditional activity rules[369] may prevent back and forth switching between packages with different eligibility[370]. As a result, some switching decisions (from packages with greater eligibility to packages with less eligibility) might be irreversible. However, it is possible that after any such decisions price differentials might change, so that the bidder wishes to switch back to a package with greater eligibility. However, it is not possible to eliminate switching impediments under the traditional activity rules.

7.71 In relation to the SCA, DotEcon advises that this format does not fully suppress substitution risks. In particular, switching between different categories of lots may be inhibited by the activity rules, which are put in place to ensure that bidders do not increase demand as prices increase. However, where there are different categories, it is possible that the price of lots in one category might become *relatively* cheaper compared to the price of lots in a different category; therefore, when lots in different categories are substitutable it is possible a bidder may want to increase its demand for a lot category if it has become relatively more attractive to other lot categories, *even* if prices have not become lower in absolute terms.

7.72 The SCA allows bidders to switch demand across lot categories in one go, however when a bidder reduces its eligibility then it will be unable to submit any further bids that would involve an activity level greater than its current eligibility level – therefore, bidders are not able to switch back and forth between packages with different eligibility. Differences in eligibility points across packages of interest,[371] which likely to arise in this award, can thus create impediments to switching, which can lead to substitution risks.[372]

[369] Activity rules are used to ensure that bidding is progressive, with Bidders reducing their demand as the prices of Lots increase,

[370] Eligibility refers to the number of Lots that a Bidder is permitted to bid on in a particular round. The eligibility points are effectively weights applied to each lot category to reflect an allowed rate of switching between different lot categories.

[371] Eligibility points have been set to align exactly with the relative difference between the minimum prices of the licences.

[372] See worked example in DotEcon Award Design Report, p63.

7.73 The CCA and CMRA address this problem by adopting better defined activity rules that allows bidders to bid for packages with greater eligibility if this is consistent with revealed preference constraints arising from the bidder's earlier choices. However, these activity rules are only appropriate when all bids submitted in the auction are considered, and when bidders have the option, and are required, to maintain a set of bids that reflect their relative preferences throughout the auction.

7.74 In combinatorial auction formats, substitution risks can be suppressed by allowing bidders to make mutually exclusive bids for alternative packages under the guarantee that the bidder will be assigned a package that maximises its surplus given the auction prices.[373] This means that a bidder can express its valuations for a number of alternatives, and then rely on the auction mechanism to select the most preferred outcome against those valuations. The CCA, CMRA and the SBCA all adopt this approach.

7.75 As noted above, substitution risks are addressed in combinatorial formats (i.e. the SBCA, CCA and CMRA) by allowing bidders to make multiple, mutually exclusive bids for alternative packages, and using a winner and price determination mechanism that maximises bidder surplus given the bids received.[374] The activity rules applied in the CCA[375] and CMRA also mitigate switching impediments by allowing bidders to switch back and forth between packages with different eligibility as prices develop, provided that this is consistent with the relative caps created by the bidder's bids in earlier rounds.[376]

7.76 The open aspect of these formats (along with the activity rules that create incentives for bidders to bid in line with their valuations in each round) allows bidders to gather information about likely relative prices, and about how their demand might fit with that of competitors. Bidders can then use this information to mitigate uncertainty about the final outcome and refine their bid strategy. This can be useful in scenarios where there is a large number of potential packages of interest, but bidding for all of them is unrealistic; knowing which packages it

[373] DotEcon Award Design Report, p25.

[374] DotEcon Award Design Report, p25.

[375] The CCA referred to in this Chapter is the format used by ComReg in the 2012 Multi-Band Spectrum Award and the 2017 3.6 GHz Spectrum award. Earlier versions of the CCA used in Austria and the UK did not use revealed preference based activity rules.

[376] Both formats prevent bidders from artificially holding back demand by using revealed preference based activity rules which requires that bid differentials must reflect prices at which bidders dropped demand. For example, in the CCA bidders could submit primary bids for packages that exceed the bidder's current eligibility provided that doing so is consistent with the preferences that the bidder has previously expressed through bids made in primary bid rounds where the bidder has dropped eligibility. Similarly, in the CMRA, a bidder may submit a bid for a package with eligibility greater than its existing eligibility, if this does not exceed the relative caps. See DotEcon Award Design Report for further discussion.

might stand a chance of winning can help a bidder to determine the packages on which it should focus its bids to maximise its chances of winning its preferred package (given the demand of other bidders and final auction prices).

7.77 In a sealed bid award (e.g. SBCA), a bidder would be able to express valuations for a number of different options in a single sealed bid but would be unable to switch demand across those options in response to information about relative prices. It has no price discovery mechanism whereby bidders can process the information made available through the auction (at the end of each round in a multi-round auction) in order to update their valuations or identify and switch between alternative lot categories given the demand in others. A bidder could end up buying one package when they would have preferred a different package at the end prices.

7.78 ComReg is of the preliminary view that open combinatorial auctions (i.e. the CCA and CMRA) are best suited to dealing with substitution risks that may arise in the proposed award.

7.3.6 Bidder information deficits

7.79 Bidder information deficits arise when a bidders' bids or preferences across different packages would have been different if it had more information about the nature of demand. In particular, a more efficient outcome could have been obtained if more information had been available to bidders prior to determining its final set of bids.

7.80 In that regard, DotEcon identifies the following potential sources of bidder uncertainty:

- Common value uncertainty;
- Conflicts in demand; and
- Potential for bidder error.

Common value uncertainty

7.81 Common value uncertainty occurs when bidders are faced with uncertainty about the value of the spectrum offered. The valuation ascribed to spectrum by bidders can be affected by uncertain factors common to all bidders such as future technologies and demand in downstream markets. However, these common factors are subject to uncertainty as bidders need to form expectations about the way in which they will develop. Where there is common value uncertainty, bidders may want to update their own valuation in light of information received about the valuations of other bidders, which reduces

uncertainty and promotes efficiency.[377] In this context, open auction formats will help bidders to reduce common value uncertainty, allowing bidders to adjust their valuations on the basis of information disclosed in the bidding process. However, the extent to which such information is useful to bidders depends on the extent to which alternative users intend to use the spectrum or whether some bands are more substitutable than others.

7.82 DotEcon are of the view that, in the proposed award, common value uncertainty is likely to be less relevant compared to the 2012 MBSA, as there is less uncertainty about the potential use of the spectrum on offer.[378] For example, the 700 MHz band possesses similar characteristics and is highly substitutable to the sub-1 GHz spectrum assigned under the 2012 MBSA (i.e. 800 MHz and 900 MHz), which is already in use – therefore, the actual value of 800 MHz and 900 MHz provides a good benchmark for the likely value of 700 MHz spectrum. However, for the remaining bands[379], DotEcon advises that where there are potentially different uses of the spectrum with varying business models it can be difficult for a bidder to separate out the information that is relevant to its particular use case. Therefore, even if the 2.1 GHz Band is currently used for mobile services, there is likely to be greater uncertainty around their value (both in absolute and relative terms).[380]

7.83 Further, DotEcon notes that there is likely to be an element of common value uncertainty due to the potential for the award spectrum to be used for 5G services. For example, each of the bands outlined in this award will likely be used to support 3G, 4G and 5G[381] technologies and services. The advent of 5G presents uncertainties common to all operators about the value of the spectrum

[377] The valuations of other bidders could contain useful information that might be relevant to a bidder's own valuation. For example, a bidder might reduce its own valuation if it sees other bidders dropping out sooner than expected, or revise it upwards if it sees other bidders staying in at higher prices than expected.

[378] DotEcon Award Design Report, p71.

[379] The outcome of the 3.6 GHz award is unlikely to remove value uncertainty as may exist between the remaining bands because the 3.6 GHz band was assigned on its own.

[380] For example, the benchmark price per MHz for 2.1 GHz is five times larger than the 2.6 GHz band[380] and there is likely to be uncertainty about the extent to which such price differences are likely to be reflected in final prices through the interaction of bidders in Ireland. (i.e. would bidders prefer more 2.6 GHz at a lower price).

[381] While the 700 MHz, 3.6 GHz and 26 GHz bands have been identified as the pioneer bands for 5G in Europe and technical harmonisation decisions have been adopted or are in the final stages of adoption for these bands, work to revise the technical harmonisation decisions to support 5G technology for other spectrum bands (namely 900 MHz, 1.8 GHz, 2.1 GHz and 2.6 GHz) is ongoing.

Source: CEPT roadmap for 5G, (Version 7, Revised 26 October 2018),

https://www.cept.org/Documents/ecc/47557/ecc-18-146-annex-21_cept-roadmap-5g

used to support such services.[382] These include:

- the current absence of a complete set of 5G technical standards[383];
- the finalisation of technical harmonisation decisions to facilitate 5G in other spectrum bands;
- the availability, timing and cost of 5G-enabled equipment for relevant bands;
- the full range of bands that any future mobile technology standard would encapsulate[384]; and
- Rollout strategies and consumer demand for 5G services are unknown. In particular, it is not clear how existing operators will migrate from 3G and 4G services, and the time period over which such migration will occur.

7.84 ComReg is of the preliminary view that although the risks of common value uncertainty are less compared to 2012 MBSA, it should be a consideration for this award, and that an open auction format (CCA, CMRA, SCA, SMRA) is preferable in order to mitigate this uncertainty.

Conflicts in demand

7.85 When there is a large amount of spectrum available (as in the proposed award) it may be impractical/infeasible for bidders to express their full demand for all possible combinations of lots that may be of interest. This might be due to complexity on the bidder side (e.g. difficulties in estimating accurate valuations for such a large set of alternative packages, and with preparing and submitting a consistent set of bids for them) or due to computational limitations on the auctioneer side (which might require setting a cap on the number of packages for which each bidder can bid). Therefore, in practice bidders may need to restrict their bids to a subset of all possible packages of potential interest. This could result in a bidder failing to be assigned any lots and/or outcomes in which

[382] In the 2012 MBSA, the assigned bands were used to support existing services (e.g. 2G in 900MHz) and the rollout of new 3G (900 MHz) and 4G services (800 MHz and 1800 MHz). Similarly in this award, rights of use in these bands will likely be used to support existing 3G (in the 2.1 GHz band) and 4G services and the deployment of new 4G (e.g. in 2.1 GHz band) and 5G (e.g. in the 700 MHz) services.

[383] While 3GPP Release 15 provides standardisation for specific aspects of the non-standalone and standalone versions of 5G, standardisation enhancement work continues in relation to future 3GPP Releases. https://www.etsi.org/technologies/5g

[384] Consideration of the spectrum requirements of future 5G networks is not limited to the 26 GHz band. WRC-19 will consider the following potential 5G bands as specified in Resolution 238 (WRC-15): 24.25In - 27.5 GHz, 31.8 - 33.4 GHz, 37 - 40.5 GHz, 40.5 - 42.5 GHz, 42.5 - 43.5 GHz, 45.5 - 47 GHz, 47 - 47.2 GHz, 47.2 - 50.2 GHz, 50.4 - 52.6 GHz, 66 - 76 GHz and 81 - 86 GHz.

lots are left inefficiently unsold. Had the bidder bid for a wider range of frequency options or better considered the value of particular packages, then the award could have ended with a more efficient outcome.

7.86 This risk is particularly significant in sealed bid processes, which do not provide any information to bidders about the demand from competitors' that could help bidders to identify which packages they might be able to win within their budget/valuation. Conversely, DotEcon advises that open (multi-round) auctions disclose some information about the level of competition, allowing bidders to update expectations and estimates of competitors' behaviour and to adjust their valuations and bids accordingly.[385] This processes may help bidders in assessing where their demand could best fit with that of others, in order to judge which packages they might be able to win, and makes bids for these. In an open award, as prices and demand develop (in particular in the latter stages of the award) a bidder can gather information about which packages it can realistically win and focus its bids on those packages. This is particularly relevant for important harmonised spectrum where operators are likely to want to carefully consider their packages given the impact receiving one particular package over another could have on its ability to provide services downstream. Therefore, in this context, an open process may achieve a more efficient distribution of spectrum than a sealed bid process.

7.87 ComReg is of the preliminary view that reducing inefficiencies arising from conflicts in demand should be a consideration for this award, as with the large amount of spectrum available bidders are likely to face practical limitations with respect to the number of package for which they can prepare and submit bids. Furthermore, ComReg is of the preliminary view that this can be best addressed through an open auction process.

Bidder error

7.88 Bidder error can lead to inefficient outcomes if the bidder who places the highest value on the spectrum fails to acquire that spectrum because of a failure to adequately submit bids that best reflects its valuation structure, or because the bidder omitted certain bids. In effect, inexperienced bidders may unintentionally omit certain bids which would have been winning bids had they been included, and may end up winning too little or too much spectrum relative to an efficient outcome, paying too much for the lots they win, or regret not having bid higher for additional lots given the final price at which such lots are sold. However, the consequences of mistakes may not only affect the bidders making mistakes, but more generally distort the outcome of the auction and potentially affect other

[385] DotEcon Award Design Report, p67.

bidders too.

7.89 DotEcon notes that bidders in this award are likely to be well informed regarding the auction rules and their own valuations.[386] However, it cannot be ruled out that new (and potentially inexperienced) bidders may wish to participate in the award, and it seems reasonable not to expose bidders to a high risk of ending with an unwanted outcome simply due to bidding mistakes from any bidders. An open auction format could also still help to reduce the risk of an inefficient outcome due to bidder error. This is because, (unlike in a sealed bid auction) open auction formats provide opportunities to recover (subject to auction rules) from mistakes.

7.90 ComReg is of the preliminary view that reducing the extent of bidder error should be a consideration for this award, and that an open auction format is preferable to mitigate the risk of inefficiencies arising from possible errors.

Award Formats

7.91 Bidder information deficits can be mitigated by allowing bidders to observe the bidding behaviour of competitors. In that regard, the SBCA is unsuitable to mitigate against these concerns, as there is only one round of bidding and bidders are unable to adjust their own valuation in light of the bidding behaviour of rivals. Given the potential bidder information deficits identified above, DotEcon recommends the use of an open auction format for this particular award.[387]

7.92 The use of an open auction format allows bidders to obtain information about the demand of other bidders and refine their valuations and bid strategy in light of this information. However, there is a balance between providing additional information to bidders and reducing incentives for gaming as described above. For example, depending on the information made available to bidders, there is scope for signalling and/or targeting of particular competitors, facilitating anti-competitive behaviour such as collusion or predatory behaviours. Moreover, DotEcon advises that the potential for engaging in strategic demand reduction is accentuated when bidders have information that allows them to assess whether they could bring the auction to a close with a unilateral reduction in demand.[388] In some formats this further increases the risk that some lots may end up going inefficiently unsold, as several bidders might reduce their demand to this end at the same time.

7.93 Open multi-round auction formats, including the SMRA, CMRA, SCA and the

[386] DotEcon Award Design Report, p68.

[387] DotEcon Award Design Report, p31.

[388] DotEcon Award Design Report, p72.

CCA, provide bidders with various degrees of information regarding the demand for spectrum during the award (for example information about specific bids placed by bidders, aggregate demand for each lot/lot category, or whether or not prices need to increase for a lot/lot category).

7.94 The SMRA may provide more transparency and detailed bidder information than other formats. DotEcon however cautions that increased information increases the scope for gaming, predatory or vexatious bidding and tacit collusion as described above.[389] In a typical SMRA with a high degree of transparency it is easy to formulate gaming strategies aimed at reducing competition and trying to establish tacitly collusive arrangements. It is possible to limit transparency to reduce this problem (e.g. by not revealing the identity of the standing high bidders, or detailed aggregate information about the bids received that have not become standing high bids), but this can exacerbate the problem of aggregation risks, as bidders have less information to assess the chances of being stranded as the highest bidder on only some of the lots they are bidding for. Further, as discussed above, under the SMRA there may be switching impediments that limit the extent to which bidders can react to the information they obtain.

7.95 Alternatively, the CCA and CMRA provide more limited transparency which limits the extent to which it can be used for engaging in anticompetitive strategies. For example, bidders are able to identify which lot categories are facing excess demand based on which round prices are greater than reserve prices or the previous round prices. Further, aggregate demand data provides bidders with a little more transparency about the level of demand causing the increase in those prices.

7.96 Therefore, ComReg is of the preliminary view that an open auction format is preferable in order to mitigate bidder information deficits. In particular, the CMRA or CCA are the best formats for providing information to bidders without compromising efficiency through increased risk of gaming

7.3.7 Complexity

7.97 Complexity is an important consideration because it can lead to inefficient outcomes whereby the bidder who places the highest value on the spectrum fails to acquire that spectrum because of a failure to adequately understand the assignment mechanism and the interaction of bids made by it and other operators. In that regard, the design of the Proposed Award should, to the greatest extent possible, seek to minimise the complexity for bidders. However, ComReg notes that this should not act to the detriment of the Proposed Award

[389] DotEcon Award Design Report, p68.

and should be appropriately balanced against the risks identified above.

7.98 There are typically three types of complexity within an auction format.

- Computational complexity refers to the complexity involved in the process of determining the outcome of the award and the winning combination of bids that results in the most efficient outcome.
- Mechanical complexity refers to the complexity arising from understanding the auction rules and operation of the auction.
- Bidding complexity refers to the complexity of the bidding process during the award and the extent to which bidders are able to evaluate their valuations for various options and reflect them in a straight-forward manner through bids

7.99 Readers are referred to Annex 8, Document 15/140 for further information on each type of complexity.

7.100 At the outset, it should be noted that the burden of computational complexity, regardless of the award format, falls entirely on the auctioneer who typically uses algorithms where necessary to determine which of the bids will be winning bids and to determine what the winning bidders pay. In order to ensure bidders have full confidence in the Proposed Award, a programme of tests independent from the auctioneer on the operation of the winner and price determination algorithms will be implemented for the Proposed Award.

7.101 Further, ComReg has previously released a working version of the algorithms for bidders to test various inputs and outputs providing another level of authentication. Therefore, bidders can be confident that winner and pricing determination will be fully fit for purpose and reliable in assessing the valuations of competing bids. ComReg assess each format for mechanical and bidding complexity below.

7.102 While it varies from auction to auction, the rules in the SMRA and the SCA are relatively simple and transparent (in the SMRA bids are made on a lot-by-lot basis and bidders only need to improve their offers in response to being outbid, whilst in the SCA bidders are given a clock price and simply need to indicate how many lots in each category they would want to acquire at these prices). Alternatively, combinatorial auctions such as the SBCA, CMRA and CCA are more complex to implement, as they require some mechanism for collecting multiple package bids from individual bidders.[390] However, as noted above,

[390] In relation to views of Nera that package bidding introduces complexity, ComReg notes that package bidding does introduce some complexity, but designing an effective bidding strategy for an award with many lots organised into categories as proposed for this auction adds complexity regardless of the format.

much of this complexity resides with the auctioneer and has little effect on bidders. Once the auction is understood, the process for submitting bids is relatively straightforward.

7.103 In effect, while the SMRA and SCA have less mechanical complexity, it can increase bidding complexity due to the risks and uncertainties faced by bidders when lots are complementary for bidders. In a multi-band award such as the one proposed, it can become difficult to bid on each lot independently of other lots in a bidder's desired footprint. For instance, as discussed above, both of these formats may create switching impediments when bidders can acquire multiple lots and may wish to switch several lots across different categories. This might lead to situations in which some bidders might be unable to switch their full demand in response to price changes (especially in the SMRA) or where switching decisions might be irreversible. In these cases, bidders will need to make a choice between alternative packages on the basis of their expectations about final relative prices, to ensure they do not end up winning the wrong package.

7.104 In a similar way, where bidders may consider settling for fewer lots but at a lower price per lot (due to loss of synergies when additional lots cannot be obtained), then bidders may need to make the decision of whether to compete for additional lots or settle for fewer lots at a lower price on the basis of their expectation about final prices. They also need to consider the risk that they may end up winning a small package at prices that exceed their valuation, or that they may miss the opportunity to bid for a small package at smaller prices. Therefore, designing an effective bidding strategy in such cases can be complex and will depend on assumptions about the behaviour of others.

7.105 In that regard, DotEcon are of the view that non-combinatorial auction formats present an unreasonably high risk of an inefficient outcome in the proposed award. This is due to the likely complementarities across lots, and thus that the additional complexity from using a combinatorial auction format is justified on the grounds that its greater efficiency is likely to offset any drawbacks from the additional mechanical complexity.[391] In particular, in this context package bidding simplifies the bidding process, and the possibility of making mutually exclusive bids for alternative packages mitigates switching risks and reduces the scope for bidder errors that could arise from wrong assumptions about the demand from competitors and the likely outcome of the process.

[391] DotEcon Award Design Report, p28.

7.106 The SBCA is mechanically the least complex combinatorial format, as it does not require activity rules. In this context, bidders only need to consider any bidding constraints that might apply to them, and provide a list of mutually exclusive bids for alternative packages. However, although not mechanically complex, the sealed bid aspect of this format can introduce a high degree of complexity for bidders when they face information deficits, in particular if they are unable to evaluate and bid for all possible packages of potential interest, which is likely to be the case in this award especially given the large number of lots available. In this case, a sealed bid process can be challenging for bidders, and increases the scope for bidder errors (e.g. in relation to the choice of packages that the bidder wishes to bid for, and to determining optimal bid amounts).

7.107 Both the CCA and the CMRA have relatively complex mechanics in relation to activity rules and winner and price determination. However, once the format itself is understood and bidders have generated their valuations for different packages of lots, the process of bidding to reflect these valuations (and importantly, relative preferences between different packages) can be relatively straightforward. Furthermore, the open nature of these formats mitigates uncertainty about the final outcome, as price and demand information revealed during the clock rounds provides an indication of possible outcomes and prices. This can assist bidders in identifying the relevant packages to bid for, and setting optimal bid amounts.

7.108 The CCA has already been used in Ireland for the 2012 MBSA and more recently the 3.6 GHz Award in 2017, so many potential bidders are likely to be familiar with its features. Furthermore, ComReg aims to provide a detailed bidder training programme, including an auction workshop presentation[392], the use of mock auctions[393], bidder playgrounds[394], and winner and price determination software[395] which allows bidders to simulate auction scenarios and calculate prices paid for a given set of winning bids. In light of this extensive bidder training, ComReg is also not persuaded by Nera's view that package bidding can lead to bidders struggling with excessive complexity (noting that the lab experiments referred to by Nera did not take account of the extensive bidder training provided by ComReg in actual spectrum awards).

[392] Where the main features of the award are stepped through in a face to face meeting (or facilitated via the internet) with interested parties.

[393] ComReg provides a mock auction scenario for each bidder, where the various features and auction rules are illustrated.

[394] This allows bidders access to the Electronic Auction System where it can create its own auction simulations including the number of bidders and associated bids.

[395] This software allows bidders to easily calculate winning bids and prices based on hypothetical bids chosen by the bidder or resulting from the simulated auctions.

7.109 A potential disadvantage of the CMRA is it is a relatively new format, having been first introduced in 2016, and has not been used in Ireland, so bidders are unlikely to have prior experience with it. The activity rules in the CMRA would be very similar to those used in the 2012 MBSA. However, the process for submission of additional bids alongside headline bids, and the alternative approach for assessing bids and determining if the auction can end or, alternatively, which prices should be increased, would be relatively novel features. ComReg notes that sufficient bidder training can also reduce this impact. For example, as in recent auctions, ComReg could assist all bidders in developing a detailed understanding of any award format and the associated auction rules through the above training tools. However, some likely participants would likely have a greater understanding of the CCA, and feel more confident bidding in a CCA than in a CMRA.

7.110 Also, the CMRA may be challenging for bidders who may want to bid for many alternative packages, as such bidders may need to update a large number of bids in each round. Given the large number of lots available, it may be easier if bidders only need to consider all of these bids in the supplementary bids round of a CCA, where bidders typically have a number of days to prepare their final set of supplementary bids. As noted by DotEcon, bidders might need to consider a significant number of bids each round, which could be challenging; conversely, in a CCA bidders would only need to make a comprehensive assessment of all their bids in the supplementary bids round.[396]

7.111 In this regard, the CCA may also provide greater opportunities for bidders to correct, through their supplementary bids which are only required after the conclusion of the clock stage, potential bid errors from the clock rounds.

Budget constraints

7.112 In relation to the CCA, concerns have been raised that there may be uncertainty about what bidders would be required to pay having made certain bids.[397] This can cause difficulties for bidders under certain circumstances:

- Bidders with a budget constraint may not be able to bid their full valuation for all the packages of interest, as this might exceed their

[396] DotEcon Award Design Report, p87.

[397] The price a winning bidder has to pay in the CCA is determined based on the concept of opportunity cost ('second price rule') and reflects the highest value that could have been generated by assigning lots won by it to other bidders instead. The opportunity cost cannot be greater than the winning bid amount, as otherwise this alternative assignment would have won, but could be lower. This means that the price that a bidder may be required to pay is potentially lower than its winning bid amount. Given that the price paid can be lower than the amount bid, there may be uncertainty over what bidders would ultimately be required to pay having made certain bids.

budget. In such cases, determining the optimal bids for a number of alternative packages may be challenging; and

- Even when bidders may be able to bid at valuation, they may face internal governance issues when seeking approval to make bids at levels significantly higher than expected prices.

7.113 However, the open stage of the CCA provides an effective mitigation of this problem, which should help bidders in identifying the packages they may be able to win within their budget, and also determining the maximum prices they might be required to pay under normal circumstances for the packages they have bid for in the final clock round. Therefore, whilst these concerns could be material in the SBCA, ComReg considers, in light of its experience in recent awards, such concerns to be relatively minor and manageable in the CCA, especially under the proposed activity rules.[398] In this regard, bidder training provided by ComReg would help bidders to learn how to make good use of the information disclosed during the open stage in order to determine their final set of supplementary bids.

7.114 Given the above, ComReg is of the preliminary view that a CCA is the most appropriate format for allowing bidders to make best use of the information obtained over the course of the award.

7.3.8 Conclusion on ComReg's Preferred Auction Format

7.115 In selecting a suitable auction format, and taking account of the discussion above, the preferred auction format should be the one that, on balance, best achieves the objectives that the auction mechanism should:

- be flexible enough to allow bidders to construct their preferred packages of lots without facing aggregation risk and winning unwanted subsets of their demand;
- reduce or avoid substitution risks allow bidders to switch between lots as relative prices develop;
- be transparent to the greatest possible extent allowing bidders to obtain information that is easily understood by potential bidders but without facilitating gaming opportunities;
- minimise the risk of inefficient outcomes and allow all bidders to sufficiently express their demand without creating excessive complexity;

[398] The use of relaxed primary bids and the final price cap in more recent awards reduced these concerns by allowing certain bids to be made in the clock stage that would previously have needed to have been made in the supplementary stage. Consequently, clock prices in those awards were better predictors of what the successful bidders would have to pay as the outcome of the clock rounds were more aligned with the award outcome.

- encourage participation in the process and avoid outcomes where spectrum goes unsold despite efficient demand existing for that spectrum; and
- provide incentives for bidders to engage in normal competition, and not in strategic or collusive behaviour.

7.116 In its assessment of alternative auction formats, ComReg considers that the lots offered in this award are likely to be either substitutable or complementary (within bands, across bands, and across the two time slices), and that this warrants the choice of a combinatorial auction format. This rules out the SMRA and SCA for this award as other award formats assessed above provide the same benefits as the SCA and SMRA but are not exposed to substitution risks.

7.117 Whilst the SMRA provides for price discovery and bidders have a high degree of visibility on spectrum value, ComReg notes that when bidders seek complementary lots aggregation and substitution risks are high in the SMRA. The SMRA can be modified to some degree in an attempt to mitigate these problems; however, such modifications do not eliminate these risks entirely and could even impose greater penalties or other risks on bidders. ComReg is therefore of the view that a SMRA is unsuitable for the Proposed Award.

7.118 The SCA deals with aggregation risks by allowing bidders to specify their demand in each round, and thus reduce its demand by multiple lots at the same time. However, the SCA may easily lead to inefficiently unsold lots, especially when bidders have synergistic valuations, and may still create switching impediments for bidders who may wish to switch between packages with different eligibility.

7.119 Furthermore, the SCA provides relatively strong incentives for strategic demand reduction, which may increase the risk of an inefficient outcome, including the possibility of inefficiently unsold lots if multiple bidders reduce demand at the same time. Given that the proposed spectrum is particularly important in the delivery of end user services, the harm arising from inefficiently unsold lots is likely to be high in this award. In this way a SCA could substantially affect the efficiency of the award outcome. Therefore, ComReg is of the view that a simple clock auction is unsuitable for the Proposed Award.

7.120 Amongst the combinatorial auction formats considered, the SBCA is the least complex and most easily understood by bidders. However, it does not offer price discovery or allow for adjusting bids in light of information on competitors' demand. Where there is some uncertainty about the value of some bands or where bidders would switch to an alternative band in response to the evolution of prices, it exposes bidders to not being able to react to a rival offer for the same spectrum, and choose between alternative targets.

7.121 The SBCA also creates difficulties and risks for bidders when there is a large number of lots and bidders cannot bid for the full range of packages they might wish to acquire; in this case bidders will need to determine the relevant set of packages to submit bids for and, as discussed above, doing so can be very difficult and risk a sub-optimal outcome without any information about the demand of other bidders and which bids might be likely to win. Given the number of bands in the award and potential uncertainty about the relative value across bands, bidder information deficits are likely to justify the use of an open combinatorial auction format, despite its relatively greater mechanical complexity.

7.122 Both the CCA and the CMRA:

- allow for package bidding, eliminating aggregation risk, and mitigating substitution risks by allowing bidders to make a range of mutually exclusive bids for alternative packages;
- feature an open stage that helps to mitigate bidder information deficits, reducing the risk of an inefficient outcome; and
- mitigate the risk of inefficiently unsold lots, provided that bidders submit a sufficiently rich set of bids that reflects their demand for alternative packages.

7.123 However, as noted by DotEcon, with the large number of lots available in the award the CMRA could be challenging for bidders who wish to maintain a large list of bids, as such bidders may need to reconsider and update many bids on a round-by-round basis (whereas the CCA requires bidders to consider their final set of bids only once in the supplementary bids round). In addition, the CMRA is relatively novel, whilst the CCA has already been used for previous spectrum awards in Ireland, and in particular for the 2012 MBSA, which used the same activity rules that would be required for the upcoming award.

7.124 In light of the foregoing, having considered the DotEcon Award Design Report and responses to Document 18/60, ComReg is of the preliminary view that the CCA is the auction format best suited to deal with the considerations outlined in this paper. In particular, the CCA:

- avoids aggregation risks, by allowing bidders to bid for packages of lots, under the guarantee that bidders will only be assigned a combination of lots if they have specifically made a package bid for it;
- mitigates substitution risks by allowing bidders:
    - to submit multiple, mutually exclusive bids for alternative packages, and selecting winning bids and prices in a way that

ensures that bidders prefer their own winning outcome to that of any other bidder given the final prices;

- to switch across lot categories in response to price changes during the open stage, without creating an unacceptable risk of gaming or strategic behaviour that weakens competition;

- is sufficiently transparent and provides opportunities for bidders to pool information through the bidding process to mitigate any concerns about bidder information deficits.
- mitigates incentives for bidders to strategically reduce demand, which could result in an inefficient assignment and reduce service provision in downstream markets;
- allows for the possibility of non-uniform prices, which might be the only way of supporting an efficient outcome when valuations are synergistic, avoiding inefficiently unsold lots;
- mitigates the risk of inefficiently unsold lots, by allowing bidders to offer, through supplementary bids, to take those lots that would remain unsold at clock prices; and
- mitigates the risk of and destabilises tacit collusion.

7.4 Lot size of generic spectrum

7.125 In light of ComReg's preferred award format (i.e. CCA) offering spectrum into their smallest usable blocks provides bidders with greater flexibility to aggregate spectrum blocks to fit a bidder's demand profile. The CCA allows for the aggregation of lots by bidders into packages of spectrum that would constitute larger blocks in line with their respective business plans, without the risk of bidders winning only a subset of this demand and not being able to provide for higher throughput. For example, Nera's concerns in relation to the block size of 2×5 MHz or 5 MHz being too small only arises in an award format that does not use package bidding.[399] In a CCA bidders can only include blocks of 2×10 or 2×20 (if that is their requirement) in their preferred packages, eliminating the risk of obtaining a smaller block such as 2×5 MHz or 5 MHz.

[399] For example, Nera notes in relation to the 2.1 GHz Band that 2×5 MHz may be too small a unit to justify deployment of 4G or 5G technology once 3G networks are turned off.

7.126 Bidders can choose the exact amount of spectrum that they wish to acquire and reduce this amount in relatively small increments, if necessary, as market prices become more apparent. If lots are only offered in lot sizes greater than the smallest usable block of spectrum it could result in lots being inefficiently distributed across bidders or remaining unsold if bidders have marginal demand below the minimum lot size. Alternatively, the aggregation of spectrum into lots of larger size could limit bidders' options, potentially pushing them above their actual demand and possibly leading to an inefficient use of spectrum, along with an increase in the associated costs of acquiring such spectrum rights of use.

7.127 ComReg notes that the relevant European harmonisation measures for mobile broadband use of the proposed bands specify frequency arrangements formed of 5 MHz blocks.[400] Further, LTE user equipment (Release 13) supports a subset of 6 different system bandwidths (1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz and 20 MHz). However not all bands support all six different bandwidths. In that regard, the minimum bandwidth supported for each of the proposed bands is 5 MHz[401]. With a lot size of 5 MHz or 2×5 MHz, and assuming that two time slices are employed for the 2.1 GHz, 2.3 GHz and 2.6 GHz bands the maximum number of lots available in this award should not be overly complex[402] (although there would need to be a limit on the number of supplementary bids that could be submitted in order to manage computational complexity, as used in the 3.6 GHz Award)[403].

7.128 In that regard, DotEcon believes there is no reason to deviate from the approach recommended in the harmonisation Decisions i.e. that paired spectrum should be made available as 2x5 MHz lots, and unpaired spectrum as 5 MHz lots.[404] DotEcon further notes that lots can be aggregated into larger blocks that would meet bidder's requirements.

7.129 The packaging of spectrum into 5 MHz blocks offers more options for bidders in the award. In particular, the smaller blocks provide greater flexibility for any interested parties to tailor the size of a licence to their particular needs while, at the same time, making it possible to accommodate more users within the available spectrum. While it is unlikely that any bidder will require only 5 MHz of spectrum, as bidders reach their demand limit an additional 5 MHz of spectrum

[400] EU implementing Decision (EU) 2016/687, ECC Decision (06)01, ECC Decision (14)02, ECC Decision (05)05.

[401] https://www.etsi.org/deliver/etsi_ts/136100_136199/136101/13.05.00_60/ts_136101v130500p.pdf

[402] For example, the 3.6 GHz award had 594 lots available (66 blocks were made available across nine different regions).

[403] For example, in the 3.6 GHz award a supplementary bids could contain bids for up to 1,000 Packages.

[404] DotEcon Award Design Report

might fall within this demand, whereas a larger block size would fall outside that range and a bidder might have to overstate or hold back this marginal demand. In an award that has potential for a range of bidders seeking different bandwidths this could result in spectrum being inefficiently distributed across bidders or remaining unsold. Further, some bidders may want to acquire spectrum rights of use for an additional 5 MHz block to use it as a guard band in certain bands[405].

7.130 ComReg, therefore is of the preliminary view that frequency-generic spectrum should be offered using lot sizes of 5 MHz or 2×5 MHz, as appropriate.

7.131 The use of frequency-specific lots are assessed below noting that the size of any frequency-specific lot is determined depending on the circumstances of the particular band.

7.5 Frequency-Generic or Frequency-Specific Lots

7.132 The lots being made available in the Proposed Award can be offered on either a frequency-specific or frequency-generic basis. In that regard:

- In a frequency-specific auction, bidders bid on lots where each lot is assigned a specific radio frequency range. The winning bidder is assigned rights of use to those frequencies and has no opportunity to be assigned rights of use to a different part of the band at a later stage. This approach does not require a frequency assignment stage ("assignment stage") and there would be just one stage of bidding.
- In a frequency-generic auction, bidders bid on lots independent of the position of those lots within the band. Where lots are assigned in this fashion, the auction requires an assignment stage in which the specific frequencies to be assigned to winners of the frequency generic lots are determined. Where there are material value differences for different parts of the band, a competitive process that allows bidders to express their preferences over different assignment options may be required.

[405] For example in TDD bands where bidders may wish to have full freedom to vary the uplink /downlink configuration to be different than the default profile as specified in the Inter Licensee Synchronisation Procedure.

7.133 DotEcon notes that a frequency-generic approach is typically preferred where frequency blocks are likely to be very close substitutes and are of similar value to bidders. While bidders may have a preference for certain frequencies, the valuation for a generic lot would not change materially if a bidder was assigned one particular frequency over the other. Where any bidder requires a certain position in the band, it would have an opportunity to reflect that preference in the assignment stage that follows.

7.134 Alternatively, a frequency-specific approach might be appropriate if some bidders are likely to have strong preferences for certain frequencies which would likely impact the value of one or more lots materially depending on which frequencies are assigned. In more severe cases, a winner of generic spectrum could prefer to not have been assigned any spectrum if it ended up outside its preferred frequency range. This usually arises if bidders have different values for different frequencies within the same band. If the lots within a generic lot category have different values for a bidder (i.e. not all lots have the same value to a bidder), it may be difficult for the bidder to decide how much to bid for a given number of generic lots when it does not know the value of the spectrum it will ultimately be assigned.

7.135 DotEcon advises[406] that where possible (i.e. where there is no material value difference across frequencies), spectrum rights should be assigned as frequency-generic lots to determine total bandwidth before determining the assignment of specific frequencies of each bidder. In particular:

- the use of this approach guarantees that winning bidders would receive contiguous assignments, which supports efficient use of the spectrum; and
- offering spectrum rights in categories of identical lots can reduce bidding complexity relative to offering each spectrum block as an individual lot, as this might reduce the total number of different lot combinations that bidders may need to consider when determining their bids.

7.136 ComReg agrees with DotEcon for the reasons outlined above and also observes that the latter reason is particularly relevant in the Proposed Award where a large amount of spectrum rights (470 MHz) is proposed be made available for assignment.

7.5.1 Assessment of frequencies within bands

7.137 Given the above, DotEcon advises that it is first necessary to assess the extent to which frequencies within a particular band may differ in value. In that regard, ComReg sets out its preliminary views on any value differences within each of

[406] DotEcon Award Design Report, Section 5.2

the bands and the preferred packaging approach.

700 MHz Duplex

7.138 DotEcon are of the view that there are not any material, systematic differences in the characteristics/value of different blocks in the 700 MHz Duplex[407] such that each 5 MHz or 2×5 MHz lot within each band is likely to be of similar value.

7.139 Noting the above, and ComReg's consideration of the band plan considerations and technical conditions for 700 MHz Duplex band as discussed in this document, ComReg is of the view that the 700 MHz Duplex would be made available on a frequency-generic basis.

2.3 GHz Band

7.140 Based on current information[408], ComReg notes two potential sources of uncertainty in relation to the value of blocks in the 2.3 GHz Band.

A. The frequency range 2 390 – 2 400 MHz has a lower in block EIRP limit of 45 dBm / 5 MHz to ensure coexistence with systems above 2.4 GHz. This represents a 23 dB reduction compared to all other blocks in the 2.3 GHz band.[409]

B. The frequency range 2 307 – 2 327 MHz is used by Eir's Rurtel network to provide fixed telephony services in rural areas as part of its Universal Service Obligation.

7.141 **In relation to A** above, DotEcon notes that if the power limits mean that the potential uses of the band are more limited (which may result in the value of this spectrum being lower than the value of other 2.3 GHz spectrum with less restrictive technical constraints) there may be an argument for allowing bidders to bid for those frequencies separately to the rest of the band. ComReg notes that using a lower maximum EIRP will gives a lower transmission and coverage range and may be more suitable to some network deployments types over others

[407] See Para 6.22 for certain issues that may arise in relation to one or more winning bidders being assigned more than 2×10 MHz rights of use.

[408] See Plum 2.3 GHz Co-existence Report

[409] See Section A.2.1.1 ECC Decision 14(02). Harmonised technical and regulatory conditions for the use of the band 2300-2400 MHz for Mobile/Fixed Communications Networks (MFCN).

7.142 Therefore, ComReg is of the preliminary view that a frequency-specific lot may be necessary for those frequencies. While larger bidders may be somewhat insulated from being assigned up to 1 - 2 blocks at a lower power, it cannot be ruled out that smaller bidders may be interested in relatively modest amounts of spectrum, and the impacts of being assigned these frequency blocks instead of unencumbered lots would be larger should its network deployment require operating higher than 45dBm/5MHz eirp.

7.143 DotEcon advises that those frequencies should be offered as single 10 MHz lot rather than two separate 5 MHz lots as there is less likely to be demand for a single 5 MHz power restricted lot, and complexity in bidding for same is reduced relative to making it available in two separate 5 MHz lots.

7.144 Noting the above, ComReg proposes that the frequency range 2 390 – 2 400 MHz would be offered as a single frequency-specific lot.

7.145 ComReg also proposes that where the winning bidder of the frequency-specific lot also wins frequency-generic lots in the 2.3 GHz band, where feasible the assignment options would ensure that it is assigned the lots contiguous to the frequency-specific lot.

7.146 In **relation to B**, ComReg observes that the preferred packaging approach would depend on the nature and extent of any migration by Eir of its RurTel network out of the 2.3 GHz band going forward, in advance of the Proposed Award.

7.147 There are three areas in which Eir currently operates its RurTel service. These areas are illustrated by the interference contours[410] given in Figure 10 and defined as the areas of Galway[411], Kerry[412] and Donegal[413]:

[410] See Plum 2.3 GHz Co-existence Report

[411] The Galway region impacts all or part of counties Galway, Mayo, Roscommon and Clare.

[412] The Kerry region impacts all or part of counties Kerry and Cork.

[413] The Donegal region impacts all or part of counties Donegal, Cavan, Leitrim and Sligo.

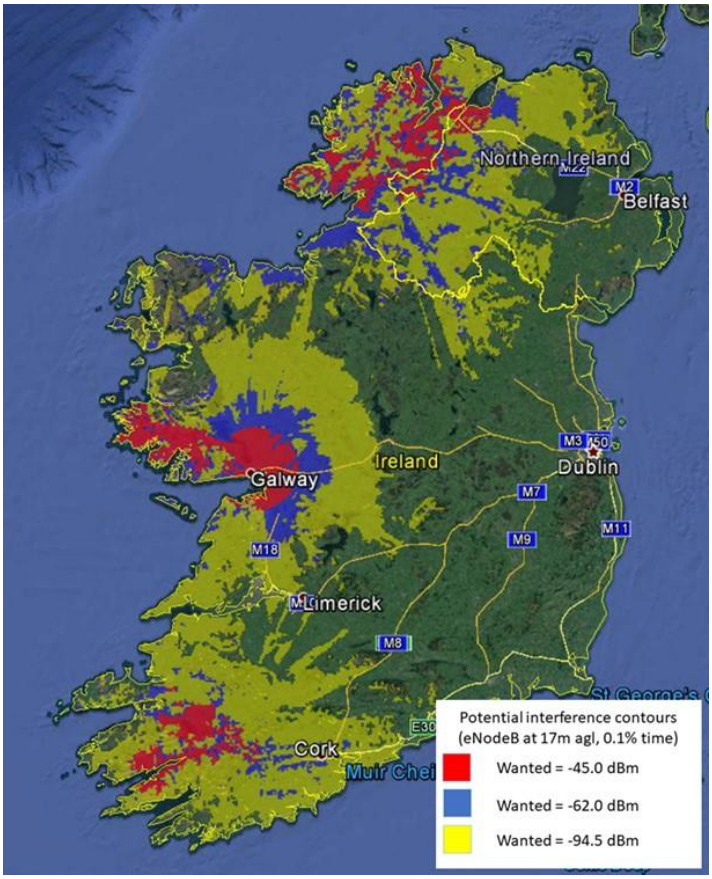

Figure 10: RurTel Interference Contours

7.148 ComReg envisages three broad scenarios based on the potential circumstances of the band at the time of the award, set out below.

7.149 First, in the event of **full migration by Eir** sufficiently in advance of the Proposed Award (or there is sufficient certainty by the time of the Proposed Award that this will occur before the commencement date of new rights in the band) then the lots in the frequency range 2 307 – 2 327 MHz could be treated as frequency-generic spectrum (i.e. five generic 5 MHz lots in the frequency range 2 305 – 2 330 MHz would be made available for assignment). These lots could then be included in the same lot category as the remaining spectrum in the 2.3 GHz Band (other than the top 10 MHz).

7.150 Second, in the event of **no further migration by Eir**, that is, if Eir has not significantly migrated its RurTel network out of the 2.3 GHz Band in all areas[414] before the holding of the Proposed Award (or there is insufficient certainty by the time of the Proposed Award that it will do before the commencement of new rights in the band), then the 2 300 – 2 330 MHz range[415] could be treated as a single frequency-specific lot available to all bidders.

7.151 In this scenario:

- the frequency-specific lot would be subject to the technical co-existence parameters (e.g. the setting of a limited number of temporary coordination areas[416] corresponding to the areas and frequencies covered by Eir's existing Rurtel licences); and

- depending upon the outcome of the Proposed Award[417] and as discussed in Chapter 9, Eir would be granted a transition licence[418] which would facilitate the full migration of RurTel out of the 2.3 GHz Band. The timeframe for such migration would be determined in the transition process, where amongst other things ComReg notes that the duration of transition licences would seek to ensure that existing RurTel customers have access to a suitable alternative voice service.

7.152 Further, where a winning bidder of this frequency-specific lot wins other frequency-generic lots in the 2.3 GHz Band and does not win the 2 390 – 2 400 MHz lot, the assignment round would ensure that the winning bidder is assigned the frequency-generic lots contiguous to this frequency-specific lot.

7.153 Where a winning bidder of the 2 300 – 2 330 MHz lot were also to win the 2 390 – 2 400 MHz lot (but not all of the generic lots) this would clearly result in the assignment of non-contiguous rights of use in the band. Bidders would therefore need to be aware that winning both frequency-specific lots (but not all of the generic lots) in the 2.3 GHz band would result in the assignment of non-

[414] Areas of Galway, Kerry and Donegal as defined above.

[415] ComReg is of the preliminary view that it would be appropriate to include the isolated 5 MHz lot with the RurTel frequencies for a 30 MHz frequency-specific lot. As noted by DotEcon, in this case, there would also be an isolated 5 MHz unrestricted use block at the bottom of the band (i.e. 2 300 – 2 305 MHz). On the expectation that there is unlikely to be demand for this 5 MHz block on its own, if assigned it would be allocated alongside the adjacent restricted use frequencies and use of the lot would likely be *implicitly* subject to the same restrictions.

[416] Should Eir migrate from the 2.3 GHz band in the future, a winning bidder then enjoys unencumbered right of use.

[417] ComReg observes that should Eir win this frequency-specific lot, then a transition licence would not be required as the continued operation of the RurTel network would be facilitated under the new spectrum rights issued to Eir.

[418] "Transition" refers to the activities required from existing and new licensees to adjust their networks to comply with the outcome of a spectrum award process. This is discussed in detail in Chapter 9.

contiguous rights of use.

7.154 Third, in the event of **partial migration by Eir** in advance of the Proposed Award (i.e. if Eir significantly migrates its network from one, or any two, of the RurTel areas defined above) ComReg would need to consider the extent of the migration at the time of the Proposed Award to determine whether the 2 300 – 2 330 MHz frequencies could be included as six frequency-generic 5 MHz lots with the rest of the band (up to 2 390 MHz), or if it would be more appropriate to make it available separately as a frequency-specific lot.

7.155 In this regard, ComReg observes that:

- there are a number of partial migration scenarios, including scenarios where only one area is fully migrated or scenarios where a combination of any two areas are fully migrated; and
- the significance of any one of these partial migration scenarios to ComReg's determination will depend on a number of factors, including for example, the geographic and population areas affected (see below) and the maximum duration of any RurTel transition period. For example, should Galway and Kerry be fully migrated before the Proposed Award or shortly afterwards, ComReg observes that about 6% of the population would remain in a RurTel coordination area.

Table 7: RurTel Population Area

Areas	No. Licences	Population	Population %
Donegal	21	292 000	6
Galway	7	523 000	11
Kerry	6	462 000	10
Total	34	1 277 000	27

7.156 In this partial migration scenario, ComReg observes that the framework discussed above in respect of no migration would, in general terms, also be required for those areas not yet migrated (i.e. the setting of technical co-existence parameters, the issue of transitional rights to Eir, and the assignment round considerations in relation to frequency-specific lots, etc.).

2.1 GHz Band

7.157 Eir's current 2.1 GHz licences run for the duration of the first time slice (i.e. 2022 – 2027.

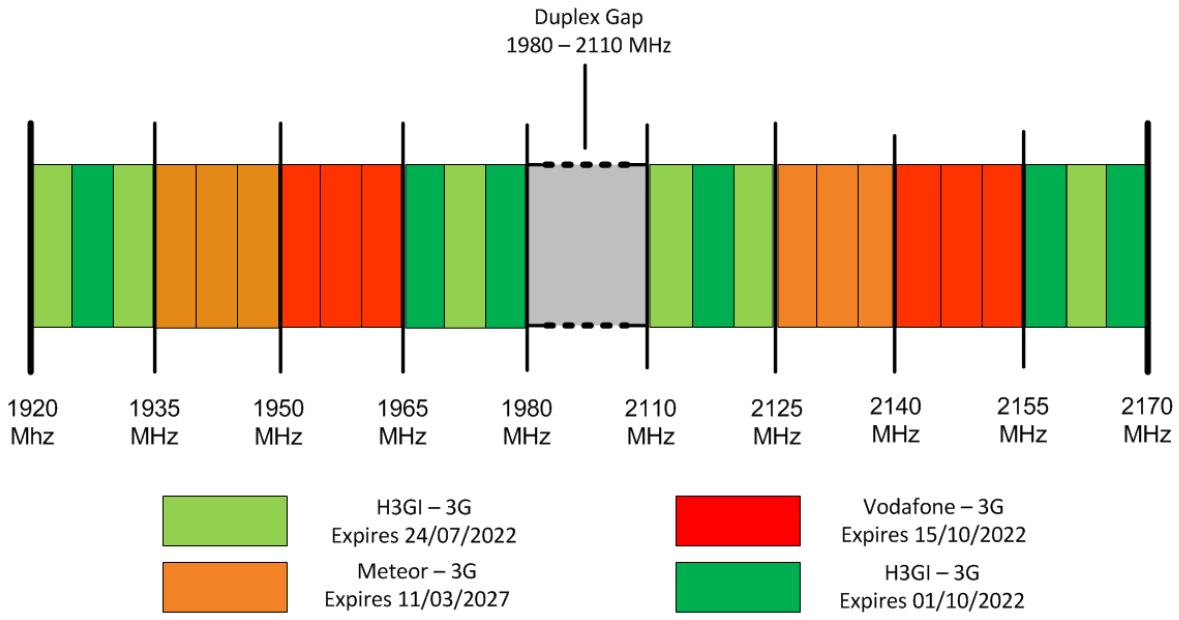

Figure 11: The 2.1 GHz Band

7.158 As illustrated in Figure 11, Eir's existing licence would split the remaining frequencies in the Time Slice 1 into two categories.

i. Three 2×5 MHz blocks below Eir's existing assignment

ii. Six 2×5 MHz blocks above Eir's existing assignment

7.159 However, this would limit the scope for a winning bidder being assigned contiguous spectrum within the band and raises difficulty for bidders valuing generic spectrum when it could end up with non-contiguous lots. For example, a winning bidder could be assigned 2×20 MHz in the 2.1 GHz Band rights of use which could be split into 2×15 below Eir and 2×5 MHz above Eir. Moreover, it might be impossible to assign all winning bidders contiguous spectrum (e.g. if one bidder wins 4 lots and another bidder wins 5 lots, there is no way in which both can get contiguous assignments).

7.160 DotEcon has considered this matter and note that if Eir's current assignment were to remain in that position within the band, then this would add complexity to the award and reduce the scope for assigning contiguous spectrum. Similar to the approach used in the 2012 MBSA and in the interests of an efficient assignment, DotEcon recommend that Eir, as a condition of participating in this award, be required to relocate its current holdings to accommodate contiguous assignments for all winners. DotEcon also note that this could be subject to some form of rebate to cover any reasonable costs of relocation that are incurred by the operator. ComReg notes and agrees with the views of DotEcon.

7.161 ComReg observes that a frequency-generic approach with the potential for non-

contiguous spectrum could present bidders with the problem of deciding how much frequency-generic lots in the 2.1 GHz band would be worth to them without knowing whether those frequencies would be assigned on a contiguous or non-contiguous basis. This could distort bidding incentives in the primary stage and risk inefficient award outcomes. For example:

- if a bidder's value was based primarily on receiving contiguous lots, a bidder may bid on the basis of receiving contiguous frequencies but then be assigned spectrum on a non-contiguous basis at a price above the bidder's valuation for such (non-contiguous[419]) lots;

- alternatively, it may submit relatively lower bids in the primary stage to guard against the risk of being assigned non-contiguous spectrum. As a result, it may not bid enough in the primary stage and subsequently not be assigned any (or less) spectrum when the efficient outcome (based on valuations) would have involved that bidder winning something (or more).

7.162 Alternatively, ComReg observes that the 2.1 GHz band could be split into two categories of generic lots (i.e. a sub-band of 2×30 MHz of spectrum above Eir's current holdings, and another sub-band of 2×15 MHz of spectrum below). While this approach would allow for guaranteeing contiguous frequencies within each of the sub-bands (and bidders could bid on that basis), this would add complexity to the award and it would limit the maximum amount of contiguous spectrum that any given bidder could be assigned in the band relative to the scenario in which Eir were to relocate. Noting that operators may have preferences to obtain up to 2×20 MHz of contiguous spectrum in this band[420], given for example the spectrum efficiency of such bandwidths for 4G/5G use, ComReg observes that this approach may result in an inefficient spectrum assignment.

7.163 Finally, if Eir is assigned 2.1 GHz rights of use in Time Slice 2, ComReg observes that it would likely be required to transition from its existing frequencies[421] at that stage in order to accommodate contiguous assignment options for all winning bidders in Time Slice 2 (see Assignment Stage below). In that regard, it would likely be preferable for all winning bidders to have the option of the same frequencies across both Time Slices.

[419] A bidder may have a lower value on non-contiguous spectrum as stranded lot(s) may be difficult to use.

[420] Nera, in its submission, notes that operators can be expected *"to have preferences for larger contiguous blocks within bands, both for 4G, which to date has worked with blocks up to 20 MHz, and the first generation of 5G, which will use larger contiguous blocks of up to 100 MHz"* and that 20 MHz in any band *"is a better size for 4G/5G use".*

[421] This would require transition activities for all winning bidders on expiry of Time Slice 1.

7.164 Noting the above, and similar to the approach used in the 2012 MBSA, ComReg proposes that Eir would be required to participate in the assignment stage of the Proposed Award to determine the location of Eir's current spectrum rights in the 2.1 GHz Band.

Relocation rebates

7.165 In the 2012 MBSA, ComReg provided for the possibility of a relocation rebate to compensate licensees for relocation costs in a number of circumstances. ComReg considers that such a circumstance may also arise in this award in order to relocate Eir's current spectrum rights in the 2.1 GHz band.

7.166 In this regard, ComReg proposes to apply the same relocation rebate possibility as used in the 2012 MBSA[422], namely that:

- If Eir does not avail of the early liberalisation in the 2.1 GHz Band and does not win spectrum in the time slice 2, then in such cases, the relocation rebate would be equal to the relocation costs necessitated as a result of the assignment stage;
- If Eir does not avail of the early liberalisation in the 2.1 GHz band and does win spectrum in the time slice 2, then in such cases, the relocation rebate would consider of the additional time-value-of-money costs associated with bringing forward the relocation activities necessitated as a result of the assignment stage, but not the relocation costs themselves; and
- If Eir can reasonably prove to ComReg that it has directly incurred relocation costs as a result of the assignment of 2.1 GHz frequencies that it would not have otherwise incurred at some point in time, ComReg would consider a relocation rebate.

7.167 Similar to the 2012 MBSA, any relocation costs incurred by Eir would be examined by ComReg to determine if such costs are objectively justified and proportionate.

2.6 GHz Band

7.168 As noted in Chapter 6, ComReg proposes that two 5 MHz restricted blocks (2 570 – 2 575 MHz and 2 615 – 2 620 MHz) would be required in the 2.6 GHz band where FDD and TDD spectrum blocks are adjacent to one another.

7.169 The use of restricted blocks is a potential source of uncertainty in relation to the value of 5 MHz lots in the 2.6 GHz Duplex Gap (i.e. the 50 MHz unpaired arrangement in the frequency range 2 570-2 620 MHz) as among other things,

[422] See paragraph A4.7 of ComReg Document 12/52.

ComReg proposes that these two 5 MHz restricted blocks would have a lower in-block EIRP limit of 25 dBm / 5 MHz compared to 61 dBm/ 5 MHz for unrestricted blocks.

7.170 Noting the above, ComReg is of the preliminary view that the reduced power limits on those blocks may limit the deployment potential and as such reduce the value of those frequencies compared to alternative frequencies in the 2.6 GHz Duplex Gap.

7.171 In determining whether the 2 570 – 2 575 and 2 615 – 2 620 frequency ranges should be assigned on a frequency-generic or frequency-specific basis, two options are available.

1. ComReg could assign all lots in the 2.6 GHz Duplex Gap on a frequency-generic basis. In that regard, Bidders would run the risk of being assigned low powered lots in the assignment stage. A bidder would be assigned both lots only where it is assigned all lots in the 2.6 GHz Duplex Gap.

2. The 2 570 – 2 575 and 2 615 – 2 620 frequency ranges could be offered as two frequency-specific lots. While this would add an additional four lot categories (i.e. each lot across two time slices) into the Proposed Award, ComReg observes that this would allow bidders to bid for these lots in the primary round of the award. If two winning bidders win a frequency-specific lot each, then these winning bidders would automatically be assigned any other frequency-generic lots it wins in the 2.6 GHz Duplex contiguous to the frequency specific lot.

7.172 Given the above, and noting the bidders may value the 2 570 -2 575 and 2 615 – 2 620 frequency ranges differently to the other lots in the 2.6 GHz Duplex Gap, ComReg is of the preliminary view this spectrum should be considered on a frequency-specific basis.

7.5.2 Assignment Stage

7.173 Following the main stage (i.e. the primary and supplement bid rounds of the Proposed Award) ComReg proposes that the award will proceed to the assignment of specific frequencies to winners. The purpose of the assignment stage is to determine the specific frequencies to be assigned to winners of the frequency-generic lots and any additional prices they would have to pay.

7.174 Similar to the 2012 MBSA, and the 3.6 GHz Award, ComReg proposes to determine the set of feasible frequency assignments for each winning bidder in accordance with certain principles or requirements in order to maximise the benefits to users and ensure the efficient use of spectrum. For example, the award of a contiguous spectrum in a band where feasible.

7.175 ComReg would note that it would not be appropriate to fully set out these principles at this time as any principles would depend on matters that are considered in this consultation and developments in the bands between now and the time of the award. In particular, DotEcon in its Award Design Report note that there are a number of different factors to consider in determining the potential frequency assignments. Notwithstanding, ComReg summaries some of the issues that may be relevant in determining appropriate principles.

7.176 For the 700 MHz Duplex, principles to inform the assignment options include that:

- each winning bidder be awarded a contiguous block of spectrum in accordance with the number of lots assigned to it; and
- unsold lots are grouped into a contiguous block within the band

7.177 For each of the Performance Bands (i.e. 2.1 GHz Band, 2.3 GHz Band and the 2.6 GHz Band (split into the FDD and TDD sub-bands)), principles to inform the assignment options include that:

- each winning bidder be awarded a contiguous block of spectrum in accordance with the number of lots assigned to it;
- any winning bidder that has been awarded the same number of lots in both time slices[423] would be assigned the same frequencies in each Time Slice;
- any winning bidder that has been awarded a different number of lots across both time slices, would be presented with options which aim to maximise the extent to which the same frequencies are assigned in each time slice; and
- unsold lots would be grouped into a contiguous block where appropriate, noting that there further consideration is needed as to whether the unsold lots be used for other purposes or simplifying the transition process[424]..

[423] In time slice 1 Eir's current spectrum rights of 2×15 MHz would be counted as 3 lots.

[424] As identified in the DotEcon Award Design Report, p94

7.178 Where frequency-specific lots are required, (potentially in both the 2.3 GHz and the 2.6 GHz Duplex Gap), principles to inform the assignment options include that:

- where feasible the winners of such lots would be assigned the frequency-generic lots won by it in that band on a contiguous basis to the frequency-specific lot.

7.179 As discussed earlier, where there is a winner of two frequency-specific lots in the same band, noting that these frequency-specific lots would be at the top and bottom of the bands, it would not be possible to assign contiguous spectrum to that winning bidder unless the winning bidder also won all the frequency-generic lots in that band.

7.180 Further, ComReg notes that certain issues in the various bands may necessitate constraints being placed on winning bidders in the assignment stage.

- In the 2.1 GHz Band, ComReg proposes that Eir would be required to participate in the assignment stage in order to determine the frequency assignment of its current spectrum rights and to accommodate contiguous assignments in the band; and
- In the 700 MHz Duplex, where one or more bidders win over 2×10 MHz, constraints would be imposed as described in section 6.2.1. (Paragraphs 6.21-6.23)
- In the 2.3 GHz Band, and in a scenario where both a partial migration of the Rurtel service and where 2 300 - 2 330 MHz band is awarded on a generic basis, that it may be more appropriate be awarded the lots that coincide with the Rurtel frequencies.

7.6 Unsold lots

7.181 The particular approach for dealing with unsold spectrum rights of use will depend on the amount and type of spectrum that is unsold. ComReg is of the view that discretion is required on how to proceed if the issue of unsold spectrum rights of use becomes a reality. This is to avoid providing a negative incentive to bidders to strategically withhold demand during the auction in the hope of being assigned this spectrum on the same or more preferable terms as those offered in the auction in a follow-up process.

7.182 Therefore, for the purpose of the Proposed Award, ComReg is of the preliminary view that it should retain its discretion regarding how it might treat any unsold spectrum lots depending on the factual circumstances arising from the Proposed Award, save that it intends that unsold lots will not be assigned for a reasonable period after the process has ended.

7.7 Competition Caps

7.7.1 Background – ComReg's approach to spectrum competition caps to-date

7.183 In light of its objectives to promote and safeguard competition to the benefit of consumers, ComReg has, in recent spectrum awards, imposed caps on the amount of spectrum rights that any bidder could obtain in an award, where such cap(s) applied only for the duration of the award. That is, the cap was not an enduring restriction. ComReg refers to such award-specific caps as "competition caps".

7.184 ComReg has previously stated that the main purpose of a competition cap is to ensure that the distribution of spectrum rights in an award is determined by competition among bidders, subject to ensuring that extreme asymmetric outcomes which could harm downstream competition do not emerge from the award. In that regard, DotEcon advises that highly asymmetric spectrum holdings across operators can be undesirable, particularly where there is a limited number of operators in the market.[425]

7.185 ComReg would also make the following preliminary high-level observations relevant to the appropriate level of any competition cap:

- Effective competition does not require symmetric spectrum holdings between operators[426];
- A competition cap that is too restrictive could create artificial excess supply, particularly where there is a large amount of spectrum available

[425] If MNOs have access to different amounts of spectrum and these benefits are enjoyed significantly more by some but not others, this may restrict the ability of those with access to less spectrum to compete effectively in the downstream market(s).

[426] See, for example, paragraph 688 of the European Commission's 2014 decision on the acquisition of Telefónica Ireland by Hutchison 3G UK Holdings Limited (Case M.6992) where the Commission noted "*the fact that, after the merger, there will be spectrum asymmetry is not, as such, anticompetitive*." Concerns about asymmetric spectrum holdings have also been considered and dismissed by the Commission in more recent cases (e.g. Case M.7758 - *Hutchison 3G Italy / Wind / JV* and Case M.8792 - *T-Mobile NL/Tele2 NL*). Also, in a December 2017 judgment, the English High Court accepted Ofcom's view that competition in the UK retail mobile market "*was working well notwithstanding the considerable asymmetry in spectrum holdings between BT/EE and its rivals*" (H3G v Ofcom and Others [2017] EWHC 3376 (Admin), at paragraph 62).

for release across a number of spectrum bands, and this may not result in the efficient use of spectrum;

- Given that there is spectrum above and below 1 GHz proposed to be made available, operators may choose to adopt different strategies. For example, incumbent operators may seek to acquire:
    - spectrum rights with which to continue providing the existing or similar levels of service capability; or
    - greater amounts of spectrum with which to provide different services than presently provided in anticipation of likely future requirements.

  Such differences are not necessarily incompatible with a competitive market.
- There is a balance between allowing operators the opportunity to obtain sufficiently large contiguous blocks of spectrum to meet their existing and likely future requirements, and excluding excessively concentrated outcomes where downstream competition would likely be harmed.

7.186 For the avoidance of doubt and as for previous awards, ComReg would stress that any proposed cap would only apply for the duration of the Proposed Award and operators would be free to trade, lease and combine spectrum rights following the Proposed Award (to the extent that such rights of use of spectrum are designated as being tradable or leasable), subject to competition law and the legal framework for electronic communications in Ireland (including the conditions attached to their licences).

7.7.2 Background – downstream competition – mobile and fixed wireless operators

7.187 As identified in the 'Spectrum for Award' RIA, the WBB ecosystem in Ireland includes both Mobile Network Operators (MNOs) and Fixed Wireless Access (FWA) operators. These are two potential categories of users of the spectrum rights of use in the Proposed Award.[427] ComReg sets out below some observations on these two potential uses/categories of users and developments in associated downstream markets in advance of setting out its proposed competition cap(s).

Mobile services

[427] Another potential user would entities operating a small-cell network for providing **wholesale capacity** to other operators (i.e. Dense Air). This may provide operators with an alternative source of capacity and reduce the need for holding spectrum licences directly themselves. DotEcon notes that although such users are a positive development it does not fundamentally change current conditions of competition in mobile retail markets.

7.188 There are 6.3 million mobile subscribers of mobile telecommunication services (incl. MBB & M2M) in Ireland. There are three MNOs (Vodafone, Eir and Three) active in providing these services on a nationwide basis, accounting for over 90% of all subscribers. The remaining 10% are carried by four MVNOs[428] (LycaMobile, Tesco Mobile, Postfone and Virgin Mobile.) The market shares of each operator is set out below in Table 8.

Table 8: Market shares by subscribers and revenue[429]

Operator	Q4 2018 (subscribers)	Q4 2018 (revenue)
Vodafone	38.8%	42.5%
Eir	16.8%	18.5%
Three	35.1%	32.0%
Tesco	6.5%	4.4%
Others	2.9%	2.7%

7.189 MNOs use a mobile network and licensed spectrum band(s) to deliver mobile services. Mobile operators typically use sub-1 GHz spectrum to provide wide area coverage, and higher frequencies for capacity in higher density areas. MNOs are therefore likely to be particularly interested in the Proposed Award given the availability of both types of spectrum rights. In that regard, the accumulation of excessive rights of use in the Proposed Award by MNOs could create potential competition concerns in downstream mobile markets. MNOs have large amounts of existing holdings and which are relevant to the competition assessment provided below. Table 9 below sets out the current relevant spectrum holdings of all three MNOs.

[428] MVNOs are service providers that purchase access and call origination at the wholesale level from MNOs in order to offer their own retail mobile services to subscribers at retail level.

[429] ComReg Quarterly Report, Q4'18.

Table 9: Current MNO spectrum holdings and asymmetry

Band	Three	Vodafone	Meteor
800 MHz	20 MHz	20 MHz	20 MHz
900 MHz	30 MHz	20 MHz	20 MHz
Total sub-1 GHz	**50 MHz**	**40 MHz**	**40 MHz**
1800 MHz	70 MHz	50 MHz	30 MHz
3.6 GHz[430]	100 MHz	105 MHz	85 MHz
2.1 GHz FDD	60 MHz	30 MHz	30 MHz
Total supra-1 GHz	**230 MHz**	**185 MHz**	**145 MHz**
Total	**280 MHz**	**225 MHz**	**185 MHz**

7.190 Given the potential use of all the bands for the provision of mobile services, DotEcon notes that the assignment of the available spectrum in the Proposed Award has the potential to impact on competition between mobile operators in the provision of mobile and potentially fixed wireless services, and therefore spectrum holdings of MNOs are likely to be particularly relevant when considering any measures to promote and safeguard competition.

Fixed Wireless Services

7.191 Fixed wireless is a method of delivering wireless internet services between two fixed points. This requires the use of outdoor, rooftop mounted directional antennas and, unlike mobile, a fixed device at the customer premises. Fixed wireless is typically provided on a regional and localised basis and has been particularly beneficial for the provision of internet services in rural areas.

7.192 Currently FWA operators provide services to 47,522 customers in different parts of the State. Imagine is a quasi-national operator and is the largest FWA operator in the State, accounting for around half of all subscriptions. The remaining FWA operators provide services on a localised basis in small towns and villages. In some areas an operator may be the only provider of fixed broadband services, or the provider of the best available broadband service, as other service providers (e.g. satellite broadband providers) may not be able to provide a sufficiently comparable service in terms of download/upload speeds, latency, price etc. These areas are likely to be in the more sparsely populated areas of Ireland.

[430] Note that these numbers are the maximum assigned to the operator in any given region, so the cap calculations take into account the maximum spectrum any operator could get in any part of the country.

7.193 This partial geographical coverage of FWA (which is provided using a variety of technologies including LTE) in Ireland means that FWA services are not universally available. FWA services are used by consumers in areas where copper, FTTx or CATV network-based broadband services may not be available. While Fixed Wireless has similar product characteristics to other retail broadband services and may provide some indirect constraints, ComReg has previously noted that, for most customers, FWA is unlikely to be a sufficiently close substitute for broadband services provided over copper, fibre or cable[431] though it may offer stronger substitutes to fixed broadband in the future.[432]

7.194 Currently, fixed wireless services are delivered through a combination of (a) licenced and (b) licence-exempt spectrum bands.

(a) Fixed wireless delivered through licensed spectrum rights of use

7.195 Around 20,000 subscribers are provided with FWA services over licensed spectrum. Currently, licenced spectrum refers to FWA services provided over the FWALA licensing framework[433] and 3.6 GHz liberalised use licences.

7.196 The FWALA licensing framework, initiated by ComReg in 2003, facilitates the provision of wireless broadband (WBB) services in two licensed bands.

1. 10.5 GHz Band (10.154 GHz – 10.672 GHz)
    - There are five 2×28 MHz channels in the 10.5 GHz band nationwide (excluding Dublin and Cork)
    - In Dublin and Cork, there are four 2×28 MHz channels and two 2×14 MHz channels
2. 26 GHz band (24.549 GHz – 25.781 GHz)
    - There are five 2×28 MHz channels identified for FWALA licensing in the 26 GHz band

[431] See Para 3.96 – Document 18/94.

[432] Similarly, DotEcon notes that in some cases, mobile services may be an alternative to both FWA and traditional wired access, in rural areas limited mobile coverage and/or lower speeds means that general mobile broadband services are not an effective substitute to FWA or wired service. Therefore, FWA is less likely to compete with mobile broadband services in those rural areas.

[433] The regulations governing the issue of Fixed Wireless Access Local Area licences are the Wireless Telegraphy (Fixed Wireless Access Local Area licence) Regulations, 2003 (S.I. 79 of 2003) and Wireless telegraphy (Fixed Wireless Access Local Area licence) (amendment) Regulations, 2003 (S.I. 530 of 2003).

7.197 Both spectrum bands are assigned on a geographic basis depending on availability. The service area of a FWALA licence is defined by a circle, with 20km radius from nominated centre point. There are 29 service areas in various areas of the country (28 in 10.5 GHz and 1 in 26 GHz).

7.198 The 3.6 GHz Band was previously facilitated under the FWALA licensing framework but has since been licensed on a liberalised use basis[434] with transition of existing users continuing.[435]

- Imagine was assigned 60 MHz in all non-urban regions[436] is the largest fixed wireless operator in the country and is currently providing services using the 3.6 GHz Band
- We understand that all three mobile operators which were assigned 3.6 GHz rights of use across all regions in the 2017 3.6 GHz Award have been assessing FWA services since then:
    - Vodafone is currently considering the rollout of a FWA service in rural areas[437];
    - Three Ireland is focussing on FWA as an alternative to broadband over fibre[438]; and
    - Eir is currently trialling FWA in sites in Meath and Mayo.[439]

7.199 If FWA is ultimately provided by these MNOs it would represent new entry for fixed wireless services.

License exempt

7.200 Fixed wireless services are also provided using spectrum in the licence-exempt 2.4 GHz and 5.8 GHz frequency bands.

- 2400 – 2483.5 MHz (2.4 GHz Band)
- 5725 – 5875 MHz (5.8 GHz Band)

7.201 Ten operators provide 20,259 subscribers with services using this spectrum (primarily over the 5.8 GHz Band).

[434] https://www.comreg.ie/industry/radio-spectrum/spectrum-awards/3-6ghz-band-spectrum-award/

[435] https://www.comreg.ie/industry/radio-spectrum/spectrum-awards/3-6ghz-band-spectrum-award/

[436] Border Midlands and West, South West, East, and South East.

[437] https://www.siliconrepublic.com/comms/vodafone-ireland-rural-broadband

[438] https://www.siliconrepublic.com/comms/three-5g-ireland

[439] https://www.siliconrepublic.com/comms/vodafone-ireland-rural-broadband

Conclusion on use types

7.202 DotEcon is of the view that the acquisition of the available spectrum by mobile operators and the impact on competition in mobile telecommunications services (especially mobile broadband) is likely to be the most relevant factor when determining the need for measures to safeguard competition.[440] In effect, any distortion or restriction of competition arising from this award is likely to arise in mobile telecommunications services and that should be the main consideration in determining appropriate caps.

7.203 In particular, DotEcon does not see any compelling evidence to suggest that other services (e.g. fixed wireless) are as yet relevant for the assessment of downstream competition in mobile telecommunications services.[441] For example:

- FWA services are distinct to mobile services, as they are used as an alternative to a fixed services in areas where it might be uneconomic to provide fixed services. Therefore, FWA is less likely to compete with mobile broadband services in those areas and general mobile broadband services are not likely to be an effective substitute to FWA.

- Any limited substitution is in one direction such that mobile broadband may be substitutable in certain areas, however, FWA services are not a good alternative to mobile broadband services by virtue of only being available at a fixed location.

- The provision of FWA services in a smaller geographic areas is unlikely to impose any material competitive constraint on national mobile services.

7.204 Moreover, any future fixed/mobile convergence would more likely lead to national mobile network operators offering FWA services in particular locations, rather than specialist (and often geographically limited) FWA providers extending their offering into full mobile services. This would provide additional competition for fixed wireless services in the future.

7.205 Finally, to the extent that other users are assigned spectrum rights of use (e.g. FWA operators) this would likely benefit consumers without creating distortions to competition in mobile markets.

[440] DotEcon Award Design Report, p39.

[441] DotEcon Award Design Report, p41.

7.206 ComReg agrees with DotEcon and is of the preliminary view that the impact on competition in mobile telecommunications services is the primary concern when determining competition caps for the proposed award.

7.207 Further such a competition cap would be unlikely to create any particular competition concerns in the provision of fixed wireless services. For example:

- Given the relative spectrum holdings of FWA operators and the MNOs, the proposed competition caps would be clearly be less restrictive upon Imagine and other FWA operators. For example, currently Imagine has 60 MHz of 3.6 GHz spectrum, while MNOs have between 185 and 285 MHz.
- FWA services are also provided using spectrum in the licence-exempt 2.4 GHz and 5.8 GHz bands. Licence-exempt spectrum is unaffected by this award. This would continue to be the case even if FWA operators were unsuccessful in the Proposed Award.
- As previously noted, MNOs are also beginning to look at providing fixed wireless services and could potentially compete for fixed wireless subscribers in the future using the 3.6 GHz Band and/or the bands in the Proposed Award.
- Smaller regional FWA operators could potentially form a joint bidding group to bid for national rights of use as provided for in previous awards. [442]

7.7.3 Views of respondents to Document 18/60

7.208 Five respondents (Dense Air, Eir, Imagine, Nera (on behalf of Three), and Vodafone) submitted comments on spectrum caps.

7.209 Eir submits that there is a substantial spectrum imbalance between Three and the other MNOs which, in its views, if left unaddressed, significantly distorts the competitive landscape[443]. In the context of an auction, Eir submits that spectrum caps should include existing spectrum holdings.

7.210 Dense Air submits that one of the key mechanisms to enable spectrum to be obtained by complementary players (like Dense Air) is to impose a spectrum cap on “Mid Band” sub-6 GHz spectrum (like 2.3 GHz and 2.6 GHz and existing 3.6 GHz assignments). Dense Air also submits that no single operator should obtain more than 150 MHz of this combined Mid Band spectrum.

[442] See Para 3.26 – Document 16/71.

[443] Eir states that Three possesses 50% of the 2.1 GHz band, 47% of the 1800MHz band and 43% of the 900MHz band.

7.211 Imagine submits that two levels of caps be introduced in relation to all existing 2G, 3G and 4G spectrum that is also designated for 5G deployment, being:

vii. an overall cap where any one operator should not hold more than 25% of the spectrum that is expected to be available in 2020; and

viii. band caps of 100 MHz on low (<1 GHz) spectrum; 200 MHz on mid (1-6 GHz) spectrum; and 25% of available high (> 6 GHz) spectrum.

7.212 In relation to its suggested mid-band cap, Imagine also contends that "[*f]ailure to ring-fence spectrum in the mid-band for FWA use could result in hoarding of spectrum by mobile operators and lead to a long-term inability to deliver non-mobile use-cases for 5G exacerbating the digital divide on further eroding the industry's overall ability to evolve in a balanced and healthy manner*."

7.213 Vodafone agrees that the value of the 2.3 GHz Band is lower than the 2.6 GHz Band because it has a smaller ecosystem of devices available, and that this should be a consideration in the design of competition caps if this band is to be auctioned with the 2.6 GHz band.

7.214 Nera submitted the following:

- **700 MHz Band:** a 2×10 MHz cap per operator could be set, relying on the reserve price and/or competition from entrants to ensure a fair price outcome. If a higher cap were set, allowing for competition between the MNOs in this band, Nera suggests that ComReg should ideally avoid any auction format that uses opportunity cost pricing, as such formats are, it claims, known to encourage over-bidding for incremental spectrum in situations where winning bidders are setting each other's prices.[444]

- **Common cap across 2.3 and 2.6 GHz bands:** Nera submits that it makes sense for any cap to extend across these bands. For example, a cap of 120 MHz per operator would ensure that if any two operators acquired spectrum up to this cap, then there would still be 40 MHz available for other bidders.

- **2.1 GHz Band:** Nera submits that it would be challenging to set band-specific spectrum caps. On the one hand, there is a strong case for a cap to ensure every operator can win some spectrum so as to maintain their 3G networks after 2022. This could be achieved with, say, a 2×25 MHz cap ensuring a minimum of 2×10 MHz for a third operator. However, this may encourage auction outcomes skewed to supporting 3G, and not the efficient long-term use of the spectrum for 4G or 5G.

[444] ComReg addresses concerns in relation to opportunity cost in Chapter 7.

7.215 Before setting out its proposals on competition caps, ComReg addresses the following relevant issues which inform its proposals:

i. Eir's claim regarding a "substantial spectrum imbalance";

ii. Imagines' submission regarding possible spectrum hoarding;

iii. Whether existing spectrum holdings should be included in any caps; and

iv. Whether one or more caps are required in order to take account of the differences between the bands and the impact an excessive aggregation in a particular band may have on competition.

7.7.4 Preliminary issue (i) – Eir's submission regarding existing "substantial spectrum imbalance" between Three and other MNOs

7.216 First, and leaving aside the spectrum holdings in the 3.6 GHz Band for the moment, ComReg recalls that the current asymmetry in the remaining bands in favour of Three directly resulted from the acquisition of Telefónica Ireland Ltd (O2) by Hutchison 3G UK Holdings Limited (Hutchison) ("the Merger"), which was conditionally cleared by the European Commission in 2014 (Case M.6992)[445].

7.217 Second, ComReg further recalls that the Commission specifically considered the accumulation by Three of O2's spectrum rights and, among other things, noted that:[446]

> *"The Commission considers that the change in spectrum holdings resulting from the merger is unlikely to have anticompetitive effects. The merger will not reduce the spectrum holdings of Eircom and Vodafone and, hence, it will not have any impact on the network quality and speed offered by Eircom and Vodafone. The fact that, after the merger, there will be spectrum asymmetry is not, as such, anticompetitive. In this respect, the Commission points out that, at present, each of Vodafone and Eircom have more spectrum than Three. This has not, however, prevented Three from competing effectively in the Irish retail market."*

[445] The decision is available at: http://ec.europa.eu/

[446] See section 7.6.2.2 of the Commission's decision.

7.218 In relation to the 900 MHz Band, the Commission also noted:[447]

> *"In the 900 MHz band, the merged entity would hold three blocks of spectrum (2x15 MHz), which is one block more than Eircom and Vodafone, which will each hold two blocks (2x10 MHz). The Commission does not consider that, as a result of this imbalance, Eircom would be unable to compete. In this respect, the Commission points out that Three currently has only one block (1x5 MHz) of 900 MHz spectrum, being half of the 900 MHz spectrum held by Eircom and Vodafone. This inferior spectrum holding has not prevented Three from competing."*

7.219 Third, ComReg observes that, going forward, all of Three's existing 2.1 GHz FDD spectrum rights (60 MHz) will expire in 2022, reducing the current level of asymmetry.

7.220 Fourth, and recalling that the Commission's findings of unlikely anti-competitive effects were made in 2014 and that ComReg's 3.6 GHz Award was concluded in May 2017, ComReg is also not aware of any material to suggest that the distribution of 3.6 GHz Band spectrum rights between the MNOs as a result of this award was such as to create new and/or additional competition concerns. ComReg observes that no such views have been expressed by operators following that award or in response to Document 18/60 in that connection.

7.221 ComReg further observes that the market shares of the MNOs post-Merger have been relatively static. Vodafone is unchanged, with Three and Eir each having around 1% less market share each and Tesco gaining around 2% (Q2 2014 – Q4 2018). [448] In particular, there does not appear to have been any further concentration downstream post-Merger. For example, DotEcon notes:

- The overall revenue distribution in the mobile market has not changed materially;
- There has been a (small) redistribution of revenue share away from the merging MNOs, with Three's revenue share falling by the most amongst the MNOs;
- Vodafone remains the largest operator, and Eir the smallest MNO, has maintained its pre-Merger revenue share; and

[447] Ibid.

[448] ComReg Quarterly Report – Q4 2018.

- The HHI[449] (taking all operators other than the MNOs to be a single entity) of the mobile market based on revenue share has fallen slightly from 0.346 to 0.322 (falling HHI indicates reducing concentration).

7.222 Further, DotEcon notes that the available evidence (including the views of the Commission at the time of the Merger) would suggest that a post-award spectrum asymmetry *at least* at the same level as after the Merger is unlikely to be problematic and there does not seem to be any particular need or justification to seek to actively reduce the current differences in MNO spectrum holdings on competition grounds.

7.223 In light of the above, there does not appear to be any basis for the view that existing spectrum asymmetry is harming competition and, in effect the existing asymmetries provide a floor below which a cap would likely impose too much of a restriction on the flexibility of bidders to obtain sufficient rights of use.

7.7.5 Preliminary issue (ii) – Imagine's claim of potential spectrum hoarding by MNOs to detriment of FWA providers

7.224 ComReg does not consider Imagine's concerns that MNOs would hoard spectrum rights to the detriment of FWA providers particularly convincing for a number of reasons including:

- Given the increasing demand for data services, MNOs are likely to have an existing need for additional rights of use to satisfy such demands going forward (including for FWA services).
- ComReg is also proposing specific coverage/rollout obligations (see Chapter 8) for each of the bands proposed for award, meaning that services would need to be provided using spectrum rights obtained in each of the bands.
- The proposed on-going spectrum fees are designed to incentivise the efficient use of spectrum.
- The proposed competition caps limits the amount of spectrum that can be assigned to any one operator. In particular, the proposed caps are more restrictive on MNOs given existing spectrum holdings, reducing the extent to which any hoarding could arise.

[449] Herfindahl–Hirschman Index, equal to the sum of the squares of the market shares.

7.7.6 Preliminary issue (iii) – whether existing spectrum holdings should count towards any spectrum competition cap(s)

7.225 In relation to existing holdings, ComReg agrees with DotEcon's observations that any competition caps applied should take into account existing holdings, since these rights (together with the spectrum holdings arising from the outcome of the Proposed Award) would inform the post-award competitive landscape[450]. In that regard:

- the current sub-1GHz bands (700MHz, 800MHz and 900MHz) are likely to be sufficiently close substitutes over the long-run for providing coverage and there is likely to be merit in applying a sub-1GHz cap;
- the 2.1 GHz, 2.3 GHz and 2.6 GHz bands can all be used to provide WBB and have existing ecosystems with compatible devices. They are also likely to be sufficiently close substitutes for one another and to a greater or lesser extent, the 1800 MHz and 3.6 GHz bands.

7.226 The ability of an operator to compete in a market is determined to a certain degree by the overall amount of spectrum the operator holds across all bands. Large asymmetries in the total amount of spectrum held by different operators might limit effective competition at the service level. Taking account of existing spectrum holdings in bands other than those to be assigned when applying a competition cap limits the ability of those bidders who already hold large amounts of spectrum to unreasonably strengthen incumbency advantages and asymmetries as a result of the spectrum they win in the award. Therefore, taking account of current spectrum holdings when setting competition caps can help reduce barriers to entry and prevent future distortions to competition.

7.227 In light of the above, ComReg is of the preliminary view that any caps applied should take into account existing holdings of all operators assigned rights of use in the 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz and 3.6 GHz bands, since these rights (together with the spectrum holdings arising from the outcome of the Proposed Award) would play a part in the post-award competitive landscape.

7.7.7 Preliminary issue (iv) - whether one or more caps are required in order to take account of the differences between the bands.

7.228 In a multi-band spectrum award, an important consideration is whether any competition cap should be applied as one or more band-specific caps or as one overall cap.[451] The extent to which spectrum bands should be included in

[450] DotEcon Award Design Report, p44.

[451] An overall cap refers to the total amount of spectrum, bidders could acquire in all the proposed bands. This would include bands that may be considered under a separate sub 1 GHz cap.

different categories of competition caps depends on the extent to which bands (including existing spectrum holdings) are regarded as substitutes or complements.[452] [453] In that regard:

- If spectrum rights in multiple bands to be included in the award are substitutable from the perspective of bidders, then the cap should apply across bands. Using a number of band-specific caps instead of an overall cap for substitutable spectrum would unduly restrict the range of potential outcomes, and would not improve the opportunities for entrants.
- If spectrum rights are complementary, then band-specific caps may be needed to safeguard and/or promote competition by limiting the extent to which bidders could otherwise make use of the flexibility under an overall cap to acquire an excessive amount of spectrum in one or more particular bands (e.g. an important coverage band).
- Where existing holdings are substitutes for spectrum rights in the proposed bands, it is appropriate to consider those bands in the same cap in order to ensure that asymmetries do not result which would distort competition in downstream markets.

7.229 DotEcon recommends that both a sub-1 GHz cap and an overall cap be applied for the Proposed Award for the following reasons:

- A sub 1-GHz cap is necessary because:
  - the 700 MHz, 800 MHz and 900 MHz bands are all likely to be substitutes for one another in the long run for providing wide area coverage; and
  - in the short run, access to sufficient sub-1 GHz spectrum is also likely to be important to mobile operators for maintaining legacy 2G/3G networks whilst simultaneously improving/deploying 4G/5G services; and
- An overall cap is necessary because the 2.1 GHz, 2.3 GHz and 2.6 GHz bands can be used to provide WBB and have existing ecosystems with compatible devices and are all likely to be substitutable[454] to a greater or lesser extent; applying an overall cap will protect against the possibility

[452] ComReg discusses the substitutability and complementarity of different bands in the Spectrum for Award RIA (Chapter 4).

[453] The main concern here relates to substitutability of inputs in the production process rather than end-user demand substitutability. Where bands are neither substitutes nor complements, ComReg would not normally include spectrum bands in the same award.

[454] DotEcon also notes that there is imperfect substitutability between all the bands and some bands may be more substitutable than others. For example, DotEcon bands above 1 GHz might also offer an (imperfect) substitute for the 700 MHz spectrum, in the sense that winning more 700 MHz spectrum also provides capacity and might at the margin reduce the need for supra-1 GHz spectrum somewhat.

of award outcomes that result in a highly asymmetric distribution of the spectrum across operators.

7.230 ComReg agrees that both a sub-1 GHz cap and an overall cap appear necessary for the Proposed Award. The 'Spectrum for Award' RIA already sets out that the 700 MHz band is complementary to the other candidate bands and the latter bands are substitutable for one another. Further, absent a sub-1 GHz cap, any bidder could obtain all 700 MHz rights of use which would likely create competition concerns given, among other things, the advantages of 3 band carrier aggregation as discussed in the Coverage RIA. ComReg notes Nera's concern that a band specific cap that provides for competition for lots between the MNOs could encourage over bidding due to the opportunity cost pricing rule. However, as previously discussed, concerns about price driving in a CCA are overstated and this is not therefore considered further here.

7.231 In relation to suggestions from Imagine and Dense Air that a separate cap should be set above 1 GHz, ComReg notes that an overall cap (which considers spectrum above and below 1 GHz) already prevents bidders accumulating excessive amounts of spectrum above 1 GHz. Further, it provides greater flexibility for a variety of different outcomes to occur as it requires bidders to consider the trade-off of bidding for one band over another (e.g. between being assigned more 700 MHz Duplex at the expense of other bands above 1 GHz).

7.232 If a separate above 1 GHz cap was used, bidders (particularly MNOs) could bid for 700 MHz Duplex without having to consider the impact of those bids on its preference for other bands above 1 GHz. An overall cap potentially accommodates a greater range of services (mobile & fixed wireless) as bidding for more 700 MHz Duplex reduces the amount of spectrum that can be assigned in other bands. This might promote a more efficient outcome where operators bid for a balanced combination of 700 MHz Duplex and bands above 1 GHz, potentially allowing for a greater number of operators offering a variety of services in in the downstream market.

7.233 In relation to Vodafone's suggestion that 2.3 GHz is a lower value band and that this should be a consideration in the design of competition caps, it is unclear what Vodafone is proposing. However, the 'Spectrum for Award' RIA previously determined that the 2.3 GHz band was likely substitutable to the other Performance Bands and warranted inclusion in the proposed award (which Vodafone supports). In that regard, ComReg has already provided its views on why a band specific cap for substitutable spectrum is not appropriate.

7.234 In relation to the value differences referred to by Vodafone, applying a cap to a

greater or lesser extent depending on the presumptive value of 2.3 GHz Band[455] compared to other bands could lead to a distortion of bidder preferences caused by award design rather than bidder preferences across related bands. Given uncertainty about the actual extent of any value difference between 2.3 GHz Band and other bands, it is important that any proposal does not depend too heavily on a presumed trade-off. For example, if a looser cap was inappropriately applied to the 2.3 GHz Band because it is perceived to have a lower value, it may result in operators inefficiently favouring the 2.3 GHz band in the award over other bands.

7.235 Further, the 2.3 GHz Band is likely to be relevant to fixed wireless and other users. Therefore, an approach to competition caps which distorted bidding incentives and resulted in MNOs inefficiently favouring the 2.3 GHz band could have important consequences for fixed wireless and other users.

7.7.8 Proposed competition caps

7.236 ComReg outlines its sub-1 GHz and overall competition cap proposals in turn below.

7.237 First, ComReg notes that competition caps, among other measures, can promote new entry by limiting the spectrum available to incumbents. However, for the reasons outlined in the 'Assignment Process' RIA, a spectrum reservation for new entrants does not appear to be warranted in this award. Therefore, competition caps that would result in an effective reservation of spectrum (i.e. if the total amount that could be acquired by incumbent operators in total under the proposed caps is less than the spectrum available in the award) would, for same reasons, also appear unwarranted.

7.238 Further, DotEcon sees little justification for reserving spectrum for a non-mobile users by placing a tight cap on the three MNOs, as suggested by Imagine.[456] Both Imagine and Dense Air were able to compete successfully for spectrum in the 3.6 GHz Award without such reservations. Given the high level of uncertainty about the form that non-traditional business models might take and whether they will ultimately be successful, it would be inappropriate for ComReg to make an implicit or explicit reservation of spectrum for such service providers.

[455] Separately, ComReg would in any event note that any difference in relative values is unlikely to be significant as a sufficient degree of harmonisation and equipment availability has already taken place and more can be reasonably expected in the near future. In the long run, as technologies become less linked to specific frequencies, all the proposed bands above 1 GHz have similar radio propagation characteristics and therefore should be greater substitutes in the future.

[456] DotEcon Award Design Report, p36.

7.239 Similarly, in relation to Imagines' and Dense Air's suggestions around the level of caps, ComReg notes that a cap corresponding to '25% of overall spectrum being made available by 2020' or a cap of 150 MHz on "Mid Band" spectrum would be highly restrictive[457] and result in an effective reservation for non-incumbents[458]. Where competition caps are implemented, a balance has to be struck between the setting of caps at a level that ensures spectrum availability for entrants and the risk of spectrum going unsold where demand from existing operators is such that it would otherwise be assigned.

7.240 For example[459]:

- Spectrum may go inefficiently unsold in a number of ways, including:
  - ComReg would be required to assess the amount of any effective reservation and interest from non-incumbents could be limited to below the amount that is effectively reserved.
  - If entrants place bids only for larger packages (if entrants require a minimum amount of spectrum that is greater than the amount of spectrum effectively reserved for them), but their bids are not sufficiently high as to displace incumbents from the additional spectrum they may require.
- It may attract speculative entry from non-mobile parties wanting to sell on their spectrum holdings in the future, noting that competition caps are applicable to the award only and any bidders would be free to trade subject a separate trading / leasing framework.
- There may be a danger that an entrant or non-MNO may not have an efficient business model to compete effectively downstream (against existing incumbents or other operators) and over the long run will eventually exit the market, resulting an inefficient assignment.

7.241 Finally, in relation to Nera's suggestion that that a common cap apply across the 2.3 GHz and 2.6 GHz Bands, and a 2×10 MHz cap per operator for the 700 MHz Duplex, ComReg notes the following.

[457] For example, in relation to Imagines suggestion, it would prevent Three from participating in the award. (Three is currently assigned 280 MHz which is around 25% of the spectrum that would be available post-award.). Similarly, Dense Air's suggestion of a cap of 150 MHz on "Mid Band" spectrum (2.3 GHz and 2.6 GHz and existing 3.6 GHz assignments) would also be restrictive as Vodafone and Three would only be able to bid for up to 50 MHz across three spectrum bands, significantly reducing competition during the award and limiting the potential upgrade of mobile services, particularly in more densely populated areas.

[458] In that regard, DotEcon sees no need for special measures to protect non-mobile users (such as specialist FWA providers) by reserving spectrum or through other asymmetric measures (e.g. individual or collective caps on mobile operators). This could also be potentially detrimental to existing and well-established mass-market services provided by the MNOs for a speculative and uncertain benefit in much smaller specialist downstream markets.

[459] See 'Assignment Process' RIA for a more detailed assessment.

- the competition cap proposals below include existing spectrum holdings rather than just the spectrum being made available in the proposed award, and ComReg's proposals should be viewed in that light.

- given the spectrum asymmetries that already exist, a symmetric or common cap would provide no opportunity for other incumbents to reduce this asymmetry (which may be beneficial for competition). For example, a 2×10 MHz 700 MHz cap would prevent Vodafone and Eir from having the opportunity to reduce the asymmetry to Three.

7.242 Therefore, ComReg does not consider it appropriate to apply competition caps which would effectively lock in that asymmetry.

Sub 1-GHz Competition Cap

7.243 There is currently 130 MHz[460] (2×65 MHz) of existing sub-1 GHz spectrum rights of use, with an additional 60 MHz (2×30 MHz) proposed to be made available in the 700 MHz band, giving a total of 190 MHz (2×95 MHz) to consider when determining an appropriate sub-1 GHz cap. Table 10 illustrates the risks attached to certain caps in terms of the potential for unsold spectrum and the asymmetry between Three and Eir (the greatest asymmetry in spectrum holdings currently being between these two MNOs).

Table 10: Sub-1 GHz outcomes

Sub 1-GHz Cap	Unsold (MHz)	Asymmetry
50	40	0
60	10	0
70	0	20
80	0	40
90	0	50
100	0	60
110	0	70

Sub 1 GHz Cap below 70 MHz (2×35 MHz)

7.244 DotEcon notes that a cap of below 70 MHz (2×35 MHz) would leave some spectrum (2×5 MHz) that could not be assigned to incumbent operators creating

[460] The 2.1 GHz unpaired band is harmonised at ECC level for DA2GC rather than WBB (and consequently has been identified by ComReg as unsuitable for this award). It is therefore not relevant for competition between MNOs in the mobile market and not included in the assessment of competition caps.

a significant risk of inefficiently unsold lots if there was no demand from other parties. Further, while there may be demand for 700 MHz spectrum beyond the MNOs, there does not seem to be any clear benefit in setting a cap that is so tight that it could unduly restrict competition in the Proposed Award, and potentially leave some highly valuable spectrum unassigned.

7.245 ComReg agrees that setting a cap below 70 MHz (2×35 MHz) would amount to an effective reservation of spectrum as described above and could also result in inefficiently unsold lots as described above. Therefore, ComReg is of the preliminary view that a sub-1 GHz cap of below 70 MHz would not be suitable for this award.

Sub 1 GHz Cap above 70 MHz (2×35 MHz)

7.246 ComReg observes that a cap of over 70 MHz (for example Imagine suggests a cap of 100 MHz) could result in an outcome where two MNOs obtained all of the available 700 Duplex MHz rights which would be unlikely to promote or safeguard competition.

7.247 ComReg notes that 700 MHz Duplex rights of use would allow an MNO to use Carrier Aggregation across the three sub-1 GHz bands, thereby reducing the costs of deploying high-speed connectivity across wide areas. In circumstances where one MNO did not obtain any 700 MHz rights, it would need to carrier aggregate with 1800 MHz (or alternative) spectrum rights which would not be as cost effective and may already be required to meeting existing demands. In such circumstances, ComReg would be concerned if that MNO could not effectively and/or cost efficiently replicate the advantages that would accrue to the other MNOs which did have access to 700 MHz Duplex spectrum rights, given said disadvantages would affect its ability compete effectively in the relevant market/s.

7.248 Whilst such concerns would apply to any MNO which did not obtain 700 MHz Duplex rights, they are likely to be more acute in the case of Eir which, among other things, has a smaller customer base (and therefore lower mobile revenues with which to seek to ameliorate the above disadvantages) and lower amounts of spectrum holdings overall (including 1800 MHz).

7.249 In addition, ComReg observes that the opportunity to obtain additional sub-1 GHz spectrum rights is unlikely at this juncture to arise until 2030 at the earliest.[461]

7.250 In light of the above, ComReg agrees with DotEcon's recommendation that a

[461] See also, LS Telcom BB-PPDR Report.

cap above 70 MHz would not be suitable for the Proposed Award.

Sub 1 GHz Cap of 70 MHz (2×35 MHz)

7.251 Given the above, DotEcon recommends a sub-1 GHz cap of 70 MHz for the Proposed Award.

7.252 ComReg agrees with the views of DotEcon and considers that a sub-1 GHz spectrum competition cap of 70 MHz would be a proportionate and balanced response having regard to ComReg's functions, objectives and duties, and to the matters raised by respondents, as:

- compared to a cap of below 70 MHz, it would not unduly restrict the range of demand and would better ensure the efficient use of spectrum by minimising the potential for lots to be inefficiently unsold and therefore unused.
- compared to a cap above 70 MHz, it would ensure a minimum of three winners win at least 2×5 MHz each thereby reducing any risk of asymmetric sub-1 GHz holdings post-auction.

7.253 In light of the above, ComReg is of the preliminary view that a sub-1 GHz competition cap of 70 MHz (2×35 MHz) is appropriate for the Proposed Award.

Overall Cap

7.254 First, ComReg recalls that the main purpose of a competition cap is to ensure that the distribution of spectrum rights in an award is determined by competition among bidders, subject to ensuring that extreme asymmetric outcomes which could harm downstream competition do not emerge from the award.

7.255 DotEcon has outlined two factors that should be considered to help inform the determination of a suitable overall cap:

- The difference in above 1 GHz holdings needs to be judged against a background of substantially increasing availability of additional spectrum such that the impact of any existing asymmetry would be reduced. For example, prior to the 3.6 GHz Award, the asymmetry between Three and Eir (using the definition above) was 80 MHz (or 20% of total spectrum holdings at the time). Following the 3.6 GHz Award (which assigned 350 MHz of spectrum to the market) the absolute asymmetry between Three and Eir increased slightly to 95 MHz, but as a percentage of total holdings had fallen to just 14%.
- The spectrum above 1 GHz proposed to be made available would far exceed the current asymmetry in above 1 GHz holdings (470 MHz available v 95 MHz asymmetry) meaning it should be sufficient to set caps on bidders with a view to ensuring that the spectrum distribution

is not too asymmetric rather than actively intervening to affect downstream markets.

7.256 Table 11 illustrates the 'worst possible outcomes'[462] of an overall cap in terms of both unsold spectrum and the level of asymmetry between Three and Eir.

[462] As noted by DotEcon, it is possible that some of the available spectrum is assigned to parties other than the MNOs. In this scenario the worst-case asymmetries presented above would not necessarily hold, however DotEcon note that:

- such a scenario would be the result of legitimate competition in the award from other potential users who might add competition to downstream markets.
- caps should provide reasonable opportunities for bidders to compete for spectrum in the award without being denied access purely for anti-competitive purposes
- competition caps should not prevent a user from acquiring additional spectrum that could be used effectively for improving services to consumers because another bidder might not be able or willing to effectively compete in the auction with all other interested parties.

Table 11: Worst-case outcomes under different overall competition caps

Overall Cap	Unsold (MHz)	Asymmetry between Three and Eir	Asymmetry as % of total spectrum available to MNOs
340	20	0	0
345	5	0	0
350	0	10	1%
355	0	25	2.4
360	0	40	3.9
365	0	55	5.3
370	0	70	6.7
375	0	85	8.2
380	0	100	9.6
385	0	115	11.1
390	0	130	12.5
395	0	145	13.9
400	0	160	15.4
405	0	175	16.8
410	0	190	18.3
415	0	205	19.7
420	0	220	21.2

Overall Competition Cap below 350 MHz

7.257 As previously noted, caps that act as an effective reservation of spectrum do not appear to be warranted in this award.

7.258 DotEcon notes an overall cap of below 350 MHz would not be appropriate as it risks leaving spectrum inefficiently unsold if there is not demand other than from the three existing MNOs.

7.259 ComReg agrees with DotEcon's views in this regard. An overall competition caps below 350 MHz would limit the extent of feasible competition between the MNOs and could lead to unsold spectrum in the event that there is no demand from other parties. .

Overall Competition Cap below 375 MHz

7.260 DotEcon notes that the current level of asymmetry between the MNOs is 95 MHz (including current 2.1 GHz FDD holdings) and that this asymmetry would not be exceeded with a cap of between 375 MHz and 380 MHz. Further, there should be no concerns about an outcome in which such asymmetry is maintained.

7.261 ComReg agrees with DotEcon noting that there is no evidence to suggest that developments since the merger have altered competition in any significant way such that a restriction greater than existed at the time of the merger would be required.

7.262 Therefore, ComReg is of the preliminary view there would seem to be little justification to actively seek to reduce the asymmetry in MNO holdings at this time.

Overall Competition Cap between 375 – 420 MHz

7.263 DotEcon suggests that a cap of above 375 MHz would not be unreasonable, and that a cap of between 375 MHz and 420 MHz might be appropriate for avoiding excessively asymmetric post-award holdings but not unduly restricting bidders in the auction.

- A cap of 375 MHz would correspond to a worst case asymmetry of 85 MHz or 8.2% of total available spectrum.
- A cap of 420 MHz would correspond to an asymmetry of 21.2% of the total spectrum available to the MNOs post award which is similar to the post-Merger asymmetry relative to total spectrum holdings at that time.

7.264 ComReg agrees with DotEcon and is of the preliminary view that a competition cap between 375 MHz and 420 MHz would be appropriate.

7.265 In light of the above and based on the information currently before it, ComReg is of the preliminary view that it is appropriate to consider a competition cap for the proposed award within the range of 375 – 420 MHz. In that regard, ComReg observes the following (noting that the asymmetry could be more[463] or less depending on the interaction of bidders during the award).

- A cap of 375 - 380 MHz would approximately retain the level of asymmetry between MNOs (in terms of total MHz) present after the Merger and the 3.6 GHz Award i.e. 85 – 100 MHz (or 8-9% of spectrum

[463] This worst case scenarios are based on certain assumptions (e.g. MNOs being assigned spectrum) and the asymmetry could be greater. For example, in the event that Three is assigned the maximum allowable by the cap and Eir wins nothing (because it did not bid, or was outbid by a new entrant). However, as noted by DotEcon this would be the result of legitimate competition in the award from other potential users.

holdings). It is unlikely that a cap set at these levels would distort competition at the retail level in light of the Commission's comments in its decision on the Merger and the market experience in the intervening period.

- Alternatively, the cap could be set at a level above 380 MHz and would give bidders additional flexibility to bid for the packages of spectrum they require to provide services. In particular, DotEcon note that as more spectrum becomes available, the absolute difference in spectrum holdings may be relatively less important.[464] In that regard, ComReg notes the following.
    - A cap of 385 – 395 would potentially increase the asymmetry to 130 MHz, or 12% of available spectrum holdings.
    - A cap of 400 - 420 would potentially increase the asymmetry to 160 MHz and above or around 15 - 20% of available spectrum holdings. This would be double the absolute asymmetry prior to the award but that asymmetry as a % of total holdings available would be similar to the time of the Merger.

7.266 Given the above, ComReg welcomes views and supporting material from all interested parties in relation to its proposals.

7.8 Fees

7.267 This section considers matters in relation to fees that would potentially apply to rights of use assigned under the Proposed Award. In this section ComReg considers the following:

- Why the use of minimum prices is appropriate for the proposed award;
- Methodology for deriving minimum prices for the proposed award;
- The minimum price structure and whether a split of the minimum price into an upfront (SAF) and ongoing (SUF) portion is appropriate; and
- The level of the minimum price including the proposed upfront SAF and ongoing SUFs that will be applicable to rights of use assigned under the Proposed Award.

7.268 For ease of reference, ComReg sets out below definitions for the main technical terms used in this section:

[464] DotEcon Award Design Report

- **Reserve Price/Minimum SAF**– This is the minimum bid for such a lot to be assigned. The reserve price in an auction is an established price floor below which a lot will not be sold. The Reserve Price indicates the minimum SAF for each Lot included in the Licence and does not include any subsequent payment of SUFs.

- **Spectrum Access Fee ("SAF")** – This is the upfront fee which is payable by a winning bidder for a licence at the end of the auction.

- **Spectrum Usage Fee ("SUF")** – This is the annual fee which a successful bidder must pay throughout the duration of the licence and is additional to the Reserve Price or Minimum SAF.

- **Minimum Price** – This price is the combination of the Reserve Price and SUF and is therefore the total price per lot set at the beginning of the auction. For bidders, the effective minimum price is the sum of the upfront reserve price and the discounted stream of annual SUFs.

7.8.1 Views of respondents to 18/60

7.269 Two respondents (Imagine and Nera) submitted views with regard to spectrum fees.

7.270 Nera submitted four key messages regarding fees:

1. Given the significant increase in supply of spectrum and limited ability of operators to monetise 5G services, ComReg should expect spectrum prices per MHz to fall relative to the 2012 award.
2. Excessive spectrum pricing in this award could delay 5G roll-out in Ireland, and would be detrimental to mobile operators, their customers and the wider economy.
3. Avoiding high spectrum prices is particularly important in Ireland, given the challenges of attracting investment capital in a relatively small market with a relatively large rural population, and the fact that Ireland is transitioning from a position of relative spectrum scarcity to relative abundance versus other EU countries.
4. There are concrete actions that ComReg can adopt to avoid high prices in the multiband award, such as:
    - setting modest but non-trivial reserve prices, and
    - avoiding award rules that could artificially drive spectrum prices.

7.271 Nera, also notes two other ways that regulators can help operators plan and manage their costs, namely being transparent about the level of fees that will apply to licences and allowing operators to spread payments over the licence term. In this regard, Nera states that ComReg has been a leader within Europe. Unlike most other regulators, Nera notes that ComReg specifically includes the annual Spectrum Usage Fees ("SUF") as a part of the reserve price. For example, the SUF in the 3600 MHz auction represented 58% of the overall reserve price (discounted at 8.63%). Nera contends that ComReg should continue this approach.

7.272 While Imagine supports the CCA mechanism used in the 3.6 GHz Award, it adds that the rules surrounding the timing of payments should be modified for this award as it believes that they can significantly disadvantage smaller operators by requiring a larger proportion of the fees up-front. Imagine states that in the 3.6 GHz Award, 100% of the auction price increases were added to the up-front fees instead of being distributed across the duration of the licence or by increasing the annual licence fee.

7.8.2 Why the use of minimum prices is appropriate for the proposed award

7.273 The purpose of this section is to explain the rationale for applying a minimum price and consider whether a minimum price is necessary for the Proposed Award. DotEcon advises[465] that minimum prices are necessary, to reduce the incentives for:

- strategic behaviour within an auction aimed at decreasing the price paid (including both tacit collusion within an auction and also arrangements entered into prior to an auction aimed at decreasing competition within the auction); and
- speculative bidding aimed at attempting to acquire the spectrum at a low price in the hopes that the value will increase in the future and the spectrum can be sold on at a profit.

7.274 ComReg notes and agrees with the above views of DotEcon.

7.275 ComReg notes that low participation scenarios are likely in spectrum awards given the low number of potential users which provides bidders with incentives to bid conservatively to keep prices low. In these circumstances, an appropriate minimum price needs to be set in order to reduce incentives for bidders to engage in strategic behaviour aimed at obtaining access to valuable spectrum at a price below the level that would be determined by competition between

[465] DotEcon Benchmarking and Minimum Prices Report

bidders (e.g. collusion or strategic demand reduction). A low or non-existent minimum price could lead to less intensive competition if bidders have incentives to bid strategically to keep prices artificially low.

7.276 Also, given ComReg's statutory objective of promoting competition, the Proposed Award should minimise the opportunity and incentive for participants to engage in any collusive behaviour which could compromise the Proposed Award and lead to distortions of competition in downstream markets. Therefore, in the present case, minimum prices may be necessary to:

- prevent frivolous/speculative bidding occurring during the award;
- mitigate the risk that offering spectrum at a low price could lead to bidders acquiring excessive amounts of spectrum or taking up spectrum for short term use, which might displace valuable future uses;
- ensure that rights of use will not be sold to low-value inefficient users due to low participation (in the event that a higher value use may emerge in the near future);
- reduce the potential gains associated with gaming behaviour aimed at restricting competition in the award (such as tacit collusion); and
- encourage bidders to compete, thus promoting an efficient outcome.

7.277 ComReg is therefore of the preliminary view that a minimum price is appropriate for the proposed award.

7.8.3 Methodology for deriving minimum prices for the proposed award

7.278 In respect of the level at which the minimum prices should be set, there are a number of factors relevant to the Proposed Award that need to be balanced, including that:

- the minimum price should not be set so high as to choke off demand of serious bidders;
- the minimum price should not be set so low that there is participation by frivolous bidders; and
- the minimum price should not facilitate collusive behaviour (whether tacit or explicit) or otherwise fixing of demand[466].

[466] Concerns about collusive behaviour and strategic demand reduction are not merely theoretical and have occurred in practice. See Section 3.1 - Document 16/57a.

7.279 There are four possible approaches that can be used to set minimum prices in the Proposed Award.

- low but non-trivial;
- administrative costs;
- business modelling; and
- benchmarking.

7.280 ComReg considers that minimum prices set by reference to (i) administrative costs or (ii) low but non-trivial approach are both derived independently of the market value of the spectrum. Setting prices at a low but non-trivial price is likely to be substantially below the market value of the spectrum. With prices starting at such levels, bidders would likely have a strong incentive to behave strategically to keep prices at close to that level. Furthermore, low participation levels could lead to less intense competition if bidders have incentives to bid conservatively to keep prices low. Therefore, ComReg is of the view that minimum prices should not be set either by reference to administrative costs or according to a low but non-trivial approach.

7.281 Business modelling involves creating a model in order to assess bidder's likely willingness to pay. Benchmarking estimates the value of lots using observed prices in concluded awards, and adjusts to take account of differences between awards and transactions. However, ComReg is of the preliminary view that business modelling is inappropriate as an approach to determining minimum prices for the following reasons:

5. there could be a substantial difference in the business case of interested bidders;
6. large information asymmetries exist between the seller and bidder;
7. there is a large amount of uncertainty surrounding the results of the modelling process; and
8. transparency would be difficult.

7.282 Consistent with the approach taken in more recent awards (e.g. 3.6 GHz

- Low minimum prices in 3G auctions incentivised such behaviour. Swiss (2000) and Dutch 3G auctions (2000), lead to bidder attempts to fix demand at the level of supply for similar reasons.
- Strategic demand reduction likely to have occurred in the US FCC Nationwide Narrowband Auction (1994), German GSM Auction (1999), and Austrian 3G auction (2000).

Award), ComReg considers benchmarking to be an appropriate approach to setting minimum prices in the Proposed Award.

7.283 In particular, it can overcome the information asymmetries apparent in other approaches to setting minimum prices because it has the advantage of revealing information about the actual willingness to pay for spectrum in other jurisdictions. In this respect, the minimum price will not act as a basis for bidders to behave strategically but instead will provide for the efficient assignment and use of spectrum by ensuring that spectrum is awarded to those who value it the most.

7.284 Nera notes that regulators should take great care to avoid actions that could distort auction outcomes and lead to prices that exceed a fair market level. For the avoidance of doubt, this approach does not set out to predict the final winning price but to derive a conservative lower bound estimate of the minimum price. As a result, the minimum price is set with a view to keeping the risk of choking off efficient demand very low. For example, ComReg notes that benchmarking was used successfully in the 2012 MBSA and the 3.6 GHz Award where final prices were many multiples of reserve prices. In that regard, ComReg notes Nera's view that the 3.6 GHz Award was competitive, resulting in a **fair market price** of approximately € 0.04 per MHz per capita.

7.285 Therefore, ComReg's preliminary view is that it is appropriate to use benchmarking as the approach to determine minimum prices in the Proposed Award.

7.8.4 Minimum Price Structure

7.286 ComReg is of the preliminary view that the Proposed Award should have a two-part payment structure composed of an upfront SAF and an on-going stream of indexed SUFs, for the following reasons:

- paying SUFs on an ongoing basis during the licence period would encourage licence holders to consider the opportunity cost of holding rights of use throughout the period of the licence;
- a real financial outflow (i.e. the SUF) will provide a stronger incentive than an opportunity cost alone (i.e. the revenue forgone from not trading) to use spectrum efficiently;
- SUFs should remain helpful in the event that the secondary trading spectrum market does not function properly;
- SUFs encourage efficient use of the full assignment as opposed to seeking partial transfers from the spectrum trading regime; and

- SUFs encourage those operators who have no desire to retain spectrum but do not wish to trade spectrum, to return it to ComReg.

7.287 SUFs should be index-linked to the overall Consumer Price Index ("CPI") as published by the Central Statistics Office of Ireland (or its successor) to ensure that the real value of the SUF is maintained throughout the entire license period. As the CPI may vary over time, the SUF per Lot may increase or decrease over the duration of the licences based upon the increases or decreases in the CPI for the relevant time period.

7.8.5 Minimum Price Split

7.288 The minimum price is typically made up of an upfront component that is the reserve price/minimum SAF and the sum of annual SUFs over the duration of the licence. Therefore, it is necessary to determine how to split the overall minimum price between an upfront payment and ongoing stream of SUFs.

7.289 An upfront payment is necessary to discourage frivolous bidders from participating in the auction. Given that binding bids apply to the upfront part of the minimum price, a low upfront proportion would increase the risk of speculative bidders (bidding for spectrum in the expectation of selling or sub-leasing to other parties, rather than deploying services), or bidders with speculative business plans to bid for spectrum in the hope of delivering certain services but with the expectation that such rights of use could be leased or transferred at a later time.

7.290 A low SAF would mean that bidders could be assigned a large amount of spectrum at a low upfront cost, and could return some spectrum at a later date avoiding any outstanding SUFs. This may create incentives for a bidder to acquire a large amount of spectrum at low cost in order to maximise rents in the short term and perhaps prevent more efficient long-term use over the entire licence duration. The risk of such behaviour is greater where important harmonised bands are available because there is a reduced risk of such spectrum subsequently going unsold in secondary markets, if required.

7.291 In relation to ComReg's objective of ensuring the efficient use of spectrum, SUFs provide incentives for licensees to hand back part or all of their spectrum holdings in the event that they no longer have use for the spectrum (and are therefore not binding). SUFs incentivise bidders to re-assess their need for spectrum on account of annual fees payable to retain their spectrum holdings. This promotes the continued optimal use of spectrum to the benefit of competition in downstream markets. Further, deferring part of the balance of payments across upfront fees (SAFs) and ongoing payments (SUFs) allows bidders to spread a portion of the cost of licences over the licence duration. This is particularly helpful for less well-resourced bidders, facilitating greater

participation and strengthening competition in the auction.

7.292 ComReg is therefore of the preliminary view that a fee structure composed of both a minimum upfront SAF and ongoing SUFs should be applied.

7.293 The minimum price split should provide that the level of the SUF is sufficiently high so as to incentivise the return of unused or under-utilised spectrum. In order for SUFs to be effective, they should ideally be set at a level that reflects the opportunity cost of holding the spectrum. In terms of the SUF, this cannot be known prior to the award. (However, in setting the SUF as a proportion of the minimum price, and ultimately the final price, which does reflect the opportunity cost of the spectrum, the SUF should encourage the return of unused or underused spectrum to ComReg.

7.294 In relation to the minimum price split, the 3.6 GHz Award used a minimum price split of 40/60 split (i.e. 40% minimum SAF and 60% SUF) because for that award ComReg was of the view that was likely to be a greater range of bidders of significantly different size and financial strength and there may be a case for a higher SUF proportion. In particular, a 40/60 split between the SAF and SUFs could be more appropriate to encourage smaller bidders without creating significant additional risk of speculative entry.

7.295 Given the outcome of the 3.6 GHz Award and the assignment of rights of use to non-MNO bidders (Imagine and Airspan), DotEcon is of the view that a similar minimum price split would be appropriate for this award given the potential users are likely to be the similar. Further, this split balances the need to impose a sufficiently high upfront fee to deter non-serious bidders and strategic bidding, and the benefits of spreading a proportion of the fees across the licence term.

7.296 Therefore, in light of the above and having taken into account the views expressed by DotEcon, ComReg is of the preliminary view that the minimum price splits for this award should be apportioned on a 40/60 basis.

Issues raised in Document 18/60 in relation to SAFs and SUFs

7.297 Eir submits that it would be placed at a disadvantage if renewal fees, determined by an auction, are to be paid upfront at the end of the auction some 8 years in advance of actual renewal.

7.298 At the outset, ComReg notes that it is not renewing existing licences but is instead issuing new rights of use. Notwithstanding, Eir appear to be concerned that it would be required to pay its upfront licence fee for Time Slice 2 around 7 years in advance of licence commencement.

7.299 However, DotEcon does not agree that Eir would be at any significant disadvantage relative to other operators and does not recommend that payments for Time Slice 2 spectrum for any bidder be deferred.[467] In particular, DotEcon notes that:

- there is no reason that payments for Time Slice 2 in the 2.1 GHz Band should be processed differently because a bidder (e.g. Eir) holds rights of use (and potentially liberalised rights of use) in Time Slice 1. Time Slice 2 should be treated the same for all bidders regardless of their existing holdings.

- the payment structure faced by Eir would be similar to any other operator that was assigned 2.1 GHz rights of use in both time slices. Those bidders would also be required to pay in advance for access to the spectrum over the period of Time slice 2 and at the same time as paying for access over the first Time Slice.

- deferring payments for Time Slice 2 could create significant scope for speculative bidding for Time Slice 2 from bidders whose bids might not be backed by appropriate financing and might be relying on the delay until payment was due.

7.300 ComReg notes and agrees with the above views expressed by DotEcon. In Time Slice 2, all bidders are in similar positions with all of the available 2.1 GHz spectrum available for assignment. Each bidder would be obliged to pay for those rights of use 7 years in advance of commencement. This approach is necessary to reduce the default risks associated with deferring some or all of the minimum price into the future

7.301 Eir also has the option of liberalising its existing rights in the period up to 2027, allowing it to provide LTE 2100. This is the same as other bidders who would need to be assigned new rights of use in Time Slice 1. Further, the SUFs associated with Time Slice 2 would not begin until the commencement of that licence. The same process would apply for the other bands where Time Slices apply. For example, if any bidder was assigned rights of use in Time Slice 2 but not Time Slice 1 it would be required to pay an upfront fee at the time of the award and 7 years in advance of commencement.

7.302 Therefore, ComReg is of the preliminary view that upfront fees would be required for Time Slice 2 in the 2.1 GHz Band and other rights of use where Time Slices apply.

7.303 In relation to Imagine's suggestion that the auction should determine ongoing

[467] DotEcon Benchmarking and Minimum Prices Report, p33.

fees, rather than the upfront payment, DotEcon do not recommend an approach that allows for some of the auction price to be deferred across the duration of the licences by increasing the SUFs. In particular, the proportion of the overall payments that is deferred should decrease as the auction price increases above reserve. [468]This is necessary to deter non-serious, vexatious, or speculative bidding. There is a danger that deferring the increase in the auction price above reserve encourages bids that may not be securely financed and might even be at risk of default. These issues are of greater concern when the available spectrum is expected to be particularly valuable and/or important for the downstream market.

7.304 Further, DotEcon notes that putting some of the auction price into the SUFs would potentially mean applying different annual fees per MHz for each licensee (since auction prices are non-linear), which could distort post-auction incentives across operators for returning spectrum to ComReg and complicate secondary trading.

7.305 ComReg notes and agrees with DotEcon that the approach suggested by Imagine would not be appropriate. In particular, given that prices are expected to exceed conservative minimum prices, the upfront payment would likely account for a small portion of the final price across all bands, increasing the risk of speculative bids as described above.

7.9 Benchmarking Approach for Minimum Prices

7.306 As noted above, ComReg considers it appropriate to use benchmarking as an approach to determine a conservative minimum price. This section sets out ComReg's proposed approach in relation to benchmarking.

7.307 The auctions included in the benchmarks provided by DotEcon[469] arise in different jurisdictions and are invariably structured differently in terms of price and licence term. In addition, various macroeconomic factors such as inflation and exchange rates limit the extent to which final prices in a spectrum award are comparable across different jurisdictions. Therefore, it is first necessary to make adjustments to ensure any benchmarked valuations are adjusted to a common basis.

7.308 In order to obtain prices that are comparable, DotEcon has made the following adjustments:

[468] DotEcon Benchmarking and Minimum Prices Report, p61.

[469] DotEcon Benchmarking and Minimum Prices Report

- Each benchmark has been normalised to a common licence duration of 15 years[470] .
- A discounted present value of the stream of fees for the licence (including the upfront fees and any further instalments and annual licence fees) has been used with a real discount rate of 7.13%.[471]
- The prices have been converted to a common currency by first converting to US Dollars using purchasing power parity (PPP) exchange rates, and then converting to Euro.
- The prices have been adjusted for inflation using the United States CPI to express prices in 2019 terms.
- The average price per MHz per capita in each award is calculated providing a single observation for each award.[472]

7.309 To form a reasonable view on the minimum price for a given band, DotEcon considers a number of nested sub-samples of the relevant awards for calculating the benchmarks:

- all awards (for the relevant band(s));
- competitive auctions (observations from awards which use an auction mechanism and in which the price of at least one licence exceeds its reserve price);
- competitive auctions in the last 10 years (as recent market conditions and technical developments are more likely to have been considered by operators valuing spectrum in these auctions); and
- competitive auctions in the last 10 years in Europe, which may be considered more likely to reflect the value of spectrum in the Irish market.

7.310 Separately, DotEcon uses an objective and transparent rule to identify outliers using standard definitions of outliers rather than excluding data points in an ad-hoc manner. In that regard, DotEcon excluded observations that:

- lie more than three standard deviations away from the sample mean; or
- lie more than three times the interquartile range away from the 75th percentile

[470] The 2.1 GHz Band has a licence duration 1 – 2 years shorter than the remaining bands in order to provide for co-expiry (i.e. new rights of use in the 2.1 GHz band begin in October 2022, while other bands commence following the award).

[471] Based on the estimates provided for the mobile sector WACC in ComReg, 2014, Cost of Capital, Document 14/136 and D15/14: https://www.comreg.ie/publication-download/cost-of-capital

[472] As a consequence, where an award included spectrum in multiple bands the observation will only provide the weighted average price across these bands.

7.311 DotEcon notes that the distributions of the licence price observations do not follow a normal distribution, but rather are positively skewed with a long upper tail of higher values.[473] In effect, the arithmetic average is likely to be above the median, in which case there will be more observations below the mean than above. In this case, the geometric mean[474], which is less affected by extreme upper values, is a better predictor for the central tendency and relevant benchmarks. For these reasons, DotEcon notes that for this award the geometric mean is the key measure for the purposes of setting minimum prices. Finally, DotEcon notes that if minimum prices are set close to the geometric mean it can be reasonably confident that actual clearing prices will likely be above minimum prices.

7.312 ComReg notes and agrees with the overall approach taken by DotEcon for the following reasons:

- it uses relevant prices and data from the bands that are being awarded in the Proposed Award and data from the award of bands that are technically and commercially comparable to the 700 MHz Duplex frequencies (i.e. 800 MHz and 900 MHz bands);
- the approach is consistent with previous benchmarking approaches which resulted in minimum prices being set lower than final prices e.g. the 2012 MBSA and the 3.6 GHz Award;
- it takes account of the differences between jurisdictions and makes appropriate adjustments;
- it gives a range of estimates that allows ComReg to establish a conservative lower bound estimate of value most relevant to Ireland; and
- it uses an objective and transparent rule to identify outliers and provides a geometric mean in order to account for any additional variation in benchmarks, further reducing the risks of minimum prices being set too high or too low.

7.313 In the following section, ComReg sets out the results, based on the results of DotEcon's analysis, for each of the proposed bands. T

The 700 MHz Duplex

7.314 The 700 MHz Duplex benchmark uses 24 observations (auction results) from

[473] DotEcon Benchmarking and Minimum Prices Report, p4.

[474] The geometric mean is similar to the arithmetic mean but the data points are multiplied rather than added, and it uses the number of data points to find the root of that product of the number of data points rather than dividing the sum by the number of data points. It may be appropriate to use the geometric mean to determine the average of a data set that might not strictly be normal. In effect, it provides additional protection (beyond excluding outliers) against the estimate being skewed by higher data points.

awards of the 700 MHz band in other jurisdictions. The USA auction in 2008 was identified as an outlier and excluded for the purpose of estimating the benchmark. The results of 700 MHz Duplex estimates are set out in Table 12 below.

Table 12: DotEcon 700 MHz Duplex Benchmark Estimates

Sample	Obs.	Mean (Geometric)	Mean (Arithmetic)
All awards	24	0.214	0.336
Competitive awards	16	0.254	0.372
Last 10 years (competitive)	11	0.325	0.421
Last 10 years – European (competitive)	5	0.360	0.421

7.315 Introducing an additional 70 observations from the 800 and 900 MHz bands (given the commercial and technical similarities to the 700 MHz Duplex) increases the sample size and the price obtained in the USA 700 MHz auction in 2008 is not identified as an outlier, however the Hong Kong (2011) and in Polish auction (2016) are identified as outliers and excluded for the purpose of estimating the benchmark. The results of these estimates are set out in Table 13 below.

Table 13: DotEcon 700, 800 MHz Benchmark Estimates

Sample	Obs	Mean (Geometric)	Mean (Arithmetic)
All awards	94	0.210	0.455
Competitive awards	62	0.251	0.520
Last 10 years (competitive)	48	0.352	0.618
Last 10 years – European (competitive)	29	0.385	0.572

7.316 Given that there is a relatively large subsample for licences awarded in competitive auctions in the last ten years in Europe, DotEcon considers these estimates most relevant. In light of these results, DotEcon observes that a conservative estimate of prices is likely to fall in the range of between €0.38 and €0.57 (per MHz per capita), with €0.38 (per MHz per capita) as a conservative

estimate for a minimum price in the 700 MHz band.

7.317 ComReg agrees that a minimum price of €0.38 (per MHz per capita) at the lower end of the 700 MHz band GHz benchmarks is appropriate and would run little risk of choking off demand. In particular, a benchmark of €0.38 (per MHz per capita) is the same as the €0.38 (per MHz per capita) minimum price set for the 800 and 900 MHz bands in the 2012 MBSA, noting that final prices were significantly above the sum of reserve prices. ComReg therefore considers that a minimum price of €0.38 (per MHz per capita) is unlikely to choke off demand for 700 MHz rights of use.

7.318 Nera notes that the significant increase in supply of spectrum and limited ability of operators to monetise 5G services means ComReg should expect spectrum prices per MHz to fall relative to the 2012 4G auction. Similarly, it notes that excessive pricing could delay the roll out of 5G services. However, as noted previously, benchmarking does not set out to predict the final winning price but simply derives a conservative estimate of the minimum price. The final prices (and actual differences between bands) are not determined by ComReg and will be determined by the interaction of bidders during the award. Given the extent to which final prices exceeded the sum of minimum prices in 2012 MBSA, minimum prices for this award set within a similar range are unlikely to choke off demand.

7.9.1 The 2.1 GHz Band

7.319 The 2.1 GHz benchmark uses 82 observations from awards of the 2.1 GHz band in other jurisdictions. The UK (2000), Germany (2000), France (2000), Italy (2001) and Egypt (2007) were identified as outliers and excluded for the purpose of estimating the benchmark. The results of these estimates are set out in Table 14 below.

Table 14: DotEcon 2100 MHz Benchmark Estimates

Sample	Obs	Mean (geometric)	Mean (arithmetic)
All awards	77	0.228	0.411
Competitive awards	37	0.303	0.467
Last 10 years (competitive)	17	0.333	0.484
Last 10 years – European (competitive)	3	0.197	0.234

7.320 The 2.1 GHz Band benchmarks appear significantly higher compared to benchmarks for other high frequency bands (e.g. 2.6 GHz).[475] This occurs regardless of whether more dated (UMTS)[476] or more recent (LTE) awards are used to benchmark prices. Notwithstanding, DotEcon expects the more recent 2.1 GHz benchmarks (where future LTE use was a consideration) to provide better estimates of the value to mobile operators that wish to migrate their networks to LTE. However, there are only three observations of competitive European awards in the last decade as this band was already assigned across most of Europe during that period.

7.321 Therefore, DotEcon considers a wider group of observations, particularly all competitive awards in the last 10 years. In light of these results, DotEcon observes that a conservative estimate of prices is likely to fall in the range of between €0.33 and €0.48 (per MHz per capita). However, in acknowledgement of the lack of available European data points in the last 10 years and the suggested benchmarks for the 2.3 and 2.6 GHz bands, DotEcon suggests a benchmark of €0.2 per MHz per capita (in line with recent competitive European awards) should be appropriate for the proposed award.

7.322 ComReg agrees with the proposed minimum price of €0.2 per MHz per capita as suggested by DotEcon. In particular, the use of a benchmark lower than the suggested range is warranted given the difference in benchmarks between the 2.1 GHz Band and other potentially substitutable spectrum. The extent to which such valuation differences arise in practice will be determined by the interaction of bidders during the award.

7.323 The main concern in relation to the 2.1 GHz band is whether a minimum price set at these levels would risk choking off demand. However, ComReg notes that a benchmark of €0.20 (per MHz per capita) is similar to the €0.19 (per MHz per capita) minimum price set for the 1800 MHz band (which is immediately below 2100 MHz) in the 2012 MBSA, noting that final prices were significantly higher than the sum of reserve prices. ComReg therefore considers that a minimum price of €0.20 (per MHz per capita) is unlikely to choke off demand for 2100 MHz rights of use.

[475] ComReg notes that while it considers the 2.1 GHz Band and 2.6 GHz Band as substitutable (because from the perspective of an operator if it can use either band for provision of services to customers), this does not preclude the possibility that there may be differences between the bands in how effective or cost-efficient they are for providing particular services (i.e. substitutability is imperfect). An example is the use of spectrum at different frequencies having a common role in providing capacity. Therefore, spectrum that is substitutable from a technical perspective does not necessarily translate in to similar minimum prices since the final valuation are ultimately determined by bidders.

[476] The more dated awards occurred just at the peak of the telecoms, media and technology (TMT) equity bubble that potentially drove up entrants' valuations

7.9.2 The 2.3 GHz and 2.6 GHz Bands

7.324 There are eleven 2.3 GHz band observations from awards in other jurisdictions. India (2010) and Hong Kong (2011) were identified as outliers and excluded for the purpose of estimating the benchmark. DotEcon notes that there is very little data available for awards in the 2.3 GHz Band but that the 2.3 GHz band should have similar characteristics and usage possibilities as the 2.6 GHz band in the very near future and we expect the two bands to be substitutable and of similar value. Therefore, DotEcon pooled the observations across the two bands to derive a single price estimate for spectrum in these bands. Four outliers were identified from the pooled observations.[477]

7.325 The results of these estimates are set out in Table 15 below.

Table 15: DotEcon 2.3 GHz and 2.6 GHz Benchmark Estimates

Sample	Obs	Mean (geometric)	Mean (Arithmetic)
All awards	48	0.029	0.063
Competitive awards	38	0.032	0.066
Last 10 years (competitive)	30	0.044	0.079
Last 10 years – European (competitive)	21	0.043	0.063

7.326 In light of these results, DotEcon observes that a conservative estimate of prices is likely to fall in the range of between €0.03 and €0.08 (per MHz per capita), with €0.04 (per MHz per capita) as a conservative estimate for a minimum price in the 2.3 and 2.6 GHz bands

7.327 ComReg agrees that a minimum price of €0.04 per MHz per capita is an appropriate benchmark for the 2.6 GHz and 2.3 GHz bands ComReg would also note that a benchmark of €0.04 per MHz per capita is significantly below the final price of €0.078 per MHz per capita for the 2.3 GHz band in the UK 2018 award. Similarly, it is below the final prices achieved in ComReg's 3.6 GHz Award which was assigned on a TDD basis and has less favourable propagation characteristics. ComReg therefore considers that a minimum price of €0.04 per MHz per capita is unlikely to choke off demand for 2.3 and 2.6 GHz rights

[477] The prices obtained for 2.6 GHz spectrum in two Hong Kong auctions (the BWA auction in 2009, and the 4G auction in 2013) and in two South Korean auctions (the 1800 MHz & 2.6 GHz auction in 2013, and the multiband auction in 2016).

of use.

7.10 ComReg Assessment

7.328 In consideration of the views provided by DotEcon, ComReg is of the preliminary view that the conservative ranges as recommended by DotEcon are appropriate. In particular, these ranges would run little risk of choking off demand and would satisfy each of the factors relevant to the minimum price as stated in above.

7.329 In summary, ComReg notes the following.

- The price per capita for the 700 MHz is of the same magnitude of the minimum price for the 800 MHz band in the 2012 MBSA, which was concluded successfully and all lots were sold above the reserve price.
- The price per capita for the 2.1 GHz band is of the same magnitude as the minimum price for the 1800 MHz band in the 2012 MBSA, which was concluded successfully and all lots were sold above the reserve price.
- Given that the proposed 2.3 GHz and 2.6 GHz minimum prices are lower than the 2.1 GHz band, and the three bands share similar (although not identical) characteristics, bidders are unlikely to view such prices as excessive.

7.11 Upfront SAF and SUF

7.330 The minimum fee for each band and time slice consists of a minimum upfront fee (SAF) which is paid at the end of the Proposed Award and annual Spectrum Usage Fees (SUFs) which are paid prior to the first grant of the licence and then over its duration. The SUFs due will be calculated in advance of the commencement of the licence and each subsequent anniversary. These are set out below in Table 16 and are calculated using the per MHz per capita minimum prices proposed above. SUFs are index-linked to the overall CPI as published by the Central Statistics Office.

7.331 ComReg has applied a real discount rate of 7.13%[478] to adjust the Net Present Value (NPV) for a Licence in the proposed bands with a duration of 15 years. ComReg has also used the latest population estimate of 4,961,000 from the IMF [479] to convert the benchmarks into minimum prices.[480]

Table 16: Minimum Price SAF & Annual SUF

Bands	Lot size	Time Slice	Minimum SAF, €m	SUF[481], €
700 MHz	2×5 MHz	1 & 2	7,540,720	1,168,778
2.1 GHz	2×5 MHz	1	1,376,873	615,147
2.1 GHz	2×5 MHz	2	1,694,275	615,147
2.3 GHz (2300 – 2330)	30 MHz	1	1,013,427	274,082
2.3 GHz (2300 – 2330)	30 MHz	2	754,893	274,082
2.3 GHz	5 MHz	1	227,453	61,515
2.3 GHz	5 MHz	2	169,428	61,515
2.3 GHz	10 MHz	1	454,905	123,029
2.3 GHz	10 MHz	2	338,855	123,029
2.6 GHz	2×5 MHz	1	454,905	123,029
2.6 GHz	2×5 MHz	2	338,855	123,029
2.6 GHz	5 MHz	1	227,453	61,515
2.6 GHz	5 MHz	2	169,428	61,515

[478] ComReg, 2014, Cost of Capital, Document 14/136 and D15/14 outlines a nominal discount rate of 8.63%. Inflation rate of 1.5% is used to calculate the real discount rate of 7.13%.

[479] CSO population and migration estimates April 2018, available at www.cso.ie

[480] The minimum price for the 2300-2330 MHz frequency specific lot has been adjusted to account for the reduced population that would be the case under the "no migration scenario".

[481] Subject to CPI index link

Chapter 8

8 Licence conditions

8.1 Introduction

8.1 Regulation 10(1) of the Authorisation Regulations provides that ComReg may only attach those conditions listed in Part B of the Schedule to the Authorisation Regulations to rights of use for radio frequencies for the provision of electronic communications networks and services.

8.2 In this Chapter, ComReg sets out its proposals regarding the appropriate conditions that should be attached to any spectrum rights of use that may be granted under the Proposed Award. These conditions are termed licence conditions in this document.

8.3 The licence conditions proposals in this chapter have been guided by, among other things:

- ComReg's statutory functions, objectives and duties, including in particular its obligations under the Authorisation Regulations;
- the relevant European legislation related to the bands[482]
- the rationale and licence conditions used previously by ComReg for bands used for similar purposes (e.g. the licence conditions used in the 2012 MBSA, 3.6 GHz Award, etc.); and
- the rationale and licence conditions proposed in Document 14/101 and the submissions received to that consultation;
- the Connectivity Studies comprising of the Frontier Connectivity Report (18/103a and 18/103b), Oxera Connectivity Report (18/103c) and the DotEcon Connectivity Report (Document 18/103d) along with ComReg's Information Notice (Document 18/103)
- the Plum 2.6 GHz and 2.3 GHz Co-existence Reports published alongside this document as Documents 19/59c and 19/59d, respectively; and
- other relevant information including international practices.

[482] See Annex 4 for a listing of the relevant EC, EU and ECC Decisions for the Proposed Bands.

8.4 The following licence conditions proposals are discussed in this chapter:

- service and technology neutrality;
- non-exclusive assignment of spectrum;
- coverage and rollout;
- quality of service;
- notification of the termination of a technology;
- potential wholesale access (MVNO) conditions
- spectrum transfer, spectrum leasing, spectrum hoarding; and
- technical conditions.

8.2 Service and technology neutrality

8.5 Service and technology neutrality is the principle that spectrum rights of use, and the conditions applied thereto, should not preclude the provision of any specific service and/or the use of any technology[483].

8.6 The promotion of service and technology neutrality in the rights of use spectrum, where possible, is a general principle under the regulatory framework[484]. Further, the principle of service and technology neutrality is reflected in the respective EC and CEPT harmonisation decisions on the proposed bands[485]. As set out in Annex 12, among other things, these decisions set out the technical parameters in the form of channelling arrangements and least restrictive Block Edge Masks (BEMs) that can facilitate the co-existence of multiple technologies and services.

[483] Provided, of course, that there is compliance with certain technical pre-conditions of use (normally specified at EU and CEPT level in their technical harmonisation decisions).
[484] See for example, Regulation 16(1)(a) of the Framework Regulations and Article 2 of the EU multiannual radio spectrum policy programme (RSPP) Decision No 243/2012/EU
[485] See Annex 4 for a listing of the relevant EC, EU and ECC Decisions for the Proposed Bands.

Applying a service and technology approach

8.7 Noting the above legal considerations, and the general support for this principle as expressed in previous ComReg consultations[486], ComReg is of the view that it is appropriate to apply a service and technology neutral approach to the licensing of the Proposed Bands. This would permit the deployment of all technologies and services that comply with the relevant EC/CEPT harmonisation decision for the band.

8.3 Non-exclusive assignment of spectrum rights

8.8 Wireless telegraphy licences in Ireland are generally issued on a non-exclusive basis. As such, it is standard practice that many spectrum bands licensed to particular licensees are also made available to other wireless telegraphy apparatus on a non-interference and non-protected basis[487].

8.9 Furthermore ComReg notes that, across Europe, it is generally standard practice for spectrum bands to be made available to other wireless telegraphy apparatus at the same time, provided such apparatus is operated on a non-interference and non-protected basis. This standard practice has also been adopted in the EC and CEPT Decisions relating to proposed bands.

Proposed Bands to be made available on a non-exclusive basis

8.10 For the 700 MHz, 2.1 GHz and 2.6 GHz bands, the relevant EU Decisions oblige member states to designate and make available the band on a non-exclusive basis[488]. As the relevant EU Decision is binding on Member States, ComReg confirms that rights for these bands will be will be assigned on a non-exclusive basis.

8.11 For the 2.3 GHz band, while ComReg notes this band is not subject to an explicit requirement under an existing EC Decision to make this band available on a non-exclusive basis, ComReg is of the view that it would be appropriate to do so as this would:

[486] For example, see section 6.1 of Document 15/70, section 6.2 of Document 15/140 and section 6.2 of Document 16/57 in relation to the 3.6 GHz Band Award where respondents generally supported ComReg's technology and service neutrality proposals.
[487] For example, the Liberalised Use licences in the 800 MHz, 900 MHz and 1800 MHz spectrum bands awarded under the 2012 MBSA were issued on a non-exclusive basis. This facilitates the use of these spectrum bands by other uses. For example spectrum in the 900 MHz and 1800 MHz bands has been made available to other applications using wireless telegraphy apparatus, such as Short Range Devices (Document 02/71R9), Mobile Communications on Aircraft (MCA) services and Test and Trial apparatus.
[488] See Article 3(1)(a) of Decision EU 2016/687 (700 MHz Band); Article 2(1) of Decision 2012/688/EU (2.1 GHz Band); Article 2(1) of Decision 2008/477/EC (2.6 GHz Band).

- provide for consistency across spectrum rights of use offered in the Proposed Award;
- provide for consistency across existing spectrum rights likely to be complementary or substitutable to the Proposed Bands, namely the spectrum rights assigned in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands;
- follow standard practice where spectrum bands licensed to particular licensees are also made available to other wireless telegraphy apparatus on a non-interference and non-protected basis. This for example allows other valuable services such as Mobile Communications on Aircraft (MCA) and test and trial licences to operate across bands on a non-interference and non-protected basis;
- be in line with the flexibility provided to national administrations to maintain the use of the band for incumbent services as set out in EC ECC/DEC/(14)02 (see Decides 2); and
- make provision for any future EC Decision on this band which may include obligations to make spectrum available on a non-exclusive basis.

Scope of the non-exclusive assignment proposal

8.12 Noting the above, the remaining issue to be determined is defining the scope of spectrum assignments for other uses in these bands. In that regard, ComReg notes:

- that while spectrum assignments for other uses of a licensed spectrum band can take the form of licences and licence-exemptions, it is ComReg's general policy that all such spectrum assignments are allowed only on a non-interference and non-protected basis; and
- in addition these spectrum assignments have generally followed a process where the impact on licensed services would first be considered. This assessment could be carried out at a European level (in bodies such as CEPT, ETSI or the EC[489]) or at a national level (for example, the consideration of test and trial licences or other licences types[490]). In relation to test and trial licences, ComReg notes that where such licences

[489] Services such as Short Range Devices, Mobile Communications on board Aircraft (MCA) etc. are harmonised at a European level.
[490] In the UK, Ofcom's 2.3 GHz and 3.6 GHz award noted that coordinated access for PMSE may be arranged on a case by case basis with the award licensees where there is a need to source additional spectrum outside the core PMSE bands https://www.ofcom.org.uk/__data/assets/pdf_file/0030/81579/info-memorandum.pdf

have been issued for the same spectrum rights of use as assigned to a licensee, they have been granted with the knowledge of the licensee.

8.13 Given the above, ComReg considers that it would be appropriate to permit spectrum in the Proposed Bands to be used for other uses on a non-interference and non-protected basis. In this regard, and in the interests of appropriate regulatory consistency, ComReg proposes that the non-exclusivity condition to be attached to spectrum rights in the Proposed Award would be substantively the same as the non-exclusive provision included in the licence issued in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands[491].

8.4 Coverage and rollout obligations

8.4.1 Background information and context - the primary policy issue

8.14 Before identifying options for an appropriate coverage and rollout obligation it is useful to set out the relevant background and context, in particular:

- how mobile services were provided at the time of ComReg's 2012 MBSA;
- the usages, perceptions and experiences of mobile phone users as identified by Behaviour and Attitudes Study and published in 2017;
- the results of the mobile handset and building material testing;
- ComReg's decision to permit the use of mobile phone repeaters;
- the connectivity studies commissioned by ComReg; and
- the relevant publications set out in both Europe and Ireland which relate to the setting of coverage obligations.

Situation prior to the 2012 MBSA

8.15 Prior to the 2012 MBSA, mobile services were provided using 2G and 3G technology with the main focus on voice rather than data[492]. Mobile broadband

[491] The following definitions are included in S.I 251 of 2012
"Non-exclusive", in relation to a Licence, means that the Commission is not precluded from authorising the keeping and possession by other persons of other apparatus for wireless telegraphy on a Non-Interference and Non-Protected Basis in one or more of the 800 MHz, the 900 MHz and the 1800 MHz bands;
"Non-Interference and Non-Protected Basis" means that the use is subject to no harmful interference being caused to any Radiocommunication Service, and on which no claim may be made for the protection of apparatus used on this basis against harmful interference originating from Radiocommunication Services;
[492] ComReg Quarterly Report Q4 2012, Document 13/25, p61

("MBB") was primarily delivered through 'dongles'[493] using UMTS 2100, and while this provided access to MBB services to users, its coverage and data speeds were limited due to, among other things, the propagation characteristics of the 2.1 GHz Band, the 3G technology itself and the capability of user equipment and base stations. Smartphones had not yet become ubiquitous and 2G feature phones were predominant. For example, around 2.4 million smartphones accounted for 48.7% of all mobile subscriptions[494,495] with most of these based in cities and urban areas where the additional functionality could be better utilised.

8.16 In 2010, the Digital Agenda for Europe introduced non-binding targets of access to connectivity at 30 Mbit/s (headline)[496] by 2020 to ensure territorial cohesion in Europe and a penetration target of 100 Mbit/s (50% of subscriptions in Europe by 2020) to anticipate future competitiveness needs. These targets were to be delivered through a mix of complementary technologies, deployed incrementally, and according to local circumstances[497]. The 2012 multiannual radio spectrum policy programme established by the EU[498] obliged Member States, in cooperation with the European Commission, to take all steps necessary to ensure that sufficient spectrum for coverage and capacity purposes is available in order to enable the EU to achieve the target for all citizens to have access to broadband speeds of not less than 30 Mbit/s by 2020. In pursuit of these objectives, a central aim of the mobile element was for Member States to have carried out the authorisation process for the 800 MHz band by 1 January 2013. ComReg completed the 2012 MBSA prior to this deadline, and subsequently issued spectrum rights of use for the 800 MHz, 900 MHz and 1800 MHz bands[499].

8.17 In the 2012 MBSA ComReg was of the view that while retail competition would likely drive actual coverage levels beyond the levels of its proposed obligations, it was nevertheless appropriate to set a coverage obligation on the 800 MHz, 900 MHz and 1800 MHz rights being awarded[500]. This was because, among other things, there was no guarantee that the market alone would ensure the efficient use of spectrum, and that the setting of a coverage obligation at an appropriate level would prevent cherry picking (such as in densely populated

[493] A dongle is USB device, typically the size of a flash drive that plugs in to a computer and allows the user to connect to the internet via a mobile network.
[494] ComReg Quarterly Report Q4 2012, Document 13/25, p49
[495] This also overstates the use of 3G networks as smartphones would primarily use 2G networks to deliver service and only offload to a 3G network where a signal was present.
[496] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0245:FIN:EN:PDF
[497] http://europa.eu/rapid/press-release_SPEECH-12-124_en.htm
[498] Decision No 243/2012/EU of the European Parliament and of the Council of 14 March 2012 establishing a multiannual radio spectrum policy programme, Article 6.
[499] On 5th December 2012, ComReg published an Information Notice on the frequency arrangements and results of the Multi-Band Spectrum Award Process. (Document 12/131)
[500] See section 5.5.2.6 of Document 12/52

areas) that could destabilise overall competition (observing that the revenues obtained by MNOs from densely populated areas helped fund the provision of services in less-densely populated areas). Consequently, it was a condition of each licence to achieve and maintain a minimum coverage obligation of 70% of the population of Ireland within 3 years for an existing operator and within 7 years of being awarded a licence for a new entrant[501].

8.18 In the 6 years since the 2012 MBSA, there has been a sea change in the way consumers access and use telecommunications services. In particular, the proliferation of smartphones provides users with increased functionality which can connect with multiple broadband networks and an ever increasing range of new services and applications, leading to increased data consumption. Following the grant of technology- and service-neutral (or "liberalised") rights of use[502] in the 2012 MBSA, new and improved services were quickly introduced alongside the continued provision of the existing 2G and 3Gservices. Mobile services were improved in two main ways following the 2012 MBSA:

- 3G (or UMTS) services were expanded using the 900 MHz band. This provided 3G services for the first time in areas where only 2G was previously available.[503] For example:
    - Vodafone prioritised the delivery of enhanced mobile data (i.e. UMTS 900) to regions that up to then had only mobile voice.[504]
    - Eir commenced deploying 3G at 900 MHz using UMTS 900 to improve coverage especially in rural areas.[505]
- 4G (LTE) services were also introduced to the market in 2013 and all existing operators claim population coverage of over 90%.[506]

8.19 Further, the prices for telecommunication equipment and services has fallen, contributing to the rate at which consumers access services over their phone. For example, in Ireland, communication prices have declined by 12% since December 2011, compared to an increase in the overall consumer price index

[501] Other frequency bands could count towards the 70% coverage obligation, provided that a minimum of half of the 70% population coverage level (i.e. 35% population coverage) is provided using 800 MHz, 900 MHz or 1800 MHz spectrum. This obligation applies to all spectrum bands awarded under the 2012 MBSA.
[502] The Liberalised-Use Licences in the 800 MHz, 900 MHz and 1800 MHz Frequency bands enables licence holders to deploy technologies, such as UMTS or LTE, alongside GSM thereby facilitating the provision of advanced mobile services using these bands.
[503] UMTS 900 provides between 44% (in urban areas) and 119% (rural areas) increased coverage per Node-B compared with UMTS 2100 - UMTS 900 Market Study Final Report. Ovum
[504] Vodafone Ireland Limited 2013 Reports and Consolidated Financial Statements.
[505] Eircom Limited Financial Statements 2013.
[506] http://www.vodafone.ie/network/Sure.html0
https://www.eir.ie/ourmobilenetwork/
https://www.three.ie/the-big-upgrade/

("CPI") by around 2%.[507] Operators have also introduced a range of strategies aimed at capturing market share, including All You Can Eat ("AYCE") data offers, unlimited minutes and text bundle allowances, free device pricing and competitive tariff plans. This has had the effect of increasing the extent to which consumers access services over the internet.

8.20 As a result of the above, the market has changed in a number of important ways:

- Download speeds have increased significantly. For example:
    - UMTS 2100 licences had a 384kbps obligation at the time of commercial launch of services and the National Broadband Scheme had a requirement of 1.2 Mbit/s at cell edge.[508]
    - In the most recent Drive Test[509], the average download speed was up to 22 Mbit/s depending on the operator, and LTE speeds were approximately 3.7 times faster than 3G. This compares to 2012 when 80% of fixed connections provided speeds of less than 10 Mbit/s.[510]
- The number of smartphones has nearly doubled to 4.7 million devices or 95% penetration.[511] Mobile phones or smartphones were used to access the internet by 86% of individuals in 2018.[512]
- The number of mobile broadband (dongle) subscriptions has fallen from half a million to 300,000.[513]
- Total data usage has increased by 1,500% since 2012 with the average GB use per smartphone is now 6.4 GB[514]

8.21 In effect, the need for connectivity has advanced considerably since the 2012 MBSA and consumers place ever increasing demands on fixed and mobile networks.

Usages, perceptions and experiences of mobile phone users

8.22 Despite the improvements in mobile networks and consumer satisfaction, in its

[507] Central Statistics Office, Consumer Price Index.
[508]https://www.dccae.gov.ie/en-ie/communications/topics/Broadband/closed-schemes/national-broadband-scheme/Pages/NBS-Frequently-Asked-Questions.aspx
[509] ComReg Document 18/26R1, "Assessment of Mobile Network Operators' Compliance with Licence Obligations (Coverage), Winter 2017", published 2 May 2018
[510] Ibid, Figure 3.3.7
[511] ComReg Quarterly Reports Q1 2019, Document 19/57
[512] Information Society Statistics (CSO) – Households 2018.
[513] ComReg Quarterly Reports Q1 2019, Document 19/57
[514] ComReg Quarterly Reports Q1 2019, Document 19/57

2016-2018 Spectrum Strategy Statement, ComReg noted the public perception that the mobile retail consumer experience has deteriorated.[515]

8.23 Similarly, in response to concerns about mobile connectivity, the Government established the Mobile Phone and Broadband Taskforce ("MPBT").[516] The first report by the MPBT (in December 2016) included 40 recommendations and actions associated with Government departments, agencies, local authorities, ComReg and industry providers. These recommendations also reflected issues identified by ComReg in its 2016-2018 Spectrum Strategy Statement.

8.24 In addition, and in order to prepare for the future spectrum awards and support the objectives of the MPBT, ComReg initiated a number of work streams to get a better understanding of these problems and other relevant factors, and the nature and extent of their respective impact on the consumer experience.

Understand the mobile consumer experience

8.25 **First**, ComReg published the results of a survey by Behaviour and Attitudes of residential consumers in Ireland regarding the usage, perceptions and experiences of mobile phones users (Document 17/100a) ("Mobile Consumer Experience Survey"). This survey highlighted a number of key issues with regard to mobile connectivity, in particular:

- consumer satisfaction with respondents' mobile coverage at home is relatively high with only 11% of users dissatisfied[517], rising to 19% in more rural areas.[518]
- inside the home is the location consumers most use their mobile phone for voice and data. For example:
    - nearly 70% use their mobile phone for voice or text in the house daily, falling to 60% in more rural areas[519].

[515] Spectrum Strategy Statement (Document 17/31),
[516] The Programme for a Partnership Government committed to the establishment of a MPBT to identify solutions to broadband and mobile phone coverage deficits and investigate how better services could be provided to consumers prior to full build and rollout of the network planned under the National Broadband Plan (NBP). The objective of the MPBT is to provide immediate solutions to mobile voice and broadband deficits in Ireland. It aims to alleviate telecommunications service deficits, particularly in rural Ireland, prior to full build and rollout of the network which is planned under the NBP State intervention
[517] Respondents were asked to rate their mobile phone network coverage at the home out of ten. Respondents that rated 4 or lower are classified as dissatisfied.
[518] Slide 62, Document 17/100a
[519] Slide 43, Document 17/100a

- 74% (45% every day) use their mobile phone for data usage at some point inside the home, rising to 82% (48% every day) for more rural areas.[520]

- nearly 30% of all respondents experienced various service issues for call/text and data usage during the past month in the home, the highest of all locations assessed[521].

- incidence of experiencing service issues in the house or part thereof for calls/text and data (c. 30%) is higher than the same service issues that occur outside the home (c.18%)[522].

- rural consumers have higher rates of experiencing services issues regardless of location with higher levels of service issues arising in the home or part thereof (i.e. indoor). [523]

- the four biggest service issue outdoors all relate to voice calls rather than data usage. For example, of respondents who experienced services issues[524]:

  - 54% noted that the quality of reception deteriorated when on a call.
  - 38% could not make a call.
  - 29% could not receive a call.
  - 26 % experienced a dropped call.

8.26 According to the survey, while consumers can experience connectivity issues regardless of their location, performance issues occur more frequently while indoor and in more rural parts of the country. Performance issues were also reported at other locations and when travelling, albeit at a lower rate[525].

Better understand the factors affecting the mobile consumer experience: (i) mobile handset testing and (ii) the effect of building materials on indoor mobile performance

8.27 **Second**, ComReg commenced two parallel projects in order to gain a greater understanding of two factors referred to in its 2016-2018 Spectrum Strategy

[520] Slide 46, Document 17/100a.
[521] Slide 51, Document 17/100a.
[522] Slide 51, Document 17/100a.
[523] Slides 54 and 56, Document 17/100a.
[524] Ibid – Slide 59.
[525] ComReg intends to update this survey and intends to provide updated views at the next consultation should they be available.

Statement that affect mobile user experience[526], being:

i). Mobile Handset Performance*:* to measure the antenna performance of mobile handsets available on the Irish market in order to quantify the performance of each handset when making or receiving a mobile call and to stream data **(Action 28 of MPBT)**; and

ii). Effect of Building Materials on Indoor Mobile Performance*:* to determine the extent to which some representative modern building materials impact on in-building coverage by measuring overall attenuation through each building material tested.

8.28 In relation to (i), *Mobile Handset Performance (Voice)*[527] was published in February 2018 and identified a variation in performance of up to 14 dB between handsets, meaning that some handsets have significantly poorer reception than others. In effect, consumers living in areas where signal strength is more marginal could potentially significantly improve their connectivity experience by changing their handset[528].

8.29 In relation to (ii), *The Effect of Building Materials on Indoor Mobile Performance*[529] was published in April 2018 and identified that the use of some modern building materials (in particular those containing metals such as foil-backed thermal insulation or windows with aluminium or metallic frames) can have a significant detrimental effect on the ability of radio waves to penetrate a building. In particular, the losses suffered by radio waves penetrating these materials is in the order of 20 up to 60 dB. That is, a reduction in signal strength of 100 up to 1,000,000 times. Note that these figures reflect samples of materials and not aggregate building envelope performance.

Permit the use of mobile phone repeaters in Ireland

8.30 **Third**, in June 2018, ComReg published a decision to permit the use of mobile phone repeaters[530] noting that such devices would be of particular use to households and businesses in rural areas. This aligned with Action 27 of the

[526] ComReg recognised that there may be various factors contributing to the perception of poor performance, including:
- the signal may deteriorate indoors (compared to outdoors) depending on the technology (2G or 3G) and the network operator; and
- the use of better building insulation materials (e.g. foil backed insulation, windows with metallic components and coatings, etc.) and the consequent reduction in indoor signal penetration.

[527] Document 18/05
[528] See Documents 18/78 and subsequent "mobile handset performance" test results in Documents 18/82, 18/84 and 18/109.
[529] Document 18/73
[530] Mobile Phone Repeaters - Response to Consultation and Final Decision, Document 18/58. Wireless Telegraphy Act 1926 (Section 3) (Exemption of Mobile Phone Repeaters) order 2018, S.I. No. 283 of 2018

MPBT) that ComReg explore the introduction of a regime to permit the orderly installation of mobile phone repeaters[531].

Advice on different aspects of providing connectivity in Ireland

8.31 **Finally**, and in order to assist the development of proposals for its forthcoming spectrum awards (and appropriate coverage obligations in particular), ComReg commissioned three studies on different aspects of providing connectivity in Ireland.

8.32 As discussed in Chapter 2, these are termed the Connectivity Studies and include

- The Frontier Connectivity Report (Document 18/103b and accompanying infographic Document 18/103a) which provides an overview of the challenges in providing connectivity for consumers in Ireland and outlines actions that can be taken by all stakeholders, including consumers, industry, government and ComReg, to optimise the levels of connectivity given these challenges;

- The Oxera Connectivity Report (Document 18/103c) which considers the future mobile connectivity services likely to emerge in Ireland and the estimated costs of providing connectivity to such services at high coverage levels in Ireland; and

- The DotEcon Connectivity Report (Document 18/103d) which considers options as to how appropriate coverage and rollout obligations could be included in future spectrum awards.

8.33 Taking into account the results of the Mobile Consumer Experience Survey[532] and other relevant information[533], consumer "connectivity" can be described as:

- the ability of users and their devices to connect and communicate with each other and their networks, where this can take different forms, with

[531] https://www.comreg.ie/consumer-information/mobile-phone/mobile-phone-repeaters/

[532] For example:
- consumers use their mobile phone to access voice and data services across a variety of different locations (i.e. indoor, outdoor and on the move); and
- while the mobile phone is the primary device used by consumers to communicate, it is not used exclusively over mobile networks and the predominant connection type to the internet is over fixed networks

[533] For example:
- over two-thirds of consumers use Wi-Fi more often than mobile networks when connecting to the internet using their smartphone,
- nearly 80% of people use their smartphone to connect to a fixed broadband connection at home (up from 70% in 2015)

Global Mobile Consumer Survey: Ireland 2016 There's no place like phone – Figure 16.

many different networks and devices being used, increasingly seamlessly, to communicate and consume content and applications.

8.34 Thus mobile coverage is just one aspect of consumers' need for connectivity, and providing connectivity is not the preserve of any one technology and/or network, but rather includes the use of fixed and mobile networks to provide connectivity to end-users regardless of location or the device used.

8.35 In considering the different technologies and networks, the Frontier Connectivity Report highlights the linkages between the activities of various stakeholders relevant to improving connectivity (Government, regulators, operators, consumers, equipment manufacturers etc.). These include the various work streams referred to above but also, importantly, the National Broadband Plan ("NBP"), as discussed in Chapter 2, which aims to provide high speed broadband to Irish households, which would not otherwise have access, as follows[534]:

- *70Mbit/s* - 100 Mbit/s available to at least 50% of the population with a majority having access to 100Mbit/s;
- At *least* 40 Mbit/s, and in many cases much faster speeds, to at least a further 20% of the population and potentially as much as 35% around smaller towns and villages; and
- A *minimum* of 30 Mbit/s available to all.

8.36 In developing its proposals in this document with respect to any coverage obligation, ComReg has had regard to the activities of various stakeholders including the actions and future deliverables of the NBP and the MPBT. For instance, in light of the significant commercial plans for fixed broadband connections that have been announced in recent years and the proposals of the NBP, all households in Ireland are expected to be able to access a minimum broadband service of 30 Mbit/s after the rollout of the NBP. This has important implications for the provision of connectivity and mobile coverage.

Primary policy issue – mobile coverage

8.37 In light of the above, the primary policy issue in relation to this matter can be characterised as determining an **appropriate mobile coverage obligation that contributes to improving the overall consumer connectivity experience, mindful of the availability of other technologies and networks and likely developments in same.** This may mean, for example, that it might be more appropriate to achieve certain consumer connectivity requirements

[534] https://www.dccae.gov.ie/en-ie/communications/topics/Broadband/national-broadband-plan/Pages/National-Broadband-Plan.aspx

through technologies and networks other than mobile alone.

8.4.2 Other relevant information

8.38 This section set outs other information relevant to the consideration of coverage obligations for the spectrum bands in the Proposed Award.

Relevant European information

8.39 ComReg's consideration of coverage obligations as set out in this section is mindful of and is informed by the following European information:

- Article 6(1) of the Decision No 243/2012/EU[535] which provides that all steps necessary to ensure that sufficient spectrum for coverage and capacity purposes and to achieving the target for all citizens to have access to broadband speeds of not less than 30 Mbit/s by 2020.

- EU Decision (EU)2017/899[536] which, among other things, obliges Member States, when authorising or amending rights of use in the 700 MHz band to:

    - take due account of the need to achieve the target speed and quality objectives set out in Article 6(1) of Decision No 243/2012/EU, including coverage in predetermined national priority areas where necessary, such as along major terrestrial transport paths, for the purpose of allowing wireless applications; and

    - assess the need to attach conditions to the rights of use for frequencies within the 700 MHz frequency band and, where appropriate, shall consult relevant stakeholders in that regard;

- "European 5G roadmap"[537] - which, among other things, aims to see 5G connectivity in large cities and along major transport routes of every European country by 2025;

[535] DECISION No 243/2012/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 March 2012 establishing a multiannual radio spectrum policy programme.
[536] DECISION (EU) 2017/899 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2017 on the use of the 470-790 MHz frequency band in the Union.
[537] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: "5G for Europe: An Action Plan"

- BEREC's publications on mobile coverage[538] and spectrum authorisations and award procedures including coverage obligations[539];
- RSPG opinions and reports, and in particular the joint BEREC and RSPG joint report on facilitating mobile connectivity in "challenge areas"[540] and the RSPG Report on Efficient Awards and Efficient Use of Spectrum[541]; and
- the use of coverage obligations elsewhere[542].

8.40 In addition, ComReg is also mindful of the new "connectivity" general objective (and related recitals) in the new EECC:

- *"Promoting connectivity and access to, and take-up of, very high capacity networks, including fixed, mobile and wireless networks, by all citizens and businesses of the Union"* (Article 3(2)(a))
- where *"…that connectivity objective translates, on the one hand, into aiming for the highest capacity networks and services* ***economically sustainable*** *in a given area, and, on the other, into pursuing territorial cohesion, in the sense of convergence in capacity available in different area"* (Recital 23 – ***emphasis added***); and
- *"Ensuring widespread connectivity in each Member State is essential for economic and social development, participation in public life and social and territorial cohesion. As connectivity and the use of electronic communications become an integral element to European society and welfare, Member States should strive to ensure Union-wide wireless broadband coverage. Such coverage should be achieved by relying on the imposition by Member States of appropriate coverage requirements, which should be adapted to each area served and* ***limited to proportionate burdens*** *in order not to hinder deployment by service providers."* (Recital 109 – ***emphasis added***).

Relevant national information

8.41 ComReg's consideration of coverage obligations as set out in this section is mindful of and is informed by the following national information:

[538] BOR (18) 237: BEREC Common Position on information to consumers on mobile coverage,
[539] BOR (18) 235 BEREC Report on practices on spectrum authorization and award procedures and on coverage obligations with a view to considering their suitability to 5G
[540] Document RSPG18-001
[541] Document RSPG16-004 FINAL
[542] Information on the coverage obligations used elsewhere in Europe is available from Cullen International (a pay subscription website)

- MPBT - Focus Group Report on Mobile Coverage[543] which established a focus group to provide guidance with respect to categories of location where high quality reliable mobile coverage should be made available as a priority. The focus group determined that the services available on a mobile phone at the categories of locations should be mobile voice calls, text messages and basic data connectivity, such as web browsing; and

- The respondents views to Document 18/60, where two respondents (Nera and Eir) commented on coverage:

    - Eir believes that encouraging more mobile coverage in rural areas will be an important factor to take into account when considering the appropriate format for a Proposed Award and queries whether the objectives of the potential award process will be informed by the Government's Mobile Phone and Broadband Taskforce; and

    - Nera believes that symmetric coverage obligations set at "precautionary" levels which can be achieved commercially should not distort bidding. It cautions against the setting of onerous obligations to a sub-set of licences, which then sell a discount to unencumbered spectrum. Instead it states that there are better solutions, for example, having a further auction stage in which operators compete in a reverse auction to reduce their payments for spectrum in return for committing to non-commercial coverage targets in specified geographic areas.

8.4.3 The 700 MHz band is considered separately to other spectrum bands.

8.42 It is widely accepted[544] that, when targeting the provision of a good quality of service over wide areas, sub 1 GHz bands that have favourable propagation characteristics should be used.

8.43 Of the proposed bands in the award, the 700 MHz band is best suited for this purpose and this is acknowledged in the EU Parliament & Council decision[545] and 700 MHz EC Decision[546].

8.44 By comparison, the other Proposed Bands have propagation characteristics

[543] MPBT - Focus Group Report on Mobile Coverage
[544] Many respondents (including Three, ESBN and Viatel) to Document 14/101 acknowledged the differences in propagation characteristics between sub 1 GHz bands (i.e. the 700 MHz) and higher frequency bands (including the 2.3 and 2.6 GHz Bands proposed at that time) that are used for capacity.
[545] Recitals 2, 4, 9 and Article 3 (1).
[546] Recitals 2, 3,

where the propagation losses due to terrain, buildings, trees etc. are greater than sub 1 GHz bands and as such are typically more suited[547]:

- to support additional capacity to mobile devices over relatively short distances; and,
- to provide connections to rooftop locations over wider areas where near line of sight can be obtained.

8.45 In light of the above and noting the difference in how the 700 MHz band would be used versus the 2.1 GHz, 2.3 GHz and 2.6 GHz bands (termed the "Performance Bands"), the coverage and rollout obligations for the 700 MHz Band is considered separately to that of the Performance Bands.

8.46 The next sections are set out as follows

- In relation to the 700 MHz Band
  - Key questions in setting any coverage obligation
  - Options for any coverage obligation
  - Details of the coverage obligations
- In relation to the Capacity / Performance Bands
  - Key questions in setting any coverage / rollout obligation
  - Options for any coverage / rollout obligation
  - Detail of the coverage / rollout obligation

8.47 Following this a summary of the proposed coverage and rollout obligations are set out.

8.4.4 700 MHz Duplex - key questions in setting an obligation

8.48 Set out below are three key questions that need to be considered in establishing an appropriate coverage obligation, these are informed by and have particular regard to material from the Connectivity Studies. For instance, and as noted by DotEcon "*coverage interventions need to be designed with some evaluation of the likely benefits to society of various alternative ways of extending coverage to ensure that overall net benefits (i.e. benefits less costs) are maximised*".[548]

8.49 These key questions are as follows::

[547] Further ComReg has set out the distinctions between coverage and Performance Bands in the Spectrum Bands for Award RIA in Chapter 4.

[548] Coverage obligations and spectrum awards a report from DotEcon Ltd, published November 2018, p19. (Document 18/103d)

A. If a coverage obligation should apply, whether it should be on a geographic or population basis;

B. In light of A, whether any coverage obligation should also include an indoor coverage dimension; and

C. In light of A and B, whether any minimum speed (e.g. expressed in terms of Mbit/s) should apply to any such obligation/s.

A. Geographic or Population Coverage

8.50 By way of background ComReg notes that national coverage obligations can be divided into two categories:

1. **Geographic coverage**: where the licensee is required to cover a percentage of the geographic area - measured in terms of the % square area (km) of the State.
2. **Population coverage**: where the licensee is required to cover a percentage of the population - typically measured in terms of household population that have access to a specified service.

8.51 Geographic coverage obligations have the advantage of providing coverage beyond those areas where households are located, such as roads and where people work or spend leisure time. However, unless targeted at specific locations or categories of areas, the effects of a geographical coverage obligation may be difficult to predict as it is not clear how a requirement to cover a particular geographical area might translate into the proportion of the population consequentially served. Further, while some geographic areas may require connectivity (e.g. where the population is located or transits) other areas may not (e.g. forestry or mountainous regions), and obliging coverage in the latter could result in inefficient infrastructure investment that would be better targeted at other areas of the network where connectivity is more likely to be required/utilised.

8.52 Population coverage obligations normally target areas where people live. Population obligations have the advantage of providing coverage where people spend most of their time, whether at or near their house or at work places close to houses.

8.53 Ireland is one of the most rural counties in Europe and as discussed below the costs of achieving widespread geographic mobile coverage are particularly high in Ireland, owing to its highly distributed and rural populations. For example:

- Ireland's population density of 69.3 people per km^2 is considerably lower than the EU28 average of 117.5 people per km[549];
- Ireland's low population density of 70 people per km^2 falls to just 27 people per km^2 in the rural areas;
- 37% of the population lives in rural areas;
- 3% of the population lives in 28% of the total land area;
- 70% of the population lives in 3% of the total land area;
- 76% of the total landmass is forestry or farmland;
- 72% of the Irish population live in NUTS 3[550] areas that are defined as predominantly rural areas. By contrast, across the EU as a whole only 22% of the population live in areas that are defined as rural regions; and
- 71.8% of houses in rural areas are categorised as one-off houses[551].

8.54 The above factors illustrate the challenges Ireland's demographics pose to network deployment as the number of users per base station varies significantly depending on where it is located. In particular, there are certain areas that are unlikely to be commercially viable and such areas may have large costs associated with same.

8.55 To better understand the feasibility of enhancing the connectivity of mobile networks in Ireland, ComReg commissioned Oxera[552] to estimate the cost, number of new sites[553] and rollout time[554] that an average existing mobile operator would require in order to extend the provision of a MBB service from current coverage levels.

8.56 Oxera assessed different types of coverage including the costs of providing population and geographic coverage.

[549] Source Eurostat, 'Population density' 2016.
[550] The Nomenclature of Territorial Units for Statistics (NUTS) were created by Eurostat in order to define territorial units for the production of regional statistics across the European Union. NUTS 3 refers to the latest iteration of those regions. There are 8 NUTS 3 regions in Ireland. Each NUTS-3 region is classified as predominantly rural, intermediate or predominantly urban based on certain thresholds of population size and density.
[551] http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?Maintable=E1063&Planguage=0
[552] https://www.comreg.ie/publication/future-mobile-connectivity-in-ireland/ (Document 18/103c)
[553] Based on licensing information it is estimated that Irish MNOs currently have circa 2000 to 2500 sites in each of their networks, the majority of which are co-located.
[554] The network rollout time is based on a CADR of 2.5% for new sites. This is calculated from the historical site licensing date of Irish MNOs. This means that a network of 2,000 sites would add 50 new sites in a year, while a network of 2,400 sites would add 60 new sites in a year.

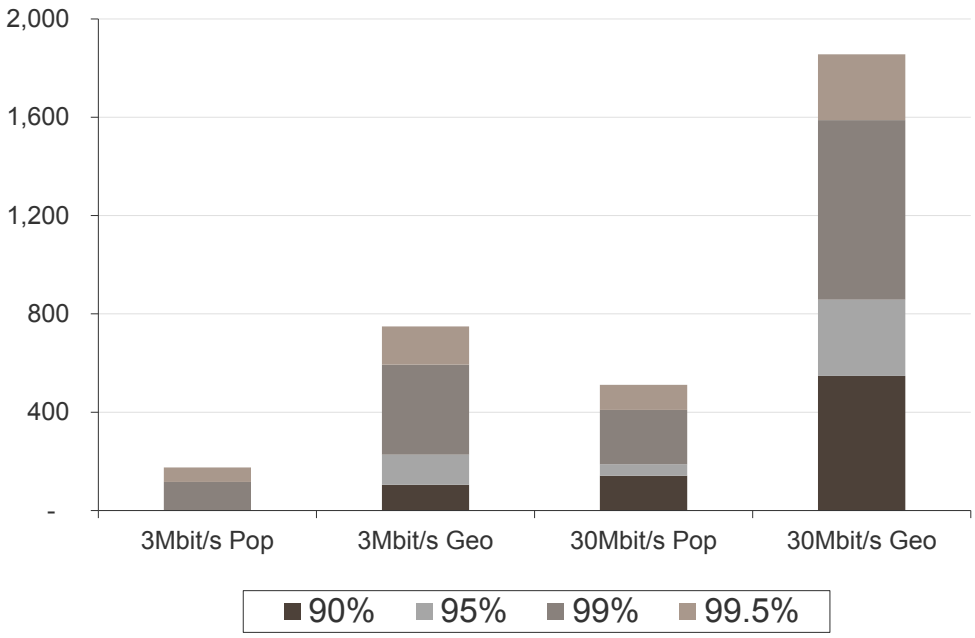

Figure 12: Estimated cost of achieving population or geographic coverage (€m, 2017 monies), Oxera

8.57 In summary, Oxera found that targeting high levels of geographic coverage is significantly more costly than targeting population coverage[555]. Figure 12 above illustrates the difference in estimated cost associated with geographic and population coverage showing that targeting geographic population is between 3 (99%) and 5 (95%) times greater. For example[556] :

- achieving 90% geographic coverage (€548 million) is around 4 times more costly than targeting 90% population coverage (€142 million);
- achieving 95% geographic coverage (€858 million) is around 4.5 times more costly than targeting 95% population coverage (€188 million); and
- achieving 99.5% geographic coverage (€1,860 million) is around 3.6 times more costly than targeting 99.5% population coverage (€511 million).

8.58 Further, as noted by DotEcon and Frontier, a consumers' willingness to pay is not aligned with the cost of increasing coverage, with just 12% willing to pay more for incremental geographic coverage. The average willingness to pay for incremental coverage was an extra €2.17 (7%) and €1.98 (6%) per month for additional voice and data coverage respectively[557]. Therefore, DotEcon

[555] Focused geographic interventions are more likely to cost effective where focussed on specific areas such as road coverage, as they create additional coverage where it is likely to be useful.
[556] The target coverage is where a single user at a cell edge can obtain 30Mbit/s download.
[557] Mobile Consumer Experience Survey 2017 – Slide 7.

observes[558] that, at some point, increasing coverage is not an effective competitive strategy, as the higher price needed to sustain this discourages more consumers than the coverage improvement gains.

8.59 In addition, ComReg observes that the Oxera findings for a geographic rollout[559] would require 5,910 new three-sector sites (of which 313 of these would be in challenging terrain) and 1,252 carrier upgrades to existing sites. For this 10 year rollout, Oxera assume a network roll-out Compound Annual Growth Rate ("CAGR") of 19.96% (from mid-2020) which Oxera note is 'unachievable' given that the current rollout rate of 2.5%. To achieve this rollout with the current rollout rate of 2.5%, Oxera note that this would require a time period to after 2070. Therefore, full geographic coverage is unlikely to emerge due to both time and cost considerations. Also, even assuming that spectrum rights are assigned and an operator could overcome time and cost considerations, the cost of providing such coverage levels (estimated at €1.9 bn – see Figure 12 above) would likely be passed onto end-consumers in any event.

8.60 In light of its findings, Oxera recommends that coverage obligations **should not be designed with a focus on providing ubiquitous geographic coverage** as this would be extremely costly. Instead, **coverage obligations should be population-focused primarily** where people live, but also consider where people work, transit and commute, and places of interest.

8.61 Population coverage obligations normally target areas where people live, and have the advantage of providing coverage where people spend most of their time, whether at or near their house or at work places close to houses. For example, on average, workers live within 15 km of their place of work[560] and typically move from rural to urban areas during the day (e.g. there is a net migration of around 170,000 workers to urban areas during the day)[561]. Further, where a population obligation is targeted at residential addresses, it will incidentally cover areas around or between those addresses such as places of work and leisure, roads and farmland. Even when targeting population, an outdoor base station transmitting in a particular band (e.g. 700 MHz) will cover a certain geographic area regardless of the population within that area[562].

[558] Section 3.2.1 of Document 18/103d - https://www.comreg.ie/publication/coverage-obligations-and-spectrum-awards/
[559] ComReg Document 18/103c, scenario 4 results
[560] https://www.cso.ie/en/releasesandpublications/ep/p-cp6ci/p6cii/p6td/
[561] https://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?MainTable=E6034&TabStrip=Select&PLanguage=0&FF=1
[562] The area covered will depend on factors such as the topography and the particular radio frequency,

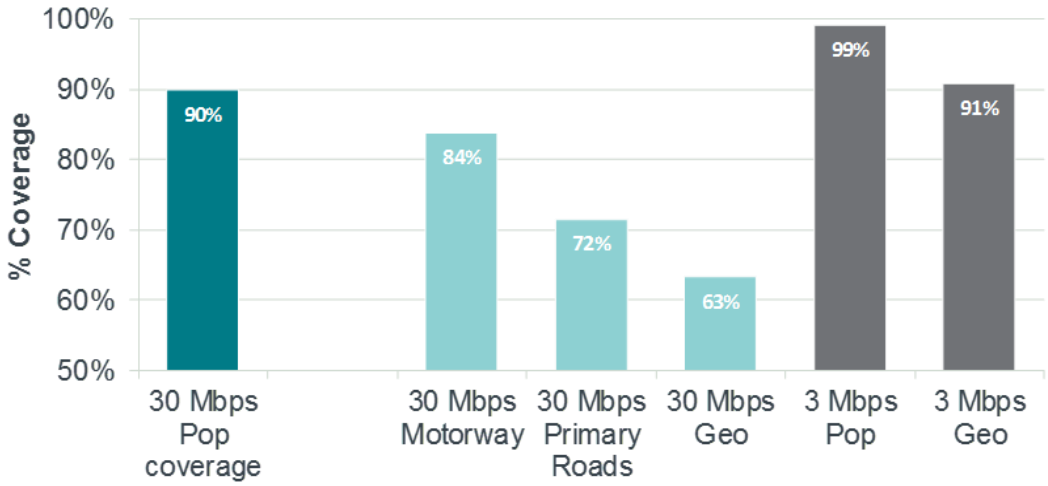

Figure 13: Incidental 30Mbit/s coverage from 30Mbit/s population coverage, Oxera[563]

8.62 As shown in Figure 13 above, targeting population coverage also leads to incidental geographic coverage and road coverage. For example, if an MNO rolls out a network to achieve 90% population coverage, it will (simply by virtue of where people live) incidentally achieve geographic coverage of around 60% with the same speed, and over 90% geographic coverage at a lower speed (3 Mbit/s). Further, population coverage can be obtained at a substantially lower cost and is likely to be more commercially attractive as consumers are more likely to be concerned with coverage where they are likely to be rather than where they are not.

8.63 Finally, as noted by DotEcon, a high geographical coverage requirement is unlikely to be effective, as it provides an incentive to provide coverage in areas that are cheap to serve on a per km^2 basis, rather than where users would benefit most. This may create perverse incentives, as it could encourage deployment in large areas that can be covered cheaply (e.g. hill tops) which may in fact be where people don't live, work or travel.

8.64 In light of the above, ComReg is of the preliminary view that a "coverage" obligation should **focus upon population coverage.**

B. Indoor or outdoor coverage

8.65 Indoor coverage obligations would require a licensee to provide coverage of a particular standard inside buildings.

8.66 It has become more challenging to obtain a reliable direct connection between a device inside a building and a mobile network base station. All building materials reduce the strength of signals to some extent, but modern buildings,

563 Source: ComReg Document 18/103c

that are designed to minimise heat loss by using certain types of insulation, were understood to increase the signal loss. With this in mind, ComReg has quantified the effects of some representative modern building materials on indoor radio signal performance.[564] In particular, ComReg's research found that:

- Different types of window could lead to between 15 dB and 45 dB power loss compared to the reference.
- Across all insulation materials tested (shown in Section 4.2 of the building material testing report), there was between 15 and 60 dB additional power loss compared to the reference loss.[565]
- The block materials tested (shown in Section 4.3 of the building material testing report) predominantly exhibited 5 dB of attenuation compared to the reference result, with the exception of cavity blocks, which caused an additional 25 dB of attenuation compared to free space.

8.67 The main drawback of attempting to set an indoor obligation is that due to variations in construction materials and building design (e.g. number of rooms and storeys), there is no guarantee that a good outdoor mobile signal will be ever able to effectively penetrate inside buildings and even between all rooms within a single building. For example, where a good outdoor signal is present the user experience could vary substantially inside adjacent but different buildings, particularly where a house uses a greater amount of the efficient insulation materials. In effect, an indoor coverage obligation might provide a good service for one house but not another even where both could be in close proximity to each other. A mobile operator might satisfy an additional dB margin on its outdoor coverage, however some houses may still not have sufficient reception indoors and this is to be expected if the thermal insulation installed is performing to expectations.

8.68 In order for an indoor obligation to be effective and meaningful in the longer term, it would need to be set at a level capable of ensuring sufficient reception in buildings with high levels of insulation, given such requirements for new buildings and incentives for homeowners to install such materials in existing homes.[566] This would likely require operators to densify their networks significantly – but without any certainty that such densification would be

[564] ComReg document 18/73, The Effect of Building Materials on Indoor Mobile Performance, August 2018.
[565] Of all the insulation materials surveyed, Polyiso Rigid Foam products tended to exhibit the worst radio attenuation characteristics
[566] For example, the 2012 Energy Efficiency Directive ("EED") requires EU Member States to set up energy efficiency schemes. Ireland's scheme - known as "Better Energy Homes" – provides grants to support households adopt more environmentally friendly materials. The Irish government has supported this policy by updating its Building Regulations for all newly constructed houses.

effective in all, or the majority of situations.

8.69 Further, indoor obligations are difficult to accurately measure and would require access to buildings and 'backpack' mounted equipment. As a result, indoor coverage obligations are typically approximated by an outdoor drive test. This is done by estimating an additional margin[567] depending on how much indoor coverage is required (i.e. external wall, multiple indoor walls). However, as noted by Oxera, mobile signal indoors can vary significantly between buildings and even between rooms within a single building, thus making it impractical to estimate a loss that would accurately reflect indoor reception.[568]

8.70 In light of the real and practical obstacles, the Connectivity Studies do not recommend the use of indoor coverage obligations for an outdoor mobile network. For example:

- DotEcon notes that "it is not feasible to expect to address indoor coverage problems by setting tougher requirements on outdoor signal levels or extending the geographical area where outdoor services must be available; this is unlikely to be a successful or sustainable solution."[569]
- Oxera notes that "the provision of indoor mobile connectivity can be promoted through complementary solutions other than mobile network roll-out, for example through Wi-Fi calling or mobile repeaters."[570]
- Frontier notes that "providing guaranteed indoor connectivity using mobile networks is not practical or effective since mobile signal performance will vary."[571]

8.71 ComReg observes however that that there are good solutions for indoor connectivity including the use of :

i. Wi-Fi and native Wi-Fi calling on a fixed broadband connection; and

ii. licence-exempt mobile phone repeaters.

[567] Indoor coverage is not measured in Ireland. The BEREC and RSPG joint report on Facilitating mobile connectivity in "challenge areas" (BoR (17) 256) notes that in other countries, the additional margin used varies from 6 dB (Romania) to 20dB (Austria). The same report also notes that modern energy efficient buildings or windows may attenuate radio signals up to 40 dB, when conventional building attenuation is 15 – 20 dB.
[568] Future Mobile Connectivity in Ireland - a report (Document 18/103c) from Oxera Consulting LLP ("Oxera"), with Real Wireless Ltd – p7, p3.
[569] Coverage obligations and spectrum awards a report from DotEcon Ltd, Document 18/103d – p9.
[570] Future Mobile Connectivity in Ireland - a report (Document 18/103c) from Oxera Consulting LLP ("Oxera"), with Real Wireless Ltd – p7.
[571] Meeting Consumers' Connectivity Needs" – a report (Document 18/103b) - p45.

Native Wi-Fi

8.72 Native Wi-Fi is a service that can be provided by MNOs which makes it possible for consumers to make/receive phone calls and text messages from their native Wi-Fi enabled mobile phone using an available Wi-Fi connection, rather than going through the mobile network directly. This can be particularly suitable to providing indoor connectivity where the mobile network coverage is not sufficient indoors.

8.73 Eir[572] was the first operator offering Native Wi-Fi calling where all of its plans currently being sold can avail of this[573], with Vodafone announcing in March[574] this year that it has also enabled Wi-Fi calling on its network and. Vodafone has indicated plans to launch a voice over Wi-Fi ("VoWiFi") service[575].

8.74 Not all consumers can currently benefit from Native Wi-Fi because:

- Not all MNOs/MVNOs offer Native Wi-Fi as part of their mobile service offering;
- In addition, certain consumers do not yet have a Native Wi-Fi enabled phone. For example, 22% of all mobile phones are 3 years old or more, rising to 34% in more rural areas.[576] Many of the earlier phones are unlikely to be Native Wi-Fi enabled.[577]
- Certain consumers, particularly rural consumers, may not currently have an internet connection sufficient to benefit from Native Wi-Fi calling regardless of operator or handset availability; and
- Certain consumers may not have access to the internet at all. For example, 11% of households do not have internet access (of which 40% claim to not need internet access[578]) but may still require a mobile voice service indoors.

8.75 These factors are likely to become less relevant over time (although certain

[572] https://www.eir.ie/wificalling/
[573] https://www.eir.ie/wificalling "*All eir Mobile plans currently being sold can avail of WiFi Calling*"
[574] https://www.siliconrepublic.com/comms/volte-vodafone-voice-over-4g-wi-fi-5g
[575] https://www.siliconrepublic.com/comms/vodafone-voice-lte-wifi
[576] Slide 34, Document 17/100a
[577] For example, certain models on the Apple or Android platforms are not Wi-Fi calling enabled. For example, to use Wi-Fi Calling using the Apple platform an iPhone 5c or later is required on a supported Mobile Operator.
https://support.apple.com/en-ie/HT203032
[578] CSO Information Society Statistics – Households 2018.

households may never avail of internet access[579]) because:

- the NBP aims to deliver high speed broadband services to all businesses and households in Ireland at a minimum speed of 30Mbit/s download and 6Mbit/s upload.[580]

- over the same period, the natural replacement cycle of phones should allow most consumers to be able to benefit from Native Wi-Fi.

8.76 In the meantime, the use of mobile phone repeaters is likely to be of benefit to those consumers who face indoor mobile connectivity issues and cannot avail of Native Wi-Fi.[581]

8.77 Given the benefits to consumers from the provision of Native Wi-Fi ComReg sets out in section 8.4.11 below a proposed condition on any rights of use issued on foot of the Proposed Award to be that if a mobile voice service is provided to a licensee's customers (which would include any provided to third party customers by a licensee, for example in the case of MVNO arrangements) then it must also provide Native Wi-Fi.

Mobile phone repeaters

8.78 For premises that do not yet have a fixed broadband connection, and where there are still difficulties in obtaining indoor mobile connectivity, the use of a mobile phone repeater offers a viable solution. These act to strengthen the mobile signals that are received indoors by amplifying signals between a mobile phone and a network operator's base station. In July last year, ComReg cleared the use of mobile phone repeaters with specific technical characteristics in Ireland[582], meaning that consumers can now purchase and install such repeaters themselves regardless of their service provider. Information on these devices is provided on the ComReg website[583]. Figure 14 below provides information on Mobile Repeaters

[579] CSO Information Society Statistics – Households 2018. For example, 40% of those without access claim "*not to need internet*".
[580] https://www.dccae.gov.ie/en-ie/communications/topics/Broadband/national-broadband-plan/high-speed-broadband-map/Pages/Interactive-Map.aspx
[581] https://www.comreg.ie/consumer-information/mobile-phone/mobile-phone-repeaters/
[582] Wireless Telegraph Act 1926 (Section 3) (Exemption of Mobile Phone Repeaters) Order 2018, S.I. 238 of 2018
[583] https://www.comreg.ie/consumer-information/mobile-phone/mobile-phone-repeaters/

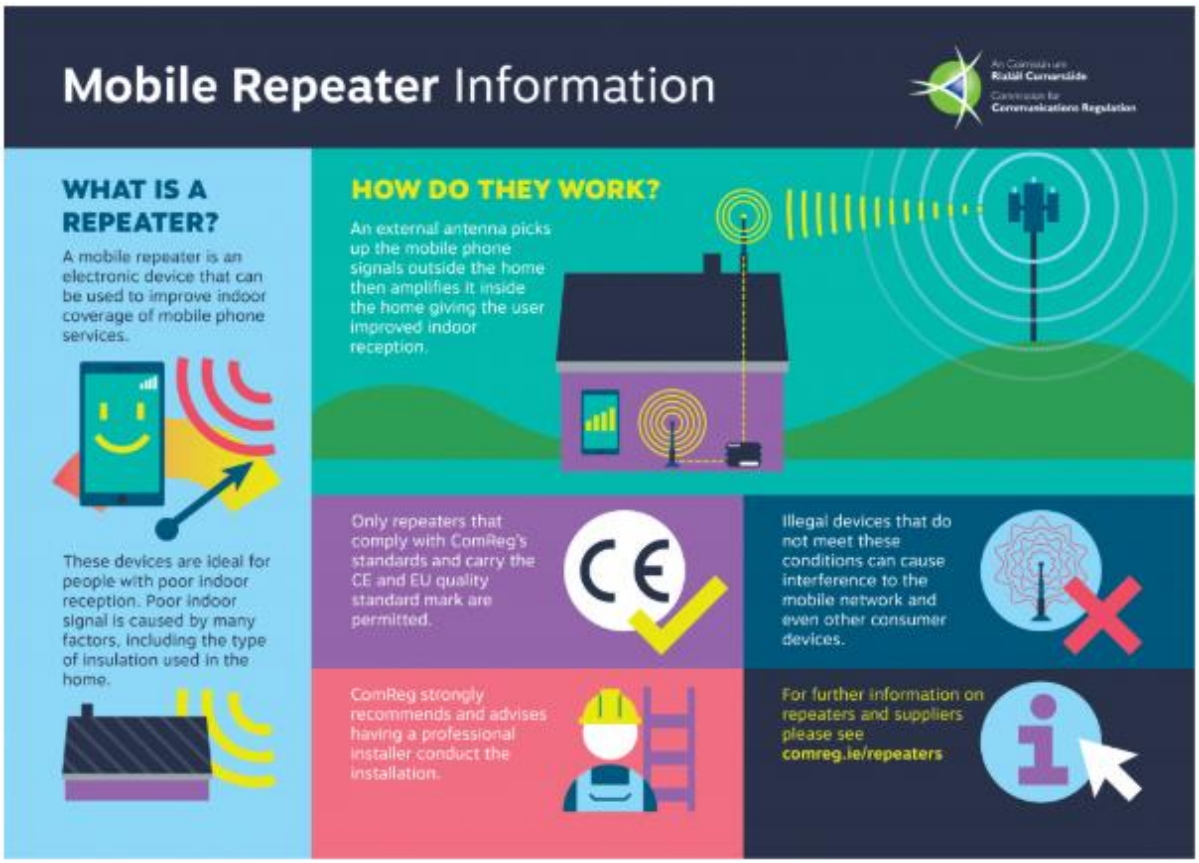

Figure 14: Mobile Repeater Information

Summary

8.79 In summary, indoor connectivity (voice and data) can largely be provided through fixed networks supplemented with the use of mobile phone repeaters where relevant. This allows mobile networks to improve the connectivity experience where consumers cannot easily access fixed networks (e.g. typically outside of the home and work). For example, mobile phones or smartphones were used to access the internet away from home or work by 85% of individuals in 2018, either via the mobile phone network and/or a wireless network. The most common form of accessing the internet by mobile phone or smartphone when away from home or work was via the mobile phone network (72%), access via a wireless network (such as Wi-Fi) was 60%.[584]

8.80 In light of the above, ComReg is of the preliminary view that a coverage obligation should focus on **outdoor coverage only.**

C. Quality of service

8.81 As noted earlier, it was a condition of each licence arising from the 2012 MBSA award to achieve and maintain a minimum coverage obligation of 70%

[584] Information Society Statistics (CSO) – Households 2018

population. This coverage, as measured in ComReg's drive test, represents the ability to place a call at a specific location; at a specific time; and using a standard handset.

8.82 In light of the significantly increased use of data services, and the likelihood that voice services will be provided over data in the future (e.g. with VoLTE), ComReg is of the preliminary view that in order to be effective, any proposed coverage obligation would need to apply to data services. The importance of the 700 MHz band for data services is recognised in the 700 MHz EC Decision which notes that the 700 MHz band should be used for the provision of terrestrial wireless broadband electronic communications services to meet the increasing demand for wireless data traffic and is a valuable asset for deploying cost-efficient terrestrial wireless networks with high capacity coverage.

8.83 Voice calls also remains an important use for consumers with 96% using their mobile phone to make traditional voice calls using telephone numbers. Further, use of traditional mobile voice minutes has increased by around 15% (or 400,000 minutes per quarter) since the 2012 MBSA despite the increased availability of OTT applications such as Skype and WhatsApp. Therefore, any data standard should, at a minimum, also provide for the ability to place a call. In that regard, while Oxera did not explicitly model a voice service, a 0.2 Mbit/s data rate is used as a proxy for a voice service which means that a 3 Mbit/s data rate would provide for the ability to place a call.[585]

8.84 Oxera identified and modelled the following data rates[586]:

- 3 Mbit/s – which effectively represents a minimum mobile data rate;
- 30 Mbit/s – which represents the target data rate for 2020 (as set out in Article 6 the EU Decision 243/2012/EU (the RSPP Decision)); and
- 50 Mbit/s – which represents a higher data rate.

3 Mbit/s

8.85 While a 3 Mbit/s obligation would provide for the ability for consumers to place a call, ComReg does not believe such a low level would be appropriate in present circumstances given, among other things:

- A 3 Mbit/s rate would not achieve the target speed and quality objectives identified in the RSPP Decision (as referenced in Article 3(1) of EU Decision (EU)2017/899 for the 700 MHz band);

[585] See Table 4.4 of Document 18/103c. https://www.comreg.ie/publication/future-mobile-connectivity-in-ireland/
[586] For the purposes of the model this represented a single user at cell edge.

- Operators are already likely to be providing at least 3 Mbit/s to high levels of population. For example, Oxera's modelling suggests that a "synthetic" operator in 2017 would be providing a 3 Mbit/s service to around 97% of the population[587];

- Oxera's modelling also suggests that such a synthetic MNO could more cost effectively target a significantly larger proportion of the population with improved quality of service (e.g. 30 Mbit/s), compared to extending 3 Mbit/s coverage to the remaining 2-3% population; and

- Oxera considers that from mid-2020, the commercial extension of mobile networks is likely to switch to a focus on extending higher-speed connectivity (e.g. minimum 30 Mbit/s population coverage).

30 Mbit/s or 50 Mbit/s

8.86 The assignment of 700 MHz rights would allow MNOs to use Carrier Aggregation across the three sub 1 GHz bands[588] - a key feature enabled via the ETSI/3GPP standardisation process that will reduce the cost and facilitate the deployment of high-speed connectivity across wide areas[589]. Oxera advises that the assignment of the 700 MHz band and Carrier Aggregation reduces the cost of providing coverage (as site upgrades cost less than building new sites)[590]. This allows the upgrading of existing sites to provide speeds in excess of 3 Mbit/s at substantially lower costs than building new sites.

8.87 However, a quality of service obligation of 50 Mbit/s is unlikely to be appropriate for a number of reasons including:

[587] The network cost modelling takes a hypothetical synthetic MNO, which is based on a blend of sites from existing Irish MNOs. This provides a representative picture of coverage at a generic level. To estimate the likely costs associated with different deployment scenarios for future mobile connectivity services, Oxera developed a mobile network cost model for a synthetic mobile network that represents an 'average' mobile network in Ireland. The synthetic network is based on Irish MNO data from 2017, (i.e. licensed site numbers, site locations, and licensed frequency bands). The licensed site information from the Three network was not considered as it was going through a network consolidation, at the time of modelling and its licensed site information was likely to change given this consolidation.
[588] ETSI TS 136 101 (Release 15)
[589] Carrier aggregation is used in LTE-Advanced in order to increase the bandwidth, and thereby increase the bitrate.
[590] Oxera identify that the additional costs that would be incurred by an existing operator who did not have access to the 700 MHz band would be in the range of €20 to €55 million, with a base value of €34.5 million. To put these values in context, the Oxera Report advises that mobile operators have annual Capex investments of €80m - €96m of which around €8m – €19m is used to improve mobile coverage.

- the higher target speed requires more network infrastructure increasing the costs of deployment and the rollout time required as a higher number of sites are required to deliver that speed at cell edge;
    - For example, to reach 81% population coverage (30 Mbit/s) requires 35 additional sites and 397 upgrades and would take two years. Alternatively, to reach the same population coverage for 50 Mbit/s would require 288 sites and 1088 upgrades.[591]
- it may not be economically sustainable to impose a 50 Mbit/s requirement. The Oxera Report found that increasing the target speed from 30 Mbit/s to 50 Mbit/s has a very material effect on costs[592].
- a significantly longer rollout period would be required for 50 Mbit/s given the higher number of sites that would need to be deployed compared to 30 Mbit/s.

8.88 Alternatively, a 30 Mbit/s obligation is likely to be appropriate for the purpose of setting a coverage obligation for the following reasons.

- It takes account of the need to achieve the target speed and quality objectives set out in Article 6(1) of Decision No 243/2012/EU;
- It would appear to be economically viable given the availability of carrier aggregation and 700 MHz rights of use.
- Targeting 30 Mbit/s would result in significant incidental 50 Mbit/s speed for a significant proportion of the population[593]. For example, a 90% population coverage requirement at 30 Mbit/s would result in 74% of Ireland's population getting speeds of 50 Mbit/s. [594]

8.89 As noted by DotEcon, it is important that coverage obligations are not overambitious in terms of the bandwidth requirements, as this will greatly increase costs for little additional benefit. In particular, DotEcon notes that mobile coverage obligations should not be seeking to replicate the speeds and consumer experience deliverable over fixed broadband (which will increasingly use fibre over the timeframes being considered). Speed targets such as 30 Mbit/s will support many useful services, include growing demand for machine-to-machine communication, and also support voice.[595]

8.90 Therefore, ComReg is of the preliminary view that the proposed outdoor

[591] Document 18/103c
[592] See Annex 3.10 of ComReg Document 18/103c, Scenario 9: 50Mbit/s population coverage.
[593] Other parts of the cell area closer to the base station will likely have a higher throughput rate.
[594] Source Document 18/103c, Scenario 2.
[595] Coverage obligations and spectrum awards a report from DotEcon Ltd, Document 18/103d – Section 2.5.2.

population coverage should primarily focus on **a minimum data rate of 30 Mbit/s for a single user at cell edge.**

8.91 Notwithstanding the above, ComReg also recognises that there can be circumstances where it would not appropriate to apply a 30 Mbit/s coverage obligation to the spectrum rights won. For example, in the case of a new entrant only winning rights in the 700 MHz band, or an existing MNO only winning 2×5 MHz in the 700 MHz band. In such instances, lower data rates would apply, as set out below in ComReg's proposals.

Outdoor voice service issues

8.92 As noted above, the main outdoor service issues across all types of consumers (rural and urban) relate to voice calls. The outdoor population coverage options below would provide for voice coverage. However, because voice services are currently provided over GSM and UMTS (i.e. 2G and 3G networks) it is not clear whether a population coverage obligation at a rate of 30 Mbit/s would necessarily improve the quality of service for voice calls to any material degree.

8.93 Investments in 2G and 3G have matured and any additional investments are likely to be targeted at 4G/5G networks. Investment in 2G/3G technologies to improve voice services would likely be inefficient given operators are likely to begin transitioning to 4G/5G networks over a period of time. Further, any obligation to improve voice services delivered over 2G/3G networks would not likely be proportionate given the availability of alternative more efficient measures to achieve the same ends.

Voice over LTE (VoLTE)

8.94 The deployment of VoLTE which is a technology that allows a voice call to be placed over an LTE network would likely improve voice services[596] for consumers and would be consistent with operator's investments in 4G/5G services.

8.95 VoLTE[597] should improve consumer's mobile voice experience in a number of ways.

[596] For example 4G.co.uk identify that it can provide superior voice quality, improved coverage and connectivity, better battery life and video calling, https://www.4g.co.uk/what-is-volte/

[597] VoLTE is a voice service based on operator's network while OTT services are provided by OTT operators and are independently managed. The data streams in (OTT) voice applications are not differentiated from other IP data traffic. Alternatively, VoLTE operates as a native application in the user's device, providing priority over other data streams to deliver higher quality of service.

- It connect calls much faster than a traditional GSM or UMTS technologies (i.e. the latency on LTE is lower than GSM and UMTS allowing calls to connect quicker.)

- It supports higher quality calls by providing enhanced HD voice services improving the quality of voice calls beyond the narrowband voice and HD voice services currently deployed on existing 2G and 3G networks.[598]

- Subscribers will have the flexibility to make calls and use 4G mobile data services simultaneously without compromising 4G data connectivity speed.[599]

- VoLTE is available across a wide variety of handsets. For example, there are 1,973 devices in GSA's database which support VoLTE technology, of which nearly 90% are phones.[600]

8.96 Similarly, VoLTE is also likely to provide benefits to MNOs. For example:

- The deployment of VoLTE would release additional spectrum for LTE services after the transition from 2G/3G services which are currently essential in the provision of voice services.

- VoLTE also provides greater spectral efficiency and capacity compared with conventional circuit-switched calls over legacy 2G and 3G networks. VoLTE has up to three times more voice and data capacity than 3G UMTS and up to six times more than 2G GSM.[601]

- It can provide operational savings for operators as it can run all services (voice and data) across the same infrastructure compared to having one for data and one for voice.[602] [603]

8.97 For these reasons, operators have already begun to roll out VoLTE. For example

[598] https://www.ericsson.com/en/news/2016/6/enhanced-hd-voice-for-volte-launched-by-t-mobile-and-ericsson
[599] https://www.ericsson.com/tz/sv/press-releases/5/etisalat-misr-and-ericsson-launch-egypts-first-voice-over-lte-volte-services
[600] GSA, February 2019, VoLTE and ViLTE: Global Market Update
[601] Document 17/70r,'Market Review Fixed Voice Call Termination and Mobile Voice Call Termination', published 2 November 2017.
[602] https://www2.deloitte.com/ie/en/pages/technology-media-and-telecommunications/articles/tmt-pred16-telecomm-volte-vowifi-capacity-reach-capability.html
[603] Network standards like UMTS open a dedicated channel between nodes to handle voice, text and data, in a technique called "circuit switching. VoLTE works over IP-based networks and supports packet switching which allows users to equally share bandwidth resources rather than dedicated channels.

- A total of 253 operators worldwide are investing in VoLTE in 113 countries, including 184 operators with commercially launched VoLTE-HD voice service in 87 countries, up from 137 operators in 65 countries 12 months ago.[604]

- Vodafone recently announced the rollout of VoLTE across the entire country [605] following trials in 2017[606].

- Eir also announced that it intends to rollout VoLTE services.[607]

8.98 In light of the above, ComReg, in section 8.4.11 below, proposes a condition on any rights of use issued on foot of the Proposed Award to be that if the rights holder has deployed LTE and a mobile voice service is offered on its network to a licensee's customers (which would include any provided to third party customers by a licensee, for example in the case of MVNO arrangements) then it must also provide VoLTE .

8.4.5 700 MHz Duplex –the preferred coverage obligation ranges

8.99 In this section ComReg:

- first outlines the high level regulatory options assessed when considering the coverage obligation ranges to apply to the spectrum rights in the 700 MHz Band. This is informed by, amongst other things, the preceding discussion and its draft Coverage RIA on same as set out in Annex 7; and

- then sets outs its preferred coverage obligation range option.

8.100 As set out above, in establishing a coverage obligation, ComReg is of the preliminary view that :

- a coverage obligation should **focus on delivering coverage to the population** rather than a focus on geographic or area coverage;

- there are good solutions for providing indoor coverage (i.e. Native Wi-Fi and mobile phone repeaters) and as such a coverage obligation should **focus on outdoor coverage only**; and

[604] Source: www.gsacom.com
[605] https://www.siliconrepublic.com/comms/volte-vodafone-voice-over-4g-wi-fi-5g
[606] https://www.independent.ie/business/technology/vodafone-switches-on-volte-service-on-its-network-35973395.html
[607] https://www.siliconrepublic.com/comms/huawei-eir

- in terms of the quality of service the proposed outdoor population coverage should primarily focus on **a minimum data rate of 30 Mbit/s for a single user at cell edge.**

8.101 In that regard, any option considered below incorporates the above three points. ComReg's draft RIA on the application of a coverage obligation to the rights of use in the 700 MHz band is set out in Annex 7 and it identifies the following options for consideration:

- **Option 1 -** Impose no coverage obligation.
    - This would mean that all licensees would have full flexibility to choose how extensive their rollout would be regardless of the amount of spectrum rights of use it was assigned in the 700 MHz Duplex. For example, a licensee could choose to provide no services, only to provide services in high density areas, or choose to differentiate itself as a provider with an extensive network footprint.
- **Option 2 -** Impose a coverage obligation which would require a licensee with 700 MHz Duplex rights of use to provide a minimum level of coverage sufficient to serve between 70% to 90% of the population, together with a minimum data rate of 30 Mbit/s for a single user at cell edge. Option 2 is informed by, among other things:
    - that, in the 2012 MBSA, a 70% coverage obligation was considered necessary given, among other things, there was no guarantee that market forces alone would ensure the efficient use of spectrum and that this level would prevent cherry picking (such as in densely populated areas)[608]; and
    - Oxera's view that operators providing coverage of 90% population at 30 Mbit/s appears likely even if no coverage obligation were set.
- **Option 3 -** Impose a coverage obligation which would require a licensee with 700 MHz Duplex rights of use to provide a minimum level of coverage to serve between 90% to 95% of the population, together with a minimum data rate of 30 Mbit/s for a single user at cell edge.
    - This option is informed by Oxera's view that such a coverage obligation would appear feasible for an existing MNO to meet.
- **Option 4 -** Impose a coverage obligation which would require a licensee with 700 MHz Duplex rights of use to provide a minimum level of coverage

[608] 70% of the population corresponds cities and towns including towns under 500 population but with at least 50 inhabited houses.

to serve 95 – 99.5% of the population, together with a minimum data rate of 30 Mbit/s for a single user at cell edge.

- This option would provide high speed services to very high levels of the population.

8.102 Each of the above options are symmetric such that all 700 MHz licensees are required to meet the same minimum coverage targets under the same conditions

8.103 The draft Coverage RIA analyses the above options considering the impact on stakeholders, competition and consumers in line with ComReg's framework for regulatory impact assessments. ComReg notes that it intends to further develop this draft Coverage RIA in light of feedback from all stakeholders to this consultation.

8.104 The full assessment is set out in Annex 7, however in summary, the assessment identifies that more than one preferred option may be necessary to account for the particular circumstances that might arise in the Proposed Award. In particular, an obligation suitable for MNOs would likely be excessive for new entrants. In that regard, ComReg is of the preliminary view that a preferred option is required for (i) existing MNOs, and (ii) new entrants.

8.105 In this regard, and for the reasons set out in the Draft Coverage RIA, ComReg's preferred coverage obligation option for:

- existing MNOs is Option 3 - a minimum level of coverage to serve between 90% to 95% of the population, together with a minimum data rate of 30 Mbit/s for a single user at cell edge; and

- new entrants is Option 2 - a minimum level of coverage sufficient to serve between 70% to 90% of the population, together with a minimum data rate of 30 Mbit/s for a single user at cell edge.

8.106 Before setting out further details on the specifics of each coverage obligation and the associated rollout timelines, ComReg notes DotEcon's advice on precautionary and interventionist coverage obligations.

Precautionary and Interventionist coverage obligations

8.107 The DotEcon 'Coverage and Spectrum Awards' Report identifies two types of coverage obligations.

- precautionary coverage obligations, where the obligations do not exceed the levels of coverage that might be expected anyway from well-functioning competition between network operators;

- interventionist coverage obligations, which can be expected to constrain the commercial choices of network operators and force coverage in excess of competitively determined levels.

8.108 ComReg notes that the preferred coverage option for existing MNO's (Option 3) likely corresponds to a precautionary coverage obligation whereby actual commercial coverage delivered is likely to exceed the obligation. Alternatively, Option 4 likely corresponds to an interventionist coverage obligation where commercial coverage would not likely exceed the obligation and operators would incur a cost for providing the additional coverage (i.e. the difference between what would have been provided commercially and the interventionist obligation). As noted above, setting an interventionist obligation as part of the assignment process could lead to the inefficient assignment of the radio spectrum and cause distortions to competition. It could also represent poor value for money in the procurement of coverage.

8.109 In that regard, DotEcon outlines a number of options for procuring coverage beyond what would be provided commercially. Similar to the approach taken in Chapter 5, it is not proposed to fully repeat DotEcon's discussion and analysis of these options here. Rather, stakeholders are again encouraged to review these options as set out in the DotEcon report (18/103d). However, in summary, DotEcon make a number of observations.

- Bundling spectrum and interventionist coverage obligations into coverage lots creates a number of risks, including:
    - not assigning spectrum if coverage obligations have been set too harshly and coverage lots go unsold.
    - foregoing the option for the State not to award the coverage obligation if it cannot get value for money for the coverage extension being procured.
- A reasonable estimate of the external value of a coverage improvement should be the State's maximum willingness to pay for the coverage extension[609].
- Where operators have existing spectrum holdings capable of providing coverage (i.e. existing 800 MHz and 900 MHz rights of use), there may be options to procure the interventionist coverage obligation separately from this award;

[609] See Section 4.2.2 of Document 18/103d - https://www.comreg.ie/publication/coverage-obligations-and-spectrum-awards/

- It would be inefficient to procure a coverage increment if its cost (which is directly reflected in the reduced auction revenue) exceeds the external benefit achieved from the coverage obligation;

- Having the option not to award a coverage obligation is a useful tool for ensuring that value for money is achieved, especially if there is a danger that competition to serve the coverage obligation might be weak.

8.110 In relation to 'interventionist' coverage obligations to secure more extensive coverage outcomes than would result from marketplace competition alone, ComReg observes that there may be broader social reasons that would support such an approach and that these would need to be carefully designed, and based on an assessment of the costs and benefits to society of the additional coverage sought.

8.111 ComReg further observes that 'interventionist' obligations are ideally achieved via a sequential step in a spectrum award or through a separate process. Such mechanisms may provide advantages for the State in ensuring that the societal benefits obtained exceed the costs of any such obligations. The use of a separate process would also allow policy makers the ability to identify what 'precautionary' coverage obligations and competition between network operators would first deliver, retaining the ability for more targeted interventions later if necessary.

8.4.6 700 MHz Duplex – ComReg's coverage obligations proposals

8.112 Taking the preferred coverage obligation ranges for existing MNOs and new entrants as discussed above, and as assessed in the draft Coverage RIA, this section sets out ComReg's proposed coverage obligations for 700 MHz Duplex rights.

Obligations applicable to existing MNOs

8.113 In this section, ComReg sets out:

- its proposed coverage obligation) and rollout timing for covering population percentage and other coverage dimensions percentage; and

- its proposed coverage obligation at specific locations.

Existing MNOs: Coverage obligation and rollout timing

8.114 As discussed above, and as assessed in the draft Coverage RIA, ComReg's preferred coverage obligation option for existing MNOs is Option 3 which identifies the appropriate obligation to be within the range 90 - 95% population for a 30 Mbit/s mobile broadband service.

8.115 As set out in the draft Coverage RIA, a key factor informing the preferred option is the Oxera Report which modelled the levels of coverage for a synthetic network in different scenarios. For the existing MNO's, Oxera's Scenario 2 is the relevant scenario corresponding to a **target coverage of 30 Mbit/s mobile broadband population coverage**.

8.116 While ComReg is aware that coverage and rollout of existing MNOs may differ to that of the synthetic network modelled in Oxera Scenario 2, applying the detailed results from Oxera's Scenario 2 (see Figure A3.5 of the Oxera Report) provides information for ComReg's proposed obligation.

8.117 Specifically, using the new site build CAGR of 2.5% which is reflective of typical rollout rate for MNOs, and assuming that an existing MNO obtains 2×10 MHz of 700 MHz spectrum rights, the results of Oxera's Scenario 2 identifies that it would be possible to achieve 30 Mbit/s single user throughput at cell edge:

- for 90% population by November 2024 and
- for 95 % population by September 2027.

8.118 Applying the above information to a coverage and rollout obligation, and assuming that 700 MHz spectrum rights becomes available in mid-2020, ComReg proposes the following coverage population percentage obligation for 30 Mbit/s single user throughput at cell edge, namely to achieve:

- 85% population in 3 years;
- 92% population in 5 years, and;
- 95% population in 7 years.

8.119 When targeting 30 Mbit/s population coverage, the results of the Oxera's Scenario 2 (see section 5.2.3 of the Oxera Connectivity Report) also indicates that significant 'incidental' coverage is also achieved on other coverage dimensions. For example, the Oxera Report identifies that with 95% population coverage (30 Mbit/s) the 'incidental' coverage achieved is :

- 99.3% population coverage (3 Mbit/s);
- 92% geographic coverage (3 Mbit/s)
- 90.4% motorway coverage (30 Mbit/s);
- 81.7% primary road coverage (30 Mbit/s);

8.120 Considering that this coverage will be provided incidentally when delivering the obligation of 30 Mbit/s 95% population coverage, ComReg is of the preliminary

view that this 'incidental' coverage should also be included in the proposed coverage obligation.

8.121 In the same way as the 30 Mbit/s 95% population obligation is to be delivered at different stages across 7 years, the incidental coverage obligations will apply in stages. ComReg therefore proposes the following coverage obligation (see Table 17) for an existing MNO who wins 2×10 MHz (or more) of spectrum in the 700 MHz band.

8.122 The coverage obligation below, can be met using any spectrum bands available to the existing MNO.

Table 17: 700 MHz (2×10 MHz) Coverage Obligation - Existing MNO

Outdoor Coverage Service (Single User Throughput Cell Edge)	Coverage dimension	Coverage level to be met in:			Source of data
		3 Years	5 Years	7 years	Oxera/Real Wireless Study - Document 18/103c
30 Mbit/s	Population	85%	92%	95%	Scenario 2 results
30 Mbit/s	Motorways	75%	85%	90%	Scenario 2 results
30 Mbit/s	Primary Roads	60%	75%	80%	Scenario 2 results
3 Mbit/s	Population	99%	99%	99%	Scenario 2 results
3 Mbit/s	Geographic area	90%	91%	92%	Scenario 2 results

Existing MNO only wins 2×5 MHz in the 700 MHz Duplex

8.123 An assumption that informs the Oxera Scenario 2 results is that the spectrum portfolio which assumes that 2×10 MHz of 700 MHz rights is available to the synthetic MNO, alongside 2×10 MHz in the 800 MHz and 900 MHz bands. This spectrum portfolio would allow three band sub 1 GHz carrier aggregation to be deployed, using 2×10 MHz in the 700, 800 and 900 MHz bands.

8.124 The benefit of this is that carrier aggregation can be a useful feature to provide a better throughput and coverage over a given area. This is illustrated in Figure A2.5 of the Oxera Report (Document 18/103c) where for given range the throughput can be increased by implementing carrier aggregation.

8.125 In light of this, and noting that an existing MNO may only obtain 2×5 MHz of spectrum in the 700 MHz Duplex, ComReg proposes that in this scenario, the first three rows of the coverage obligation set out in Table 17 above would be amended to replace the 30 Mbit/s throughput with a 20 Mbit/s throughput.

Existing MNOs: Coverage obligation at specific locations

8.126 As noted in the background and context section above, the MPBT in its report of December 2016 identifies a wide range of issues impacting on broadband and mobile services and established 40 actions aimed at accelerating the delivery of telecoms infrastructure by Commercial operators and also at facilitating the rollout of the State led Intervention under the NBP.

8.127 In particular, Action Point 40 of the report called for a review and recommendations to address the issue of blackspots. Following this Action Point, a focus group[610] was established '*to provide guidance with respect to categories of location where high quality reliable mobile coverage should be made available as priority.'* In doing so, the focus group was to *'take account of the increase in consumer expectations to have high quality, reliable mobile coverage in these locations'*.

8.128 The Focus Group Report[611]:

- tabled a ranked list of categories of locations (see Figure 15 below) where high quality mobile coverage should be available; and
- recommended that mobile voice telephone calls, text messaging and basic data activity such as web searches and browsing, should be available on a mobile phone at each of these categories of locations.

[610] The Focus Group comprised delegates from Government Departments (Department of Communications, Climate Action and Environment, Department of Rural and Community Development, Department of Transport, Tourism, and Sport and Department of Housing, Planning and Local Government), Government Agencies (Industrial Development Authority, Enterprise Ireland, The Agriculture and Food Development Authority, The Health Services Executive and Transport Infrastructure Ireland), and Local Authorities.
[611] MPBT - Focus Group Report on Mobile Coverage

Output of Task Force – Ranked list of Categories of location	
TOTAL SCORE	**CATEGORIES**
223	Industrial Estate, Hospital, Higher Education Campus
216	High numbers of persons working
205	High density of persons living
203	Sports Club, Library, Garda Station/Crisis Co-ordination centre
202	Medium numbers of persons working
201	Post office, School, Tourist attraction information point
197	Medium density of persons living
197	Low density of persons living
194	Motorways and busy Primary roads
181	Slack Primary roads, Regional and Local roads, Rail lines
179	Low numbers of persons working
177	Cycleway, Leisure walkways, Hillwalking routes

Figure 15: Ranked list of location categories identified by the MBPT Focus Group

8.129 It was the intention of the Focus Group that its output

> *"… should influence the actions of the mobile network operators in their work to reduce mobile phone blackspots. It will inform policy in the Department of Communications, Climate Action and Environment in respect of priorities for mobile phone services.* ***It should be considered by the Commission for Communications Regulation (ComReg) in its future spectrum allocation strategies.****"(****emphasis added****)*

8.130 In considering the above, ComReg notes, firstly, that in order to ensure that any coverage obligation at a specific location remains precautionary, rather than interventionist (as identified by DotEcon in Document 18/103d and described above), ComReg should identify areas that a MNO would likely provide service in a functioning competitive market and secondly that for this to be effective and reliable it needs to be from a competent authoritative source.

8.131 In relation to the first point, ComReg has considered the analysis of the Focus

Group where it, in broad terms,[612] identifies that the categories of locations consist of locations where (i) people live and work, (ii) strategic community points/ places where things happen and (ii) transient and commuting areas.

8.132 In relation points (i) and (ii) ComReg notes that the proposed coverage and rollout obligation for existing MNOs as set out in Table 17 will to a large extent address where people work, live and the strategic points/places where things happen, however ComReg notes that there may be some locations that may not be directly captured, for example, industrial estates, hospitals, higher education campuses and tourist attraction information points.

8.133 ComReg notes that these locations are either a high or medium priority in the categories of locations identified in the Focus Group.

8.134 In relation to point (iii), ComReg notes that the coverage obligation to provide service to motorway and primary road coverage will to a large extent serve to address transient and commuter areas, save along rail lines, cycleways, leisure walkways and hillwalking routes.

8.135 In relation to providing service to rail lines, cycleways, leisure walkways and hillwalking routes, the Focus Group list these areas as the lowest priority in terms of the requirement to provide mobile voice and data services.

- In relation to rail the Focus Group identify that *"…more people travel by road than rail, noting that bus/coach travel contributes to this effect*". Further ComReg also notes that the rail line owners and operators are likely to be best placed in providing solutions for in rail carriage connectivity[613].

- In relation to cycleways, leisure walkways and hillwalking routes, ComReg notes that providing comprehensive coverage of these areas would likely be beyond the coverage that a MNO would deliver in a functioning competitive market, as these areas would typically be in rural / mountainous areas which, as identified in the Oxera report, are areas that are very costly to serve. Further these are areas which have challenges in deploying infrastructure as identified by the MPBT.

8.136 Therefore, ComReg does not propose identifying cycleways, leisure walkways and hillwalking routes locations as ones that should be considered in a potential coverage obligation.

8.137 However, considering that the Focus Group identifies transient and commuter areas in general as a priority and that the main transport corridors being

[612] Informed by Table 1 of the Focus Group Report
[613] https://railway-news.com/why-rail-operators-must-get-on-board-with-mobile-coverage-solutions/

motorways and primary roads capture this to a large extent, ComReg notes key elements of transient and commuter areas would consist of transport and commuter hubs, specifically air and sea ports along with train and bus stations.

8.138 In light of the above, ComReg proposes that existing MNOs who win 700 MHz rights of use would be obliged to provide coverage at specific locations as detailed below. The proposed obligation would be to provide outdoor 30 Mbit/s single user throughput coverage at the following categories of location as defined by the relevant competent authority and listed in Annex 8.

- **Business and Technology Parks (including Strategic Sites):** the IDA provides a list of 31 Business and Technology Parks and 9 Strategic Sites
- **Hospitals:** the Health Service Executive (HSE) provides a list of 48 public hospitals and 17 private hospitals
- **Higher Education Campuses**: the Higher Education Authority (HEA) provides a list of 8 Universities, 11 Institutes of Technology and 5 Other Colleges
- **Ports (Air and Sea):** The Department of Transport, Tourism and Sports (DTTAS) provides a list of 7 airports and the Irish Maritime Development Office (IMDO) provides a list of 7 passenger seaports
- **Principal Bus Stations:** Bus Éireann provides a list of the main 16 bus stations
- **Train Stations: T**he National Transport Authority (NTA) provides a list of 144 train stations
- **Visitor Attraction – Information Centres:** Fáilte Ireland provides a list of the top 21 fee charging and top 21 free of charge visitor attractions[614]

8.139 The names and locations of the above specific locations are as set out in Annex 8.

8.140 From analysing the current mobile coverage of the existing MNOs, ComReg observes that some level of coverage (either 2G, 3G or 4G) is available at the majority of the locations identified above. Noting the findings of the Oxera Report which suggest that MNO's will likely target upgrading their networks to provide a better quality of service (30 Mbit/s) and noting that some of the locations are remote, ComReg observes that it will take time for an existing MNO to deploy 30 Mbit/s coverage at some of these locations. Therefore in

[614] By visitor numbers in 2017.

establishing a rollout time period for the provision of a 30 Mbit/s service at these locations, ComReg proposes that for each of the above categories as follows:

- 75% of the specific locations would have coverage within 3 years
- 90% of the specific locations would have coverage within 5 years
- 100% of the specific locations would have coverage within 7 years.

8.141 This 7 year obligation aligns with the earlier obligation to deliver 30 Mbit/s population coverage to 95% population.

Obligations applicable to new entrants

8.142 As discussed above, and as assessed in the draft Coverage RIA, ComReg's preferred coverage obligation option for new entrants is Option 2 which identifies the appropriate obligation to be within the range 70 - 90% population for a 30 Mbit/s mobile broadband service.

8.143 As set out in the draft Coverage RIA, a key factor informing the preferred option is the Oxera Report which modelled the levels of coverage for a synthetic network in different scenarios. For a new entrant, Scenario 8 is the relevant scenario corresponding to a **target coverage of 30 Mbit/s mobile broadband population coverage**.

8.144 While ComReg is aware that coverage and rollout of a new entrant may differ to that modelled in Oxera Scenario 8, applying the detailed results from Oxera's Scenario 8 (see section A3.9 of the Oxera Report) provides information for ComReg's proposed obligation.

8.145 The Oxera Report identifies two network evolution scenarios:

- moderate—1084 macrosites within 3 years and 9 months; 1,882 macrosites in the first 14 years (a similar network size to current incumbent MNOs); a network roll-out CAGR of 2.5% afterwards;
- aggressive—1084 macrosites within 3 years and 9 months; a network rollout CAGR of 17.8% thereafter.

8.146 This is depicted in Figure A3.9 of the Oxera Report (Document 18/103c) where in the moderate case a new entrant would achieve 30 Mbit/s to 75 % of the population in approximately 2 years, 85% of the population in approximately 5 years and 90 % of the population in approximately 9 years. In light of this and noting that:

- the obligation to apply to a new entrant should ensure that the spectrum is efficiently utilised;

- consumers are offered a competitive service;
- a new entrant will have a significant outlay of costs in rolling out a network from a zero base, and;
- obligations should not deter a credible new entrant.

ComReg is of the view that an appropriate obligation for a new entrant would be reflective of a more moderate rollout as modelled by Oxera, and be somewhat relaxed with an aim to provide the right incentive for new entry.

8.147 An assumption that informs Oxera's Scenario 8 results is the new entrant has 2×10 MHz of spectrum in the 700 MHz band as well as 2×20 MHz of spectrum in the 2.6 GHz Band (a Performance Band). With this spectrum portfolio, Oxera models the rollout of the new entrant's network utilising carrier aggregation between the 700 MHz and the 2.6 GHz band.

8.148 As noted earlier, the benefit of this is that carrier aggregation can be a useful feature to provide a better throughput over a given area. This is illustrated in Figure A2.5 of the Oxera Report where for given range the throughput and coverage can be increased by implementing carrier aggregation.

8.149 Noting that Oxera's scenario 8 results are dependent upon the amount of spectrum that a new entrant would win (both in the 700 MHz and the Performance Bands), ComReg proposes the coverage obligation for a new entrant (see Table 18 below) would vary depending upon the amount of spectrum rights won by the new entrant.

Table 18: 700 MHz Coverage Obligation – New Entrant

Spectrum won	Outdoor Coverage Service (Single User Throughput Cell Edge)	Coverage dimension	Coverage level to be met		
			4 Years	6 Years	10 years
700 MHz (2×10 MHz) + 2×20 MHz in Performance Bands	30 Mbit/s	**Population**	75%	80%	90%
700 MHz (2×10 MHz)	20 Mbit/s				
700 MHz (2×5 MHz)	10 Mbit/s				

8.4.7 700 MHz Duplex - Measuring and monitoring the coverage obligation

8.150 As identified above, one of the key inputs informing the establishment of the coverage obligation is the modelling conducted by Oxera / Real wireless in the Document 18/103c.

8.151 Oxera /Real Wireless identify that in estimating the additional mobile network infrastructure and costs, the mobile network cost model uses the single user throughput (SUTP) at cell edge for the targeted service in a lightly loaded network as the basis for determining the coverage of a macrosite.

8.152 SUTP is defined as the downlink bit rate that can be successfully delivered to a single active user per cell at a particular depth and consistency of coverage. This is the downlink bit rate or download speed that a user could experience when not contending with other users for service in that cell, so that the cell delivers the maximum possible data rate to a single user consistent with the signal quality experienced by that user

8.153 As set out above, ComReg proposes throughput obligations for single user throughput (SUTP) at different levels (e.g. 3 Mbit/s, 10 Mbit/s, 20 Mbit/s and 30 Mbit/s) depending on the particulars of the obligation.

Information relevant in measuring and monitoring the coverage obligation

8.154 ComReg sets out below relevant information available that would inform it of how to measure and monitor coverage obligations, in particular:

- ECC Report 256 (17 October 2016) – LTE coverage Measurements;
- BEREC Common Position on information to consumers on mobile coverage BOR 18 (237) [615];
- Previous approaches used by ComReg in assessing compliance with coverage obligations;
- Approaches used in other member states;
- The analysis and modelling conducted by Oxera/Real Wireless in Document 18/103c; and;
- Information from national sources such as for example ComReg's Outdoor Coverage Map.

[615] BOR (18) 237: BEREC Common Position on information to consumers on mobile coverage,

8.155 The ECC Report 256 and BEREC reports provide guidance on the methods of measuring and monitoring a coverage obligation and in particular there are a number of items included that are relevant and will inform ComReg considering the specific objectives of this award aiming to achieve a certain throughput in a connection.

General approach in assessing compliance with coverage obligation

8.156 ECC Report 256 gives an overview of different approaches of determining LTE coverage and identifies that the coverage can be determined by various methods. These include previously used approaches such as the use of direct measurements techniques, verifying coverage level predictions from operators and more recent techniques such as crowd sourcing. The report notes that in every method assumptions need to be made to balance the accuracy and effort and that each administration needs to find a well-balanced method in determining a coverage level.

8.157 The BEREC report, looked at the approaches taken in Member States in providing information to consumers on mobile coverage. In gathering this it surveyed member states on the various approaches which included information on the approaches for determining compliance with coverage obligations.

8.158 The report recommends that NRA's should base coverage estimation (numerical data or maps) on coverage calculations/predictions, whenever it is not economically or technically possible to carry out field measurements of the whole country. It also notes that theoretical or prediction based mobile coverage information is the only known methodology that enables NRA's to derive an estimate of mobile coverage over the entire countries landmass. It also notes that the reliability of the coverage information should be verified where appropriate by field measurements.

8.159 ComReg calculates the outdoor coverage of each of the mobile operators for 2G, 3G and 4G technologies and this is made available on the ComReg website. This is a useful tool in depicting the coverage of operators across the entire state and is in line with the BEREC recommendations. In light of this **ComReg proposes that the Outdoor Coverage Map supported by field measurements where appropriate be a key component in assessing compliance with the coverage obligations.**

The appropriate metric to use

8.160 Acknowledging that future 5G networks will be rolled out over time, LTE technology is expected to continue to be used by operators in delivering data to consumers for some time. Also information on the abilities of LTE is well established.

8.161 While there are a number of parameters to consider[616] the BEREC report and ECC Report 256 identify that the relevant metric for measuring signal power for LTE is the Reference Signal Received Power (RSRP). Of the 22 countries identified in the BEREC report as using predictions tools 18 define thresholds for RSRP. Oxera in Document 18/103c uses RSRP to predict the LTE coverage level and ComReg currently uses RSRP in displaying coverage on its Outdoor Coverage map. In light of the above **ComReg proposes to use a RSRP metric for determining the coverage levels of an LTE network.**

The appropriate RSRP level

8.162 In developing the appropriate level it is worth considering the approaches from taken in other Member States.

8.163 In 2015, the NRA[617] in Germany established an obligation aimed at determining a desired throughput level where the base RSRP was linked to an LTE carrier deployed in 10 MHz bandwidth. In meeting the obligation the RSRP was lowered as the bandwidth of the LTE carrier increased[618].

8.164 When modelling the expansion of a network, Oxera in Document 18/103c, takes a comparable approach. The distinction being in the Irish context that the effective bandwidth available to a user could be increased through aggregating carriers from other sub 1 GHz bands, for example increasing the downlink bandwidth from single carrier (10 MHz) to dual carrier (20 MHz) to three carrier (30 MHz) aggregation. The result being for a given throughput (e.g. 30 Mbit/s SUTP) the coverage range is extended from each site by introducing multi band carrier aggregation. This is illustrated in Figure 16 below extracted from the

[616] The key measurement parameters outlined in ECC Report 256 which are employed to determine mobile broadband service are;

- **Field Strength and Received Signal Level** which can be measured with a standard field strength meter, the electric field strength is represented in dBµV/m
- **RSRP (Reference Signal Received Power)** which is defined as the linear average of the reference signal power (in W) within a number of specific resource elements across a specified bandwidth. LTE specific equipment is required to decode the LTE downlink signal to make this measurement
- **CQI (Channel Quality Indicator).** This is an information field that the UE sends to the base station to indicate a suitable downlink transmission rate. Again an LTE enabled UE handset is required to measure this value
- **Throughput (or bitrate)** which is commonly expressed in Megabits per second is the most important network performance indicator from the user perspective and as such will be a part of any coverage condition applied by ComReg to this proposed award.

[617] Bundesnetzagentur (BNetza)

[618] https://berec.europa.eu/eng/document_register/subject_matter/berec/regulatory_best_practices/common_approaches_positions/8315-berec-common-position-on-information-to-consumers-on-mobile-coverage

Oxera Report (Document 18/103c) for different scenarios.

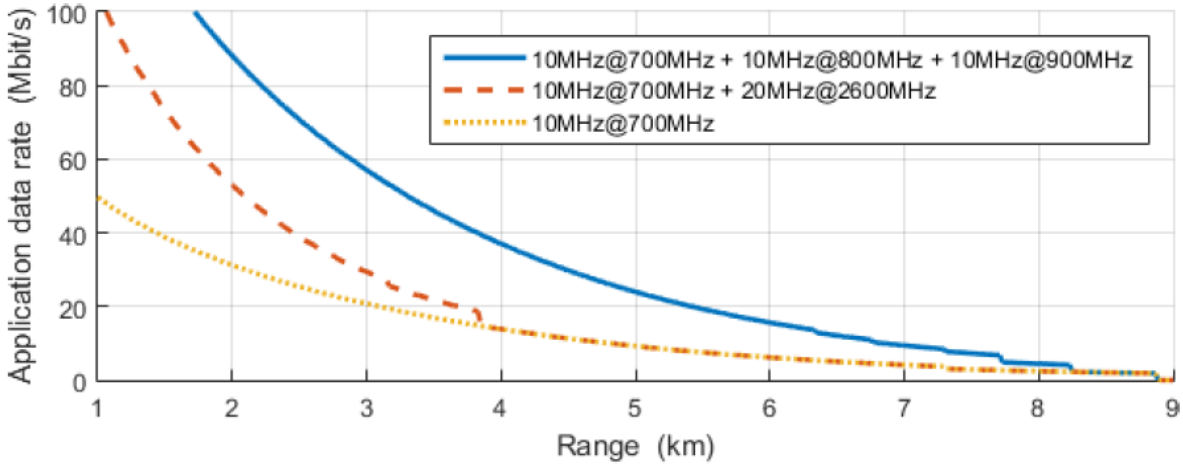

Figure 16: Figure A2.5 of the Document 18/103c – indicative range expected in rural terrain for different spectrum combinations

8.165 In the UK as part of their award of 700MHz and 3.6-3.8GHz spectrum Ofcom is proposing that an RSRP signal strength of -105dBm or better would be required to obtain a connection speed of at least 2 Mbit/s. Note that this 2Mbit/s is qualified as being in a loaded cell, distinct from 30 Mbit/s single user throughput obligation proposed in section 8.4.6 and modelled by Oxera/Real Wireless.

8.166 Taking a broader look, the BEREC report identifies the RSRP levels used by the Member States where the level of -110 dBm is most commonly used. However ComReg notes that the throughput obligations established by operators previously were more targeted at basic connections. As ComReg proposes, in the higher case, obligations to deliver 30 Mbit/s SUTP, a higher RSRP may be more appropriate.

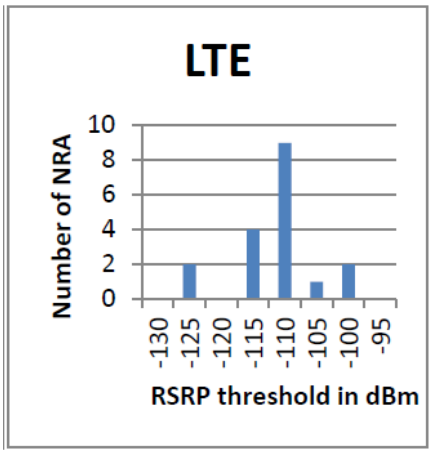

Figure 17: Number of NRA's using given thresholds for LTE – BEREC report

8.167 The Oxera Report provides the estimated coverage of the synthetic network in

2017 and this is presented in Table 4.3 of Document 18/103c. As identified by Oxera, these levels are predicted using a single carrier of 10 MHz in the downlink.

8.168 Comparing the 30 Mbit/s SUTP levels modelled by Oxera to the ComReg Outdoor Coverage Map which also models a 10 MHz carrier in the downlink, ComReg notes that, in general terms, the above levels are achieved by the three MNO's when modelling approximately -95 dBm. Noting that inevitably there will be individual variance of the above between operators.

8.169 The proposed coverage obligations, as set out in section 8.4.6, are consistent with the recommendations of Oxera of what is possible for an operator to deliver commercially with obtaining new spectrum in the 700 MHz Band. In particular, Oxera note that a commercial operator would likely wish to invest in improving 30 Mbit/s population coverage, given the higher potential returns to investment in 30Mbit/s (see Section 5.5.1 of Document 18/103c). Oxera note that improving 30Mbit/s population coverage through upgrading sites and additional available spectrum (rather than having to build new sites) means that the initial incremental cost of improving coverage from its starting position of 62.4% is low.

8.170 Informed by Oxera' Report amongst other things, ComReg intends to establish an obligation that aims to incentivise operators to upgrade sites with additional spectrum, make use of improvements in technology such as new standards including carrier aggregation and carrier sharing or extension techniques.

8.171 How the above techniques are deployed on a network will yield varying benefits in terms of increasing the range of a cell for a given throughput, however ComReg envisages that the techniques will be those used to expand throughput coverage.

8.172 Considering the above and comparing the coverage levels of the Oxera Report, and the Outdoor Coverage Map, ComReg proposes to establish a RSRP base level of -95dBm as a proxy for a 30 Mbit/s SUTP level for a 10 MHz downlink carrier. Where capacity increasing techniques are used such as carrier aggregation and/ or deploying additional bandwidth, a lower RSRP value can be used.

8.173 While further considerations are needed in this regard, ComReg notes that by carrier aggregating an additional 10 MHz could result in approximately 5- 10dB lower RSRP when targeting a given throughput.

8.174 ComReg will also identify an RSRP level for the other throughput levels identified in section 8.4.6, specifically 20 Mbit/s, 10 Mbit/s and 3 Mbit/s but notes that these will be relative to the -95dBm per 10 MHz downlink level identified

above and as such will be at lower levels.

8.175 ComReg also notes that the assessment of compliance with the coverage obligation may take into account a number of other actors, including

- drive test measurements could be used to assess compliance with the measurement for certain metrics, e.g. roads, population or to verify the modelling conducted by ComReg
- that as new technologies are rolled out, ComReg would consider how this could influence meeting the coverage obligations.

8.176 ComReg proposes to consider this matter further in advance of its response to consultation and draft decision and welcomes views at this juncture.

8.4.8 Performance Bands - key questions in setting an obligation

8.177 In this section ComReg sets out the key questions in setting an obligation to rights awarded in the 2.1 GHz, 2.3 GHz and 2.6 GHz Bands (the "Performance Bands[619]"). In doing so, it is informed by, amongst other things, the discussion and information set out in sections 8.4.1, 8.4.2 and 8.4.3 above.

8.178 Prior to setting out the regulatory options for the Performance Bands, ComReg assesses what type of coverage/rollout obligation (if any) is necessary to ensure the efficient use of the Performance Bands and avoid incentives to hoard spectrum without putting it into use. Each of the bands could be suitable for a number of different uses which would likely require different levels of infrastructure and network rollout. In that regard, ComReg is cognisant that the extent of rollout will be different depending on how the spectrum is used. For example, setting a rollout obligation on the basis of the spectrum being used for mobile services could have the undesired effect of discouraging deployment of other services whose networks are planned differently.

8.179 ComReg assesses the following key questions to consider in setting out any Performance Band coverage/rollout obligation:

- **First**, what are the potential uses for the Performance Bands;
- **Second,** what type of obligation (i.e. population or base station rollout) is more appropriate, and;

[619] As noted in the draft 'Spectrum for Award' RIA these bands are typically used for capacity on mobile networks but provide coverage and capacity for fixed wireless networks. For the remainder of this draft RIA these bands are collectively referred to as the 'Performance Bands'

- **Third,** whether a symmetric or asymmetric coverage obligation would be required given the different potential uses and the different position of existing operators to new entrants.

Potential uses of the Performance Bands

8.180 ComReg notes that there are a number of likely potential uses for the Performance Bands. The responses to Document 18/60 and the draft 'Spectrum for Award' RIA (Chapter 4) identified at least three potential use types. These are mobile, fixed wireless and small cell use.

8.181 In relation to **mobile services** all the MNOs are of the view that the Performance Bands are suitable for mobile services[620]. In using the Performance Bands for mobile services, similar to the use of the 1800 MHz and 2.1 GHz bands MNOs are likely to using existing sites in order to provide additional mobile capacity and/or coverage, for example where the Performance Bands would be used in carried aggregation with a sub 1 GHz band. Furthermore, in relation to mobile services:

- The 2.1 GHz Band is an established mobile band that has been used to provide UMTS services in Ireland since 2002. Further, it has been rolled out across circa 60 LTE/LTE advanced networks worldwide. [621]

- The 2.6 GHz Band is a well-established band in Europe for MFCN/ECS and is a major mobile capacity / Performance Band in 164 LTE/LTE advanced networks worldwide.[622]

- The 2.3 GHz band is also a mobile capacity band and is rolled out across 50 LTE/LTE advanced networks worldwide.[623]

8.182 In relation to **Fixed Wireless** services, there may be particular interest in LTE-TDD rights of use, as Fixed Wireless services are already provided on a TDD basis in the 3.6 GHz Band[624]. Further, in response to Document 18/60, Imagine[625] observes that all the Performance Bands are suitable for Fixed Wireless.

[620] ComReg notes that while Eir would prefer that the 2.3 GHz Band is not included in the Proposed Award as it is not currently harmonised by the European Commission, it did not dispute the LTE equipment availability in this band. See Chapter 3 for further detail.
[621] LTE Frequency Bands Worldwide – 8 April 2019 Global mobile Suppliers Association – GSA
[622] LTE Frequency Bands Worldwide – 8 April 2019 Global mobile Suppliers Association – GSA
[623] LTE Frequency Bands Worldwide – 8 April 2019 Global mobile Suppliers Association – GSA
[624] See Para 4.50 'Spectrum for Award' RIA on relevance of TDD spectrum to Fixed Wireless.
[625] See Chapter 3

"A wide variety of RF bands, and certainly those under discussion in this consultation (including 700 MHz, 1.4 GHz, 2.1 GHz, 2.3 GHz, 2.6 GHz and 26 GHz), have been allocated by 3GPP for LTE/5G and the ability to have both intra-band and inter-band carrier aggregation allows for true gigabit offerings in both urban and regional/rural areas ***for both FWA and MBB use cases****" (****emphasis added****)*

8.183 In relation to emerging use of **Small Cells**, small cells operators are likely to provide services that can be used by MNOs or other parties (e.g. verticals) to provide services in specific areas[626]. When small cells are used for mobile purposes, small cell operators will have similar use for the same spectrum as MNOs over small areas[627]. For example, Dense Air Ireland notes[628] that:

"Dense Air Ireland (and Airspan Spectrum Holdings) have a strong interest in acquiring additional TDD Spectrum at 2.3 GHz and 2.6 GHz and believe the release of these bands will promote the rapid deployment of pervasive 4G LTE and support mass deployment of both standalone and non-standalone 5G networks."

8.184 In summary, the above suggests that there are at least three potential uses for spectrum in the Performance Bands, being mobile, Fixed Wireless and Small Cells. These use types are also consistent with the outcome of the 3.6 GHz Award where rights of use were assigned to licensees providing mobile[629], fixed wireless[630] and small cell services[631].

Population coverage versus base station rollout obligation

8.185 In Document 14/101, ComReg was of the preliminary view that a minimum coverage obligation for the Performance Bands[632] should apply to ensure the efficient use of the radio spectrum, and that this could take the form of a population coverage requirement or other appropriate measure.

8.186 Since then, ComReg's consideration of the appropriate form of coverage obligation has advanced further, noting among other things the multiple potential uses for spectrum above 1 GHz and the different likely deployment approaches for these different uses. In that regard, ComReg used a base station rollout obligation in its recent 3.6 GHz Award[633] and a population

[626] For example indoors, business parks, high capacity hot-sports, etc.
[627] For example, Airspan has used 2.3 TDDLTE small cell and small cell backhaul solutions in conjunction with mobile operators and its outdoor 4G LTE-Advanced Base Stations equipment supports the 2.3 GHz band. (See section×in draft Spectrum for Award RIA)
[628] See Chapter 3.
[629] Vodafone Ireland Ltd, Three Ireland Hutchison Ltd, Meteor Mobile Communications Ltd.
[630] Imagine Communications Ireland Ltd (Imagine)
[631] Airspan Spectrum Holdings Ltd (Airspan)
[632] These were referred to the Capacity Bands in 14/101.
[633] 2017 3.6 GHz Award.

coverage obligation in its 2012 MBSA[634].

8.187 A population coverage obligation requires a licensee to rollout coverage to a minimum proportion of the population. Population obligations are normally used where bands are capable of wide area mobile coverage (e.g. 700 MHz, 800 MHz and 900 MHz[635]). The deployment of such bands is normally targeted to achieve the maximum levels of population but commencing in higher density areas.[636] For the reasons set out earlier in Chapter 8, ComReg is of the preliminary view that the 700 MHz Duplex licences should include a population coverage obligation of 95% (70 – 90 % for new entrants) at 30 Mbit/s. Noting this, it is questionable whether it would be efficient to require Licensees to achieve specific population targets in the Performance Bands when such an obligation is already proposed for the 700 MHz band (noting that spectrum in the Performance Bands can also be used towards meeting this coverage obligation).

8.188 Further, population coverage obligations are not suitable for Fixed Wireless and Small Cell services where the network deployment is very different to that of a mobile network and does not necessarily target higher density areas which make population coverage obligations commercially achievable. For example, the business case for a fixed service may be to provide services in rural areas of lower population density or alternatively to cover specific geographic areas (e.g. Small Cells). Implementing a population coverage measure of fixed wireless and Small Cells would therefore likely to be difficult to achieve and could lead to inefficient investment and/or provide inappropriate investment incentives.

8.189 For example, in order to satisfy a population coverage requirement

- A Fixed Wireless operator could be forced to cover higher density areas when its business case might be targeted at rural areas where a fibre service is currently not available.
- A Small Cell operator may not directly provide retail services and its business case may instead be to provide additional capacity:
    - indoors to verticals; and/or
    - to mobile operators in some but not all high density areas; and/or
    - to fixed wireless operators in rural areas.

[634] 2012 MBSA
[635] In the 2012 MBSA, it was a condition of a Liberalised Use Licence that the Licensee achieve and maintain a minimum coverage obligation of 70% of the population within 3 years for an existing MNO and 7 years for a new entrant.
[636] See Oxera Report - Section A2.5.1 - The merit function,

8.190 This would require additional unnecessary and therefore inefficient investment.

8.191 In the 3.6 GHz Award, ComReg considered that the deployment of base stations at cell sites (be that at a high site, a small cell or other cell site type) was likely to be common to the likely potential uses for the band. It therefore considered that a base station rollout obligation would likely be more appropriate to ensure the timely and efficient use of spectrum.

8.192 Given the above, ComReg is of the preliminary view that a base station rollout obligation would be more appropriate for the Performance Bands in this award for the following reasons:

- A population coverage obligation is already being used for the 700 MHz band in the Proposed Award[637].
- The Performance Bands can already be used to assist in achieving the population coverage and QoS (i.e. 30 Mbit/s) obligation in the 700 MHz Band.
- The deployment of base stations at cell sites is likely to be common to all potential uses for the Performance Bands.
- It would be consistent with the principle and obligations in respect of service and technology neutrality as a base station obligation is appropriate for all use types and would encourage the rollout of a variety of different services; and
- It would promote efficient investment and innovation in new and enhanced infrastructures by facilitating network rollout in an efficient manner. This is because, unlike a coverage obligation, there is less risk of unnecessary and therefore inefficient investment.

Should the base station rollout obligation be symmetric or asymmetric noting the different potential uses and future licensees?

8.193 As discussed above, there are a number of potential uses and users for the Performance Bands, and the network rollout for these will vary, such that a rollout obligation for one potential use or user might be excessive for another use or user.

8.194 For example, as noted in the draft 'Spectrum for Award' RIA a fixed wireless service can be provided over much larger distances than would be the case for

[637] As noted in Document 14/101, where spectrum is to be used for capacity purposes only (e.g. in high traffic hotspots like town centres), a coverage requirement may, on balance, be less effective for ensuring the efficient use of spectrum than where the spectrum is used, at least partially, for wide area coverage purposes.

a mobile network, especially in an urban or suburban environment. In effect, the delivery of fixed wireless services requires fewer base stations than a mobile service to serve the same area because, amongst other things, the receiving antenna is mounted and fixed while the mobile antenna is located in a moveable device and needs to overcome constantly changing terrain (buildings, clutter, etc.).

8.195 A base station rollout obligation suitable for mobile networks would likely be far in excess of what would be required to efficiently rollout a fixed wireless service over the same area. Such an obligation would therefore prevent spectrum rights of use from being used efficiently or at all across a variety of different uses. This could, in turn, reduce competition within the award. Alternatively, imposing a base station rollout obligation on MNOs which is more suited to fixed wireless networks would likely be too low to ensure the efficient rollout of mobile services and could lead to spectrum hoarding displacing other uses.

8.196 Regardless of the potential use, new entrants to the market would not have an existing network with which to rollout spectrum rights of use. Noting that rolling out a new network is more challenging and time consuming than upgrading an existing network[638], it is therefore necessary to attach a separate obligation to rights of use won by new entrants which is reflective of the need to build a new network over an appropriate period.

8.197 Therefore, if a base station rollout obligation is deemed necessary, ComReg is of the preliminary view that an asymmetric obligation would likely be required for the Performance Bands such that:

- a mobile and non-mobile coverage obligation should be provided across all bands;
- compared to existing operators, new entrants should be subject to a less onerous obligation across all the Performance Bands; and
- existing 2.1 GHz Licensees should be subject to a higher rollout obligation for that band given existing rollout (and consequently already being in a position to meet a coverage condition close to existing rollout);

8.198 Finally, where spectrum is being used by a winning bidder for different uses, ComReg is of the preliminary view that the more onerous coverage obligation stipulated in the licence should apply. Once the coverage and rollout obligations for each particular use are clearly defined then it is up to each bidder (new

[638] For example, there is an extensive network infrastructure already deployed by MNOs in the 2.1 GHz Band which would be beneficial in meeting any rollout obligation for the 2.1 GHz Band, and potential the 2.3 GHz and 2.6 GHz Bands should multi-band equipment (i.e. across all three Performance Bands) be deployed by the existing MNOs.

entrant or incumbent) to value these lots on the basis of the obligations applying to that bidder.

8.4.9 Performance Bands- the preferred rollout obligation option

Relevant background information

8.199 In determining the regulatory options available, ComReg also sets out some relevant background information on the following:

- 3.6 GHz Base Station rollout.
- Rollout obligations in other jurisdictions.
- Existing MNO rollout in proposed and related bands.

3.6 GHz Award Base Station rollout

8.200 Given the current use of the 3.6 GHz Band for non-mobile uses (e.g. fixed wireless and small cells) the existing 3.6 GHz rollout obligations[639] provide a useful reference point for determining an appropriate base station obligation for the Performance Bands. The following rollout obligations apply in respect of the 3.6 GHz Band.

- for each of the non-urban regions[640]: the deployment of network controlled base stations[641] at 15[642] to 25[643] sites and that these sites should be located in 3 to 5 different counties within the region;
- for the Dublin region: the deployment of network-controlled base stations at 15-25 sites; and
- for all other urban regions: the deployment of network-controlled base stations at 2-4 sites.

8.201 Further, one of the 3.6 GHz band licensees, Imagine, proposes to rollout fixed wireless services to rural parts of Ireland with 325 sites[644] live by June 2020[645].

[639] See Table 3, Document 16/71.
[640] See Section 2.2, Document 16/71.
[641] Network controlled base stations are those under the ownership of the operator and which have backhaul capability over a network connection under the control of the operator. Therefore plug and play type base stations (such as femto cells) or repeaters do not count toward this obligation.
[642] Licensee holding up to and including 100 MHz in the 3.6 GHz Band in that Region
[643] Licensee holding over 100 MHz in the 3.6 GHz Band in that Region
[644] 155 sites live by June 2019
[645] https://www.rte.ie/news/business/2019/0213/1029304-imagine-to-bring-high-speed-broadband-to-rural/

Recent rollout obligations in other Member States

8.202 ComReg's 3.6 GHz obligations were in part informed by rollout obligations adopted in other European countries. In the intervening period, ComReg notes that the Austrian Telecom Control Commission ("TKK") recently awarded the 3.6 GHz Band on a regional basis, with rollout obligations dependent on the quantum of spectrum acquired and the regions in which a licensee acquired rights of use.[646] In the event a bidder obtained rights of use in excess of 90 MHz in all of the regions, an obligation to roll out to 970 locations by 30 June 2022 would apply.[647]

Existing MNO sites in 1800 MHz and 2.1 GHz Band

8.203 Table 19 below sets out the number of licensed sites in the 1800 MHz Band and the 2.1 GHz Band of the existing MNOs. The 1800 MHz Band and the 2.1 GHz Band are existing spectrum bands that could be considered substitutable to the Performance Bands. The rollout in these bands provides relevant information on what rollout could be considered feasible for the Performance Bands in the context of a mobile network.

Table 19: Number of licensed sites in 1800 MHz and 2.1 GHz band of the existing MNOs[648]

Band	Eir (Sites)	Three (Sites)	Vodafone (Sites)
1800 MHz	393	1276	847
2100 MHz	1,456	1,920	1,505

Regulatory options

8.204 In light of the above, and as discussed in Annex 9 where ComReg set outs its draft Rollout RIA, ComReg considers that the following regulatory options are potentially available.[649]

8.205 As discussed further below, ComReg is of the view that a mixture of options may be appropriate depending on the bands concerned, how the spectrum is used (i.e. mobile or non-mobile) and by whom (i.e. incumbent or new entrant).

[646] https://www.rtr.at/en/inf/Konsult_5GAuktion2018_2/Consultation_3_4_to_3_8_GHz.pdf
[647] Ibid, Section 3.5.2 , Section 3.5.3 and Section 3.5.4.
[648] Source: ComReg's Licensing database
[649] ComReg also considered a fifth potential option of imposing an even higher base station rollout obligation than all other options, broadly in line with Three's existing rollout in the 2.1 GHz Band. However, this option was dismissed as clearly being disproportionately onerous and therefore inappropriate in terms of the policy issues and objectives discussed above.

- **Option 1:** Impose no rollout obligation.
    - This would mean that each licensee would have full flexibility to choose how extensive their rollout would be regardless of the amount of spectrum rights of use assigned to it.
    - An operator could choose to provide no services, only to provide services in high density areas, or choose to differentiate itself as a provider with an extensive network footprint.
- **Option 2:** Impose a rollout obligation, with a rollout period of 3[650]- 5[651] years for 80 - 500 network controlled base stations.
    - The lower end of this range of base stations is informed by the base station rollout obligation used in the 3.6 GHz Award in Ireland.[652]
    - The upper end of this range is informed by the proposals in the 3.4-3.8 GHz award in Austria (2019).[653]
    - Propose an obligation at a minimum of **290 base stations** (i.e. the mid – point of the range) but may set the obligation in the lower or higher end of the range depending on any additional information or advice it receives.
- **Option 3:** Impose a rollout obligation, with a rollout period of 3 – 5 years for 500 – 1,200 network controlled base stations.
    - The upper end of this range is informed by Three's existing rollout of the 1800 MHz Band to over 1,200 base stations. However, ComReg notes that part of this rollout relates to legacy GSM services and may not therefore be reflective of an efficient 4G/5G rollout.
    - Propose an obligation at **525 base stations** (i.e. the median[654] of the existing 1800 MHz rollout) but may set it lower or higher in the

[650] ComReg notes that the Oxera Report (Document 18/103c) advised that standard network upgrade for existing MNOs could be provided every two days over a 3 year period (i.e. 550 upgrades). This rollout period is sufficient to cover the suggested rollout in Options 1, 2 and 3. Option 4 refers to the 2.1 GHz Band which has already rolled out to these levels.
[651] This takes into account the longer rollout period that would be required for new entrants.
[652] In that award, if a licensee obtained rights of use up to 100 MHz across all of the regions, then the rollout obligation would be 78 base stations.
[653] ComReg proposes that the upper range of Option 2 be 500 base stations; approximately half of the obligation attached to National licences in the Austrian award. The population of Austria is approximately 8.86 million (2019) and the population density stands at approximately 106 people/km2. The population of Ireland is approximately 4.7 million (2016) while the population density is 70 people/km2.
[654] Given the existing rollout, the median is a better measure of the central tendency as it is not skewed by high Three rollout.

range depending on any additional information or advice it receives.

- **Option 4:** Impose a rollout obligation, with a rollout period of 3 - 5 years for 1,200 – 1,900 network controlled base stations.
    - The upper end of this range is informed by Three's rollout in the 2.1 GHz Band.
    - The 2.1 GHz Band was the only band licensed to provide 3G coverage prior to the 2012 MBSA. Site rollout partly reflected the lack of alternative spectrum (particularly spectrum suitable for coverage) with which to rollout 3G services. However, in the intervening period an additional 280 MHz of spectrum has been assigned to MNOs across three different bands (800 MHz, 900 MHz and 1800 MHz).
    - Further, it is proposed to assign an additional 350 MHz in the Proposed Award across three more bands (700 MHz Duplex, 2.3 GHz Band and 2.6 GHz Band). The existing rollout of the 2.1 GHz Band provides useful information on what rollout could be achieved in the future. However, rollout set at these levels may be above what could be deemed efficient for the rollout of 4G/5G services given the availability of alternative bands (particularly coverage bands) which were not available when UMTS 2100 was rolled out.
    - Propose an obligation under Option 4 at **1,200 base stations** (i.e. the lower end of the range) to provide flexibility in the rollout of 4G/5G services but may set it lower or higher in the range depending on any additional information or advice it receives.
- **Option 5:** Impose a rollout obligation, with a rollout period of 3 – 5 years for over 1,900 network controlled base stations.
    - This option would require base station deployment in excess of network deployment for existing 1800 MHz and 2.1 GHz Band.
    - This obligation would align the likely rollout of sub 1 GHz bands with that of the Performance Bands.

8.206 The draft Rollout RIA, set out in Annex 9, analyses the above options considering the impact on stakeholders (being existing operators and potential new entrants), competition and consumers in line with ComReg's framework for regulatory impact assessments.

8.207 ComReg notes that it intends to further develop this draft RIA in light of feedback from all stakeholders to this consultation.

8.208 The full assessment is set out in Annex 9, however in summary and light of the draft RIA ComReg is of the preliminary view that a combination of the options (as set out in Table 20 below) are required rather than applying one option uniformly to all new rights of use.

8.4.10 Performance Bands – the proposed obligation

8.209 Table 20 below summarises ComReg's preliminary view on the preferred options and identifies the proposed base station rollout obligation applicable for in the different scenarios.

Table 20: Summary of proposed base station rollout obligation for the Performance Bands

Service	New Entrant Obligation			Existing Operator[655] Obligation		
	2.1 GHz	2.3 GHz	2.6 GHz	2.1 GHz	2.3 GHz	2.6 GHz
Mobile	Option 2 (290)	Option 2 (290)	Option 2 (290)	Option 4 (1,200)	Option 3 (550)	Option 3 (550)
Other	Option 2 (80)	Option 2 (80)	Option 2 (80)	Option 2 (290)	Option 2 (290)	Option 2 (290)

8.210 In line with the analysis set out in the draft Rollout RIA, ComReg proposes that the above rollout obligation would be achieved in the period of 3 – 5 years.

Base station capability requirements

8.211 In the 3.6 GHz Award a minimum base station capability standard was established that in general terms aimed to encourage licensees to use more efficient equipment and technologies. This element took the form of setting a minimum data throughput capability of any deployed base station that would contribute to the rollout obligation. The 3.6 GHz Award identified a minimum base station capability of deliver 4 bits/Hz[656]

8.212 In the interests of continuing to encourage licensees to use efficient equipment and technologies ComReg proposes to apply a minimum base station capability requirement. Noting that the potential uses of the Performance Bands tend to use equipment with similar technology capabilities which initially may be LTE and may migrate to future 5G deployments, it would therefore seem appropriate

[655] Existing operator refers to the existing licensees in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands.
[656] 4 bps/Hz is achievable with LTE-A using 16QAM modulation (See section 3.2.1 of Plum Report 3 Document 1575). Other technologies could achieve this throughput rate utilising 64QAM

to continue to set a minimum base station capability requirement based on the capabilities of an LTE base station, while not setting the requirements at a level that might preclude other technologies.

8.213 Noting the above and that equipment is available that can deliver better than 4 bits/Hz, ComReg considers it appropriate to maintain a base station capability requirement of 4 bits/Hz in relation to the base stations that count towards the rollout obligation.

8.214 For the avoidance of doubt, the proposed obligation does not prevent equipment which does not meet the minimum capability requirement from being used in the Performance Bands[657]. However, such equipment would not count towards the rollout obligation or the maintenance of this obligation over the duration of the licence.

Measurement and monitoring the Base Station Rollout obligation

8.215 To measure and monitor the base station rollout for the performance bands, ComReg proposes to use a similar process to that use in the 3.6 GHz band.

8.216 Similar to the 3.6 GHz band, ComReg also proposes that spectrum leasing would also count to meeting the Performance Band rollout obligation.

8.4.11 Other obligations for operators providing a mobile voice service

8.217 As indicated in Section 8.4.4 above ComReg proposes other obligations on operators providing a mobile voice service, these relate to the provision of

- Native Wifi; and,
- VoLTE.

Proposal to apply a Native Wi-Fi obligation to any rights of use in the Proposed Bands where a mobile voice service is provided

8.218 Given the benefits to consumers from the provision of Native Wi-Fi as identified in Section 8.4.4 above, ComReg proposes a condition on any rights of use issued on foot of the Proposed Award to be that if a mobile voice service is provided to a licensee's customers (which would include any provided to third party customers by a licensee, for example in the case of MVNO arrangements) then it must also provide Native Wi-Fi.

8.219 In order to ensure that this benefit is available to consumers in a timely way after the award of spectrum, ComReg proposes this obligation would require

[657] Subject to compliance with all other conditions, including without limitation, BEMs.

this functionality be enabled within 1 year of licence commencement.

8.220 ComReg considers that such a condition is justified and proportionate for a number of reasons, including:

- it would better facilitate the rollout of Native Wi-Fi in an efficient manner, which should contribute to users deriving maximum benefit in terms of choice, price and quality;
- it would promote efficient investment and innovation in new and enhanced infrastructures by encouraging the rollout of Native Wi-Fi;
- it would be proportionate because, among other things, the use of an indoor coverage obligation would be less effective and would impose significant additional costs on operators. For example:
    - ComReg's Building Materials study has shown that losses suffered by radio waves due to sampled building materials is in the order of 20 to 60 dB (which is sufficient to significantly reduce or even prevent connectivity in some cases)[658];
    - DotEcon notes that it is not feasible to expect to address indoor coverage problems by setting tougher requirements on outdoor signal levels or extending the geographical area where outdoor services must be available[659];
    - Oxera notes that attempting to provide full indoor coverage from a mobile network is likely to require an MNO to operate on a basis that would not be economically sustainable[660]; and,
    - There do not appear to be less onerous means by which improved voice services could be achieved.
- it provides winning bidders with a one year time period from licence commencement to deploy Native Wi-Fi which should be sufficient given that 2 of the 3 MNOs have already or have plans to implemented this facility.
- would accord with the principle of safeguarding competition to the benefit of consumers and promoting, where appropriate, infrastructure-based competition; and,

[658] Document 18/73, 'The Effect of Building Materials on Indoor Mobile Performance'.
[659] Document 18/103d,'Coverage obligations and spectrum awards A report for ComReg',p9
[660] Future Mobile Connectivity in Ireland - a report (Document 18/103c) from Oxera Consulting LLP ("Oxera"), with Real Wireless Ltd – p14.

- Further ComReg notes that this obligation ensures that Action 39[661] of the mobile phone and broadband taskforce is achieved.

Proposal to apply a VoLTE obligation to any rights of use in the Proposed Bands where a mobile voice service is provided

8.221 In light of the above, ComReg proposes a condition on any rights of use issued on foot of the Proposed Award to be that if the rights holder has deployed LTE and a mobile voice service is offered on its network to a licensee's customers (which would include any provided to third party customers by a licensee, for example in the case of MVNO arrangements) then it must also provide VoLTE[662].

8.222 In considering the period upon which to rollout VoLTE across a network, ComReg understands that:

- Vodafone has already[663] rolled out VoLTE across its network; and,
- Eir intends[664] to do so as part of its wider network rollout over the next 2 years[665].

8.223 For any MNO that has yet to rollout VoLTE, ComReg understands that the deployment of VoLTE can take time as the nature of the technology is complex and there are a variety of network and operation support system challenges. If deployed over too short a period the quality of voice calls could deteriorate particularly where voice calls have to fall back on 2G/3G networks when 4G networks are unavailable (e.g. rural areas where 4G coverage is lower). For example, if not managed correctly, transferring voice calls between LTE 'packet switched' to legacy 2G/3G 'circuit switched' can compromise quality of service and result in dropped calls. The use of 2G/3G technologies will be required until LTE coverage matches that of 2G/3G.

8.224 Considering the above and in order to ensure that the benefits of VoLTE are made available to consumers in an orderly and sustainable way. ComReg is of the preliminary view that this obligation would need to be met across all sites within 2 years of licence commencement and that 50% of the sites should be met within 1 year.

8.225 ComReg considers that such a condition is justified and proportionate for the

[661] Action 39 *"All operators will introduce WiFi calling, VoLTE and other network feature and functionality enhancements at the earliest juncture and report on progress to the Taskforce Implementation Group"*
[662] This obligation would extend to providing this for any MVNO's carried on the network.
[663] https://www.independent.ie/business/technology/vodafone-switches-on-volte-service-on-its-network-35973395.html
[664] https://www.siliconrepublic.com/comms/huawei-eir
[665] https://www.eir.ie/mobilenetworkupgrade/

reasons set out above, and in summary include:

- it would better facilitate the rollout of VoLTE in an efficient manner, which should contribute to users deriving maximum benefit in terms of choice, price and quality;
- it would encourage the efficient use of the radio spectrum and avoid inefficient investment costs in 2G/3G technologies that will likely be decommissioned over a period of time;
- it would promote efficient investment and innovation in new and enhanced infrastructures by encouraging the rollout of VoLTE;
- it would be proportionate because, among other things:
    - the objective of the obligation (i.e. improve voice QoS in a manner which would avoid inefficient investment costs) would accord with ComReg's statutory objectives and regulatory principles as described above;
    - there do not appear to be less onerous means by which improved voice services could be achieved;
- would accord with the principle of safeguarding competition to the benefit of consumers and promoting, where appropriate, infrastructure-based competition; and,
- it provides winning bidders with 2 years to deploy VoLTE, reflecting that this needs to be carefully deployed and made available to consumers in an orderly way which in ComReg's view provides sufficient time for appropriate testing and validation.

8.4.12 Summary of proposed coverage and rollout obligations

8.226 In summary the proposed obligations attached to rights of use for the Proposed Bands are set out and are presented as follows:

1. 700 MHz Duplex coverage obligations applicable for;
    a) existing MNO's; and,
    b) new entrants.
2. Performance Band Rollout obligations applicable for:
    a) MNO's (existing and new); and,
    b) other users

3. Other obligations for an operator providing a mobile voice service on its network.

1 (a) Existing MNO's obtaining rights in the 700 MHz Duplex

8.227 An existing MNO who wins at least 2×10 MHz of spectrum in the 700 MHz Duplex would need to meet:

- Coverage levels as set out in Table 21 below; and
- Coverage at specific locations as set out in Table 22 below.

Table 21: Obligations on an existing MNO winning at least 2×10 MHz in the 700 MHz Duplex

Outdoor Coverage Service (Single User Throughput Cell Edge)	Coverage dimension	Coverage level to be met in:			Source of data Oxera/Real Wireless Study - Document 18/103c
		3 Years	5 Years	7 years	
30 Mbit/s	**Population**	85%	92%	95%	Scenario 2 results
30 Mbit/s	**Motorways**	75%	85%	90%	Scenario 2 results
30 Mbit/s	**Primary Roads**	60%	75%	80%	Scenario 2 results
3 Mbit/s	**Population**	99%	99%	99%	Scenario 2 results
3 Mbit/s	**Geographic area**	90%	91%	92%	Scenario 2 results

Table 22: Coverage at specific locations

What	Where	When
Outdoors: 30 Mbit/s (Single User Throughput Cell Edge)	Specific locations as set out in Annex 8 which include • **Business and technology Parks (including strategic sites)**: The IDA identifies a list of 31 business and technology Parks and 9 Strategic Sites • **Hospitals**: the Health Service Executive (HSE) identifies a list of the 48 public and 17 private hospitals • **Higher Education Campuses**: The Higher Education Authority (HEA) identifies a list of 8 Universities, II Institutes of Technology and 5 other colleges • **Air and Sea Ports**: the Department of transport tourism and Sport (DTTAS) identifies a list of the 7 main airports and the Irish Maritime Development Office (IMDO) identify a list of the 7 passenger sea ports. • **Train and bus stations**: the National transport Authority identifies the busiest 100 train stations and Bus Eireann identifies a list of the main 16 bus stations • **Top visitor attraction information points**: Failte Ireland identifies a list of the top (12) fee charging and (12) free entry visitor attractions.	For each category 70 % in 3 years 90 % in 5 years 100 % in 7 years

8.228 For an existing MNO, that wins less than 2×10 MHz of spectrum in the 700 MHz Duplex would need to meet the above obligations, except the single user throughput cell edge level would be 20 Mbit/s. This is of course a minimum and it would be open for any such operator to advance this levels further if it sees fit.

1 (b) New entrant winning rights in the 700 MHz Duplex

8.229 A new entrant who wins spectrum of at least 2×10 MHz in the 700 MHz Duplex and 2×20 MHz of capacity spectrum or equivalent[666] would need to meet the obligations as set out in Table 23 below.

[666] This could also be 40 MHz of TDD spectrum.

Table 23: Obligations on an existing MNO winning 2×10 MHz in the 700 MHz Duplex and 2×20 MHz of capacity spectrum

Outdoor Coverage Service (Single User Throughput Cell Edge)	Coverage dimension	Coverage level to be met			Source of data
		4 Years (2024)	6 Years (2027)	10 years (2030)	Oxera/Real Wireless Study - Document 18/103c
30 Mbit/s	**Population**	75%	80%	90%	Scenario 8 results

8.230 For a new entrant who wins 2×10 MHz or 2×5 MHz in the 700 MHz duplex would need to meet the above obligation, except the single user throughput cell edge level would be reduced to 20 Mbit/s and 10 Mbit/s respectively. These are of course minima and it would be open for any such operator to advance these levels further if it sees fit.

2. Performance Band Rollout obligations applicable for MNO (existing and new entrant) and other users.

8.231 ComReg proposes that a base station[667] rollout obligation is applied to winners of rights of use in the any of the Performance Bands identified in Table 24, reflecting the different category of rights holder, MNO (existing or new entrant) or other user.

Table 24: Summary of proposed Performance Bands base station rollout obligations

Service	New Entrant Obligation			Existing Operator Obligation		
	2.1 GHz	2.3 GHz	2.6 GHz	2.1 GHz	2.3 GHz	2.6 GHz
Mobile	Option 2 (290)	Option 2 (290)	Option 2 (290)	Option 4 (1,200)	Option 3 (550)	Option 3 (550)
Other	Option 2 (80)	Option 2 (80)	Option 2 (80)	Option 2 (290)	Option 2 (290)	Option 2 (290)

3 Other obligations for an operator providing a mobile voice service

8.232 Given the benefits to consumers from the provision of Native Wi-Fi, in particular addressing indoor connectivity, ComReg proposes a condition on any rights of

[667] A minimum base station capability requirement of 4bit/Hz is required in order to meet the rollout obligation

use issued on foot of the Proposed Award to be that if a mobile voice service is provided to a licensee's customers (which would include any provided to third party customers by a licensee, for example in the case of MVNO arrangements) then it must also provide Native Wi-Fi within 1 year of licence commencement.

8.233 ComReg proposes a condition of the rights of use issued on foot of the Proposed Award to be that if the rights holder has deployed LTE and a mobile voice service is offered on its network to a licensee's customers (which would include any provided to third party customers by a licensee, for example in the case of MVNO arrangements) then it must also provide VoLTE across all sites within 2 years of licence commencement and that 50% of the sites should be met within 1 year.

8.5 Quality of service Obligations

8.234 Part B of the Schedule to the Authorisation Regulations specifically mentions 'quality requirements' as one of the conditions which can be attached to spectrum rights of use and that even in competitive markets there are situations where, due to information asymmetries, the setting of minimum Quality of Service (QoS) standards may be necessary in order to protect end users. In this section, ComReg sets out its proposals for two QoS standards:

- network availability; and
- a voice call standard.

8.5.1 Network availability

8.235 Noting previous discussion on network availability in the 2012 MBSA[668] and 3.6 GHz band[669] consultation processes, the application of a network availability obligation to spectrum rights issued in those awards, and the analysis of the draft 'Network Availability' RIA on as set out in Annex 10, ComReg is of the view that it is appropriate to set a network availability obligation for spectrum rights for the Proposed Bands.

8.236 Among other things this would:

- protect end users against unreasonable levels of disruption to their service and safeguard the interests of consumers against operators who might otherwise have unacceptably high levels of network unavailability; and

[668] See section 5.6.2 of ComReg Document 12/25 http://www.comreg.ie/_fileupload/publications/ComReg1225.pdf
[669] See Documents 15/140 (section 6.7), 16/57 (section 6.6)

- promote regulatory consistency with the existing licences issued for spectrum rights in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands which have this obligation.

8.237 ComReg proposes that the obligation should apply to all wireless service providers in the Proposed Bands.

8.238 In relation to network availability, ComReg proposes to set the following conditions:

- each licensee is to keep a log of network availability, available for inspection by ComReg;
- each licensee is to ensure that network unavailability is less than 35 minutes per six month period; and
- the calculation of network unavailability will be subject to weighting factors (see below) that take account of traffic load variations.

Weighting Factors (divide duration of each network event by weighting factor)			
	Monday to Friday	Saturday	Sunday
For periods between 07:00 and 24:00 hours	1	2	4
For periods between 00:00 and 07:00 hours	4	8	16

8.239 In line with the approach taken in the 3.6 GHz Award and 2012 MBSA[670], ComReg proposes that all relevant services provided to a licensee's customers and provided to third party customers by a licensee (e.g. in the case of MVNO arrangements) are to be captured under this QoS obligation. ComReg also proposes that its assessment of this obligation will be made against the aggregate total.

[670] See Section 5.6.3 of Document 12/25

8.5.2 Voice Call Standards

8.240 ComReg considers that there is a possibility that at least some of the rights of use that may be awarded in the Proposed Award will be used to provide voice call services.

8.241 Noting previous discussion on voice call standards in the 2012 MBSA[671] and 3.6 GHz Award[672] consultation processes, the application of a voice call standards obligation to spectrum rights issued in those awards, and the analysis of the draft 'Voice Call Services' RIA on as set out in Annex 10, ComReg is of the view that it is appropriate to set a voice call standards obligation for spectrum rights for the Proposed Bands in cases where voice services are provided.

8.242 Among other things this would:

- safeguard the interests of consumers against operators who might not otherwise maintain acceptable quality levels for voice calls in line with current expectations; and
- promote regulatory consistency with the existing licences issued for spectrum rights in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands which have this obligation.

8.243 For this obligation, ComReg proposes to attach similar QoS standards for voice calls to those applied in the 3.6 GHz Award.

8.244 Specifically, ComReg proposes that that for each six month period:

- the maximum Permissible Blocking Rates[673] must not be exceeded;
- the maximum Permissible Dropped Call Rates[674] must not be exceeded; and
- the speech transmission quality must meet or exceed the appropriate standard.

[671] See section 5.6.2 of ComReg Document 12/25 http://www.comreg.ie/_fileupload/publications/ComReg1225.pdf
[672] See Documents 15/140 (section 6.7), 16/57 (section 6.6).
[673] This is a measure of the proportion of unsuccessful call attempts to successful calls, when a subscriber tries to make a call. The rate of blocked calls is measured using a 'Time consistent busy hour'. The time consistent busy hour is determined from the operator's voice traffic. It is the one-hour period during which there is the highest level of traffic. The blocked call rates are measured for the same one-hour period during each review period (e.g. 6 months). The one-hour period is determined by the operator and is subject to ComReg's approval.
[674] This is a measure of the proportion of calls which are ended before the caller/receiver ends the call. This measure is based on a three minute call duration.

8.245 ComReg proposes that all relevant non-VoIP[675] 'voice call' and managed VOIP[676] voice call services provided to a licensee's customers and to third party customers by a licensee would be captured under this voice call obligation.

8.246 'Managed' voice call services includes the traditional voice call services carried over circuit-switched connections and the 'managed' packet-switched voice call services (e.g. using VOIP[677] or some other similar protocol) which can be provided over different technologies (e.g. VoLTE[678], Native Wi-Fi, etc.).

8.247 'Unmanaged' voice call services[679] are not considered in this proposed licence condition. Such services include voice call services provided by over the top (OTT) applications that do not use session initiation protocol/IP multimedia subsystem (SIP/IMS) signalling and are delivered in best effort manner through the Internet access service (i.e. with no prioritisation).[680]

8.248 Finally, ComReg also proposes that any assessment of this obligation would be made against the aggregate total[681].

8.6 The notification of the termination of a technology

8.249 While Regulation 18 of the General Authorisation ("GA") (Document 03/81R6)[682] sets out a number of consumer protection rules that apply to Authorised Persons in the event of a cessation of service[683], ComReg notes that the cessation of services caused by the termination of the use of one technology in favour of another is currently not within the scope of the consumer protection provisions of Condition 18 of the GA.

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[675] Voice over Internet Protocol.
[676] Managed VOIP call services are considered to be substitutable with traditional voice call services and are increasingly used by consumers.
See, for example, paragraph 2.6 of Market Review: Retail Access to the Public Telephone Network at a Fixed Location for Residential and Non Residential Customers – Document 14/89 in relation to fixed voice calls.
[677] Voice over Internet Protocol.
[678] VoLTE is a managed voice service that benefits from prioritisation over other traffic.
ITU, 'Quality of Service Regulation Manual' (2017), Section 5.4.4.
https://www.itu.int/dms_pub/itu-d/opb/pref/D-PREF-BB.QOS_REG01-2017-PDF-E.pdf
[679] 'Unmanaged' voice call services are provided over the applications and/or networks of third parties which the licensee would have very limited control over the quality of the service experienced by the end user.
[680] ITU, 'Quality of Service Regulation Manual' (2017), Section 5.4.4.
[681] The aggregate total refers to the voice call standard in respect of both services provided to the licensee's customers and services provided to any third party (via contractual or other arrangements) customers by the licensee.
[682] https://www.comreg.ie/publication-download/general-authorisation-for-the-provision-of-electronic-communications-networks-and-services
[683] Amongst other things, Regulation 18 obliges an Authorised Person to:

- notify ComReg of an actual or anticipated cessation of service affecting a substantial number of consumers (Condition 18.2);

8.250 As the cessation of a technology can result in "consumer disruption" issues, and noting that a similar provision was included in licences assigned in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands, ComReg is of the view that it is appropriate to propose a similar licence condition for the Proposed Bands. This proposed licence condition would require a licensee to give 6 months' notice to ComReg of its intention to terminate the provision of services using one technology in favour of another technology.

8.251 In addition, and as discussed in the 3.6 GHz Award consultation process[684], should a licensee notify ComReg that it would cease using one technology in favour of another in a time period of less than 6 months, ComReg would assess the proposal at that time, in light of its statutory functions, objectives and duties, considering, among other things, how disruption to consumer services would be minimised.

8.252 In the interests of appropriate regulatory consistency, ComReg proposes to attach a licence condition (in respect of notification of the termination of a technology) to spectrum rights in the Proposed Bands on substantively the same terms as that imposed previously for licences in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands.[685]

8.7 Potential wholesale access (MVNO) conditions

8.253 In this section, ComReg sets out some preliminary observations as to whether, in the context of ComReg's obligation to promote effective competition (and to avoid distortions of competition in the internal market for ECS), it may be appropriate to attach[686] wholesale access (MVNO) conditions to some or all of the 700 MHz rights of use that would be granted on foot of the Proposed Award and, if so, the general approach that any such wholesale access conditions could take.

- provide ComReg with information which it deems necessary, where ComReg forms the view that there is a reasonable probability of a cessation of service (Condition 18.4); and
- at all times use reasonable endeavours to ensure the effect of any cessation of service is minimised (Condition 18.5).

[684] See Section 6.4 of Document 15/140, and Section 6.4 of Document 16/57.

[685] The following licence condition is included in S.I 251 of 2012

6. It shall be a condition of any Licence to which these Regulations apply, that the Licensee shall: (12) (a) notify the Commission, not less than 6 months prior to the proposed cessation of use of any terrestrial system listed in Schedule 1 to which the Liberalised Use Licence relates and; (b) use all reasonable endeavours, to ensure that any adverse effects on users from the cessation of use of a terrestrial system are minimised;

[686] See, in particular, Regulation 10 of the Authorisation Regulations and Article 5(2)(a) of the RSPP Decision. See also Article 52 of the EECC which, although not yet binding, effectively reflects Article 5(2)(a) of the RSPP Decision.

8.7.1 Background

8.254 In May 2014, the European Commission ("EC") conditionally approved the acquisition of Telefónica Ireland Limited ("O2 Ireland") by Hutchison 3G UK Holdings Limited ("Hutchison") ("the Merger").[687]

8.255 The EC's investigation concluded that the Merger, in its original form, would firstly result in a significant impediment to effective competition in the Irish retail market for mobile telecommunications services[688]; that is to say the market where mobile network operators ("MNOs") and mobile virtual network operators ("MVNOs") sell their telecommunications services to consumers and businesses ("Retail Market"). In the Retail market, the EC considered that the Merger would:

- eliminate competition between the merging parties and remove Hutchison 3G Ireland Limited ("Three") as an important competitive force in the market by changing its incentives to compete aggressively on price and service innovation and remove pressure on the remaining competitors' prices; and

- affect Eircom Limited's ("Eir") ability to compete effectively after the Proposed Acquisition, because Three would have the ability and incentive to terminate or frustrate Eircom's existing network sharing agreement with O2.

8.256 The EC also found competition concerns in the Irish wholesale market for access to mobile networks and call origination ("Wholesale Market"). In this market, MNOs compete with each other as potential network hosts and providers of call origination services to MVNOs that use these services to compete in the retail market for mobile telecommunications services. The EC considered that the Merger would:

- reduce the number of MNO hosts for MVNOs, which could lead to deteriorated access conditions for MVNOs and a negative impact for end consumers; and

- affect Eir's ability to compete as a credible host for MVNOs because Three would have the ability and incentive to terminate or frustrate Eircom's existing network sharing agreement with O2 Ireland.

8.257 Given these concerns, the EC considered that, without remedies, the then proposed Merger would have led to higher prices and less competition.

[687] See: http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=2_M_6992 .
[688] This includes services such as voice, SMS, MMS, mobile internet, mobile broadband.

8.258 Hutchison proposed a number of commitments to resolve the EC's competition concerns. In summary, the commitments accepted by the EC ("Commitments") involved Hutchison committing to the following:

- offering to Eircom to continue the existing network share agreement (between Meteor and O2) on improved terms;
- providing wholesale access to Three's network to two new MVNOs on the basis of "capacity agreements" in return for fixed payments; and
- offering to one of the two MVNOs (but not both) the option to acquire certain spectrum rights of use to enable one or the other to become a MNO. The option will be available for 10 years starting from 1 January 2016.[689]

8.259 UPC (now Virgin)[690] and Carphone Warehouse ("ID Mobile") entered into the capacity agreements under the Commitments with Hutchison in 2015.

8.7.2 Impacts of the Merger

8.260 Following the EC's conditional approval of the merger, ComReg stated that it remained concerned that, given the substance and form of the Commitments, the EC's competition concerns would not be fully addressed, and that significant negative consequences for Irish consumer welfare may result.[691] In that regard, ComReg identified its primary concerns with the Commitments, in summary, as follows:

- they appeared inadequate and ineffective to address the serious competition concerns and consumer harm identified by the EC (for example higher prices); and
- they did not appear to comply with the EC's requirements as set out in its Remedies Notice[692].

[689] Hutchison committed to divest 2×5 of 900 MHz, 2×10 MHz of 1800 MHz, and 2×10 MHz of 2100 MHz to one of the two MVNOs facilitated by the Commitments
[690] Virgin Media Ireland, previously known as UPC Ireland, provides national mobile, television and broadband services.
[691] ComReg Information Notice 14/53 - *European Commission completes its investigation into the proposed acquisition by Hutchison 3G UK Holdings Limited of Telefónica Ireland Limited (EC Case M.6992)* .
[692] Commission Notice on remedies acceptable under the Council Regulation (EC) No 139/2004 and under Commission Regulation (EC) No 802/2004 Official Journal C 267, 22.10.2008, p. 1-27 https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52008XC1022(01)

8.261 ComReg observes that the subsequent EC Competition Commissioner, Margrethe Vestager, has since questioned the effectiveness of MVNO-type remedies noting that:[693]

> *"….operators would have depended so entirely on the new company that they wouldn't have been able to compete effectively. And the remedy did not resolve the structural problems created by the disruption to the current network sharing agreements in the UK".*

8.262 On 20 June 2018, the Body of European Regulators for Electronic Communications ("BEREC") published the results of its analysis into the price impact of recent mobile mergers.[694] For Ireland, the results indicate that the Merger has led to price increases of up to 20% in the first half of 2015.[695]

8.263 Following publication of the BEREC study, Three noted the following[696].

- *"Three Ireland does not accept the findings of this report, which is simplistic and highly caveated," ……. "The study only looks at an 18 month period after Q1 2014. During this period Three Ireland made one plan price change which had no effect on 99pc of its customer base."*
- *"Since acquiring O2, Three Ireland has invested close to half a billion euro in modernising and updating the network. The scale of this investment would not have been possible had the acquisition not been approved."*
- *"The acquisition of O2 by Three turned what was a dysfunctional four player market into a functional, highly competitive three player market."*
- *"Three's acquisition of O2 has been good for competition in Ireland as it has allowed us to continue to offer competitive plans and maintain All You Can Eat Data for our customers, one of the few operators in Europe to do so"*

[693] https://ec.europa.eu/commission/commissioners/2014-2019/vestager/announcements/competition-and-investment-telecoms_en?newsletter_id=221&lang=en
[694] https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8168-berec-report-on-post-merger-market-developments-price-effects-of-mobile-mergers-in-austria-ireland-and-germany
[695] ComReg Document 18/61: https://www.comreg.ie/publication/publication-of-a-study-into-the-price-effects-of-the-acquisition-of-hutchison-3g-uk-holdings-ltd-of-telefonica-ireland-ltd/
[696] https://www.independent.ie/business/technology/mobile-prices-now-higher-due-to-three-buying-o2-says-irelands-telecoms-watchdog-37079972.html

8.7.3 MVNOs facilitated by the Commitments

8.264 In respect of the MVNOs facilitated by the Commitments, ComReg observes that:

- ID Mobile, which launched on 20 August 2015, exited the market on 6 April 2018; and
- The second MVNO, Virgin Mobile, was launched on 5 October 2015 and has [✂ [redacted] [697];
  - Mobile can be purchased separately or added to all Virgins' bundles (television, fixed broadband etc.) for an additional fee. 11.4% of Virgin customers have a mobile subscription bundled with a fixed service.[698]
  - Two plans are available: Virgin Mobile 2GB and Virgin Mobile Unlimited[699].
  - Virgin Mobile provides somewhat cheaper mobile package rates depending on whether the customer is an existing Virgin Media customer.
  - Virgin does not provide a fixed broadband, television or fixed telephony services nationally, as its network, which is predominantly connected to households, currently passes around 900,000 premises in Ireland, meaning its bundled mobile services are not available nationally.
- Virgin Mobile is now the only MVNO that can avail of the spectrum divestment commitment.
- After 5 years[700], the MVNO has the option to extend the term of the Capacity Agreement for a maximum additional period of 5 years (10 years in total). There is no provision to review and this MVNO agreement is due to expire in 5 years.

8.7.4 Potential approaches for any wholesale access (MVNO) condition

8.265 In light of the above, ComReg outlines below two wholesale access (MVNO) approaches which have been employed in Ireland:

[697] Document 19/22 - Quarterly Key Data Report - Q4 2018.
[698] Virgin Media, Consolidated Financial Statements December 31, 2018
[699] https://www.virginmedia.ie/mobile/ (accessed May 2019)
[700] https://press.three.ie/press_releases/upc-ireland-signs-mvno-agreement-with-three/

- "retail minus" (2002 3G Licence Award)[701]; and
- "capacity agreement" (2014 EC's Merger Commitments).

2002 3G Licence Award – "Retail Minus" MVNO approach

8.266 The 2002 3G Licence Award provided for the possibility of a MVNO by including a MVNO obligation on the "A Licence" which required the successful Applicant to offer MVNO Access on a specified "Retail minus X" basis as part of the Application.

8.267 The A-Licence also had a lower spectrum access fee of €50.7m compared to €114m of the B-licence. Three won the "A Licence" and a "Retail minus at least 35%" provision is included in the MVNO obligation in its 3G licence[702]. However, no MVNO entry occurred from these 3G A-Licence provisions.

EC's Merger Commitments – "Capacity agreement" approach

8.268 The EC's capacity agreement commitment is based on providing a fixed amount of the merged entity's network capacity for a fixed price as opposed to paying on a per subscriber or per usage basis. The rationale for the capacity model was to create a strong incentive for the MVNO to fill its capacity by aggressively acquiring customers.

8.269 In summary:

- It is based on a minimum capacity of the merged entity's network in consideration for a fixed price (unknown) as opposed to paying wholesale access fees per subscriber or per usage ("pay-as-you-go" MVNO model).
- The capacity and price can be set in accordance with a reasonable glide path for the first five years of the capacity agreement.
- The duration of the two capacity agreements was five years, with an option to extend the term of the agreement for another five years.
- Each MVNO may increase its initial capacity allocation[703] up to a maximum cap of 15% of the merged entity's network capacity[704].

[701] "Pay-as-you-go" MVNO model.
[702] https://www.comreg.ie/media/2018/12/M3G1011.pdf
[703] Capacity Allocation: means an amount of capacity expressed as a percentage of the Three Network Total Capacity made available to each MVNO under a Capacity Agreement.
[704] Available after the merged entity's network reaches its total envisaged capacity

8.7.5 Seeking views and supporting material from interested parties

8.270 In light of the above, ComReg seeks the views of interested parties on whether, in the context of ComReg's obligation to promote effective competition (and to avoid distortions of competition in the internal market for ECS), it would be appropriate to attach wholesale access (MVNO) conditions to some or all of the 700 MHz rights of use that would be granted on foot of the Proposed Award, including views and supporting material on the following:

- the extent to which MVNOs generally have been effective or otherwise in promoting competition to the benefit of consumers;
- the extent to which the MVNOs facilitated by the EC's Commitments currently provide, or would be likely to provide in the foreseeable future, an effective competitive constraint in the Retail Market;
- the barriers to entry for potential entrants and barriers to expansion for existing MVNOs;
- the extent to which access has been denied (actually or constructively) to any potential MVNO entrant in the past and the circumstances of same;
- which type of MVNO obligation approach (capacity or retail minus or other) would be best suited to increasing the competitive strength and incentives of any potential MVNO entrant.
    - if capacity, what overall target would be required (e.g. enough to replicate H3GI pre-merger?)
    - if capacity, what quantum of capacity would be required (e.g. by reference to EC's limit of 15% of merged entity's capacity per MVNO);
- information on MVNO models that would:
    - enable the new MVNO entrant to provide competitive prices and services in the Retail Market;
    - create a sustainable and long-term market player in the Retail Market;
    - allow a new MVNO entrant to provide a full range of services (voice, text and data) that can compete with other operators now, and in the future;

- be suitable to attract strong MVNO competitors with economic incentives that are similar to those of MNOs; and
- be flexible enough to allow any MVNO entrant to bundle mobile with other related services (e.g. fixed, broadband and television).

8.271 ComReg does not include a draft RIA at this point in the consultation, however if, based on the responses received and other available information, ComReg progresses any MVNO proposal then it envisages setting out a draft RIA on any more detailed proposals in future consultations.

8.8 Spectrum transfers, spectrum leasing and spectrum hoarding

8.8.1 Spectrum transfers

8.272 ComReg's Spectrum Transfer Framework[705] provides for the transfer of spectrum rights of use in the RSPP Bands[706]. The RSPP bands include the 2.1 GHz and 2.6 GHz bands, but does not presently include the 700 MHz or 2.3 GHz bands.

8.273 In relation to the 700 MHz band, Article 2 of Decision (EU) 2017/899 states:

> *Upon the granting of the rights of use in the 700 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services, Member States shall allow the transfer or leasing of such rights in accordance with open and transparent procedures pursuant to the applicable Union law.*

8.274 In line with this obligation, and as noted in ComReg Document 17/82, ComReg proposes to amend the Spectrum Transfer Framework to allow spectrum transfers in the 700 MHz band.

8.275 In relation to 2.3 GHz, and while noting that there is no EU requirement for spectrum transfer to be allowed in this band, ComReg proposes to allow spectrum transfer in this band, also as among other things, this would provide consistency across the Proposed Bands.

[705] The provisions and procedures of the Spectrum Transfer Framework are set out in the:
- Spectrum Transfer Regulations (S.I. 34 of 2014); and
- Spectrum Transfer Procedures and Guidelines (ComReg Document 14/11r1)

[706] These are: 790-862 MHz, 880-915MHz, 925-960MHz, 1710-1785MHz, 1805-1880MHz, 1900-1980MHz, 2010-2025MHz, 2110- 2170MHz, 2.5-2.69GHz and 3.4-3.8GHz (the "RSPP Bands").

8.8.2 Spectrum Leases

8.276 ComReg Document 17/82 sets outs ComReg's response to consultation on a framework for the ex-ante review of proposed spectrum leases in Ireland and proposes the implementation of this for the RSPP Bands (including the 2.1 GHz and 2.6 GHz bands) and the 700 MHz band. The 2.3 GHz Band is not covered under this framework.

8.277 Presently draft Regulations have been prepared to implement the spectrum lease framework into law. However these have yet to be enacted.

8.278 In relation to the 2.3 GHz band, while noting that there is no EU requirement for spectrum leases to be allowed in this band, ComReg proposes to allow spectrum leases in this band, as among other things, this would provide consistency across the Proposed Bands.

8.8.3 Spectrum Hoarding

8.279 By way of background, Regulation 17(10) of the Framework Regulations provides that:

> *"(10) [ComReg] may, having regard to its objectives under section 12 of the Act of 2002 and Regulation 16 and its functions under the Specific Regulations, lay down rules in order to prevent spectrum hoarding, in particular by setting out strict deadlines for the effective exploitation of the rights of use by the holder of rights and by withdrawing the rights of use in cases of non-compliance with the deadlines. Any rules laid down under this paragraph shall be applied in a proportionate, non-discriminatory and transparent manner."*

8.280 ComReg also observes that the notion of *"spectrum hoarding"* can be better understood by reference to recital 71 of the 2009 Amending Directive[707] which provides:

> *"Competent national authorities should have the power to ensure effective use of spectrum and, where spectrum resources are left unused, to take action to prevent anti-competitive hoarding, which can prevent new entry."*

[707] Directive 2009/140/EC

8.281 Whilst it is not possible, at this stage, to anticipate the likelihood of spectrum hoarding occurring in respect of the spectrum rights in the Proposed Bands, ComReg considers it appropriate, in the context of ensuring the efficient use of liberalised spectrum rights in the Proposed Bands, to impose an obligation on winners of liberalised spectrum rights to comply with any rules to prevent spectrum hoarding as may be laid down by ComReg under Regulation 17(10) of the Framework Regulations.

8.282 ComReg observes that such an obligation currently exists in respect of the spectrum rights issued in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands.[708]

8.283 While no such rules have been laid down by ComReg to date, ComReg reserves the right to specify such rules in the future.

8.9 Technical Conditions

8.284 The technical licence conditions applicable to the Proposed Bands are informed by the relevant EC / ECC Decisions as identified in Chapter 6 and are set out in Annex 12.

[708] Regulation 6(5) states that *"6. It shall be a condition of any Licence to which these Regulations apply, that the Licensee shall:" "(5) comply with any rules to prevent spectrum hoarding as may be laid down by the Commission under the Framework Regulations";*

Chapter 9

9 Transition arrangements and preparatory licences

9.1 "Transition" refers to the activities required from existing and new licensees to adjust their networks to comply with the outcome of a spectrum award process.

9.2 Transition processes have been successfully completed in respect of the 900 MHz and 1800 MHz bands following the outcome of the 2012 MBSA[709], and transition arrangements are ongoing in relation to the 3.6 GHz Award.

9.3 In light of the proposals set out in this consultation document, this chapter discusses:

- proposed transition arrangements for the 2.1 GHz Band in advance of the commencement date for Time Slice 1 in that band ("Time Slice 1 Transition");
- proposed transition arrangements for the 2.1 GHz Band, 2.3 GHz and 2.6 GHz bands in advance of the commencement date for Time Slice 2 ("Time Slice 2 Transition");
- proposed transition arrangements in respect of Eir's RurTel network in the 2.3 GHz Band ("Eir 2.3 GHz Transition"); and
- preparatory licence proposals.

9.1 Time Slice 1 Transition

9.4 Transition arrangements may be required for the 2.1 GHz Band in advance of the commencement date for Time Slice 1 in that band, as any new spectrum rights of use for this band may be different, in frequency location and/or quantum of spectrum, to the existing 2.1 GHz spectrum rights of licensees (and any interim spectrum rights granted for the purpose of aligning expiry dates of those existing licences expiring in 2022 to 15 October 2022 (as discussed in Chapter 5 and Annex 5).

9.5 Figure 18 below shows the existing rights of use in the band.

[709] See ComReg Documents 13/19, 13/19a, 13/55 and 15/41. See also Annex 11 of this document for a summary of the 2012 MBSA transition.

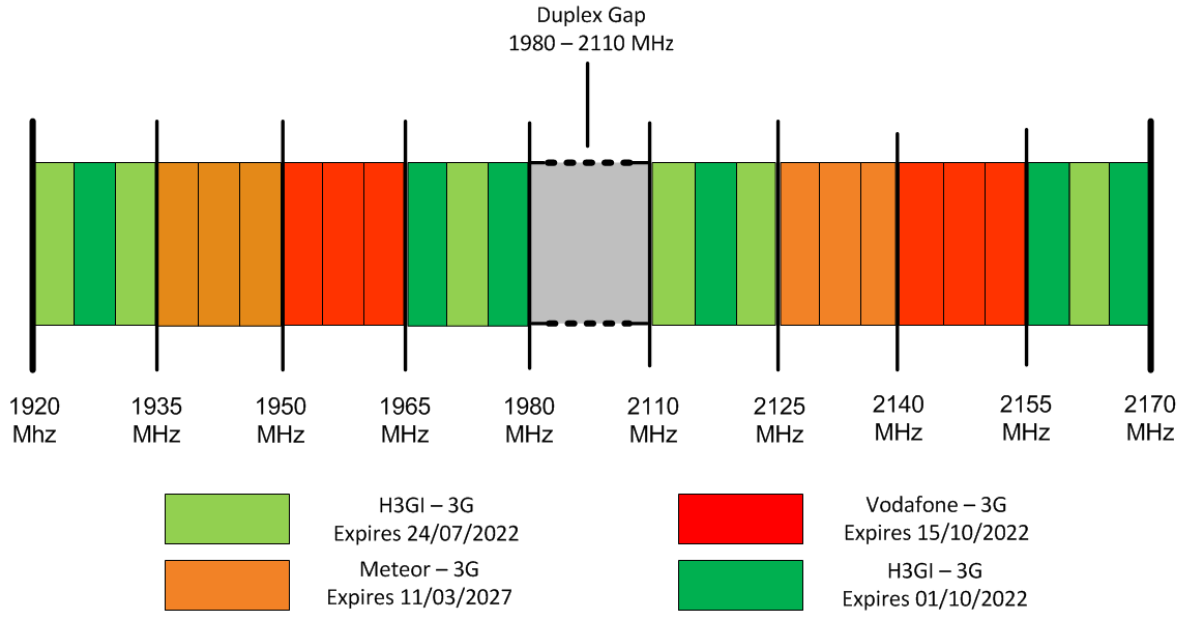

Figure 18: Existing spectrum rights in the 2.1 GHz band

9.1.1 Potential transition scenarios for Time Slice 1 Transition

9.6 Outlined below are a number of generic award outcomes which would require transition activities to be carried out by one of more of the existing licensees in the 2.1 GHz Band in advance of Time Slice 1. Note, these generic transition scenarios also apply to the Time Slice 2 Transition which is discussed separately in this chapter.

9.7 At a high level, there are three potential generic transition scenarios based on different award outcomes:

- Transition Scenario A: An existing licensee wins an equal or greater amount of new spectrum rights in the 2.1 GHz Band in Time Slice 1 but these spectrum rights are in a different frequency location in the band. This scenario could apply to all existing licensees in the 2.1 GHz Band;
- Transition Scenario B: An existing licensee wins a reduced amount of new spectrum rights in the 2.1 GHz Band in Time Slice 1. These rights could be in the same frequency location or in a different frequency location in the band. This scenario would not apply to Meteor as it will maintain 2×15 MHz of spectrum rights in Time Slice 1 under its existing 3G licence; and
- Transition Scenario C: An existing licensee does not win any new spectrum rights in the 2.1 GHz Band in Time Slice 1. This scenario would not apply to Meteor as it will maintain 2×15 MHz of spectrum rights in Time Slice 1 under its existing 3G licence.

General observations on the potential Time Slice 1 Transition scenarios compared to the 2012 MBSA transition

9.8 While the complexity and potential transition times required for each of the above transition scenarios will depend on the specific details of the transition, which will only become fully known following the outcome of the Proposed Award, a number of general observations are provided below informed by transition from the 2012 MBSA process (see also Annex 11).

9.9 The transition process of the 2012 MBSA, and its actual implementation in 2013 and 2015, provides useful information for the Proposed Award given similarities including that:[710]

- the existing licensees in the 2012 MBSA were also national mobile operators providing mobile services; and
- new spectrum rights in the 2012 MBSA were also awarded in two time slices.

9.10 At the same time, ComReg observes some important differences in the present matter which suggest that **the potential for service disruption in this transition is considerably reduced compared to that of the 2012 MBSA transition**. These different circumstances include:

- From a consumer perspective, it is likely that very few and potentially no consumers would be entirely reliant on end-services provided using 2.1 GHz Band rights, because most mobile consumer devices now operate in multiple technologies and multiple spectrum bands. Therefore, should an existing licensee lose access to rights in the 2.1 GHz Band it is likely that most consumers could continue to enjoy seamless mobile services from that operator on other technologies and/or on other frequency bands.
- From an operator perspective, it is notable that each of the existing licensees provide mobile services using multiple technologies (GSM (2G), UMTS (3G), LTE (4G)) and using multiple frequency bands (800 MHz, 900 MHz, 1800 MHz and 2.1 GHz). Should an existing licensee lose access to rights to the 2.1 GHz Band, it would be able to continue to provide seamless mobile services using its other spectrum assignments (both existing and any won in the Proposed Award).

[710] ComReg notes that the circumstances of transition for 3.6 GHz band are considerably different to that of the proposed award. In the 3.6 GHz band, the existing licences were local area licences (of which were there 292 before the award) that provided fixed wireless broadband, sometimes in areas where no alternative broadband provider exists. Noting these specific circumstances, and the importance of ensuring the efficient use of spectrum as well as maximising benefits to users, ComReg's 3.6 GHz band transition process included transition measures which provided for the continued provision of existing services while new licensees are rolling out their networks.

- The Proposed Award would release a number of additional greenfield bands (700 MHz, 2.3 GHz and 2.6 GHz) which, if won by an existing licensee, could be quickly used to provide mobile services, as most network equipment and consumers devices now operate over multiple frequency bands thereby shortening the time required by operators to bring new services to the market.

- Aside from the 2.1 GHz Band, each of the existing licensees also provides 3G services using the 900 MHz band.

9.11 There is, however, one difference in circumstances for the 2.1 GHz Band, which, at face value, would appear to potentially complicate transition. This is that currently all of the spectrum rights in the 2.1 GHz Band are assigned, leaving no unoccupied spectrum in the 2.1 GHz Band to accommodate the first move in any transition process. ComReg observes that this difficulty can be addressed in a number of ways, and one practical example would be for any transition to first focus on freeing spectrum blocks which are more lightly used.[711]

9.12 Overall, the above suggests that the Time Slice 1 Transition is likely to be **less complex and less time consuming** than the transition for the 2012 MBSA, particularly for Transition Scenarios B and C where the potential for disruption to end consumer services would have been of particular concern in the "worst case" timelines for the 2012 MBSA.

9.13 Noting the above, and based on experience from the 2012 MBSA, each of the generic transition scenarios are discussed below for the Time Slice 1 Transition. While ComReg recognises that some of the transition information and advice from the 2012 MBSA will be up to 10 years old when the Time Slice 1 Transition occurs, and given the considerable similarities discussed above, ComReg is of the view such material is nonetheless indicative of the potential timelines.

Time Slice 1 Transition: Transition Scenario A

9.14 Transition Scenario A refers to the scenario where an existing licensee wins an equal or greater amount of new spectrum rights in the 2.1 GHz band in Time Slice 1 but these spectrum rights are in a different frequency location.

9.15 ComReg recalls from transition in the 2012 MBSA that:

[711] ComReg observes that the level of network deployment of 2×5 MHz channels in the 2.1 GHz band varies within across operators and within an operator's spectrum rights, and that some 2×5 MHz spectrum channels have a low current deployment compared to other 2×5 MHz channels.

- Red-M/Vilicom[712] advised that such a transition scenario would take approximately 4 to 5 months for one band (900 MHz or 1800 MHz in that case) depending upon the inter-dependency between operators[713]; and

- four operators implemented a transition of this nature in 2013, and the overall time required for 2013 transition project was circa 4 ½ months.[714]

9.16 While Time Slice 1 Transition is somewhat complicated by the fact that all spectrum rights in the 2.1 GHz band are currently assigned, ComReg would expect that the 2012 MBSA timeframes discussed above would provide a "worst case" timeframe for Transition Scenario A (i.e. a maximum time period of 4 to 5 months).

Time Slice 1 Transition: Transition Scenario B

9.17 Transition Scenario B refers to the scenario where an existing licensee wins a reduced amount of new spectrum rights in the 2.1 GHz band in Time Slice 1.

9.18 ComReg recalls from transition in the 2012 MBSA that:

- Red-M/Vilicom considered one specific instance under this scenario (in relation to a reduction of 900 MHz spectrum from 2×7.2 MHz to 2×5 MHz), and advised that a period of 2 years would be sufficient[715]; and

- One operator, Meteor, implemented a transition of this nature in 2015 (when it transitioned from 2×20 MHz to 2×15 MHz in the 1800 MHz band) which required a period of 4 plus *"some months"* for Meteor to cease using this spectrum at 291 sites.[716]

9.19 In light of the lower potential for disruption to end-consumer services in this Time Slice 1 Transition compared to the 2012 MBSA, ComReg would expect the above 2012 MBSA timeframes to represent "worst case" timeframes.

9.20 At the same time, ComReg recognises that it will only be possible to specify precise transition timings for this scenario following the outcome of the Proposed Award.

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[712] In order to assist with transitional issues in the 2012 MBSA, ComReg commissioned expert technical advice from Red-M Wireless Limited ("Red-M") and Vilicom Limited ("Vilicom"), to detail the process steps and estimated timeframes that could be associated with various transitional scenarios.
[713] See ComReg Documents 10/71c and 10/105b.
[714] Meteor (900 MHz band), Telefonica (now Three) (900 MHz and 1800 MHz), Vodafone (1800 MHz)
[715] See ComReg Documents 10/71c
[716] The overall time required for Meteor's transition is not known to ComReg. As set out in Annex 1 of ComReg Document 15/41, in its 9 March 2015 submission to ComReg, Meteor indicated that its' project to clear the use spectrum block L at 291 sites had been in operation for some months and that it would require the full term of its spectrum rights in block L (i.e. until 12 July 2015) to complete its transition.

Time Slice 1 Transition: Transition Scenario C

9.21 Transition Scenario C refers to the scenario where an existing licensee wins no new spectrum rights in the 2.1 GHz band in Time Slice 1.

9.22 ComReg recalls from transition in the 2012 MBSA that[717]:

- Red-M/Vilicom did not advise on this scenario because, among other things, estimating such timeframes would be very difficult given that they will vary depending on the specific characteristics of each operator's network. For example, the specific network's intrinsic traffic capacity, and the dependency of same upon a specific frequency band for both coverage and traffic loading in a given area; and

- ComReg proposed to address setting timeframes for transition of this nature following the outcome of that proposed award process when the pertinent facts became available.

9.23 ComReg is of the view that a similar approach is appropriate for considering the timeframes associated with transition scenarios of this nature in this Time Slice 1 Transition.

9.1.2 ComReg's proposals – Time Slice 1 Transition

9.24 In light of the considerable similarities between Time Slice 1 Transition to the 2012 MBSA transition (and the successful implementation of the latter), ComReg's Time Slice 1 Transition proposals as outlined below are based on those set out in the 2012 MBSA.

9.25 Generally speaking, the aim of these transition proposals is to facilitate a timely and orderly transition to the outcome of the Proposed Award, while mitigating disruption to operators and consumers.

9.26 ComReg's Time Slice 1 Transition proposals are outlined below under the following headings:

- proposed obligation on all bidders to abide by the transition rules;

- collection of information from existing licensees to inform ComReg's transition proposals, transition rules and transition plans;

- setting of transition rules by which to formulate a transition plan; and

- implementation of the transition plan, including appropriate licensing arrangements to facilitate same.

[717] See ComReg Document 12/25 (section 6.2)

Proposed obligation on all bidders to abide by the transition rules

9.27 Similar to the 2012 MBSA, ComReg proposes that all participants (including existing licensees) in the Proposed Award would agree to abide by the transition rules (see below). In ComReg's view, this would be appropriate because, among other things, it would:

- facilitate an orderly and timely transition to the outcome of the Proposed Award which would likely be in their interests given that:
    - one existing licensee, Meteor, has existing spectrum rights in Time Slice 1 under its 3G licence; and
    - the other two existing licensees, Vodafone and Three, would be likely to participate in the Proposed Award to bid for new rights;
- be unlikely to adversely affect the existing licensees as abiding by the transition rules would not change the expiry date of their existing spectrum rights and they would continue to be able to enjoy such rights until expiry.

Collection of information from existing licensees in advance of the Proposed Award

9.28 While the precise nature and extent of transition activities would not be known until the outcome of the Proposed Award, it may nevertheless be important to collect information from existing licensees in advance of the Proposed Award so as to inform ComReg's transition proposals and rules.

9.29 Having regard to the responses to this consultation, ComReg will consider if specific information should be collected from existing licenses in advance of the Proposed Award.

Setting of transition rules by which to formulate a transition plan

9.30 With regard to the setting of transition rules in advance of the Proposed Award, ComReg proposes that the transition rules would define:

- the elements of a transition plan;
- the process to determine a transition plan, including the setting of the final transition plan(s) by ComReg; and
- consequential outcomes, such as the delayed commencement of new rights of use arising from transition activities.

Elements of a transition plan

9.31 A transition plan for the 2.1 GHz band is likely to consist of similar elements to the transition plan determined for the 2012 MBSA process[718], insofar as it is likely to involve:

- the identification of all transition activities to be undertaken by the existing licensees and the order in which each activity would be taken;
- the setting of milestone dates for each transition activity identified;
- where the transition activities of one existing licensee is dependent upon the transition activities of another, this would be clearly identified such that any consequential delays by one party due to the delay of another party can be clearly attributable to the responsible party;
- a robust and transparent mechanism to allow ComReg (including any of its agents or servants), existing licensees, winning bidders and other appropriate interested parties to monitor progress with the transition activity milestones;
- the completion of transition activities prior to deadline dates as determined by ComReg in the transition plan; and
- the attribution and acceptance of liability for liquidated damages payable by the existing licensee(s) to ComReg in the event of non-compliance by it/them with the transition activity milestones identified in the transition plan, where such existing licensee(s)' actions or omissions caused the non-compliance with the relevant milestone date (see further below).

Process to determine a transition plan

9.32 In determining a transition plan for the 2.1 GHz band ComReg proposes to use a similar process to that used in the 2012 MBSA[719] which, in summary, would involve:

- the setting of transition arrangements and rules by ComReg in advance of the Proposed Award which, among other things, could specify the end-date for the completion of transition activities in advance of determining the transition plan;

[718] See paragraph 3.158 of ComReg Document 12/52
[719] See paragraphs 3.157 to 3.163 of ComReg Document 12/52.

- the opportunity for existing licensees and winning bidders to collectively formulate an industry transition plan proposal for ComReg to consider[720] and, in the absence of said proposal, to make one or more submissions to ComReg as to the appropriate provisions for such a plan;

- the setting of the final transition plan, containing milestones and completion dates, by ComReg after having considered any transition plan proposal(s) received;

- the subsequent monitoring and reporting, against the progress of the relevant transition activity and the progress of the existing licensees against these milestones; and

- the completion of all of the transition activities by existing licensees in accordance with the milestones determined by ComReg as set out in the final transition plan.

9.33 Principles that would guide ComReg in setting out a final transition plan include:

- the minimisation of the potential for significant disruption to existing consumer services; and

- the commencement of new spectrum rights as soon as practicable, thereby not unnecessarily delaying the delivery of new services to end users.

Potential for delays to the commencement date of new spectrum rights and the acceptance of liquidated damages

9.34 As a consequence of the transition plan activities, and as discussed below in relation to the potential issue of interim licences for transition purposes, it is possible that the transition of some existing licensees could extend beyond the expiry date of their existing spectrum rights (including any proposed interim spectrum rights to enable the three existing licences expiring in 2022 to co-terminate on 15 October 2022 as discussed in Chapter 5 and Annex 5).

9.35 Any such interim licences for transition purposes could delay the availability of new 2.1 GHz spectrum rights in Time Slice 1 to the winning bidders. To address this possibility, ComReg proposes to adopt similar rules to those used in the 2012 MBSA process insofar as:

- Bidders in the Proposed Award would be participating in same on the express acknowledgment and acceptance that the commencement date

[720] For the avoidance of doubt, ComReg would consider a plan agreed between a subset of winning bidders if agreement between all winning bidders cannot be achieved, in particular if the parties not agreeing are not affected by that agreed plan.

of any new spectrum rights of use won in the 2.1 GHz Band in Time Slice 1 could be delayed due to the transition activities of existing licensees. Similar to the 2012 MBSA, ComReg proposes a pro-rata refund of licence fees for any such delayed commencement.

- Each applicant, as part of the application process would be obliged to accept the prospect of paying liquidated damages to ComReg in respect of non-compliance by it with the final transition plan. In ComReg's view, the payment of such liquidated damages and the prospect of such payments are appropriate (i) to reflect any potential losses to ComReg and (ii) to incentivise the completion of transition activities in an efficient, effective and timely manner. ComReg proposes to adopt an approach to the imposition of such liquidated damages similar to that used in the 2012 MBSA process.[721]

9.36 For the avoidance of doubt, ComReg intends to reserve the right not to issue interim licences for transition purposes if it forms the view that a delay to the availability of new 2.1 GHz spectrum rights would not be objectively justified, reasonable and proportionate in light of ComReg's statutory objectives which, among other things, would have regard to the nature and extent of likely material disruption to consumers and operators.

Implementation of the transition plan including appropriate licensing arrangements to facilitate transition

9.37 Noting the potential transition timeframes discussed above in relation to Transition Scenarios A, B and C for Time Slice 1 Transition, and the current estimated timings for the Proposed Award, ComReg observes there is likely to be sufficient time for transition activities to be completed for most, if not all, transition scenarios, in advance of the commencement date for new rights of use in the 2.1 GHz band in October 2022.

9.38 Accordingly, any such transition activities are likely to be facilitated under the existing 3G licences (including any interim licences to enable co-termination in October 2022 as discussed in Chapter 5 and Annex 5).

9.39 At the same time, and recognising that the full nature and extent of transition activities arising from the Proposed Award will not be known until after the conclusion of same (and that the timings of Transition Scenario C, in particular, could be considerable), ComReg also acknowledges the possibility for transition activities to extend beyond the duration of existing rights of use expiring in 2022.

[721] See section 3.8.2 of ComReg Document 12/52

9.40 At this juncture, however, and based on available information (including the process in the 2012 MBSA[722]), ComReg observes that there should be sufficient time to put in place any interim licensing arrangements for transition purposes should this prove necessary.

9.2 Time Slice 2 Transition

9.41 While ComReg is proposing specific provisions for the assignment round of the Proposed Award to eliminate the need for transition between Time Slice 1 and Time Slice 2 *in certain circumstances*[723], depending on the outcome of the Proposed Award, a Time Slice 2 Transition may nevertheless be required where any new rights of use won by a winning bidder in the 2.1 GHz, 2.3 GHz and/or 2.6 GHz bands for Time Slice 2 are different, in frequency location and/or quantum of spectrum, to the spectrum rights in those band(s) won by same bidder in Time Slice 1.

9.42 For any such Time Slice 2 Transition activities arising, ComReg proposes to implement measures similar to those proposed in relation to the Time Slice 1 Transition.

9.43 As outlined above, the three generic Transition Scenarios A, B, and C could also apply to Time Slice 2 Transition, but it is not possible to provide more specificity on transition until the outcome of the Proposed Award is known and also closer to the commencement date of Time Slice 2 of 12 March 2027.

9.44 Nevertheless, ComReg believes that it may be helpful to provisionally identify timeframes when ComReg would propose to seek transition proposals from winning bidders and existing licensees, being:

- one year in advance of 12 March 2027 for Transition Scenario A;
- two years in advance of 12 March 2027 for Transition Scenario B; and
- three years in advance of 12 March 2027 for Transition Scenario C.

[722] See ComReg Document 13/06.
[723] As discussed in Chapter 7, ComReg proposes to include a provision in the assignment round where winning bidders who win the same amount of spectrum in a spectrum band in both time slices would only be provided spectrum assignment options with contiguous spectrum assignments across the two time slices (i.e. no transition between the two time slices would be required).

9.3 Proposed transition arrangements in respect of Eir's RurTel network in the 2.3 GHz Band

9.45 This section sets out ComReg's current thinking on how best to address transition issues arising from Eir's existing use of the 2.3 GHz Band for its RurTel network in accordance with ComReg's statutory functions, objective and duties, and is informed by the earlier consideration of the RurTel network in this document where:

- background information on the RurTel network is presented in section 6.2.3; and
- the potential scenarios for Eir to migrate its RurTel network from the 2.3 GHz are discussed in Chapter 7.

9.46 From this, ComReg observes that:

- the RurTel network provides voice service to customers in rural areas of the State that do not presently have access to an alternative fixed telephony service, and is an important service particularly in the context of ComReg's objective to promote the interests of users, including by ensuring that all users have access to a universal service; and
- while the extent of RurTel network has decreased over time, it may not fully migrated from the 2.3 GHz band in advance of the Proposed Award, and it would therefore be appropriate to consider transition arrangements for Eir's RurTel network in the 2.3 GHz band.

9.47 This section set out ComReg's transition arrangement proposals for Eir's RurTel network in the 2.3 GHz Band and is structured as follows:

- background on ComReg's approach to transition issues in its 3.6 GHz Award; and
- ComReg's current thinking on (i) general guiding principles by which to address any transition scenarios which might arise and (ii) potential tools available to incentivise and ensure an orderly and efficient transition.

9.3.1 Background – 3.6 GHz Award Transition Framework

9.48 ComReg observes that there are a number of significant similarities between the situation currently faced in respect of the RurTel network in the 2.3 GHz Band and that faced by ComReg concerning the then existing FWALA licensees in the 3.6 GHz Band in the context of its 3.6 GHz Award. In particular:[724]

- as is still the case in many countries in Europe and prior to the 3.6 GHz Award, the 3.6 GHz Band in Ireland was being used to provide wireless broadband and telephone services to existing customers predominantly in rural areas. Prior to the award, ComReg estimated that there were c21,665 customers served by existing licences in the 3.6 GHz Band;
- in these areas, the incumbent operators may be the only available provider of the relevant telecommunications service (in that case, broadband services) to both homes and schools; and
- these areas were likely to be in the more sparsely populated areas of Ireland and this characteristic increased the potential impact of disruption to existing consumer services in the 3.6 GHz Band in these areas.

9.49 In light of the issues faced in the 3.6 GHz Award, and to ensure continued services for those existing customers who were at risk of losing their service while winning bidders in that award prepared for the deployment of their services (e.g. trials), ComReg developed a transition licensing framework which it consulted upon extensively with interested parties and implemented by way of the rules of the 3.6 GHz Award which all participants to same agreed to be legally bound by. These rules are contained in the 3.6 GHz Award Information Memorandum (ComReg Document 16/71).

9.50 The principles underpinning the 3.6 GHz Award Transition licensing framework can be summarised as follows:

- minimise the potential for disruption to existing consumer services;
- introduce liberalised licences as soon as possible not unnecessarily delaying the delivery of future liberalised services;
- maximise benefits to end users; and
- ensure the efficient use of spectrum during the Transition period.

[724] See ComReg Documents 15/70, 15/140, 16/57 and 16/71.

9.51 Essentially, the 3.6 GHz Award Transition licensing framework enabled existing operators to continue to provide services, across over 292 localised service areas, to their customers until such time that Winning Bidders were ready to roll-out commercial services. It comprised of the following 3 tools:

- the formulation of a transition plan, based on transition rules, to facilitate an orderly and timely transition to the outcome of the Proposed Award. ComReg put forward some general principles (identified above) and tools intended to facilitate the development of a well informed and robust transition plan, which would be determined by ComReg with input from the Existing Licensees and new licensees;

- assigning a Transition Protected Licence ("TPL") to winning bidders in the award should transition activities be required beyond the expiry of the FWALA licences on 31 July 2017. ComReg proposed that the terms and conditions associated with a TPL would be the same as those in the existing licence with the exception of the duration and the frequency assignment, which could be modified to facilitate the completion of the 3.6 GHz Award transition plan; and

- allowing an existing licensee (whether or not it won rights of use in the award), under certain pre-conditions, to obtain a Transition Unprotected Licence ("TUL") on the same terms and conditions as its Existing Licence (with certain exceptions[725]) for a period of no more than five years. The purpose of the TUL was to:

    - facilitate the timely and orderly completion of the Existing Licensee's Transition Activities in accordance with the Transition Plan; and

    - maximise the benefits to users and ensure the efficient use of spectrum during the transitional period.

[725] In particular:
- it would be issued on a non-protected non-interference basis, noting that it would be protected from unauthorised systems, that is to say those not operating legally;
- the frequency assignment would be varied by ComReg as necessary;
- the TUL would expire on or before 31 July 2022 depending upon, among other things, the availability of suitable spectrum;
- the TUL may be offered, or amended, with a modified licence footprint; and
- licence fees would be equivalent to the existing FWALA fees updated to present day prices using the overall Consumer Price Index (CPI).

9.3.2 ComReg's current thinking

9.52 Considering the nature of the services provided by the RurTel network to provide voice service to customers in rural areas of the State that do not presently have access to an alternative fixed telephony service, and observing the similarities between to the services provided by the existing licensees in the 3.6 GHz Band, ComReg firstly observes that the following transition principles would also appear to be relevant to the Eir 2.3 GHz Transition:

- minimise the potential for disruption to existing consumer services;
- introduce new rights of use in the 2.3 GHz Band as soon as possible not unnecessarily delaying the delivery of future liberalised services;
- maximise benefits to end-users; and
- ensuring the efficient use of spectrum during the Transition period.

Potential tools and measures

9.53 In that regard, ComReg sets out below some preliminary observations on the different scenarios and potential measures for same to inform consideration by interested parties.

9.54 First, in the event of **full migration by Eir** sufficiently in advance of the Proposed Award (or sufficient certainty that this will occur before the commencement date of new rights in the band) or in the event that Eir wins the 2300 - 2330 MHz frequency specific-lot[726] then there would not be a need to consider transition arrangement for the Eir 2.3 GHz network.

9.55 Second, in the event of **no further migration by Eir** before the holding of the Proposed Award (or insufficient certainty concerning any further migration before the commencement of new rights in the band) and assuming that Eir does not win new rights in the 2300 - 2330 MHz frequency specific-lot then:

[726] Should Eir win this frequency-specific lot, then a transition licence would not be required as the continued operation of the RurTel network would be facilitated under the new spectrum rights issued to Eir.

- First, and in light of ComReg's objective to promote the interests of users (including by ensuring that all users have access to a universal service), some transitional measures would appear justified to ensure that existing RurTel customers[727] can continue to access voice services beyond the commencement of new rights in the band. For example, until Eir migrated these customers onto an alternative platform/s, or sufficiently comparable services became available to these customers from another provider/s – which ever was the earliest;

- In that regard, ComReg proposes:

  - firstly, continuing to license the RurTel network under the existing licensing framework[728] but only up until the commencement date of new rights of use in the 2.3 GHz Band. That is, where ComReg would not renew or extend Eir's *existing* rights in the band beyond this date[729]; and

  - implementing a transitional licensing framework for the RurTel network whereby, following the Proposed Award and depending on the outcome of same, Eir would be provided an option, upon proper application (including payment of appropriate fees – see further below), to obtain sufficient transitional rights of use in the 2.3 GHz Band with which to maintain the RurTel services for a limited period of time and subject to various conditions (see further below);

[727] i.e. those customers remaining at the time of the commencement of new rights, noting the potential for sufficiently comparable voice services to be provided by alternative providers in the intervening period.

[728] See, in particular:

- the Wireless Telegraphy (Radio Link Licence) Regulations (S.I No. 370 of 2009); and
- ComReg's guidelines for fixed-link licences: *Guidelines to Applicants for Point to Point Radio Link Licences*, ComReg Document 09/89R2.

[729] In that regard, ComReg observes the considerable discretion afforded under the existing framework regarding, inter alia:

- whether to renew a licence: see Regulation 6(5) of the Wireless Telegraphy (Radio Link Licence) Regulations which provides that provides that, in considering whether to renew a licence, ComReg shall have particular regard to, amongst other things, the efficient management and use of radio spectrum);
- making changes to the point-to-point (including point-to-multipoint) Radio Link frequency bands available in Ireland and/or their technical conditions. See: ComReg's guidelines for fixed-link licences. Such changes may arise for a number of reasons, including: changes in spectrum allocations in accordance with the requirements of international treaties or regionally negotiated agreements; changes necessitated by EU legislation; changes in order to meet national requirements; and changes in the interest of efficient use of spectrum.; and
- requiring existing licensees to modify or cease their radio link operations in order to comply with the revised frequency bands and technical conditions (see: Regulation 8 of the Wireless Telegraphy (Radio Link Licence) Regulations).

- Second, and in terms of the general scope of any such transitional rights, and based on the available information and having regard to the approach taken in respect of the 3.6 GHz Award, ComReg envisages that:
    - such transitional rights would be on a protected basis given the nature of service (i.e. a universal service);
    - technical conditions similar to those currently in place would apply, subject to, among other things, any co-channel inter-operator coordination procedure determined by ComReg;
    - the frequency assignment and geographic scope would be varied by ComReg as necessary, including where some or all of its transitional rights would terminate earlier than Eir's proposed migration where existing active RurTel customers are in an actual position to avail of a sufficiently comparable alternative service from another operator/s (e.g. FWA with VoIP technology, mobile-based services (with a fixed repeater if required), point-to-point links in other bands, NBP etc.); and
    - there would be a clear end-date for all transitional rights which, based on current information and noting the rural locations of the existing customers, could be the ability of the RurTel customers to avail of the services that would be provided via the NBP.
- Third, it would also appear appropriate for ComReg to make the grant of any new transitional rights to Eir conditional upon it agreeing to appropriate measures that would ensure that it migrated its RurTel customers to an alternative platform/s in a timely, efficient and orderly manner, and that Eir had real incentives to do so;
- In that regard, such measures/conditions could firstly reflect those outlined above in respect of Time Slice 1 Transition:
    - proposed obligation on Eir to abide by the transition rules (including that it will undertake all reasonable and timely measures to migrate the remaining active customers of RurTel to an alternative Eir platform/s);
    - collection of information from Eir to inform ComReg's transition proposals, transition rules and transition plan;

- Eir being obliged to provide, as soon as practicable following the Proposed Award, a "transition plan proposal" to ComReg setting out, in detail, its proposed transition plan (with milestones etc);[730]
- setting of transition rules by which to formulate a transition plan; and
- implementation of the transition plan.

- Third, and in light of ComReg's power to impose fees for rights of use (which reflect the need to ensure the optimal use of the radio frequency spectrum) that the fees for any transitional rights would appropriately incentivise Eir to undertake its transition activities in a timely, effective, efficient and orderly manner. In that regard, ComReg currently envisages spectrum fees based on the higher of:
  - the existing fees set out in the Wireless Telegraphy (Radio Link Licence) Regulations (S.I No. 370 of 2009) but updated to present day prices using the overall CPI; or
  - the opportunity cost of the RurTel network remaining in the band beyond the commencement of new rights in the band. For example, and assuming a frequency-specific lot for the relevant frequencies, by reflecting the difference between the final prices for any frequency-specific lot and frequency-generic lots in the 2.3 GHz band (or a reasonable approximation of same given the proposed combinatorial nature of the auction proposed). ComReg also observes that visibility, including by way of this consultation, that such an approach would be implemented may provide incentives for Eir to progress its migration activities sufficiently in advance of the Proposed Award.

9.56 Third, in the event of **partial migration** in advance of the Proposed Award, then ComReg firstly observes that the transitional framework identified in respect of no migration would, in general terms, also be required for those areas not migrated (i.e. transitional rights of use to enable continued access to voice services, appropriate conditions etc.). However, certain specific measures (e.g. fees) identified in respect of no migration may need to be suitably adapted depending on the level of migration and the impact upon the Proposed Award. For example, if sufficient migration occurred so as to not warrant a frequency-specific lot for the relevant frequencies.

[730] For example:
- setting out in detail its proposed migration steps (i.e. key transition activities);
- the setting of milestone dates for each transition activity identified;
- a robust and transparent mechanism to allow ComReg (including any of its agents or servants), Winning Bidders and other interested parties to monitor compliance with the Transition Activity milestones and deliverable dates).

9.4 Preparatory Licences

9.57 In advance of the commencement date of any new licences issued, and in preparation for the provision of new services, winning bidders may wish to carry out preparations to their network to install or test equipment. Such preparations may require the winning bidder to keep and have possession of apparatus for wireless telegraphy, and unless licence exempted, a Wireless Telegraphy licence is required for such preparations.

9.58 Similar to the 2012 MBSA and the 3.6 GHz Award, ComReg proposes to make preparatory licences available to all winning bidders in the Proposed Award. Such licences would enable the installation of networks and associated equipment but would not allow any wireless telegraphy transmissions.

9.59 ComReg proposes that winning bidders would be able to apply for a preparatory licence following the completion of the Proposed Award and that these licences would operate until the commencement date of new licences.

9.60 Should a winning bidder wish to test or trial its network or a service in advance of the commencement of its spectrum rights, ComReg notes that winning bidders can apply for a Test or Trial licence[731].

[731] See www.testandtrial.ie

Chapter 10

10 Submitting comments and next steps

10.1 Submitting Comments

10.1 ComReg invites input from interested parties on all aspects of the Proposed Award over the next 6 weeks and by 30 July 2019. Considering the complexity of material contained in the document, ComReg has given an additional two weeks over the normal four identified in ComReg's Consultation Procedures[732].

10.2 It would make the task of analysing responses easier if comments were referenced to the relevant section / paragraph number in each chapter and annex in this document or the relevant accompanying consultant's report.

10.3 Please also set out your reasoning and all supporting information for any views expressed.

10.4 Responses must be submitted in written form (post or e-mail) to the following recipient, clearly marked —Submissions to ComReg 19/59:

Mr. Joseph Coughlan

Commission for Communications Regulation

One Dockland Central

Guild Street

Dublin 1

D01 E4X0.

Ireland

Email: marketframeworkconsult@comreg.ie

10.5 We request that electronic submissions be submitted in an unprotected format so that they can be readily included in the ComReg submissions document for electronic publication.

[732] Document 11/34

10.6 ComReg appreciates that respondents may wish to provide confidential information if their comments are to be meaningful. In order to promote openness and transparency, ComReg will publish all respondents' submissions to this consultation, as well as all substantive correspondence on matters relating to this document, subject to the provisions of ComReg's guidelines on the treatment of confidential information.

10.7 In this regard, respondents should submit views in accordance with the instructions set out below. When submitting a response to this consultation that contains confidential information, respondents must choose one of the following options:

A. Submit both a non-confidential version and a confidential version of the response. The confidential version must have all confidential information clearly marked and highlighted in accordance with the instruction set out below. The separate non-confidential version must have actually redacted all items that were marked and highlighted in the confidential version.

OR

B. Submit only a confidential version and ComReg will perform the required redaction to create a non-confidential version for publication. With this option, respondents must ensure that confidential information has been marked and highlighted in accordance with the instructions set out below. Where confidential information have not been marked as per our instructions below, then ComReg will not create the non-confidential redacted version and the respondent will have to provide the redacted non-confidential version in accordance with option A above.

10.8 For ComReg to perform the redactions under Option B above, respondents must mark and highlight all confidential information in their submission as follows:

a. Confidential information contained within a paragraph must be highlighted with a chosen particular colour,

b. Square brackets must be included around the confidential text (one at the start and one at the end of the relevant highlighted confidential information),

c. . A Scissors symbol& (Symbol code: Wingdings 2:38) must be included after the first square bracket.

For example, "Redtelecom has a market share of [✂ 25%]."

10.2 Next Steps

10.9 Following receipt and consideration of submissions in response to this consultation, and other relevant material, ComReg intends to publish a response to consultation together with a draft decision for the Proposed Award.

10.10 While ComReg cannot provide further clarity on the overall timelines at this juncture, as this will depend, among other things, on the nature of responses received to this consultation, ComReg hopes to issue the above by the end of 2019.

Annex: 1 Glossary

A1.1 Definitions

A 1.1 The definitions in this glossary shall apply to this document as a whole.

A 1.2 Where a term in this glossary is defined by reference to a definition in a section or paragraph and an explanation of that term is provided in this glossary, the latter explanation is for convenience only and reference should be made to the appropriate part of the document for the definitive meaning of that term in its appropriate context.

A 1.3 Any reference to any provision of any legislation shall include any modification re-enactment or extension thereof.

A 1.4 Terms defined in this consultation paper shall, unless the context otherwise requires or admits, have the meaning set out below:

3.6 GHz Band	The radio frequency spectrum in the range 3 400 MHz to 3 800 MHz.
2.6 GHz EC Decision	Refers to EC Decision 2008/477/EC. See section A1.3 below for further details
700 MHz band	The frequency range 694 – 790 MHz
700 MHz Duplex	The frequency range 703-733 MHz paired with 758-788 MHz
700 MHz Duplex Gap	The frequency range 733-758 MHz
700 MHz Guard Bands	Comprises of the following frequency ranges • 700 MHz Lower Guard Band (694 – 703 MHz); and, • 700 MHz Upper Guard Band (788-791 MHz));
800 MHz band	The frequency range 790 – 862 MHz
900 MHz band	The frequency range 880 – 915 MHz paired with 925 – 960 MHz

1.4 GHz band	The frequency range 1 427 – 1517 MHz
1.4 GHz Centre Band	The frequency range 1452 – 1492 MHz
1.4 GHz Extension Bands	The frequency ranges 1427-1452 MHz and 1492 – 1517 MHz
1 800 MHz band	The frequency range 1 710 – 1 785 MHz paired with 1 805 – 1 880 MHz
Unpaired 2.1 GHz Band	The frequency range 1900 – 1920 MHz
2.1 GHz Band	The frequency ranges 1920-1980 MHz paired with 2110-2170 MHz
2.3 GHz band	The frequency range 2 300 – 2 400 MHz
2.6 GHz band	The frequency range 2 500 – 2 690 MHz
26 GHz Band	The frequency range 24.25 – 27.5 GHz
Capacity band	A spectrum band whose propagation characteristics when used for mobile and similar services where user equipment is fitted with low gain antennas, render it unsuitable for its use to serve wide geographical areas, and may be more suitable for urban deployment as hot spots or high capacity infill.
Complementarity	The term can be taken as referring to spectrum bands where the value attributed by an interested party to spectrum in one band is enhanced by having or winning rights of use of spectrum in another band in relation to the Proposed Award.
Coverage band	A spectrum band whose propagation characteristics when used with low gain antennas, render it suitable to serve wide

	geographical areas, such as the deployment of macro cells for wide area services.
General Authorisation	An authorisation for an undertaking to provide an electronic communications network or service under and in accordance with Regulation 4 of the Authorisation Regulations.
2012 MBSA	2012 MBSA or the MBSA Process refers to the Multi-Band Spectrum Award process whose final results were announced in ComReg Document 12/131 on 5 December 2012
3.6 GHz Award	Refers to the award process whose final results were announced in ComReg Document 17/46 on 1 June 2017
NGA	Next Generation Access
NRA	National Regulatory Authority
RIA	Regulatory Impact Assessment, an analysis of the likely effect of, and necessity of, a proposed new regulation or regulatory change. Such assessments are carried out in accordance with Document 07/56a - Guidelines on ComReg‘s approach to Regulatory Impact Assessment - August 2007.
Spectrum right of use	Authorisation to use certain radio frequencies subject to such conditions and restrictions as may be prescribed in a licence or by any Regulations made by ComReg under section 6 of the Act of 1926.
Substitutability	The term can be taken as referring to spectrum bands which can serve the same purpose for interested parties and so those parties are relatively indifferent to switching between those bands in relation to the Proposed Award.
WBB	Wireless broadband

A1.2 European and Governmental Bodies, Regulatory and Standardisation Organisations

3GPP	The 3rd Generation Partnership Project
ComReg	Commission for Communications Regulation
CEPT	Conférence européenne des Administration des postes et des télécommunications. In English, European Conference of Postal and Telecommunications Administrations
DCCAE	Department of Communications, Climate Action and the Environment
EC	European Commission
ECC	Electronic Communications Committee (of CEPT)
ECO	European Communications Office
EU	European Union
ITU	International Telecommunication Union
RSPG	Radio Spectrum Policy Group

A1.3 Primary and Secondary Legislation

S.I.	Statutory Instrument
2002 Act	The Communications Regulation Act 2002 (No. 20 of 2002), as amended[733]
Authorisation Regulations	European Communities (Electronic Communication Networks and Services) (Authorisation) Regulations 2011 (S.I. No 335 of 2011)
Directive 2002/77/EC	A European Commission Directive on competition in the markets for electronic communications networks and services
2.6 GHz EC Decision / EC Decision 2008/477/EC	European Commission Decision on the harmonisation of the 2 500 - 2 690 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community
2.1 GHz EC Decision / EC Decision 2012/688/EU	European Commission Decision on the harmonisation of the frequency bands 1 920 – 1 980 MHz and 2 110 – 2 170 MHz for terrestrial systems capable of providing electronic communications services in the Community
700 MHz EC Decision / EC Decision 2016/687/EU	European Commission Decision on the harmonisation of the 694 - 790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services and for flexible national use in the Union
EC Decision 2009/766/EC	European Commission Decision on the harmonisation of the 900 MHz and 1 800 MHz frequency band for terrestrial systems capable of

[733] Includes the Communications Regulation (Amendment) Act 2007 and the Communications Regulation (Premium Rate Services and Electronic Communications Infrastructure) Act 2010.

	providing pan-European electronic communications services in the Community
EC Decision 2011/251/EU	European Commission Decision, amending Decision 2009/766/EC, on the harmonisation of the 900 MHz and 1 800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community.
3.6 GHz EC Decision / EC Decision 2014/276/EU	European Commission Decision on amending Decision 2008/411/EC on the harmonisation of the 3 400 – 3 800 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community.
European Parliament and Council Decision 243/2012/EU	European Parliament and Council Decision establishing a multi-annual radio spectrum policy programme.
ECC Decision (13)03	Electronic Communications Committee decision to harmonise the use of the frequency band 1 452-1 492 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL).
2.3 GHz ECC Decision / ECC Decision ECC/DEC(14)02	Electronic Communications Committee decision to harmonised technical and regulatory conditions for the use of the band 2 300 - 2 400 MHz for Mobile/Fixed Communications Networks (MFCN).
Framework Regulations	European Communities (Electronic Communications Networks and Services) (Framework) Regulations 2011 (S.I. No 333 of 2011)
Specific Regulations	Specific Regulations has the same meaning as set out in Regulation 2 of the Framework Regulations

A1.4 Glossary of Technical Terms

3G	Third Generation Mobile System (e.g. UMTS)
BEM	A Block-Edge Mask (BEM) "*is an emission mask that is defined, as a function of frequency, relative to the edge of a block of spectrum for which rights of use are granted to an operator. It consists of in-block and out-of-block components which specify the permitted emission levels over frequencies inside and outside the licensed block of spectrum, respectively."* (Source Annex to Decision 2012/688/EU)
CPI	Consumer Price Index
DTT	Digital Terrestrial Television
ECN	Electronic Communications Networks
ECS	Electronic Communications Service as defined under the Framework Regulations
FDD	Frequency Division Duplex
FWA	Fixed Wireless Access
FWALA	Fixed Wireless Access Local Area
GHz	Gigahertz (1 000 000 000 Hertz)
Guard-band	An unused spectrum bandwidth separating channels to prevent interference
GSA	The Global mobile Suppliers Association - an organisation which represents suppliers of equipment and services to the mobile industry
GSM	Global System for Mobile Communications

GSMA	GSM Association - – an organisation which represents mobile operators
Hertz	Unit of Frequency
kHz	Kilohertz (1 000 Hertz)
LTE	Long Term Evolution of 3G
LTE Advanced / LTE+	An evolution of LTE, having the capability to provide 4G services.
MFCN	Mobile/fixed communications networks
MHz	Megahertz (1 000 000 Hertz)
MNO	Mobile Network Operator
MVNO	Mobile Virtual Network Operator (a licensed mobile operator with no spectrum assignment and with or without network infrastructure)
BB-PPDR	**Broadband (BB)** **Public Protection (PP)** radio communication: Radio communications used by responsible agencies and organisations dealing with maintenance of law and order, protection of life and property, and emergency situations. **Disaster Relief (DR)** radio communication: Radio communications used by agencies and organisations dealing with a serious disruption of the functioning of society, posing a significant, widespread threat to human life, health, property or the environment, whether caused by accident, nature or human activity, and whether developing suddenly or as a result of complex, long-term processes.
SDL	Supplementary Downlink

TDD	Time Division Duplex
TD-LTE	Time Division – Long Term Evolution
TRP	Total Radiated Power
UMTS	Universal Mobile Telecommunications System.
WDMDS	Wideband Digital Mobile Data Services
WRC	World Radiocommunications Conference

A1.5 Glossary of respondents[734]

Dense Air	Dense Air Ireland Limited
Eircom	Eircom Limited
Ericsson	Ericsson Ireland / Ericsson AB
ESBN	Electricity Supply Board Networks Limited
Imagine	Imagine Communications Ireland Ltd
JRC	Joint Radio Company Ltd
Three	Three Ireland Hutchison Ltd.
Vodafone	Vodafone Ireland Limited

[734] This list provides the reference used in this document and further details for the entity(s) where known. Not all respondents provided full details of its company name in its response. ComReg has aimed to update the table based on the information available to it, but would appreciate clarifications on same.

Annex: 2 Legal Framework and Statutory Objectives

A 2.5 The Communications Regulation Act 2002 (as amended by the Communications Regulation (Amendment) Act 2007) (the "2002 Act"), the EU Common Regulatory Framework (including the Framework and Authorisation Directives[735] as transposed into Irish law by the corresponding Framework and Authorisation Regulations[736]), and the Wireless Telegraphy Acts1926 to 2009[737] set out, amongst other things, powers, functions, duties and objectives of ComReg that are relevant to the management of the radio frequency spectrum in Ireland and to this consultation document.

A 2.6 Apart from licensing and making regulations in relation to licences, ComReg's functions include the management of Ireland's radio frequency spectrum in accordance with ministerial Policy Directions under section 13 of the 2002 Act, having regard to its objectives under section 12 of the 2002 Act, Regulation 16 of the Framework Regulations and the provisions of Article 8a of the Framework Directive. ComReg is to carry out its functions effectively, and in a manner serving to ensure that the allocation and assignment of radio frequencies is based on objective, transparent, non-discriminatory and proportionate criteria.

A 2.7 This annex is intended as a general guide as to ComReg's role in this area, and not as a definitive or exhaustive legal exposition of that role. Further, this annex restricts itself to consideration of those powers, functions, duties and objectives of ComReg that appear most relevant to the matters at hand and generally excludes those not considered relevant (for example, in relation to postal services, premium rate services or market analysis). For the avoidance of doubt, however, the inclusion of particular material in this annex does not necessarily mean that ComReg considers same to be of specific relevance to the matters at hand.

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[735] Directive No. 2002/21/EC of the European Parliament and of the Council of 7 March 2002 (as amended by Regulation (EC) No. 717/2007 of 27 June 2007, Regulation (EC) No. 544/2009 of 18 June 2009 and Directive 2009/140/EC of the European Parliament and Council of 25 November 2009) (the "Framework Directive") and Directive No. 2002/20/EC of the European Parliament and of the Council of 7 March 2002 (as amended by Directive 2009/140/EC) (the "Authorisation Directive").

[736] The European Communities (Electronic Communications Networks and Services) (Framework) Regulations 2011 (S.I. No. 333 of 2011) and the European Communities (Electronic Communications Networks and Services) (Authorisation) Regulations 2011 (S.I. No. 335 of 2011) respectively.

[737] The Wireless Telegraphy Acts 1926 to 1988 and Sections 181 (1) to (7) and (9) and Section 182 of the Broadcasting Act 2009.

A 2.8 All references in this annex to enactments are to the enactment as amended at the date hereof, unless the context otherwise requires.

New European Electronic Communications Code

A 2.9 On 20 December 2018, *Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code* ("EECC") entered into force.

A 2.10 The EECC replaces the EU Common Regulatory Framework adopted in 2002 (and amended in 2009) under which ComReg has regulated electronic communications since 2003.

A 2.11 With some limited exceptions (see Article 124 of the EECC), Member States have until 21 December 2020 to transpose the EECC into national law.[738] Until then, the existing EU Common Regulatory Framework will continue to apply. However, in developing its proposals for the Proposed Award, ComReg is mindful of the EECC.

A 2.12 ComReg understands that the DCCAE will be responsible for the transposition of the EECC and will assist as appropriate.

A2.1 Primary Objectives and Regulatory Principles under the 2002 Act and Common Regulatory Framework

A 2.13 ComReg's primary objectives in carrying out its statutory functions in the context of electronic communications are to:

- promote competition[739];
- contribute to the development of the internal market[740];
- promote the interests of users within the Community[741];

[738] With the exception of Articles 53(2), (3) and (4), and Article 54 (see Article 124).
[739] Section 12 (1)(a)(i) of the 2002 Act.
[740] Section 12 (1)(a)(ii) of the 2002 Act.
[741] Section 12(1)(a)(iii) of the 2002 Act.

- ensure the efficient management and use of the radio frequency spectrum in Ireland in accordance with a direction under section 13 of the 2002 Act[742]; and

- unless otherwise provided for in Regulation 17 of the Framework Regulations, take the utmost account of the desirability of technological neutrality in complying with the requirements of the Specific Regulations[743] in particular those designed to ensure effective competition[744].

A2.1.1 Promotion of Competition

A 2.14 Section 12(2)(a) of the 2002 Act requires ComReg to take all reasonable measures which are aimed at the promotion of competition, including:

- ensuring that users, including disabled users, derive maximum benefit in terms of choice, price and quality;

- ensuring that there is no distortion or restriction of competition in the electronic communications sector; and

- encouraging efficient use and ensuring the effective management of radio frequencies and numbering resources.

A 2.15 In so far as the promotion of competition is concerned, Regulation 16(1)(b) of the Framework Regulations also requires ComReg to:

- ensure that elderly users and users with special social needs derive maximum benefit in terms of choice, price and quality, and

- ensure that, in the transmission of content, there is no distortion or restriction of competition in the electronic communications sector.

A 2.16 Regulation 9(11) of the Authorisation Regulations also provides that ComReg must ensure that radio frequencies are efficiently and effectively used having regard to section 12(2)(a) of the 2002 Act and Regulations

[742] Section 12(1)(b) of the 2002 Act. Whilst this objective would appear to be a separate and distinct objective in the 2002 Act, it is noted that, for the purposes of ComReg's activities in relation to electronic communications networks and services ("ECN" and "ECS"), Article 8 of the Framework Directive identifies "*encouraging efficient use and ensuring the effective management of radio frequencies (and numbering resources*)" as a sub-objective of the broader objective of the promotion of competition.

[743] The 'Specific Regulations' comprise collectively the Framework Regulations, the Authorisation Regulations, the European Communities (Electronic Communications Networks and Services) (Access) Regulations 2011 (S.I. No. 334 of 2011), the European Communities (Electronic Communications Networks and Services) (Universal Service and Users' Rights) Regulations 2011 (S.I. 337 of 2011) and the European Communities (Electronic Communications Networks and Services) (Privacy and Electronic Communications) Regulations 2011 (S.I. No. 336 of 2011).

[744] Regulation 16(1)(a) of the Framework Regulations.

16(1) and 17(1) of the Framework Regulations. Regulation 9(11) further provides that ComReg must ensure that competition is not distorted by any transfer or accumulation of rights of use for radio frequencies, and, for this purpose, ComReg may take appropriate measures such as mandating the sale or the lease of rights of use for radio frequencies.

A2.1.2 Contributing to the Development of the Internal Market

A 2.17 Section 12(2)(b) of the 2002 Act requires ComReg to take all reasonable measures which are aimed at contributing to the development of the internal market, including:

- removing remaining obstacles to the provision of ECN, ECS and associated facilities at Community level;
- encouraging the establishment and development of trans-European networks and the interoperability of transnational services and end-to-end connectivity; and
- co-operating with electronic communications national regulatory authorities in other Member States of the Community and with the Commission of the Community in a transparent manner to ensure the development of consistent regulatory practice and the consistent application of Community law in this field.

A 2.18 In so far as contributing to the development of the internal market is concerned, Regulation 16(1)(c) of the Framework Regulations also requires ComReg to co-operate with the Body of European Regulators for Electronic Communications ("BEREC") in a transparent manner to ensure the development of consistent regulatory practice and the consistent application of EU law in the field of electronic communications.

A2.1.3 Promotion of Interests of Users

A 2.19 Section 12(2)(c) of the 2002 Act requires ComReg, when exercising its functions in relation to the provision of electronic communications networks and services, to take all reasonable measures which are aimed at the promotion of the interests of users within the Community, including:

- ensuring that all users have access to a universal service;
- ensuring a high level of protection for consumers in their dealings with suppliers, in particular by ensuring the availability of simple and inexpensive dispute resolution procedures carried out by a body that is independent of the parties involved;

- contributing to ensuring a high level of protection of personal data and privacy;
- promoting the provision of clear information, in particular requiring transparency of tariffs and conditions for using publicly available ECS;
- encouraging access to the internet at reasonable cost to users;
- addressing the needs of specific social groups, in particular disabled users; and
- ensuring that the integrity and security of public communications networks are maintained.

A 2.20 In so far as promotion of the interests of users within the EU is concerned, Regulation 16(1)(d) of the Framework Regulations also requires ComReg to:

- address the needs of specific social groups, in particular, elderly users and users with special social needs, and
- promote the ability of end-users to access and distribute information or use applications and services of their choice.

A2.1.4 Regulatory Principles

A 2.21 In pursuit of its objectives under Regulation 16(1) of the Framework Regulations and section 12 of the 2002 Act, ComReg must apply objective, transparent, non-discriminatory and proportionate regulatory principles by, amongst other things:

- promoting regulatory predictability by ensuring a consistent regulatory approach over appropriate review periods;
- ensuring that, in similar circumstances, there is no discrimination in the treatment of undertakings providing ECN and ECS;
- safeguarding competition to the benefit of consumers and promoting, where appropriate, infrastructure-based competition;
- promoting efficient investment and innovation in new and enhanced infrastructures, including by ensuring that any access obligation takes appropriate account of the risk incurred by the investing undertakings and by permitting various cooperative arrangements between investors and parties seeking access to diversify the risk of investment, while ensuring that competition in the market and the principle of non-discrimination are preserved;

- taking due account of the variety of conditions relating to competition and consumers that exist in the various geographic areas within the State; and

- imposing ex-ante regulatory obligations only where there is no effective and sustainable competition and relaxing or lifting such obligations as soon as that condition is fulfilled.

A2.1.5 BEREC

A 2.22 Under Regulation 16(1)(3) of the Framework Regulations, ComReg must:

- having regard to its objectives under section 12 of the 2002 Act and its functions under the Specific Regulations, actively support the goals of BEREC of promoting greater regulatory co-ordination and coherence; and

- take the utmost account of opinions and common positions adopted by BEREC when adopting decisions for the national market.

A2.1.6 Other Obligations under the 2002 Act

A 2.23 In carrying out its functions, ComReg is required, amongst other things, to:

- seek to ensure that any measures taken by it are proportionate having regard to the objectives set out in section 12 of the 2002 Act;[745]

- have regard to international developments with regard to the radio frequency spectrum[746]; and

- take the utmost account of the desirability that the exercise of its functions aimed at achieving its radio frequency management objectives does not result in discrimination in favour of or against particular types of technology for the provision of ECS.[747]

A2.1.7 Policy Directions[748]

A 2.24 Section 12(4) of the 2002 Act provides that, in carrying out its functions, ComReg must have appropriate regard to policy statements, published by or on behalf of the Government or a Minister of the Government and notified to the Commission, in relation to the economic and social

[745] Section 12(3) of the 2002 Act.
[746] Section 12(5) of the 2002 Act.
[747] Section 12(6) of the 2002 Act.
[748] ComReg also notes, and takes due account of, the Spectrum Policy Statement issued by the Department of Communications Energy and Natural Resources in September 2010.

development of the State. Section 13(1) of the 2002 Act requires ComReg to comply with any policy direction given to ComReg by the Minister for Communications, Energy and Natural Resources ("the Minister") as he or she considers appropriate, in the interests of the proper and effective regulation of the electronic communications market, the management of the radio frequency spectrum in the State and the formulation of policy applicable to such proper and effective regulation and management, to be followed by ComReg in the exercise of its functions. Section 10(1)(b) of the 2002 Act also requires ComReg, in managing the radio frequency spectrum, to do so in accordance with a direction of the Minister under section 13 of the 2002 Act, while Section 12(1)(b) requires ComReg to ensure the efficient management and use of the radio frequency spectrum in accordance with a direction under Section 13.

A 2.25 The Policy Directions which are most relevant in this regard include the following:

Policy Direction No.3 on Broadband Electronic Communication Networks

A 2.26 ComReg shall in the exercise of its functions, take into account the national objective regarding broadband rollout, viz, the Government wishes to ensure the widespread availability of open-access, affordable, always-on broadband infrastructure and services for businesses and citizens on a balanced regional basis within three years, on the basis of utilisation of a range of existing and emerging technologies and broadband speeds appropriate to specific categories of service and customers.

Policy Direction No.4 on Industry Sustainability

A 2.27 ComReg shall ensure that in making regulatory decisions in relation to the electronic communications market, it takes account of the state of the industry and in particular the industry's position in the business cycle and the impact of such decisions on the sustainability of the business of undertakings affected.

Policy Direction No.5 on Regulation only where Necessary

A 2.28 Where ComReg has discretion as to whether to impose regulatory obligations, it shall, before deciding to impose such regulatory obligations on undertakings, examine whether the objectives of such regulatory obligations would be better achieved by forbearance from imposition of such obligations and reliance instead on market forces.

Policy Direction No.6 on Regulatory Impact Assessment

A 2.29 ComReg, before deciding to impose regulatory obligations on undertakings in the market for electronic communications or for the purposes of the management and use of the radio frequency spectrum or

for the purposes of the regulation of the postal sector, shall conduct a Regulatory Impact Assessment in accordance with European and International best practice and otherwise in accordance with measures that may be adopted under the Government's Better Regulation programme.

Policy Direction No.7 on Consistency with other Member States

A 2.30 ComReg shall ensure that, where market circumstances are equivalent, the regulatory obligations imposed on undertakings in the electronic communications market in Ireland should be equivalent to those imposed on undertakings in equivalent positions in other Member States of the European Community.

Policy Direction No.11 on the Management of the Radio Frequency Spectrum

A 2.31 ComReg shall ensure that, in its management of the radio frequency spectrum, it takes account of the interests of all users of the radio frequency spectrum.

General Policy Direction No.1 on Competition (2004)

A 2.32 ComReg shall focus on the promotion of competition as a key objective. Where necessary, ComReg shall implement remedies which counteract or remove barriers to market entry and shall support entry by new players to the market and entry into new sectors by existing players. ComReg shall have a particular focus on:

- market share of new entrants;
- ensuring that the applicable margin attributable to a product at the wholesale level is sufficient to promote and sustain competition;
- price level to the end user;
- competition in the fixed and mobile markets; and
- the potential of alternative technology delivery platforms to support competition

A2.2 Other Relevant Obligations under the Framework and Authorisation Regulations

A2.2.1 Framework Regulations

Regulation 17

A 2.33 Regulation 17 of the Framework Regulations governs the management of radio frequencies for ECS. Regulation 17(1) requires that ComReg, subject to any directions issued by the Minister pursuant to Section 13 of the 2002 Act and having regard to its objectives under Section 12 of the 2002 Act and Regulation 16 of the Framework Regulations and the provisions of Article 8a of the Framework Directive, ensure:

- the effective management of radio frequencies for ECS;
- that spectrum allocation used for ECS and issuing of general authorisations or individual rights of use for such radio frequencies are based on objective, transparent, non-discriminatory and proportionate criteria; and
- ensure that harmonisation of the use of radio frequency spectrum across the EU is promoted, consistent with the need to ensure its effective and efficient use and in pursuit of benefits for the consumer such as economies of scale and interoperability of services, having regard to all decisions and measures adopted by the European Commission in accordance with Decision No. 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the EU.

A 2.34 Regulation 17(2) provides that, unless otherwise provided in Regulation 17(3), ComReg must ensure that all types of technology used for ECS may be used in the radio frequency bands that are declared available for ECS in the Radio Frequency Plan published under Section 35 of the 2002 Act in accordance with EU law.

A 2.35 Regulation 17(3) provides that, notwithstanding Regulation 17(2), ComReg may, through licence conditions or otherwise, provide for proportionate and non-discriminatory restrictions to the types of radio network or wireless access technology used for ECS where this is necessary to:

- avoid harmful interference;
- protect public health against electromagnetic fields;

- ensure technical quality of service;
- ensure maximisation of radio frequency sharing;
- safeguard the efficient use of spectrum; or
- ensure the fulfilment of a general interest objective as defined by or on behalf of the Government or a Minister of the Government in accordance with Regulation 17(6).

A 2.36 Regulation 17(4) requires that, unless otherwise provided in Regulation 17(5), ComReg must ensure that all types of ECS may be provided in the radio frequency bands, declared available for ECS in the Radio Frequency Plan published under Section 35 of the Act of 2002 in accordance with EU law.

A 2.37 Regulation 17(5) provides that, notwithstanding Regulation 17(4), ComReg may provide for proportionate and non-discriminatory restrictions to the types of ECS to be provided, including where necessary, to fulfil a requirement under the International Telecommunication Union Radio Regulations ("ITU-RR").

A 2.38 Regulation 17(6) requires that measures that require an ECS to be provided in a specific band available for ECS must be justified in order to ensure the fulfilment of a general interest objective as defined by or on behalf of the Government or a Minister of the Government in conformity with EU law such as, but not limited to:

- safety of life;
- the promotion of social, regional or territorial cohesion;
- the avoidance of inefficient use of radio frequencies; or
- the promotion of cultural and linguistic diversity and media pluralism, for example, by the provision of radio and television broadcasting services.

A 2.39 Regulation 17(7) provides that ComReg may only prohibit the provision of any other ECS in a specific radio spectrum frequency band where such a prohibition is justified by the need to protect safety of life services. ComReg may, on an exceptional basis, extend such a measure in order to fulfil other general interest objectives as defined by or on behalf of the Government or a Minister of the Government.

A 2.40 Regulation 17(8) provides that ComReg must, in accordance with Regulation 18, regularly review the necessity of the restrictions referred to in Regulations 17(3) and 17(5) and must make the results of such reviews publicly available.

A 2.41 Regulation 17(9) provides that Regulations 17(2) to (7) only apply to spectrum allocated to be used for ECS, general authorisations issued and individual rights of use for radio frequencies granted after 1 July 2011. Spectrum allocations, general authorisations and individual rights of use which already existed on 1 July 2011 are subject to Regulation 18 of the Framework Regulations.

A 2.42 Regulation 17(10) provides that ComReg may, having regard to its objectives under Section 12 of the 2002 Act and Regulation 16 and its functions under the Specific Regulations, lay down rules in order to prevent spectrum hoarding, in particular by setting out strict deadlines for the effective exploitation of the rights of use by the holder of rights and by withdrawing the rights of use in cases of non-compliance with the deadlines. Any rules laid down under this Regulation must be applied in a proportionate, non-discriminatory and transparent manner.

A 2.43 Regulation 17(11) requires ComReg to, in the fulfilment of its obligations under that Regulation, respect relevant international agreements, including the ITU-RR and any public policy considerations brought to its attention by the Minister.

Regulation 23 on security and integrity and Regulation 24 on implementation and enforcement of Regulation 23

A 2.44 Regulation 23 provides:

> 23. (1) Undertakings providing public communications networks or publicly available electronic communications services shall take appropriate technical and organisational measures to appropriately manage the risks posed to security of networks and services. In particular, measures shall be taken to prevent and minimise the impact of security incidents on users and interconnected networks.
>
> (2) The technical and organisational measures referred to in paragraph (1) shall, having regard to the state of the art, ensure a level of security appropriate to the risk presented.
>
> (3) Undertakings providing public communications networks shall take all appropriate steps to guarantee the integrity of their networks, thereby ensuring the continuity of supply of services provided over those networks.
>
> (4) (a) An undertaking providing public communications networks or publicly available electronic communications services shall notify the Regulator in the event of a breach of security or loss of integrity that has a significant impact on the operation of networks or services.
>
> (b) Where the Regulator receives a notification under subparagraph (a), it shall inform the Minister of the said notification and, with the agreement of

the Minister, it shall also, where appropriate, inform the national regulatory authorities in other Member States and ENISA.

(c) Where it is considered that it is in the public interest to do so the Regulator, with the agreement of the Minister, may inform the public in relation to the breach notified under subparagraph (a) or require the undertaking to inform the public accordingly.

(5) The Regulator shall annually submit a summary report to the Minister, the European Commission and EINSA on the notifications received and the actions taken in accordance with paragraph (4).

(6) An undertaking that fails to comply with the requirements of paragraph (4)(a) or (c) commits an offence.

A 2.45 Regulation 24 provides:

24. (1) For the purpose of ensuring compliance with Regulation 23 (1), (2) and (3), the Regulator may issue directions to an undertaking providing public communications networks or publicly available electronic communications services, including directions in relation to time limits for implementation.

(2) The Regulator may require an undertaking providing public communications networks or publicly available electronic communications services to—

(a) provide information needed to assess the security or integrity of their services and networks, including documented security policies, and

(b) submit to a security audit to be carried out by a qualified independent body nominated by the Regulator and make the results of the audit available to the Regulator and the Minister. The cost of the audit is to be borne by the undertaking.

(3) An undertaking in receipt of a direction under paragraph (1) shall comply with the direction.

(4) An undertaking that fails to comply with a direction under paragraph (1) or a requirement under paragraph (2) commits an offence.

A2.2.2 Authorisation Regulations

Decision to limit rights of use for radio frequencies

A 2.46 Regulation 9(2) of the Authorisation Regulations provides that ComReg may grant individual rights of use for radio frequencies by way of a licence where it considers that one or more of the following criteria are applicable:

- it is necessary to avoid harmful interference;
- it is necessary to ensure technical quality of service;

- it is necessary to safeguard the efficient use of spectrum; or
- it is necessary to fulfil other objectives of general interest as defined by or on behalf of the Government or a Minister of the Government in conformity with EU law.

A 2.47 Regulation 9(10) of the Authorisation Regulations provides that ComReg must not limit the number of rights of use for radio frequencies to be granted except where this is necessary to ensure the efficient use of radio frequencies in accordance with Regulation 11.

A 2.48 Regulation 9(7) also provides that:

- where individual rights of use for radio frequencies are granted for a period of 10 years or more and such rights may not be transferred or leased between undertakings in accordance with Regulation 19 of the Framework Regulations, ComReg must ensure that criteria set out in Regulation 9(2) apply for the duration of the rights of use, in particular upon a justified request from the holder of the right.
- where ComReg determines that the criteria referred to in Regulation 9(2) are no longer applicable to a right of use for radio frequencies, ComReg must, after a reasonable period and having notified the holder of the individual rights of use, change the individual rights of use into a general authorisation or must ensure that the individual rights of use are made transferable or leasable between undertakings in accordance with Regulation 19 of the Framework Regulations.

Publication of procedures

A 2.49 Regulation 9(4)(a) of the Authorisation Regulations requires that ComReg, having regard to the provisions of Regulation 17 of the Framework Regulations, establish open, objective, transparent, non-discriminatory and proportionate procedures for the granting of rights of use for radio frequencies and cause any such procedures to be made publicly available.

Duration of rights of use for radio frequencies

A 2.50 Regulation 9(6) of the Authorisation Regulations provides that rights of use for radio frequencies must be in force for such period as ComReg considers appropriate having regard to the network or service concerned in view of the objective pursued taking due account of the need to allow for an appropriate period for investment amortisation.

Conditions attached to rights of use for radio frequencies

A 2.51 Regulation 9(5) of the Authorisation Regulations provides that, when granting rights of use for radio frequencies, ComReg must, having regard

to the provisions of Regulations 17 and 19 of the Framework Regulations, specify whether such rights may be transferred by the holder of the rights and under what conditions such a transfer may take place.

A 2.52 Regulation 10(1) of the Authorisation Regulations provides that, notwithstanding Section 5 of the Wireless Telegraphy Act,1926, but subject to any regulations under Section 6 of that Act, ComReg may only attach those conditions listed in Part B of the Schedule to the Authorisation Regulations. Part B lists the following conditions which may be attached to rights of use:

- Obligation to provide a service or to use a type of technology for which the rights of use for the frequency has been granted including, where appropriate, coverage and quality requirements.
- Effective and efficient use of frequencies in conformity with the Framework Directive and Framework Regulations.
- Technical and operational conditions necessary for the avoidance of harmful interference and for the limitation of exposure of the general public to electromagnetic fields, where such conditions are different from those included in the general authorisation.
- Maximum duration in conformity with Regulation 9, subject to any changes in the national frequency plan.
- Transfer of rights at the initiative of the rights holder and conditions of such transfer in conformity with the Framework Directive.
- Usage fees in accordance with Regulation 19.
- Any commitments which the undertaking obtaining the usage right has made in the course of a competitive or comparative selection procedure.
- Obligations under relevant international agreements relating to the use of frequencies.
- Obligations specific to an experimental use of radio frequencies.

A 2.53 Regulation 10(2) also requires that any attachment of conditions under Regulation 10(1) to rights of use for radio frequencies must be non-discriminatory, proportionate and transparent and in accordance with Regulation 17 of the Framework Regulations.

Procedures for limiting the number of rights of use to be granted for radio frequencies

A 2.54 Regulation 11(1) of the Authorisation Regulations provides that, where ComReg considers that the number of rights of use to be granted for radio frequencies should be limited it must, without prejudice to Sections 13 and 37 of the 2002 Act:

- give due weight to the need to maximise benefits for users and to facilitate the development of competition, and
- give all interested parties, including users and consumers, the opportunity to express their views in accordance with Regulation 12 of the Framework Regulations.

A 2.55 Regulation 11(2) of the Authorisation Regulations requires that, when granting the limited number of rights of use for radio frequencies it has decided upon, ComReg does so *"…on the basis of selection criteria which are objective, transparent, non-discriminatory and proportionate and which give due weight to the achievement of the objectives set out in Section 12 of the 2002 Act and Regulations 16 and 17 of the Framework Regulations."*

A 2.56 Regulation 11(4) provides that where it decides to use competitive or comparative selection procedures, ComReg must, inter alia, ensure that such procedures are fair, reasonable, open and transparent to all interested parties.

Fees for spectrum rights of use

A 2.57 Regulation 19 of the Authorisation Regulations permits ComReg to impose fees for rights of use which reflect the need to ensure the optimal use of the radio frequency spectrum.

A 2.58 ComReg is required to ensure that any such fees are objectively justified, transparent, non-discriminatory and proportionate in relation to their intended purpose and take into account the objectives of ComReg as set out in Section 12 of the 2002 Act and Regulation 16 of the Framework Regulations.

Amendment of rights and obligations

A 2.59 Regulation 15 of the Authorisation Regulations permits ComReg to amend rights and conditions concerning rights of use, provided that any such amendments may only be made in objectively justified cases and in a proportionate manner, following the process set down in Regulation 15(4).

A2.3 Other Relevant Provisions

Wireless Telegraphy Act, 1926 (the "1926 Act")

A 2.60 Under Section 5(1) of the 1926 Act, ComReg may, subject to that Act, and on payment of the prescribed fees (if any), grant to any person a licence to keep and have possession of apparatus for wireless telegraphy in any specified place in the State.

A 2.61 Section 5(2) provides that, such a licence shall be in such form, continue in force for such period and be subject to such conditions and restrictions (including conditions as to suspension and revocation) as may be prescribed in regard to it by regulations made by ComReg under Section 6.

A 2.62 Section 5(3) also provides that, where it appears appropriate to ComReg, it may, in the interests of the efficient and orderly use of wireless telegraphy, limit the number of licences for any particular class or classes of apparatus for wireless telegraphy granted under Section 5.

A 2.63 Section 6 provides that ComReg may make regulations prescribing in relation to all licences granted by it under Section 5, or any particular class or classes of such licences, all or any of the following matters:

- the form of such licences;
- the period during which such licences continue in force;
- the manner in which, the terms on which, and the period or periods for which such licences may be renewed;
- the circumstances in which or the terms under which such licences are granted;
- the circumstances and manner in which such licences may be suspended or revoked by ComReg;
- the terms and conditions to be observed by the holders of such licences and subject to which such licences are deemed to be granted;
- the fees to be paid on the application, grant or renewal of such licences or classes of such licences, subject to such exceptions as ComReg may prescribe, and the time and manner at and in which such fees are to be paid; and
- matters which such licences do not entitle or authorise the holder to do.

A 2.64 Section 6(2) provides that Regulations made by ComReg under Regulation 6 may authorise and provide for the granting of a licence under Section 5 subject to special terms, conditions, and restrictions to persons who satisfy it that they require the licences solely for the purpose of conducting experiments in wireless telegraphy.

A 2.65 Regulation 10(1) of the Authorisation Regulations provides that, notwithstanding section 5 of the Act of 1926 but subject to any regulations made under section 6 of that Act, where ComReg attaches conditions to rights of use for radio frequencies, it may only attach such conditions as are listed in Part B of the Schedule to the Authorisation Regulations.

Broadcasting Act 2009 (the "2009 Act")

A 2.66 Section 132 of the 2009 Act relates to the duties of ComReg in respect of the licensing of spectrum for use in establishing digital terrestrial television multiplexes and places an obligation on ComReg to issue:

- two DTT multiplex licences to RTÉ by request (see Sections 132(1) and (2) of the 2009 Act); and
- a minimum of four DTT multiplex licences to the BAI by request (see Sections 132(3) and (4) of the 2009 Act) for the provision of commercial TV content.

Article 4 of Directive 2002/77/EC (Competition Directive)

A 2.67 Article 4 of the Competition Directive provides that:

"Without prejudice to specific criteria and procedures adopted by Member States to grant rights of use of radio frequencies to providers of radio or television broadcast content services with a view to pursuing general interest objectives in conformity with Community law:

- *Member States shall not grant exclusive or special rights of use of radio frequencies for the provision of electronic communications services.*
- *The assignment of radio frequencies for electronic communication services shall be based on objective, transparent, non-discriminatory and proportionate criteria."*

Radio Spectrum Policy Programme

A 2.68 On 15 February 2012, the European Parliament adopted the five-year Radio Spectrum Policy Programme ("RSPP") which establishes a multi-annual radio spectrum policy programme for the strategic planning and

harmonisation of the use of spectrum. The objective is to ensure the functioning of the internal market in the Union policy areas involving the use of spectrum, such as electronic communications, research, technological development and space, transport, energy and audiovisual policies.

A 2.69 Among other things, Article 5 of the RSPP, entitled "Competition", provides:

"1. Member States shall promote effective competition and shall avoid distortions of competition in the internal market for electronic communications services in accordance with Directives 2002/20/EC and 2002/21/EC.

They shall also take into account competition issues when granting rights of use of spectrum to users of private electronic communication networks.

2. For the purposes of the first subparagraph of paragraph 1 and without prejudice to the application of competition rules and to the measures adopted by Member States in order to achieve general interest objectives in accordance with Article 9(4) of Directive 2002/21/EC, Member States may adopt, inter alia, measures:

(a) limiting the amount of spectrum for which rights of use are granted to any undertaking, or attaching conditions to such rights of use, such as the provision of wholesale access, national or regional roaming, in certain bands or in certain groups of bands with similar characteristics, for instance the bands below 1 GHz allocated to electronic communication services. Such additional conditions may be imposed only by the competent national authority;

(b) reserving, if appropriate in regard to the situation in the national market, a certain part of a frequency band or group of bands for assignment to new entrants;

(c) refusing to grant new rights of use of spectrum or to allow new spectrum uses in certain bands, or attaching conditions to the grant of new rights of use of spectrum or to the authorisation of new spectrum uses, in order to avoid the distortion of competition by any assignment, transfer or accumulation of rights of use;

(d) prohibiting or imposing conditions on transfers of rights of use of spectrum, not subject to national or Union merger control, where such transfers are likely to result in significant harm to competition;

(e) amending the existing rights in accordance with Directive 2002/20/EC where this is necessary to remedy ex post the distortion of competition by any transfer or accumulation of rights of use of radio frequencies.

3. Where Member States wish to adopt any measures referred to in paragraph 2 of this Article, they shall act in conformity with the procedures for the imposition or variation of such conditions on the rights of use of spectrum laid down in Directive 2002/20/EC.

4. Member States shall ensure that the authorisation and selection procedures for electronic communications services promote effective competition for the benefit of citizens, consumers and businesses in the Union."

Annex: 3 Draft spectrum management assessment – amount of 700 MHz Duplex spectrum in Proposed Award

A3.1 Introduction

A 3.1 As discussed in Document 18/60 and ComReg's Radio Spectrum Management Strategy (Document 18/118)[749], the EC 700 MHz Decision[750] provides flexibility to Member States on the potential uses for the 700 MHz Duplex, the 700 MHz Guard Bands and the 700 MHz Duplex Gap. These potential uses (which are not mutually exclusive) are:

- WBB and BB-PPDR services in the 700 MHz Duplex; and
- BB-PPDR, SDL, Machine to Machine (M2M), and wireless audio programme making and special events (PMSE) services in the 700 MHz Guard Bands and the 700 MHz Duplex Gap.

A 3.2 In Chapters 3 and 4 of this document, ComReg set out its preliminary view that the 700 MHz Duplex should be included in the Proposed Award, and that the 700 MHz Guard Bands and 700 MHz Duplex Gap should not be. In relation to the latter, ComReg notes, among other things, that these bands could potentially be made available for BB-PPDR services in the future.

A 3.3 Recognising the national flexibility afforded to Member States under the EC 700 MHz Decision in terms of the different uses for the 700 MHz band and, in particular that the 700 MHz Duplex could be used for both WBB and BB-PPDR services, this Annex sets outs ComReg's draft spectrum management assessment of the amount of 700 MHz Duplex spectrum that should be included in the Proposed Award.

A 3.4 For the avoidance of doubt, ComReg's preliminary view is without prejudice to any future decision/s which the State may take in relation to the use of the 700 MHz Duplex in Ireland.

[749] See paragraphs 4.15 to 4.25 of ComReg Document 18/118.
[750] Commission Implementing Decision (EU) 2016/687 of 28 April 2016 on the harmonisation of the 694-790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services and for flexible national use in the EU.

A 3.5 Having regard to the above and at this juncture of the consultation process, ComReg observes that its spectrum management options for the 700 MHz Duplex are:

- to progress the Proposed Award on the basis of including the full 2×30 MHz of the 700 MHz Duplex. As discussed in the LS Telcom BB-PPDR Study (including as summarised below), this option reflects the approach being taken by all the European countries considered in the LS Telcom Study, with the exception of Sweden and potentially Bulgaria[751]; or

- set aside some spectrum (i.e. 2×5 MHz or 2×10 MHz) in the 700 MHz Duplex for potential BB-PPDR use in Ireland (i.e. withhold same from the Proposed Award) should there be cogent and robust reasons from a spectrum management perspective to warrant same.

A3.2 Background

700 MHz Band – national flexibility, decisions and choices

A 3.6 As outlined in Document 18/60, the 700 MHz Band is harmonised at three levels within Europe:

iii. The least restrictive technical conditions (LRTC) and frequency arrangements for the introduction of mobile fixed communication networks (MFCNs) in the 700 MHz Band are harmonised at CEPT level by way of the ECC Decision 15(01) of 6 March 2015[752];

iv. The above LRTC and frequency arrangements are reflected in EC Implementing Decision (EU) 2016/687 of 28 April 2016[753] (EC 700 MHz Decision); and

v. Decision 2017/899 of the European Parliament and Council of 17 May 2017 on the use of the 470-790 MHz frequency band in the EU[754] (UHF Band EP&C Decision) which:

a. identifies 30 June 2020 as the date by which Member States shall allow the use of the 700 MHz Band for terrestrial systems capable of providing WBB ECS and only under the harmonised technical conditions set out in the 700 MHz Decision identified above; and

[751] See Chapter 3 of LS Telcom BB-PPDR Report for European country information.
[752] https://www.ecodocdb.dk/download/837045c3-e8c4/ECCDEC1501.PDF
[753] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016D0687&from=EN
[754] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017D0899&qid=1555491077948&from=EN

b. provides that, in order to allow the use of the 700 MHz Band in accordance with the above obligation, Member States shall, by 31 December 2017, conclude all necessary cross-border frequency arrangements within the Union.

A 3.7 The EC 700 MHz Decision provides flexibility to Member States on the potential uses for the 700 MHz Duplex, the 700 MHz Guard Bands and the 700 MHz Duplex Gap. These potential uses (not mutually exclusive) are:

- WBB and BB-PPDR services in the 700 MHz Duplex; and
- BB-PPDR, SDL, M2M, and PMSE services in the 700 MHz Guard Bands and the 700 MHz Duplex Gap.

A 3.8 The national flexibility and choice afforded in respect of the 700 MHz Duplex is outlined below.

700 MHz Duplex

A 3.9 Article 3(1)(a) of the EC 700 MHz Decision provides that:

> *When Member States designate and make available the 700 MHz frequency band for use other than high-power broadcasting networks, they shall:*
>
> *(a) designate and make available the [700 MHz Duplex] frequency bands, on a non-exclusive basis, for terrestrial systems capable of providing wireless broadband electronic communications services in compliance with the parameters set out in Sections A.1, B and C of the Annex".*

A 3.10 The Annex to the EC 700 MHz Decision also provides that:

> *"The frequency bands 703-733 MHz and 758-788 MHz* [i.e. the 700 MHz Duplex]*, or a subset thereof, may also be used for PPDR radio communications. Such use is addressed in Section A.1"*

WBB overview

A 3.11 The ability to communicate almost anywhere has become a fundamental component of modern society. The radio spectrum resource is critical to delivering these services.

A 3.12 Prior to ComReg's 2012 MBSA, mobile services were provided using 2G and 3G technologies with the main focus on voice rather than data.[755] The 2012 MBSA saw liberalised rights of use in the 800 MHz, 900 MHz and 1800 MHz bands awarded to Meteor, Telefónica, Hutchison 3G and Vodafone.

A 3.13 The assignment of these liberalised spectrum rights, particularly for the 800 MHz and 900 MHz bands (sub-1 GHz spectrum), enabled MNOs to enhance their 3G services in rural areas while also facilitating the introduction of 4G services in 2013. The 800 MHz and 900 MHz bands are particular suited to providing a coverage layer in mobile networks due to the favourable propagation characteristics of sub-1GHz spectrum.

A 3.14 MNOs also have rights of use in the1800 MHz, 2.1 GHz and 3.6 GHz bands. Spectrum bands above 1-GHz are particularly useful for carrying large amounts of information in high density urban areas. The 3.6 GHz Award[756] also assigned new rights to a fixed wireless service provider.

A 3.15 Improved WBB services, in addition to the proliferation of smartphone devices, saw mobile data traffic grow by 985% from Q4 2013 to Q4 2018, as users consumed more data-heavy content on their devices[757]. Further, a Frontier Economics report suggests that mobile data traffic will continue to grow at an average of 32% per year in Ireland up to 2022[758].

The importance of 5G services and the European 'pioneer' 5G bands

A 3.16 It is widely accepted that 5G technology, and the applications that it will enable, has the potential to stimulate economic growth by improving the efficiency of the production of goods and services and enabling greater innovation. For example:

- the "Towards 5G" policy of the EC's Digital Single Market identifies that 5G will be *"…one of the most critical building blocks of our digital economy and society in the next decade"*[759]*;* and

[755] ComReg Quarterly Report Q4 2012, Document 13/25, p61.
[756] ComReg Document 17/38.
[757] See https://www.comreg.ie/industry/electronic-communications/data-portal/tabular-information/
[758] See ComReg Document 18/35.
[759] See https://ec.europa.eu/digital-single-market/en/towards-5g

- a 2015 Boston Consulting Group study identifies that the introduction of each new generation of mobile technology has contributed between 2% and 4% to GDP[760].

A 3.17 Furthermore, the socio-economic benefits of 5G are expected to be considerable. A report prepared for the EC estimates that in 2025 the benefits arising from the introduction of 5G could reach €113.1 billion per annum and create 2.3 million jobs in Europe.[761] In relation to Ireland, the study suggests that 5G investment in Ireland will amount to around €500 million, leading to additional economic output of €1.2 billion and the creation of 10,200 jobs.

A 3.18 To support the deployment of 5G, the *5G Action Plan for Europe* emphasises the need for a coordinated approach in Europe to enhance European competitiveness and reap the greatest societal benefits. In this document, and having considered the 5G opinions of the RSPG, the EC outlined "pioneer bands" for 5G harmonisation in Europe:

> *"-Spectrum below 1 GHz, focussing on the 700 MHz band: its availability by 2020, as proposed by the Commission, being critical for 5G success.*
>
> *- Spectrum between 1 GHz and 6 GHz, where EU-wide harmonised bands are already available and licensed in a technology neutral way across Europe. In particular, the 3.5 GHz band seems to offer high potential to become a strategic band for 5G launch in Europe.*
>
> *- Spectrum above 6 GHz, for new and wider bands to be defined, in line with the WRC19 milestone."*[762]

A 3.19 In relation to these so-called pioneer bands, ComReg observes that:

- in 2017, it assigned all available spectrum in the 3.6 GHz band;
- as discussed earlier in this document, it proposes to include the 700 MHz Duplex in the Proposed Award; and
- spectrum above 6 GHz (in particular the 26 GHz band) may form part of a separate and subsequent award process.

[760] https://www.bcg.com/publications/2015/telecommunications-technology-industries-the-mobile-revolution.aspx
[761] 'Identification and quantification of key socio-economic data to support strategic planning for the introduction of 5G in Europe'
[762] Page 5 of "5G for Europe: An Action Plan"

PPDR background

A 3.20 Public safety agencies need to be equipped to react quickly and effectively to provide public protection and disaster relief (PPDR) in emergency situations. A fundamental part of this is the ability to communicate instantly on a reliable network to ensure swift and seamless communication between personnel. Radiocommunication facilities are a critical component of this infrastructure and need to be able to withstand high levels of stress that could arise in an emergency or disaster situation.

A 3.21 ECC Report 199 defines PPDR as the following:

- **Public Protection (PP) radiocommunication**: Radiocommunications used by responsible agencies and organisations dealing with maintenance of law and order, protection of life and property, and emergency situations;
- **Disaster Relief (DR) radiocommunication**: Radiocommunications used by agencies and organisations dealing with a serious disruption of the functioning of society, posing a significant, widespread threat to human life, health, property or the environment, whether caused by accident, nature or human activity, and whether developing suddenly or as a result of complex, long-term processes.[763]

A 3.22 Currently, PPDR networks rely on narrowband technologies that carry data rates sufficient for applications that are not overly data intensive due to the lower throughput capabilities of the network. However, as requirements and applications change, end users may require a network capable of a higher throughput rate to adequately equip them in public safety situations.

A 3.23 In Ireland, the National Digital Radio Service (NDRS) is the public safety network owned and operated by TETRA Ireland. The NDRS is a purpose-built mobile radio network developed using Terrestrial Trunked Radio (TETRA) technology to meet the needs of Security, Fire and Safety, Health, Government and Public Service agencies. This network uses the European harmonised spectrum band (380-385 MHz paired with 390-395 MHz) and it provides 98% overlapping land mass coverage, Air-Ground-Air coverage and wide-area communications that includes Ireland's islands and up to 20km off-shore. In addition to providing voice and messaging services, the network has GPS functions and live tracking features.[764]

[763] http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP199.PDF - "User requirements and spectrum needs for future European broadband PPDR systems (Wide Area Networks)"
[764] https://www.tetraireland.ie/

A 3.24 In the last several years, countries across Europe have started to consider upgrading or replacing their incumbent public safety networks with new broadband PPDR (BB-PPDR) networks. Among other things, this development recognises that the data requirements for emergency service end users (i.e. police, fire and ambulance services) are expected to increase beyond that which legacy (e.g. TETRA networks) can deliver.

A 3.25 To facilitate the introduction of BB-PPDR networks, CEPT, the International Telecommunications Union (ITU), the EC and European national regulators have been working together to establish harmonised frequency bands for BB-PPDR. Of particular relevance to this present assessment are:

- ECC Decision (16)02 - which set outs the BB-PPDR harmonised technical conditions for a number of spectrum bands; and
- the EC 700 MHz Decision as discussed above.

Scope of the LS Telcom BB-PPDR study

A 3.26 In light of the national flexibility afforded to Member States under the EC 700 MHz Decision regarding potential BB-PPDR use of the 700 MHz Duplex and to inform consideration of same in Ireland (including ComReg's spectrum management function and duties in relation to same), ComReg commissioned LS Telcom to conduct out a study on the various "deployment options" and spectrum requirements for any future deployment of BB-PPDR in Ireland.

A 3.27 This study entailed three main tasks, as outlined below:

- **Task 1:** Drawing on relevant material from the RSPG, ECC, EU and other relevant information, provide a summary of the key points relevant to BB-PPDR network "deployment options"[765], "spectrum options"[766] and the amount of spectrum likely to be required to operate a BB-PPDR network[767];
- **Task 2:** Having reviewed, considered and summarised the work being carried out in other relevant countries[768], provide key observations and conclusions on the feasibility of different BB-PPDR

[765] The three generic deployment options to study were: (i) Commercial, (ii) Hybrid and (iii) Dedicated networks.
[766] In particular this is to consider the harmonised spectrum options set out in the EC 700 MHz Decision and ECC Decision (16)02 as amended.
[767] In particular, this is to draw upon the work done within the ECC/CEPT to reach conclusions and recommendations, noting in particular the rationale and findings of ECC Report 199.
[768] Countries considered include: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Netherlands, Norway, Slovenia, Sweden, Switzerland and the United Kingdom.

network “deployment options”, with a particular focus on approaches in the 700 MHz band; and

- **Task 3:** In light of the findings from Tasks 1 and 2, consider and provide analysis and observations on the likely spectrum requirements for the provision of BB-PPDR in Ireland and assess, from a spectrum management perspective, the relative merits of the various “spectrum options” available in Ireland to meet said likely spectrum requirements.

A 3.28 The key findings of the LS Telcom Study are discussed below.

A3.3 Task 1: BB-PPDR deployment and spectrum options

A 3.29 In presenting its findings for Task 1, LS Telcom observe that the CEPT and the TETRA and Critical Communications Association (TCCA) in particular have developed authoritative and informative reports and recommendations that enable regulatory authorities to understand the technical, regulatory and practical implications for implementing BB-PPDR systems throughout Europe.

A 3.30 LS Telcom also observe that many of these reports and documents provide comprehensive definitions and descriptions of aspects such as the (a) network deployment options, highlighting the pros and cons of each approach, (b) the spectrum options and (c) BB-PPDR spectrum requirements.

Task 1A: BB-PPDR deployment options

A 3.31 ECC Report 218[769] and the RSPG report on *Strategic Sectoral Spectrum Needs*[770] provide a comprehensive description of all the different potential BB-PPDR deployment options. Noting this and other relevant information, LS Telcom identified three primary approaches to deploying BB-PPDR networks, namely:

- the deployment of a national dedicated network using spectrum dedicated for BB-PPDR (the **dedicated network**);

[769] https://www.ecodocdb.dk/download/bf3fb2b0-9509/ECCREP218.PDF - “Harmonised conditions and spectrum bands for the implementation of future European Broadband Public Protection and Disaster Relief (BB-PPDR) systems”
[770] Radio Spectrum Policy Group (RSPG), Report on Strategic Sectoral Spectrum Needs, Nov 2013 https://www.cept.org/files/9421/RSPG13-540rev2_RSPG_Report_on_Sectoral_needs.pdf

- support for BB-PPDR applications over commercial mobile networks (the **commercial model**). Unlike a dedicated network, the commercial model would not require dedicated spectrum for BB-PPDR or involve the need to build a new network and/or upgrade existing PPDR network infrastructure; and

- hybrid solutions which are defined as a 'combination of dedicated and commercial networks' and would generally require spectrum dedicated for BB-PPDR (the **hybrid model**). There are a number of potential hybrid model approaches including:

  - Geographical split between dedicated and commercial network infrastructure (Hybrid 1);
  - Mobile Virtual Network Operator (MVNO) model where PPDR users share Radio Access Network (RAN) with the public users (Hybrid 2)[771];
  - MVNO model combined with a geographical split (Hybrid 3); and
  - Extended MVNO model where PPDR has dedicated carriers in the commercial network's radio transmitters/receivers throughout the country (Hybrid 4).

A 3.32 The LS Telcom BB-PPDR Study notes that each of the above deployment options has advantages and disadvantages, a summary of which is set out below.

- For a **dedicated network**, LS Telcom note that the advantages include the ability to completely oversee network management and provide high levels of resilience, reliability and availability. This network model also has the potential for high capital and operational costs arising from the need to build a new network and/or upgrade existing PPDR network infrastructure.

- For the **commercial model**, LS Telcom note that this model would have lower capital and operational costs compared to the dedicated network option, and result in earlier deployment of services given the use of pre-existing commercial mobile networks. On the other hand, there would be less control of network operations and careful consideration of any specification requirement would be necessary to mitigate against any risk of network failure.

[771] For Hybrid 2 (the MVNO model), dedicated spectrum for BB-PPDR would not be required.

- For a **hybrid model**, a key benefit is the choice between a range of options that can suit national needs. Depending on the hybrid model chosen, this could result in cost savings relative to a dedicated network. However, for other hybrid models there may still be some high costs associated with network infrastructure build-outs which can take considerable time.

Task 1B: BB-PPDR spectrum options

A 3.33 For many years now, CEPT, the International Telecommunications Union (ITU)[772], European Commission and European national regulators have been working together to establish harmonised frequency bands for BB-PPDR.

A 3.34 CEPT, and in particular the ECC, has a large programme of work that continues to develop a range of decisions and recommendations relating to BB-PPDR spectrum matters[773] which have been published on a dedicated PPDR web portal.

A 3.35 Within the concept of "flexible harmonisation" (to enable national flexibility regarding how much spectrum and which specific frequency ranges should be designated for BB-PPDR), CEPT ECC Decision (16)02 sets out the harmonised technical conditions for the implementation of BB-PPDR systems within the 400 MHz and 700 MHz frequency ranges.[774]

A 3.36 ECC Decision (16)02 was amended on 8 March 2019 and now contains harmonised technical parameters for three bands as discussed below:

i. the 410-430 MHz band;

ii. the 450-470 MHz band; and

iii. the 700 MHz Band.

410-430 MHz band

A 3.37 Within the 410-430 MHz band, ECC Decision (16)02 set outs harmonised technical parameters for BB-PPDR in the following paired frequency ranges:

i. 410.0-415.0 MHz (uplink) / 420.0-425.0 MHz (downlink);

ii. 411.0-416.0 MHz (uplink) / 421.0-426.0 MHz (downlink); and

[772] One notable recommendation of the ITU is ITU-R Report M.2009 which is the broadband radio interface standard for use by public protection and disaster relief operations in some parts of the Ultra High Frequency (UHF) band in accordance with Resolution 646 (Rev WRC-15). This Resolution recognises the use of spectrum in the range 380 – 470 MHz for PPDR as a core harmonised band.
[773] CEPT web site https://www.cept.org/ecc/topics/public-protection-and-disaster-relief-ppdr
[774] http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCDEC1602.PDF

iii. 412.0-417.0 MHz (uplink) / 422.0-427.0 MHz (downlink).

A 3.38 This band is also recognised by the ITU[775] as suitable for BB-PPDR services and there is a work item in the Third Generation Partnership Programme (3GPP) to standardise parts of the 410-430 MHz band for LTE-PPDR and Private Mobile Radio (PMR)/Public Access Mobile Radio (PAMR) in Europe.[776]

The 450-470 MHz band

A 3.39 Within the 450-470 MHz band, ECC Decision (16)02 set outs harmonised technical parameters for BB-PPDR in the following paired frequency ranges:

i. 450.5-456 MHz (uplink) / 460.5-466 MHz (downlink); and

ii. 452.0-457.5 MHz (uplink) / 462.0-467.5 MHz (downlink)

A 3.40 This band is recognised by the ITU as suitable for BB-PPDR and two specific variants of the paired frequency bands for use in Europe are specified within the 3GPP standards, namely:

- 3GPP Band 31 (452.5 – 457.5 paired with 462.5 to 467.5 MHz); and
- 3GPP Band 72 (451.0 – 456.0 paired with 461.0 to 466.0 MHz).

The 700 MHz Band

A 3.41 Within the 700 MHz Band, ECC Decision (16)02 sets out harmonised technical parameters for BB-PPDR in the following paired frequency ranges:

i. 698-703 MHz (uplink) / 753-758 MHz (downlink) - 2×5 MHz of spectrum in the 700 MHz Lower Guard Band and the 700 MHz Duplex Gap (3GPP Band 68);

ii. 703-733 MHz (uplink) / 758-788 MHz (downlink) - the 700 MHz Duplex (3GPP Band 28); and

iii. 733-736 MHz (uplink) / 788-791 MHz (downlink) - 2×3 MHz of spectrum in the 700 MHz Duplex Gap and the 700 MHz Upper Guard Band (3GPP Band 28B).

A 3.42 As discussed in the background, the EC 700 MHz Decision provides flexibility to Member States regarding the potential uses of 700 MHz Band.

[775] Bands 380 – 470 MHz included in ITU-R Resolution 646 (REV.WRC 15)
[776] CEPT FM 44 input documents https://www.cept.org/Documents/fm-54/48200/fm54-18-60_new-work-item-3gpp-lte-in-410-430-for-ppdr-and-pmrpamr

Task 1C: BB-PPDR spectrum requirements (European studies)

A 3.43 From a review of the spectrum requirements for BB-PPDR, and according to the work and studies within CEPT (particularly ECC Report 199) and other organisations such as TCCA, LS Telcom firstly note the following high-level BB-PPDR operational needs which have informed these studies:

- the PPDR community has a distinct set of specific operational needs. For example, having a communications network that is continuously available 24×7×365 given its mission-critical nature;
- historically, the most critical application for first responders was voice communications for incidents that required an immediate or urgent response (and which remains the case today); and
- over time the specific operational and critical needs of end users have evolved to include a growing demand for specific data-rich applications. The PPDR community has recognised the benefits of technology evolution and innovation from 4G/LTE, as demonstrated by increased usage of commercial mobile broadband services by PPDR users.

A 3.44 In relation to the spectrum requirements for BB-PPDR, LS Telcom note that ECC Report 199 provides a range of authoritative technical inputs, parameters, and an approach to calculating the spectrum requirements for BB-PPDR. In particular, LS Telcom highlight that:

> *"2×10 MHz has been identified as a sufficient amount of spectrum for BB-PPDR by CEPT and other organisations to support the end user applications within certain usage scenarios and expected type of deployments."*

A 3.45 LS Telcom also observe that the Law Enforcement Working Party (LEWP) model used in ECC Report 199 is based on actual events that require BB-PPDR communications and also considers the extent of numbers of devices, simultaneous usage, range of applications and overall intensity of the communications environment, thereby providing a robust set of results.

A 3.46 Given this, LS Telcom use the LEWP model in Task 3 of the study to estimate the likely BB-PPDR spectrum requirements for Ireland.

A3.4 Task 2: Experiences in other European countries

A 3.47 Task 2 of the LS Telcom study consisted of reviewing, considering and summarising the BB-PPDR work being carried out in 15 European countries and providing key observations and conclusions on the deployment and spectrum approaches being taken, with a particular focus on the 700 MHz Band.

A 3.48 LS Telcom also conducted over 30 interviews with representatives from Governments, associations, industry and subject-matter experts to obtain other relevant information (see section 3.2 of its report for the list of interviewees).

LS Telcom's summary findings of the European countries studied

A 3.49 LS Telcom used a four-colour code to highlight the preferences/decisions regarding the "deployment options" and "spectrum options" for each country studied.

A 3.50 Table 25 below summarises the network "deployment options" being considered (and in some cases adopted) across the European countries studied.

A 3.51 Table 26 below summarises the "spectrum options" being considered (and in some cases adopted) across the European countries studied.

Table 25: Summary of European network deployment options

Country	Dedicated/Hybrid[777]					Commercial
	Dedicated Network	Hybrid 1	Hybrid 2	Hybrid 3	Hybrid 4	
Austria						
Belgium						
Bulgaria						
Czech Rep.						
Denmark						
Finland						
France						
Germany						
Hungary						
Netherlands						
Norway						
Slovenia						
Sweden						
Switzerland						
UK						

Yes/Decision	Under Consideration	Not Ruled Out	No/Highly Unlikely

[777] The four Hybrid approaches are:

- Hybrid 1: Geographical split between dedicated and commercial network infrastructure;
- Hybrid 2: Mobile Virtual Network Operator (MVNO) model where BB-PPDR users share Radio Access Network (RAN) with the public users;
- Hybrid 3: MVNO model combined with a geographical split; and
- Hybrid 4: Extended MVNO model where BB-PPDR have dedicated carriers in the commercial network's radio transmitters / receivers throughout the country.

Table 26: Summary of European spectrum options

Country	Dedicated/Hybrid					Commercial
	2x10 MHz 700 MHz Duplex	2x3 MHz (Band 28B)	2x5 MHz (Band 68)	450-470 MHz	410-430 MHz	
Austria						
Belgium						
Bulgaria						
Czech Rep.						
Denmark						
Finland						
France						
Germany						
Hungary						
Netherlands						
Norway						
Slovenia						
Sweden						
Switzerland						
UK						

Yes/Decision	Under Consideration	Not Ruled Out	No/Highly Unlikely

LS Telcom's key observations on the European countries studied

A 3.52 LS Telcom firstly observe that, across Europe, most Governments are now deciding (or at least studying in earnest) how to move from existing narrowband (mainly TETRA) networks to next-generation public safety/PPDR systems. In that regard, LS Telcom note that the deployment and spectrum models for each of these countries – including Ireland - will be determined by a number of factors including, in particular: specific national circumstances, equipment availability, and the wider European context.

A 3.53 Noting this context, and the findings of the European countries studied, LS Telcom observe that:

- most European governments have made significant investments in their existing narrowband networks, so it is natural for current PPDR plans to be based on the continued use of these systems until existing network support contracts come to an end or until a fully-functioning broadband alternative is in place and approved by the relevant authorities;

- the majority of the countries studied are now considering how commercial networks can form part of the solution for providing next-generation public safety/PPDR services, either on a hybrid or a standalone deployment basis. The main factors that are influencing such views include the increased technical capabilities of commercial networks to provide BB-PPDR services (e.g. with the move to LTE) and cost considerations (i.e. reduced capital and operational costs which otherwise are likely to be substantial);

- the economic costs of deploying BB-PPDR services on a commercial network are significantly lower than the costs of building a dedicated network, noting that there are other non-monetary considerations to also be considered;

- at least 4 European countries – Belgium, Czech Republic, Norway and Slovenia – have already acted to provide core PPDR services over commercial networks in the 700 MHz Duplex (Band 28), with many more seriously considering this approach. The UK has also decided to provide public safety services over commercial networks without providing additional spectrum but with investment from Government for additional sites;

- many European nations are still considering, or have not ruled out, a hybrid model – at least in the medium-term – for PPDR service provision;

- focusing on the 700 MHz Duplex, only Sweden now appears to be considering a possible future assignment of dedicated spectrum for PPDR, with 2×10 MHz yet to be assigned; and

- besides the 700 MHz Duplex, other sub-1 GHz bands (Band 28B (2×3 MHz), Band 68 (2×5 MHz), 410 – 430 MHz and 450-470 MHz) may also be available shortly and are thus being seriously considered for PPDR use.

A3.5 Task 3: Spectrum requirement and options in Ireland

A 3.54 Task 3 of the LS Telcom Study entailed an assessment of the likely spectrum requirements for BB-PPDR in Ireland, and consideration of the BB-PPDR spectrum options to meet said requirement, including consideration of the alternative uses/opportunity costs of using these spectrum options (including in the 700 MHz Duplex) for PPDR.

Task 3A: Spectrum requirement for BB-PPDR in Ireland

A 3.55 To assess the amount of spectrum required to support BB-PPDR service users in Ireland, LS Telcom used the LEWP-ETSI[778] matrix[779] which was suitably modified to take account of the specificities of Ireland. For example, its average BB-PPDR user density per site and the improved spectral efficiency associated with current LTE technology.

A 3.56 LS Telcom's summary of the functioning of the LEWP-ETSI matrix is shown in Figure 19 below.

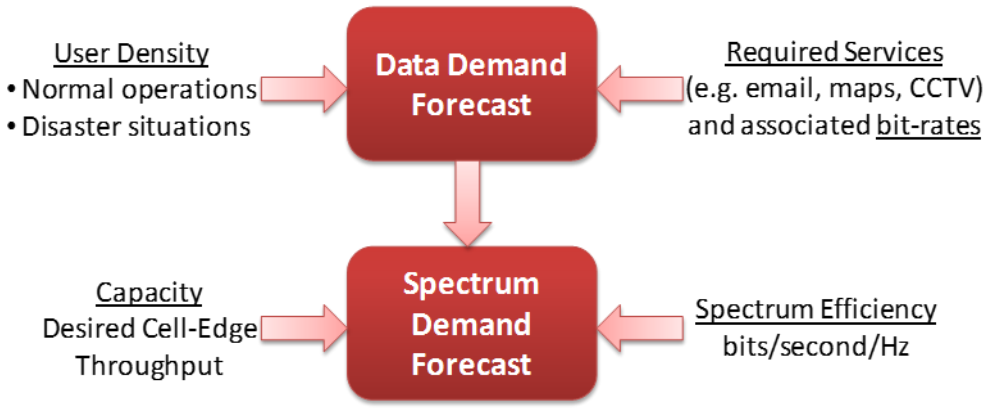

Figure 19: Summary of LEWP-ETSI spectrum demand model

[778] European Telecommunications Standards Institute
[779] The LEWP-ETSI matrix is a spreadsheet based spectrum requirements calculator used in the preparation of ECC Report 199 which is the current benchmark for BB-PPDR spectrum needs.

A 3.57 In relation to the BB-PPDR user density, LS Telcom calculated the average number of BB-PPDR users per site in Ireland[780] assuming 20,000 users and 592 sites. LS Telcom notes that the average PPDR user density in Ireland is considerably lower than the user density figures used in the original LEWP model.[781] For Dublin City and County, however, LS Telcom used the same number of users per site as used in the original LEWP model (i.e. 500 users) for the 'normal peak' operations, and 1000 users per site for an emergency situation[782].

A 3.58 LS Telcom's results of the LEWP-ETSI matrix as adapted for Ireland are presented in Table 27 below.

Table 27: Results of the LEWP-ETSI Matrix adapted for Ireland

Scenario	Uplink (MHz)	Individual Downlink (MHz)	Group Downlink (MHz)
Peak busy hour (Dublin City and	3.4	3.0	2.5
1 incident in a cell (Dublin City and	6.0	4.5	2.9
Peak busy hour (Rest of Ireland)	3.4	2.9	2.5
1 incident in a cell (Rest of Ireland)	6.0	4.1	2.9

A 3.59 Based on these results, LS Telcom consider that "*it is reasonable to conclude that 2×6 MHz would be sufficient to support PPDR usage in Ireland, both in the Dublin City and County and the rest of Ireland.*"

Task 3B: Spectrum options for a BB-PPDR network in Ireland

A 3.60 In light of the above findings, LS Telcom then considered each of the spectrum options identified in ECC Decision (16)02 in terms of equipment availability, spectrum availability in Ireland and alternative uses.

A 3.61 This assessment is set out in sections 4.3 to 4.5 of the study, the summary results of which are set out in Table 28 below.

[780] This is broken down into Dublin City and County (a high density area) and the rest of Ireland.
[781] The original LEWP model assumes 500 users per cell for a 'normal peak', and up to 2000 users per cell for an emergency situation. For Ireland, LS Telcom calculate the average number of PPDR users per site as 121 for Dublin City and County and 26 for the rest of Ireland.
[782] For the rest of Ireland, LS Telcom apply 100 users per site for a 'normal peak' and 250 users per site for an emergency situation.

Table 28: Summary of LS Telcom's spectrum option assessment

Frequency Band	Equipment availability	Spectrum Availability in Ireland	Alternative Uses
410-430 MHz (2x3 MHz)	Soon to be a recognised 3GPP band – work item in progress. Little equipment ecosystem.	2×3 MHz proposed for PPDR.	2×3 MHz proposed for Smart Grid would not be affected. ComReg proposes to migrate existing trunked radio licensees to facilitate the allocation of spectrum for BB-PPDR[783]
450-470 MHz	A recognised 3GPP band. Some equipment available.	Band not available given existing usage.	Not assessed as spectrum band is unavailable in Ireland.
700 MHz Option 1 (2×5 MHz, Band 68)[784]	A recognised 3GPP band. No equipment ecosystem yet.	Band potentially available for PPDR after March 2020.	Alternative users (SDL, PMSE) unlikely to be adversely impacted.
700 MHz Option 2 (2×3 MHz, Band 28B)[785]	A recognised 3GPP band. Equipment available off-the-shelf.	Band potentially available for PPDR after March 2020.	Alternative users (M2M/IOT, PMSE) unlikely to be adversely impacted.
700 MHz Option 3 (2×5 MHz or 2×10 MHz, Band 28)[786]	A recognised 3GPP band. Equipment available off-the-shelf.	Band potentially available for PPDR after March 2020.	Significant impact for alternative use by wireless broadband.

(green = no significant impediments, yellow = some impediments may exist, red = significant impediments)

A 3.62 LS Telcom then considered the technically viable spectrum options (i.e. those with no or some impediments for equipment and spectrum availability) which would most efficiently meet the likely spectrum requirement for a dedicated BB-PPDR network in Ireland (of 2×6 MHz). A summary of this assessment is set out in Table 29 below.

[783] See ComReg Document 19/23
[784] 698-703 MHz (uplink) / 753-758 MHz (downlink) - 2×5 MHz of spectrum in the 700 MHz Lower Guard Band and the 700 MHz Duplex Gap (3GPP Band 68);
[785] 733-736 MHz (uplink) / 788-791 MHz (downlink) - 2×3 MHz of spectrum in the 700 MHz Duplex Gap and the 700 MHz Upper Guard Band (3GPP Band 28B)
[786] 703-733 MHz (uplink) / 758-788 MHz (downlink) - the 700 MHz Duplex (3GPP Band 28);

Table 29: LS Telcom's assessment of technically viable spectrum options

Option	Amount of Spectrum	410-430 MHz	700 MHz Option 1 (Band 68)	700 MHz Option 2 (Band 28b)	700 MHz Option 3 (Band 28)
A	2×6 MHz	2×3 MHz		2×3 MHz	
B	2×8 MHz	2×3 MHz	2×5 MHz		
C	2×8 MHz		2×5 MHz	2×3 MHz	
D	2×8 MHz	2×3 MHz			2×5 MHz
E	2×8 MHz			2×3 MHz	2×5 MHz
F	2×10 MHz				2×10 MHz

A 3.63 For **Options A, B and C** in the case of a dedicated BB-PPDR network, LS Telcom observes these are the spectrum options which are being most closely considered in Europe. However, it also notes that there remains a degree of uncertainty regarding the extent to which these bands would be adopted for use in BB-PPDR networks.

A 3.64 For **Options D, E and F**, LS Telcom considers that these options would have significant impediments due to importance of the 700 MHz Duplex for future mobile broadband services, and particularly in Ireland given the challenges in delivering high speed services to rural areas. In this regard, LS Telcom note:

- in terms of the importance of 700 MHz Duplex spectrum for 5G rollout:
  - the use of the 700 MHz Duplex is important in order to provide for the timely and efficient rollout of 5G, in line with the European 5G Action Plan;
  - there are no alternative sub-1 GHz bands likely to become available in the next decade with which to provide near-term 5G services over wide areas. Whilst operators could re-farm existing sub-1 GHz mobile bands for 5G, the transition to 5G will take time to ensure that the existing 2G, 3G and 4G services on these bands are not disrupted;
- in terms of the importance of 700 MHz Duplex for rural connectivity across Ireland:

- Ireland's demographics[787] create challenges in reaching sparsely populated areas due to the high fixed costs of laying network infrastructure and maintaining it over thinly distributed populations;
- 700 MHz Duplex is important to enable operators to provide higher speed services in rural areas and along major transport routes;
- according to a variety of measures, Ireland has one of the most widely distributed and rural populations in Europe. Ensuring the fullest use of the 700 MHz Duplex for wireless broadband services helps deliver rural connectivity and is particularly important in Ireland;

- In terms of reduced availability of 700 MHz Duplex for wireless broadband, LS Telcom observe that this may restrict one (or more) operators' ability to provide a full range of services, as reduced 700 MHz Duplex assignments would likely increase the network costs of providing wide-area coverage.

LS Telcom's consideration of the optimal use of the 700 MHz Duplex

A 3.65 In light of its analysis, LS Telcom consider that:

> *"[g]iven the option of dedicating some spectrum for PPDR in the 700 MHz duplex band, or making available the whole of the band to wireless broadband services, it is the latter option (i.e. making available 2×30 MHz for the provision of wireless broadband services in Ireland) that would appear to be the optimal use of the 700 MHz duplex given the availability of alternative spectrum options for PPDR."*

A3.6 ComReg's spectrum management assessment

A 3.66 As outlined earlier, ComReg considers that the spectrum management options in relation to the 700 MHz Duplex are to:

- progress the Proposed Award on the basis of including the full 2×30 MHz of the 700 MHz Duplex; or
- set aside some 700 MHz Duplex spectrum (i.e. 2×5 MHz or 2×10 MHz) for potential BB-PPDR use in Ireland (i.e. withhold same from the Proposed Award).

[787] For example: a significant proportion of the population live in rural areas; farmland and forestry account for 76% of the total area of Ireland; Ireland has an extensive road network largely located in rural areas; Ireland's population is not dispersed equally

A 3.67 In setting out its assessment of these spectrum management options, ComReg has carefully considered the advice from LS Telcom and other relevant information before it.

A 3.68 Similar to the LS Telcom study, ComReg's spectrum management assessment first considers the BB-PPDR service, and then the potential implications for the 700 MHz Duplex band from a WBB perspective.

A3.6.1 BB-PPDR considerations

A 3.69 As noted by LS Telcom, BB-PPDR is an important service, which for many years now, CEPT, the ITU, the TCCA, the EC and European national regulators have been working together to consider the various deployment options and to establish harmonised frequency bands for the deployment of BB-PPDR networks.

European analysis indicates a wide choice of deployment and spectrum options for BB-PPDR.

A 3.70 From the results of the LS Telcom study, ComReg observes that there are a range of potential deployment options for BB-PPDR in Ireland, including the building of a dedicated network, the use of commercial networks or the use of a hybrid model.

A 3.71 In relation to the **commercial model**, ComReg observes that the majority of European countries studied are now considering how commercial networks can form part of the BB-PPDR solution either on a hybrid or a standalone deployment basis. ComReg also observes should a commercial or MVNO model[788] be adopted in Ireland, then dedicated spectrum for BB-PPDR would not be required.

A 3.72 In relation to those deployment options requiring dedicated spectrum for BB-PPDR (i.e. dedicated network and hybrid models), ComReg observes that:

- with the exception of Sweden, no other European country is considering dedicating spectrum in the 700 MHz Duplex to BB-PPDR; and
- instead, European countries are considering the other spectrum bands harmonised in ECC Decision 16(02), namely the:
    i. 410-430 MHz;
    ii. 450-470 MHz;

[788] This is the 'Hybrid 2' model in the LS Telcom BB-PPDR Report.

iii. 3GPP Band 28B (2×3 MHz in the 700 MHz Duplex Gap and 700 MHz Guard Bands); and

iv. 3GPP Band 68 (2×5 MHz in the 700 MHz Duplex Gap and 700 MHz Guard Bands).

Ireland's BB-PPDR spectrum demand of 2×6 MHz and ComReg's proposal to make 2×3 MHz available for BB-PPDR in the 410-430 MHz band

A 3.73 Recognising that Ireland has yet to take any decisions on BB-PPDR deployment, ComReg notes that Task 3 of the LS Telcom Study assumes that Ireland would require some dedicated spectrum for BB-PPDR, such as to facilitate a dedicated or hybrid network.

A 3.74 In this regard, LS Telcom first consider Ireland's BB-PPDR spectrum requirements under this assumption, and conclude that when using the LEWP-ETSI Matrix model (as used by CEPT in its studies) suitably adapted for specific circumstances in Ireland (e.g. its lower PPDR user density), *"2×6 MHz would be sufficient to support PPDR usage in Ireland, both in Dublin City and County and the rest of Ireland."*

A 3.75 In relation to LS Telcom's finding that 2×6 MHz would be sufficient to support BB-PPDR usage in Ireland (both in Dublin City and County and the rest of Ireland), ComReg firstly observes that whilst this requirement is considerably lower than the 2×10 MHz estimated in European studies, it arises from Ireland's lower user density and the increased efficiency of the technology now available, compared to the assumptions used in the European studies.

A 3.76 Second, ComReg considers that its proposal to make available 2×3 MHz in the 410-430 MHz band for BB-PPDR in Ireland would represent a significant step towards meeting the identified requirements.[789] In relation to the 410-430 MHz band, ComReg would also highlight the following:

- the propagation characteristics of the 410 – 430 MHz band are very similar to the frequencies currently used for the existing TETRA network and as such is suitable for the effective deployment of wide area coverage; and,

- Nordic Telecom recently indicated that it is developing a LTE network in the Czech Republic for critical communications (both emergency services communications as well as within critical industries such as energy) using spectrum rights in this band.[790]

[789] See ComReg Document 19/23.
[790] https://www.mobileeurope.co.uk/press-wire/nordic-telecom-develops-lte-network-for-critical-communications

700 MHz Duplex Gap and 700 MHz Guard Bands could be made available for BB-PPDR in the future

A 3.77 In relation to the other spectrum options for BB-PPDR, ComReg notes LS Telcom's findings, including that:

- spectrum in the 700 MHz Duplex Gap and 700 MHz Guard Bands (700 MHz Option 1 and 700 MHz Option 2) are other viable options for BB-PPDR use that do not have significant impediments. Further, these spectrum options are the ones being most closely considered by those European countries examined by LS Telcom; and
- the assignment of 2×30 MHz for the provision of wireless broadband services in Ireland would appear to be the best use of the 700 MHz duplex given the availability of alternative spectrum options for PPDR.

A 3.78 Having considered the information in LS Telcom BB-PPDR Study, and noting that spectrum in the 700 MHz Band will become available for uses other than DTT after 4 March 2020, ComReg observes that spectrum in the 700 MHz Duplex Gap and 700 MHz Guard Bands could potentially be made available for BB-PPDR use in the future, in line with the flexibility afforded the State in respect of same under the EC 700 MHz Decision.

A 3.79 In this regard, and as noted in ComReg's *Radio Spectrum Management Strategy Statement for 2019-2021*, ComReg will continue to monitor, investigate and contribute to the spectrum management considerations in respect of spectrum for BB-PPDR.

Summary – BB-PPDR considerations

A 3.80 First, there is a wide range of deployment and spectrum options for BB-PPDR in Ireland, including the use of commercial networks, the building of a dedicated network, or a hybrid solution.

A 3.81 From the European countries studied:

- the majority of countries are considering how commercial networks can form part of their national BB-PPDR solution; and
- while most countries are considering dedicating some spectrum to BB-PPDR, only one country, Sweden, is considering dedicating spectrum in the 700 MHz Duplex for such purposes. Elsewhere, harmonised spectrum in other bands (i.e. 410 - 430 MHz, 450 - 470 MHz and spectrum in 700 MHz Duplex Gap and 700 MHz Guard Bands) is being considered by European countries.

A 3.82 Recognising that Ireland has yet to take decisions on its BB-PPDR deployment model, in the event that the State decided that dedicated spectrum would be required for BB-PPDR, then ComReg observes that:

- 2×6 MHz appears sufficient to support PPDR usage in Ireland, both in Dublin City and County and the rest of Ireland;
- ComReg's proposal to make available 2×3 MHz in the 410-430 MHz band for BB-PPDR is a significant step towards meeting this spectrum requirement and that this band is being used by Nordic Telecom to develop a LTE network in the Czech Republic for critical communications; and
- there are technically-viable spectrum options for BB-PPDR in the 700 MHz Duplex Gap and 700 MHz Guard Bands (Band 68 (2×5 MHz), and Band 28B (2×3 MHz)). As outlined in Chapter 3, ComReg does not propose to include the 700 MHz Duplex Gap and 700 MHz Guard Bands in the Proposed Award, and this spectrum could therefore be allocated for BB-PPDR use in the future, in line with the flexibility afforded the State in respect of same under the EC 700 MHz Decision.

A3.6.2 Implications of BB-PPDR use in the 700 MHz Duplex on WBB services

A 3.83 As noted in the LS Telcom Study, the use of some of the 700 MHz Duplex for BB-PPDR would be an attractive option given the considerable amount of off-the-shelf equipment available. At the same time, setting aside a portion of the 700 MHz Duplex for BB-PPDR would have material implications for WBB services. These are discussed below in terms of:

- the importance of the 700 MHz Duplex for 5G services;
- the importance of the 700 MHz Duplex for rural connectivity in Ireland; and
- the reduced spectrum outcomes for WBB services should the full 2×30 MHz of the 700 MHz Duplex not be included in the Proposed Award.

700 MHz Duplex is an important band for 5G Services

A 3.84 As discussed earlier, it is widely accepted that 5G technology and the applications that it creates have the potential to stimulate economic growth by improving the efficiency of the production of goods and services and enabling greater innovation. For example:

- a 2015 study from the Boston Consulting Group notes that the introduction of each new generation of mobile technology has contributed between 2% and 4% to GDP; and

- the EC expects the socio-economic benefits of 5G to be considerable, estimating that in 2025 the benefits arising from the introduction of 5G could reach €113.1 billion per annum and create 2.3 million jobs in Europe. The study also suggests that 5G investment in Ireland will amount to around €500 million, leading to additional economic output of €1.2 billion and the creation of 10,200 jobs.

A 3.85 To support the deployment of 5G, and having considered the 5G opinions of the RSPG, the EC's *5G Action Plan* identified three pioneer bands for 5G harmonisation in Europe: the 700 MHz, 3.6 GHz and 26 GHz bands. In relation to these bands, the 700 MHz Band and sub-1 GHz bands are particularly important for 5G given their favourable propagation characteristics. See, for example:

- the EC's observation that spectrum below 1 GHz, focussing on the 700 MHz Band, is *"critical for 5G success"*; and

- the RSPG, which expects the first major 5G commercial deployments to be in lower frequencies, in order to provide sufficient coverage for enhanced broadband communications which may require ubiquity, low latency and low complexity.

A 3.86 In considering the role of sub-1 GHz spectrum to 5G, ComReg notes LS Telcom's views including that:

- the 700 MHz Band, being green-field spectrum for mobile services, is expected to be at the forefront of providing the initial wide-area coverage layer for 5G;

- while 5G will eventually be rolled out in other existing spectrum holdings, the re-farming of existing sub-1 GHz spectrum bands for 5G and the transition to 5G will take time because operators will aim to ensure that the existing 2G, 3G and 4G services provided using these bands are not disrupted; and

- there are no alternative sub-1 GHz bands likely to become available in the next decade that could provide near-term 5G services over wide areas.

A 3.87 Given the above, the 700 MHz Duplex is clearly important for the earliest widespread provision of 5G services, particularly because that:

- the 700 MHz Duplex is a pioneer band for 5G services in Europe;
- its greenfield availability (following the migration of DTT) would facilitate the early and widespread deployment of 5G services; and
- other existing sub-1 GHz bands have legacy users (i.e. 2G, 3G and 4G), and operators will need time to transition these bands for 5G use.

700 MHz Duplex is important for rural connectivity

A 3.88 As detailed in the Connectivity Studies[791], Ireland's demographics present a variety of material challenges to improving connectivity in rural areas. For example:

- 37% of the rural population is spread across 95% of the land area;
- of EU Member States, Ireland has the highest proportion of population that live in NUTS 3 areas classified as rural (at 72%), compared to the EU average of 22%;
- Ireland has an extensive road network (5,306 km of primary and secondary roads and a further 91,000 km of regional and local roads); and
- the road density in Ireland (21 km per 1000 inhabitants) is twice the EU average.[792]

A 3.89 Given its favourable propagation characteristics, sub-1 GHz spectrum is particularly important for providing cost-efficient, wide-area coverage and improving rural connectivity.

A 3.90 The importance of the 700 MHz Band for ensuring the provision of broadband services in rural areas in Ireland has been recognised by the State. For example:

[791] See ComReg Documents 18/103b , 18/103c and 18/103d.
[792] See ComReg Document 18/103b – Meeting Consumers' Connectivity Needs

> *"The timely release of this spectrum is a matter of national importance to Ireland as its subsequent use for mobile broadband services will assist in delivering improved network* ***coverage and speed particularly in rural areas****."* [793] *(****emphasis added****)*

A 3.91 Its importance is also recognised in the UHF Band EP&C Decision, including:

> *"Spectrum in the 700 MHz frequency band provides both additional capacity and universal coverage, in particular for the economically challenging rural, mountainous and insular areas as well as other remote areas, predetermined in accordance with areas that are a national priority, including along major terrestrial transport paths, and for indoor use and for wide machine-type communications."*

A 3.92 It is also significant that this decision obliges Member States, when they are authorising the use of the 700 MHz Band, to take due account of the speed and quality objectives set out in Article 6(1) of Decision No 243/2012/EU (i.e. the RSPP Decision), including coverage in predetermined national priority areas where necessary, such as along major terrestrial transport paths.[794]

A 3.93 In light of the above, any reduction in the amount of 700 MHz Duplex made available for wireless broadband will materially reduce the extent to which the above-identified objectives would be achieved.

A 3.94 More specifically, LS Telcom consider that a reduction in the amount of 700 MHz Duplex would affect an operator in terms of:

- Coverage: when used in conjunction with the existing sub-1 GHz bands, 2×10 MHz of 700 MHz Duplex provides a 65% coverage area gain for speeds of 30 Mbit/s[795]. See also Oxera Connectivity Study (ComReg Document 18/103c);

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[793] Migration of Broadcasting Services for 700 MHz Spectrum Band - Letter of entrustment to RTE. https://www.dccae.gov.ie/enie/communications/publications/Documents/68/Minister's%20Letter%20to%20RT%C3%89%20Chair%20setting%20out%20Act%20of%20Entrustment_Redacted.pdf

[794] Article 3(1) of the UHF Band EP&C Decision provides:
"When Member States authorise the use of or amend existing rights to use the 700 MHz frequency band, they shall take due account of the need to achieve the target speed and quality objectives set out in Article 6(1) of Decision No 243/2012/EU, including coverage in predetermined national priority areas where necessary, such as along major terrestrial transport paths, for the purpose of allowing wireless applications and European leadership in new digital services to contribute effectively to Union economic growth."

[795] An operator using carrier aggregation with 10 MHz in each of the 700, 800 and 900 MHz bands would be able to achieve 30 Mbits/s of capacity at ranges of around 4.5 km from a cell-site. In contrast, an operator using carrier aggregation with 10 MHz in each of the 800 and 900 MHz bands would be able to achieve 30 Mbits/s of capacity at ranges of up to around 3.5 km from a cell-site. See also Oxera Connectivity Study (ComReg Document 18/103c).

- Speed: additional sub-1 GHz spectrum (e.g. 2×30 MHz in the 700 MHz Duplex) makes it possible for operators to deploy extra carriers and deliver higher speeds across a wide area; and

- Network costs: While an existing operator without any 700 MHz Duplex spectrum could seek to add capacity in rural areas by deploying additional base stations to its network, the construction of such base stations (as well as extending backhaul links to such sites) is expensive and often costs many multiples of the cost of adding additional spectrum to existing base stations.[796]

Reduced spectrum outcomes

A 3.95 A reduction in the amount of 700 MHz Duplex available for wireless broadband would result in reduced spectrum outcomes for existing and potential service providers.

A 3.96 In relation to existing mobile operators, ComReg notes the following from the LS Telcom Study:

- mobile operators would likely have a preference for 2×10 MHz of spectrum in the 700 MHz Duplex; and

- reducing the quantity of 700 MHz Duplex available is likely to have the undesirable effect of constraining supply, particularly given that there is likely to be excess demand for rights of use in the band as observed in awards in other countries.

A 3.97 Given that Ireland has 3 MNOs, ComReg observes that a reduced amount of 700 MHz Duplex spectrum available for award could result in an existing operator with no 700 MHz Duplex spectrum despite participating in the award. For example, in the recent Swedish 700 MHz Duplex award, only 2×20 MHz was made available for wireless broadband (instead of the full 2×30 MHz) and the fourth mobile operator, H3G (Three), did not win any 700 MHz Duplex rights. This operator has stated that it would appeal the 700 MHz auction results claiming that the Swedish authority, PTS, had poor regard for competition.[797]

[796] LS Telcom note that the additional costs that would be incurred by an existing operator who did not have access to the 700 MHz band would be in the range of €20 to €55 million, with a base value of €34.5 million. To put these values in context, the Oxera Report advises that mobile operators have annual Capex investments of €80m - €96m of which around €8m – €19m is used to improve mobile coverage.

[797] See section 4.4.4 of the LS Telcom BB-PPDR Report. See also:

https://www.telegeography.com/products/commsupdate/articles/2018/12/12/tre-sweden-confirms-plans-to-contest-700mhz-auction-result/

A 3.98 ComReg further observes that reducing the amount of 700 MHz Duplex spectrum available for award would also limit the ability of non-MNOs and potential new entrants to secure scarce sub-1 GHz spectrum, which is particularly important for cost-efficient new entry.

A3.7 ComReg's preliminary view

A 3.99 From the assessment above, ComReg observes that:

- There are a range of deployment options for BB-PPDR (dedicated, hybrid and commercial) including some which do not require dedicated spectrum. In that regard, approaches involving commercial networks are being seriously considered by many Governments in Europe;
- In the case of a dedicated network, and based on LS Telcom's analysis using the LEWP-ETSI matrix but suitably modified to take account of the specificities of Ireland, 2×6 MHz appears sufficient to support BB-PPDR usage in Ireland, both in Dublin City and County and the rest of Ireland;
- There are a range of viable spectrum options available in Ireland to meet same including:
    - The **410-430 MHz band**, in relation to which ComReg proposes to make available 2×3 MHz for BB-PPDR.
        - the propagation characteristics of which are very comparable to that used by the existing TETRA network and as such is suitable for the effective deployment of wide area coverage which could be achieved using existing sites; and
        - Nordic Telecom, along with Nokia[798], is developing a LTE network for critical communications in the Czech Republic using spectrum rights in this band;
    - **3GPP Band 28B** (2×3 MHz in the 700 MHz Duplex Gap and 700 MHz Guard Bands) – for which the equipment ecosystem is extensive[799] due to it sharing the same duplexer as the Asia Pacific 700 MHz mobile band plan; and

[798] https://www.nokia.com/about-us/news/releases/2019/04/17/nokia-and-nordic-telecom-launch-the-worlds-first-mission-critical-communication-ready-lte-network-in-the-410-430-mhz-band/
[799] THE GSA report, March 2019 that 1,624 devices are available in this band

- **3GPP Band 68** (2×5 MHz in the 700 MHz Duplex Gap and 700 MHz Guard Bands); and
- **3GPP Band 28** (700MHz Duplex) – for which there is a considerable amount of off-the-shelf equipment available.

- The impact on alternative uses for some of the above spectrum options appears limited (e.g. limited uptake of the 700 MHz Duplex Gap and 700 MHz Guard Bands for WBB);
- However, the negative impacts of reduced availability of spectrum in the 700 MHz Duplex for WBB (i.e. if 2×5 or 2×10 MHz were allocated to BB-PPDR) would be substantial given:
  - The importance of the 700 MHz Duplex for the earliest, wide-area deployment of 5G, noting:
    - the EC's view that spectrum below 1 GHz, focussing on the 700 MHz Band, is *"critical for 5G success";*
    - the Government's view that *"The timely release of this spectrum is a matter of national importance to Ireland as its subsequent use for mobile broadband services will assist in delivering improved network* ***coverage and speed particularly in rural areas."***;
    - no alternative sub-1 GHz band would be available in the near term for wide-area deployment of 5G (whether a new sub-1 GHz band for WBB or rights in existing sub-1 GHz bands given legacy issues with the latter);
  - The challenges that Ireland's demographics already present for widespread connectivity;
  - how reduced spectrum availability in the 700 MHz Duplex would affect mobile operators' ability to deliver widespread connectivity, noting that:
    - Coverage: when used in conjunction with the existing sub-1 GHz bands, 2×10 MHz of 700 MHz Duplex would provide a 65% coverage area gain for speeds of 30 Mbit/s;
    - Speed: additional sub-1 GHz spectrum (e.g. 2×30 MHz in the 700 MHz Duplex) makes it possible for operators

to deploy extra carriers and deliver higher speeds across a wide area; and

- Network costs: While an existing operator without any 700 MHz Duplex spectrum could seek to add capacity in rural areas by deploying additional base stations to its network, the construction of such base stations (as well as extending backhaul links to such sites) is expensive and often costs many multiples of the cost of adding additional spectrum to existing base stations;

- the potential impacts on non-MNOs and potential new entrants arising from a reduction in available spectrum in the 700 MHz Duplex.

A 3.100 In light of the above, ComReg is of the preliminary view that progressing the Proposed Award on the basis of including the full 2×30 MHz of the 700 MHz Duplex would be the most appropriate option in terms of ComReg's spectrum management function and objectives.

A 3.101 In relation to the other technically-viable deployment and spectrum options available for BB-PPDR, and as noted in ComReg's Radio Spectrum Management Strategy Statement for 2019-2021, ComReg will continue to monitor, investigate and contribute to the spectrum management considerations in respect of spectrum for BB-PPDR.

A 3.102 In this regard, ComReg notes that:

- it has proposed to make available 2×3 MHz of spectrum in the 410 - 430 MHz band for BB-PPDR and that this represents a significant step towards meeting Ireland's likely BB-PPDR spectrum requirement of 2×6 MHz; and

- spectrum in the 700 MHz Duplex Gap and 700 MHz Guard Bands (i.e. Band 68 (2×5 MHz) and Band 28B (2×3 MHz)) could also be made available for BB-PPDR use if required, in line with the flexibility afforded the State in respect of same under the EC 700 MHz Decision.

A 3.103 ComReg's preliminary view is, however, without prejudice to any future decisions which the State may take in relation to the use of the 700 MHz Band under the EC 700 MHz Decision.

Annex: 4 Information on equipment availability, award status in Europe, harmonisation decisions and spectrum availability for the candidate bands.

Equipment Availability

A 4.1 The following table provides an update of the number of 4G and 5G devices identified by the GSA as being capable of operating in each band as at March 2019. https://gsacom.com/. May 2018 data represents relevant data provided in Document 18/60.

Band[800]	4G Devices May 2018 (18/60)	4G Devices March 2019	5G Devices March 2019
700 MHz Duplex (B28, FDD) (n28, FDD)	1,211	1,624	1
700 MHz Duplex Gap & Guard Bands (B67, FDD, SDL)	--	--	
800 MHz (B20, FDD)	4,558	5,550	
900 MHz (B8, FDD)	3,487	4,557	
1.4 GHz Centre (B32, FDD, SDL)	41	83	
1.4 GHz Extensions (B75, B76)	--	--	
1.8 GHz (B3, FDD, SDL)	7,731	9,378	
2.1 GHz (B1, FDD)	6,282	7,706	
2.3 GHz (B40, TDD)	3,779	4,757	
2.6 GHz (B7, FDD) (n7, FDD) (B38, TDD) (n38, TDD) (B41, TDD) (n41, TDD)	6,974 2,906 2,755	8,329 3,666 3,538	1 1 4
3.6 GHz (B42, TDD) (n77, TDD) (B43, TDD) (n78, TDD)	153 (combined total)	244 247	1 6
26 GHz[801]- (n257, TDD)	--	--	5

[800] All the bands presented in this table are identified as such by the 3GPP. Also, provided in parenthesis below is the 4G and 5G band number assigned by the 3GPP to each band. At this time, the GSA does not provide any figures for devices capable of operating in bands B67, B75, B76.

Status of Awards in Europe

A 4.2 The following table shows the status of awards in 20 European countries for the bands under consideration in ComReg's proposed award.

Awarded = ✓ Proposed = ✓ Undecided or No Info. = --

European Country	700 MHz Duplex	700 MHz SDL	1.4 GHz Centre	1.4 GHz Extension	2.1GHz	2.3 GHz	2.6 GHz	26 GHz
Austria	✓	--	✓	✓	✓✓	--	✓	--
Belgium	✓	--	✓	✓	✓✓	--	✓✓	--
Czech Republic	✓	--	✓	✓	✓	--	✓	--
Denmark[802]	✓	✓	✓	--	✓	✓	✓	✓
Finland	✓	--	--	--	✓	--	✓	✓
France	✓	--	✓	✓	✓	--	✓	--
Germany	✓	✓	✓	--	✓✓	--	✓	--
Hungary	✓	--	--	--	✓	--	✓	--
Italy	✓	✓	✓	--	✓	--	✓	✓
Netherlands	✓	--	✓	--	✓	--	✓	--
Norway[803]	✓	✓	--	✓	✓✓	✓	✓✓	✓
Poland	--	--	--	--	✓	--	✓	--
Portugal	--	--	--	--	✓	--	✓	--
Romania	✓	✓	--	--	✓	--	✓	--
Slovakia	--	--	--	--	✓	--	✓	--
Slovenia	✓	✓	--	--	✓	--	✓	--
Spain	✓	--	✓	--	✓	--	✓	--
Sweden	✓	✓	✓	✓	✓	✓	✓	--
Switzerland[804]	✓	✓	✓	✓	✓	--	✓	--
United Kingdom	✓	✓	✓	--	✓	✓	✓	--

[802] Information obtained from Cullen International states that the 26 GHz Band could be used for mobile broadband in Denmark today. https://www.cullen-international.com/product/documents/CTTEEU20180148

[803] Further information on Norwegian plans is taken from the NRA plan here: https://eng.nkom.no/topical-issues/news/_attachment/40945?_ts=168b83e4053

[804] https://www.comcom.admin.ch

Harmonisation of Bands

A 4.3 This table provides updates on the status of international harmonisation of the bands under consideration in ComReg's proposed award.

Band	ECC Decision	EC Decision	Other
700 MHz Duplex Band	ECC Decision 15(01)	EC 2016/687	UHF Band EP&C 2017/899
700 MHz Duplex Gap & Guard Bands	ECC Decision 15(01)	EC 2016/687	UHF Band EP&C 2017/899
1.4 Centre Band	ECC Decision (13)03	EC 2015/750[805]	--
1.4 Extension Bands	ECC Decision (17)06	EC 2015/750 (as amended)	--
2.1 GHz Band	ECC Decision (06)01	EC 2012/688	
2.1 GHz Unpaired	--[806]	--	--
2.3 GHz Band	ECC Decision (14)02	--	--
2.6 GHz Band	ECC Decision (05)05	EC 2008/477	EP&C 243/2012
26 GHz Band	ECC Decision (18)06	EU 2019/784	Directive (EU) 2018/1972

[805] As amended by EC 2018/661. A consolidated version of EC 2015/750 can be found here: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02015D0750-20180430&qid=1551728608784&from=EN

[806] Regarding harmonisation of the 2.1 GHz Unpaired Band, ECC Decision (06)01 facilitated the use of MFCN in the band, and this was later amended by ECC Decision (15)02, which then harmonised the Unpaired Band for Direct Air-to-Ground Communications. However, ECC Decision (15)02 was later withdrawn by ECC (18)01. https://www.ecodocdb.dk/download/0bc97406-7dbd/ECCDec1801.pdf.

Spectrum Availability

A 4.4 This table is designed to inform on the status of spectrum availability for the bands under consideration in ComReg's proposed award.

Band	Licensing status
700 MHz Duplex	RTÉ is currently licensed to provide DTT services in this band. The services are to have migrated out of this band by 4 March 2020.
700 MHz Duplex Gap & Guard Bands	RTÉ is currently licensed to provide DTT services in this band. The services are to have migrated out of this band by 4 March 2020.
1.4 GHz Centre Band	Unused.
1.4 GHz Extension Bands	Various, including fixed links used by broadcasters, An Garda Siochana, Fire Service, and Electricity Supply Board Networks (ESBN). Licences are annually renewable.
2.1 GHz Band[807]	Meteor - expires on 11 March 2027: ○ 1935-1940 / 2125-2130 MHz ○ 1940-1945 / 2130-2135 MHz ○ 1945-1950 / 2135-2140 MHz Three A Licence – expires on 24 July 2022: ○ 1920-1925 / 2110-2125 MHz ○ 1970-1975 / 2160-2165 MHz ○ 1930-1935 / 2120-2125 MHz Three B Licence - expires on 1 October 2022: ○ 1965–1970 / 2155–2160 MHz ○ 1925-1930 / 2115-2120 MHz ○ 1975-1980 / 2165-2170 MHz Vodafone - expires on 15 October 2022: ○ 1950-1955 / 2140-2145 MHz ○ 1955-1960 / 2145-2150 MHz ○ 1960-1965 / 2150-2155 MHz

[807] Licence details viewable at: https://www.comreg.ie/industry/radio-spectrum/licensing/search-licence-type/mobile-licences/ .

Band	Licensing status
2.1 GHz Unpaired Band	Three's licence in the range 1910–1915 MHz, which expires 1 October 2022.
2.3 GHz Band	Mostly unused. Eir holds 34 licences which span the frequency range: 2307-2327, this is used to provide rural telephone services (Rurtel). The locations of these are mostly in Co Donegal with some limited use in counties Galway and Kerry.
2.6 GHz Band	Unused Coexistence considerations with Aeronautical radars above 2690 MHz
26 GHz Band	Fixed Wireless Access Local Area - licensed under SI 79 of 2003 as amended, in the frequency ranges 24,605 – 24,745 MHz / 25,613 – 25,753 MHz; Individual P2P licences - licensed under SI 370 of 2009, in the frequency ranges 25,277 – 25,445 MHz / 26,285 – 26,453 MHz; and ComReg awarded spectrum rights of use for 26 GHz National Block Licences in the frequency range 24,745 – 25,277 MHz / 25,753 – 26,285 MHz (see Document 18/53). Licences, which issued on foot of the Proposed Award under S.I. 158 of 2018, will run for 10 years from their commencement date.

Annex: 5 Interim 2.1 GHz rights proposals

A5.1 Introduction

A 5.1 This annex sets out ComReg's detailed proposals to give effect to the proposal identified in Chapter 5 of this consultation document to align the expiry dates of those 2.1 GHz licences expiring in 2022 to a common expiry date of 15 October 2022.

A 5.2 In summary, ComReg proposes to:

- upon receipt of an appropriate application from Three, grant it interim 2.1 GHz rights of use - comprised of the frequencies in its existing "A Licence" – which would commence on 25 July 2022 and fully expire on 15 October 2022 (Interim 2.1 GHz A Licence);
- upon receipt of an appropriate application from Three, grant it interim 2.1 GHz rights of use - comprised of the frequencies in its existing "B Licence" – which would commence on 2 October 2022 and fully expire on 15 October 2022 (Interim 2.1 GHz B Licence);
- attach conditions to both the Interim 2.1 GHz A and B licences by reference to the current licence conditions in each of the existing "A Licence" and "B Licence", respectively, save for the removal of any obsolete conditions; and
- base the licence fees for each of the Interim 2.1 GHz A and B licences by reference to the licence fees for Vodafone's and Eir's existing 2.1 GHz licences, but updated to current day levels by reference to the overall consumer price index (CPI).

A 5.3 Before turning to the specific proposals and the reasons for same, ComReg firstly sets out background material regarding similar matters which have informed the present proposals.

A5.2 Background

Interim licences in the 900 MHz Band (2011)

A 5.4 In 2008, ComReg commenced a process to review and consult in relation to current and future spectrum assignments in the 900 MHz and 1800 MHz frequency bands, as well as to accommodate both liberalisation of the use of spectrum in those bands and the issuing of new, liberalised licences following expiry of certain GSM licences in the 900 MHz band that were due to expire in May 2011.

A 5.5 During this process, ComReg obtained sufficient clarity (in 2009 and 2010) regarding the likely expected availability (in 2013) of the 800 MHz band for ECN/ECS, following the migration of terrestrial television services out of this band (otherwise known as "analogue switch off" or ASO).

A 5.6 In light of this development, and to facilitate the joint award/assignment of liberalised rights in the 800 MHz and 900 MHz bands (and the benefits from same), ComReg proposed and consulted upon the grant of "interim" GSM 900 MHz rights to those licensees whose rights would expire in May 2011 (i.e. Vodafone and then Telefonica O2 Ireland (Telefonica) (together the Interim Licensees)) until the expected availability of 800 MHz rights in early 2013.

A 5.7 In Document 11/29, ComReg noted that its Interim 900 MHz Rights Proposal (Interim Licensing Proposal or ILP):

> *"…should be viewed as a facilitating measure that is needed in the particular, current, circumstances to maintain and safeguard existing competition and eliminate probable serious disruption to consumer services for the time being, and until such time that ComReg can finalise its broader spectrum release decision-making, implement same, and make available liberalised spectrum in a manner that would not distort competition.*" (at page 4).

A 5.8 Interested parties are referred to ComReg documents 10/57, 10/71, 11/11 and 11/29 (in particular) for further details.

A 5.9 In summary, ComReg decided that:

- Interim 900 MHz Licences would take the form of new rights of use, instead of a renewal or extension of a previously issued GSM licence[808];

[808] See, for example, page 68 of Document 11/29.

- licence conditions, save for the removal of obsolete conditions, would be aligned with the conditions of the existing GSM licences of the Interim Licensees (including that they would be for GSM-use only)[809]; and

- fees for Interim 900 MHz Licences would be based on existing GSM fees (both spectrum access fee (SAF) and spectrum usage fee (SUF)), but adjusted to account for the 15 year time difference between the grant of original GSM 900 MHz licences and proposed Interim 900 MHz Licences by reference to overall CPI.[810]

Extension of 900 MHz interim licences (2012/2013)

A 5.10 ComReg granted the above-mentioned Interim Licences to each of Vodafone and Telefonica in May 2011 with an expiry date of 31 January 2013. ComReg finalised its decision on the 2012 MBSA and held an auction for the rights of use of spectrum, the results of which were published in November 2012.

A 5.11 However, following completion of that auction, it appeared unlikely to ComReg that the relevant "transition" activities in the 900 MHz band could be completed before 1 February 2013 and the duration of the Interim Licences were extended to accommodate this following a subsequent consultation process. Interested parties are referred to Document 13/05 in particular.

Interim 1800 MHz Rights of Use for the period 1 January 2015 to 12 July 2015 (2014)

A 5.12 The 2012 MBSA also entailed an award of spectrum rights of use in the 1800 MHz band, which, among other things, took into account the fact that two of the three then existing GSM licences in the 1800 MHz band would expire on 31 December 2014, while the third and final licence would expire on 12 June 2013.

A 5.13 The 2012 MBSA incorporated features tailored to the specific situation in Ireland including:

- the use of two "Time Slices" for the award of spectrum rights of use, with Time Slice 1 running from 1 February 2013 to 12 July 2015 and Time Slice 2 running from 13 July 2015 to 12 July 2030; and

[809] See section 4.2.2 of Document 11/29.
[810] See in particular pages 34 and 35 of Document 11/29 which set out in detail the rationale and legal basis for why fees for interim rights of use should be based on existing fees.

- an “early liberalisation” option by which the then existing GSM licensees (Vodafone, Telefónica and Meteor) could bid in such a manner as to liberalise some or all of their respective existing GSM spectrum rights of use in the 900 MHz and/or 1800 MHz bands in Time Slice 1.

A 5.14 It was recognised at the time that the creation of the above two Time Slices and the commencement date of Time Slice 2 in particular could lead to an interim period of approximately 6.5 months between the expiry of the existing 15-year GSM 1800 MHz licences held by Vodafone and Telefónica, on 31 December 2014, and the commencement of any acquired liberalised 1800 MHz rights of use in Time Slice 2 (i.e.13 July 2015).

A 5.15 This could have affected Vodafone and Telefónica but not the third GSM 1800 MHz licensee, Meteor, as the expiry date of its licence was aligned with the commencement date of Time Slice 2 (being 13 July 2015).

A 5.16 The 2012 MBSA was completed in late 2012[811] in such manner that there would be a period of approximately 6½ months between the expiry of Telefónica’s existing GSM 1800 MHz licence on 31 December 2014 and the commencement of its liberalised 1800 MHz rights of use in Time Slice 2 on 13 July 2015. During that period, Telefónica would not hold spectrum rights of use in the 1800 MHz band.

A 5.17 In Document 14/88, and after having obtained clarity on a number of issues, ComReg proposed to put in place a process to facilitate the assignment of GSM 1800 MHz spectrum rights of use to Telefónica for the period 1 January 2015 to 12 July 2015.

A 5.18 ComReg set out its response to consultation and decision in Document 14/121 and, in summary, decided that granting an Interim 1800 MHz Licence was appropriate.

A 5.19 In terms of the details of the Interim 1800 MHz licence, ComReg:

- set the Interim 1800 MHz Licence to contain the same conditions as in Telefónica’s existing GSM 1800 MHz Licence; and

[811] In the MBSA, Vodafone availed of the early liberalisation option to liberalise its existing GSM 1800 MHz spectrum rights and obtain Liberalised Use 1800 MHz spectrum rights in Time Slice 1 with an expiry date of 12 July 2015. On the other hand, Telefónica was unsuccessful in its bids to use the early liberalisation option to obtain Liberalised Use 1800 MHz spectrum rights in Time Slice 1, and it retained its GSM 1800 MHz licence with an expiry date of 31 December 2014.

- set the fees for the Interim 1800 MHz Licence by reference to the fees for Telefónica's then current GSM 1800 MHz licence, as prescribed by Regulation 8 of the Wireless Telegraphy (GSM Mobile Telephony Licence) Regulations, 1999 and 2003, appropriately updated to then present day prices using the CPI published by the Central Statistics Office (CSO), with the indexation period starting from the commencement date of the GSM 1800 MHz licence on 1 January 2000; and

- stated that updating the licence fees payable was consistent with the approach taken in granting of the Interim GSM 900 MHz Licences and was also in line with ComReg's then strategy statement for managing the radio spectrum. ComReg further stated that it also remained cognisant of its statutory obligations and relevant obligations under EU Treaties which are relevant to the calculation and imposition of fees, and in particular, those obligations concerning State aid.

A 5.20 Interested parties are referred to Document 14/121 in particular for details on ComReg's reasoning and legal basis for granting these interim rights of use, and the conditions under which they were granted.

Observations and bearing upon present matter

A 5.21 ComReg observes the close similarities in terms of the underlying rationale for the current interim licence proposal and previous interim licensing proposals and, in particular, in respect of the grant of 1800 MHz interim rights to Telefonica. ComReg further observes the clear similarities in terms of the mechanics of its previous interim licensing proposals.

A 5.22 Given this, and recalling in particular the principle of promoting regulatory predictability[812] which ComReg is required to apply in its pursuit of its statutory objectives, there is obvious merit in adopting a consistent approach to the mechanics between the previous interim licensing proposals and the present matter where it is reasonable and appropriate to do so.

A 5.23 Notwithstanding this, in the following section, ComReg assesses the merits of granting interim rights of use in in the present case.

[812] "promoting regulatory predictability by ensuring a consistent regulatory approach over appropriate review periods": Regulation 16(2)(a) of the Framework Regulations.

A5.3 Key aspects of proposed grant of Interim 2.1 GHz A and B Licences to Three

Grant of individual and limited number of 2.1 GHz rights to Three only

A 5.24 First, subject to Three making an appropriate application for same, ComReg proposes to grant two individual rights of use for radio frequencies to Three for the purpose of aligning the expiry dates of those 2.1 GHz licences expiring in 2022 to a common expiry date of 15 October 2022. As noted in Chapter 5 and above, these two rights of use would only be granted to Three and would reflect Three's existing A Licence and B Licence in terms of, among other things, the quantum of spectrum and location of said spectrum within the 2.1 GHz band.

A 5.25 ComReg has assessed and is of the preliminary view that its proposal to grant these two sets of rights of use only to Three would comply with its regulatory obligations generally for the following reasons:

- although Three, Vodafone and Meteor are all MNOs with existing rights of use in the 2.1 GHz Band, only Three and Vodafone have such rights expiring in 2022 and, further, if the proposal is to align these rights of use expiring in 2022 to 15 October 2022 (being the expiry of Vodafone's 2.1 GHz rights) to enable the efficient assignment of new rights in the 2.1 GHz Band, then Three is clearly in a materially different position to Vodafone and Meteor in this context because only its existing 2.1 GHz rights would have expired by this date;
- the proposed grant of the Interim 2.1 GHz A Licence and Interim 2.1 GHz B Licence to Three only would, in this context, be objectively justified and non-discriminatory;
- in addition, the proposed grant of the interim licences would, in circumstances where there does not appear to be any obvious additional benefit to an earlier co-termination date in 2022, be more proportionate (and better promote regulatory certainty) than any potential foreshortening of existing rights of use (i.e. Vodafone's). That is, ComReg's interim licensing proposal would respect the full term of the existing 2.1 GHz rights of all licensees, including Vodafone and Meteor;
- the durations of the proposed interim licences would also be the minimum necessary to ensure co-termination with Vodafone's 2.1 GHz licence;
- by means of this consultation process, the proposed grant of the interim licences to Three only is also being made transparent;

- in the context of the promotion of competition (including ensuring there is no distortion or restriction of competition and safeguarding competition to the benefit of consumers), ComReg would highlight the following factors:
    - by avoiding the unnecessary complexity that would otherwise arise from a larger number of time slices to address the 3 expiry dates in 2022, ComReg's proposal would benefit all participants in the Proposed Award thereby, among other things, promoting competition in the award (by better enabling efficient award outcomes and, in turn, promoting efficient spectrum use, and downstream competition for services using this spectrum);
    - ComReg's proposal would safeguard existing competition in the mobile markets concerned (and protect end-users from any potential disruption to services that would otherwise arise) by avoiding a situation where Three would lose access to 2.1 GHz rights for that short period between licence expiry and commencement of any new 2.1 GHz rights won by it in the Proposed Award, while the spectrum lay fallow;
    - the durations of the Interim Licences would be of the minimum necessary to co-terminate and are of a very limited duration (i.e. 83 days and 14 days for the Interim 2.1 GHz A and B licences, respectively), especially when viewed in the context of the duration of the original rights of use (i.e. 20 years);
    - further, these Interim Licences (comprising a total of 2x30 MHz) would only take effect from mid-2022 in circumstances where ComReg is proposing to award substitutable spectrum rights in the 2.3 GHz and 2.6 GHz Bands which could be used shortly after the Proposed Award (circa 2020);
    - ComReg proposes to attach appropriate licence conditions and require the payment of appropriate spectrum fees for the proposed Interim A and B Licences to ensure that no distortions to competition would arise from the terms under which said licences would be granted;
- the proposal would encourage the efficient use and ensure the effective management of radio frequencies for the reasons identified above;
- the proposal would promote regulatory predictability for all affected parties by, among other things:

- avoiding the unnecessary complexity for all potential award participants that would otherwise arise from a larger number of time slices to address the 3 expiry dates in 2022; and
- adopting a consistent regulatory approach in similar circumstances (i.e. the proposed grant of interim rights as a facilitating measure for a spectrum award process).

A 5.26 In light of the above, ComReg is of the preliminary view that its proposal to grant interim rights of use to Three (as described in the first paragraph of this section) is justified having regard to the relevant provisions of the 2002 Act and Common Regulatory Framework and the general system of licences and licensing for MNOs in Ireland.

A 5.27 This preliminary view is, however, without prejudice to the conditions that would be attached to these interim rights and the financial terms on which these interim rights would be granted.

Proposed licence conditions

A 5.28 The purpose of the proposed grant of interim licences to Three is to facilitate the efficient assignment of new rights of use in the 2.1 GHz (and 2.3 GHz and 2.6 GHz bands), to protect consumers and to promote a consistent regulatory approach in similar circumstances. In that light, ComReg proposes that the licence conditions for each of the proposed Interim A Licence and Interim B Licence would be aligned with the text of the existing A and B Licence, respectively, save for the removal of any obsolete conditions. The text of the existing A and B licences are available on ComReg's website.[813]

A 5.29 For the avoidance of doubt, both proposed interim licences would be restricted to UMTS-use only because it would, among other things, not be objectively justified or proportionate to grant liberalised 2.1 GHz interim rights of use to Three, having regard to the objectives sought to be achieved by this proposal.

A 5.30 This proposed restriction is, however, without prejudice to ComReg's separate proposals on the liberalisation of *all* existing 2.1 GHz rights (as set out in Chapter 5 of this consultation).

[813] https://www.comreg.ie/industry/radio-spectrum/licensing/search-licence-type/mobile-licences/

Proposed spectrum fees

Background

A 5.31 By way of background, ComReg firstly recalls that:

- subject to sections 13 and 37 of the 2002 Act, it may impose fees for rights of use for radio frequencies which reflect the need to ensure the optimal use of the radio frequency spectrum (Regulation 19(1) of the Authorisation Regulations); and
- ComReg is obliged to ensure that any such fees shall be objectively justified, transparent, non-discriminatory and proportionate in relation to their intended purpose and shall take into account the objectives set out in section 12 of the 2002 Act and Regulation 16 of the Framework Regulations (Regulation 19(2) of the Authorisation Regulations).

A 5.32 ComReg also by way of background:

- refers to Table 30 below which sets out the spectrum access fees ("SAFs") for existing 2.1 GHz FDD licences (where payments still to be made are highlighted in orange);
- notes that, in relation to the payment of SAFs, Three and Vodafone each made their final SAF payments in 2018, whereas Meteor's licence started five years later and, as of November 2018, Meteor still has the last four of the SAF payments to make (totalling €31.7m on an undiscounted basis); and
- notes that, in addition to these SAFs, annual spectrum usage fees ("SUFs") of €1,904,610 apply to the 2x15 MHz of spectrum in each licence.[814]

[814] "*in respect of each 2 × 5 MHz in the 1920-1980 MHz and 2110-2170 MHz bands, a Licence fee of €634,870.*" *Per r*egulation 11(3)(a) of S.I. No. 340/2003 (the "2.1 GHz Regulations"): http://www.irishstatutebook.ie/eli/2003/si/340/made/en/print#

Table 30: Spectrum Access Fees[815] for current 2.1 GHz FDD licences (payments still to be made in orange)

Year	Three A Licence	Three B Licence	Vodafone	Meteor
0	€12.7m	€44.4m	€44.4m	€44.4m
1	€0	€0	€0	€0
2	€0	€0	€0	€0
3	€0	€0	€0	€0
4	€0	€3.8m	€3.8m	€3.8m
5	€0	€3.8m	€3.8m	€3.8m
6	€2.5m	€3.8m	€3.8m	€3.8m
7	€2.5m	€3.8m	€3.8m	€3.8m
8	€2.5m	€3.8m	€3.8m	€3.8m
9	€2.5m	€3.8m	€3.8m	€3.8m
10	€2.5m	€7.6m	€7.6m	€7.6m
11	€5.1m	€7.6m	€7.6m	€7.6m
12	€5.1m	€7.6m	€7.6m	€7.6m
13	€5.1m	€7.6m	€7.6m	€7.6m
14	€5.1m	€7.6m	€7.6m	€7.6m
15	€5.1m	€9.1m	€9.1m	€9.1m
Total	**€50.7m**	**€114.3m**	**€114.3m**	**€114.3m**

Proposal

A 5.33 In light of ComReg's obligations regarding promoting regulatory predictability, ensuring no distortions to competition and, further, in similar circumstances ensuring no discrimination in the treatment of undertakings providing ECS, ComReg proposes that:

i. the fees for each of the Interim 2.1 GHz A and B licences would be set by reference to the spectrum fees (both SAFs and SUFS) for Vodafone's and Eir's existing 2.1 GHz licences; and

ii. these fees be updated to current day levels by reference to the overall CPI to account for the change in prices of goods and services since grant of the existing A and B licences in 2002.

A 5.34 This proposal also reflects the following factors:

[815] This is based on the fees set out in S.I. No. 340 of 2003 (http://www.irishstatutebook.ie/eli/2003/si/340/) where the year 15 payment is corrected for the €0.2m rounding error.

- the proposed interim licences would comprise new rights of use rather than an extension of existing rights;
- these additional rights of use are of economic value, the determination of which is required to be made in the context of the Common Regulatory Framework which requires *inter alia* objective, non-discriminatory and transparent treatment in the award of rights to radio spectrum, taking into account the need to maximise benefits to users, ensure optimum utilisation of scarce resources and facilitate the development of competition;
- in the present case, no "market value" can be determined for these additional rights of use since there are no unassigned 2.1 GHz rights which could be awarded and used as a reference;
- therefore the fees payable for the interim licences should approximate to fees already payable by direct competitors;
- Vodafone and Eir are the relevant comparators in the present case as both are actual direct competitors in the relevant mobile markets and the other 2.1 GHz FDD licensees; and
- the proposed interim licences would provide Three additional periods beyond the 20 year licence duration of all existing 2.1 GHz FDD licences by which to continue to provide 3G mobile services and said additional periods would not in any event be available to Vodafone and Eir, given the intended purpose of the interim licensing proposal and the different factual circumstances.

A 5.35 Table 31 below sets out the proposed spectrum fees for each interim licence, and is based on the following:

- the quantum and location of spectrum in each of the interim licences would reflect the corresponding existing A and B licence;
- the duration of the Interim 2.1 GHz A Licence would be 83 days;
- the duration of the Interim 2.1 GHz B Licence would be 14 days;
- the relevant spectrum fees for each of Vodafone's and Eir's current 2.1 GHz FDD licence are:
    - total SAF of €114.3 million for access to 2×15 MHz FDD over 20 years; and
    - annual SUF of €1,904,610 for 2×15 MHz of spectrum in each licence;

- these fees would be updated on a once-off basis to present day terms to take account of the change in the prices of goods and services since the grant of the existing A and B licences in 2002. Note: ComReg proposes to calculate the overall CPI change using the latest CPI data available at the time at which it would be making the proposed licensing regulations under the Wireless Telegraphy Act (currently expected circa Q4/2020).

Table 31: Proposed spectrum fees Interim 2.1 GHz A and B licences

	Existing 2.1 GHz FDD licence fees (for 2×15 MHz) (€)	Fees updated to current price levels (from 2002-2019)[816]
Spectrum Access fee		
SAF for 20 year licence (2×15 MHz)	114,300,000	142,150,877.19
SAF on yearly basis (pro-rata)	5,715,000	7,107,543.86
SAF on daily basis (pro-rata)	15,657.53	19,472.72
Spectrum Usage Fee		
SUF on yearly basis (for 2×15 MHz)	1,904,610	2,368,696.26
SUF on daily basis (pro-rata)	5,218.11	6,489.58
Proposed Interim 2.1 GHz A Licence Spectrum Fee	1,732,678.44	2,154,871.04
Proposed Interim 2.1 GHz B Licence Spectrum Fee	292,259.01	363,472.22

[816] As noted above, ComReg proposes to calculate the overall CPI change using the latest CPI data available at the time at which it would be making the proposed licensing regulations under the Wireless Telegraphy Act.

Proposed procedures

A 5.36 As required under the Wireless Telegraphy Act 1926, to give effect to its proposals in this regard, ComReg will make specific regulations which would require the approval of the Minister of Communications, Climate Action & Environment.

A 5.37 ComReg refers to the interim 900 MHz and 1800 MHz licensing regulations by way of example.[817]

[817] See:
- http://www.irishstatutebook.ie/eli/2011/si/189/made/en/print ;
- http://www.irishstatutebook.ie/eli/2013/si/19/made/en/print ; and
- http://www.irishstatutebook.ie/eli/2014/si/554/made/en/print .

Annex: 6 Draft 2.1 GHz Band Liberalisation RIA

Introduction

A 6.1 The draft 'Spectrum for Award' RIA outlined ComReg's preliminary view that the assignment of rights of use to the 700 MHz Duplex, 2.6 GHz Band, 2.3 GHz Band and 2.1 GHz Band is the preferred option in terms of its impact on stakeholders, competition and consumers. All liberalised rights of use in the 700 MHz Duplex, 2.3 GHz Band and the 2.6 GHz Band would begin following the proposed award. In effect, those liberalised rights of use would begin prior to the expiry of the existing 2.1 GHz rights of use, which are currently not liberalised and which expire in 2022 (Three and Vodafone) and 2027 (Eir).

A 6.2 This draft RIA considers whether ComReg should vary existing 2.1 GHz rights of use such that they are "liberalised", in line with Decision 2012/688/EU[818] and, if so, the timing of any such liberalisation.

RIA Framework

A 6.3 ComReg refers to the discussion on the general RIA framework as described in the revised draft 'Spectrum for Award' RIA which is contained in Chapter 4. See, in particular, paragraphs 4.2 – 4.7.

Background

A 6.4 By way of background, ComReg sets out some information on the following which are relevant to the assessment provided in this draft RIA.

- European Commission Decision 2012/688/EU;
- ComReg's preliminary consultation on the liberalisation of the paired terrestrial 2 GHZ spectrum band (Document 14/65)[819];
- Market developments since 2014; and

[818] Decision 2012/688/EU: *"Commission implementing decision of 5 November 2012 on the harmonisation of the frequency bands 1 920-1 980 MHz and 2 110-2 170 MHz for terrestrial systems capable of providing electronic communications services in the Union"* http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32012D0688

[819] https://www.comreg.ie/publication/preliminary-consultation-liberalisation-of-the-paired-terrestrial-2-ghz-spectrum-band/

- Technical benefits of liberalisation.

European Commission Decision 2012/688/EU

A 6.5 In November 2012, the European Commission (EC) adopted a decision on the harmonisation of the frequency bands 1,920-1,980 MHz and 2,110-2,170 MHz (i.e. 2.1 GHz Band) for terrestrial systems capable of providing electronic communications services in the Union (Decision 2012/688/EU).

A 6.6 Among other things, Decision 2012/688/EU requires Member States to "*designate and make available, on a non-exclusive basis, the paired terrestrial 2 GHz band for terrestrial systems capable of providing electronic communications services, in compliance with the parameters set out in the Annex*" of that decision.[820]

A 6.7 The technical conditions set out in the Annex to Decision 2012/688/EU are derived from CEPT Report 39[821] and are presented in the form of frequency arrangements[822] for the band and Block Edge Masks[823] for base stations and terminal stations[824].

A 6.8 These technical conditions are technology-neutral and allow technologies other than the UMTS technology to be deployed in the 2.1 GHz Band (e.g. LTE).

Preliminary Consultation Document 14/65

A 6.9 In Document 14/65[825], ComReg sought views from interested parties on the implementation of Decision 2012/688/EU in Ireland (i.e. "liberalisation") in the context of ComReg's statutory functions, objectives and duties in relation to the radio frequency spectrum.

A 6.10 In particular, ComReg sought views on the potential impact of such liberalisation particularly in terms of:

[820] Article 2(1) of Decision 2012/688/EU/
[821] http://www.erodocdb.dk/Docs/doc98/official/pdf/CEPTREP039.PDF
[822] Frequency arrangements refer to the band plan and duplex mode of operation.
[823] A Block-Edge Mask (BEM) "*is an emission mask that is defined, as a function of frequency, relative to the edge of a block of spectrum for which rights of use are granted to an operator. It consists of in-block and out-of-block components which specify the permitted emission levels over frequencies inside and outside the licensed block of spectrum, respectively.*" (Source Annex to Decision 2012/688/EU)
[824] In Decision 2012/688/EU the BEM for the terminal station consists only of an in-block component.
[825] https://www.comreg.ie/publication/preliminary-consultation-liberalisation-of-the-paired-terrestrial-2-ghz-spectrum-band/

- the benefits to consumers in terms of furthering their interests by, for example, encouraging innovation, investment, and the availability and use of mobile services in Ireland; and result in better choice, price, quality of service and value for money; and/or

- whether liberalisation may give rise to a material risk of a distortion of competition to the detriment of consumers such that any benefits resulting from liberalisation would be outweighed by the detriment to consumers resulting from any such a distortion of competition.

A 6.11 ComReg received three responses[826] to Document 14/65. ComReg refers to the responses received throughout this draft RIA. However, in summary:

- Three submitted that ComReg should liberalise all 2.1 GHz rights of use with appropriate technical restrictions to avoid interference.

- Eir submitted that ComReg should consider whether to liberalise some or all of Three's 2.1 GHz holdings. In particular.

    - Liberalising all of Three's 2.1 GHz rights of use would worsen the existing spectrum asymmetry and would severely compromise Eir's ability or maintain a sustainable position in the market.

    - Eir submits that there is a strong case that only 2×15 MHz rights of use should be liberalised.

- Vodafone submitted that ComReg should proceed cautiously with moves towards liberalisation of the 2.1 GHz Band. Before liberalisation is implemented Vodafone sought a comprehensive review of the potential negative impacts of what it considers a spectrum imbalance. In particular, Vodafone contends that:

    - the effect of allowing one operator to provide LTE services using twice the 2.1 GHz spectrum of other operators would severely damage infrastructure competition.

    - liberalisation of this band combined with carrier aggregation would exacerbate the perceived imbalance between LTE services provided by Three and the LTE services provided by other operators.

A 6.12 Below, ComReg briefly discusses certain developments since the responses to Document 14/65 that are likely to be relevant to the assessment that follows in this draft RIA.

[826] ComReg intends publish the responses shortly on its website

Market developments since 2014

LTE rollout

A 6.13 All MNOs have now launched LTE but in bands other than the 2.1 GHz Band and is widespread across the country. For example, a European Commission study on broadband coverage in Europe (June 2016) found that as of mid-2016, 97.2% of the homes in Ireland had LTE coverage.[827]

A 6.14 This has resulted in a large increase in the number of 4G subscribers. For example, between Q3 2014 and Q4 2018, the proportion of 3G subscriptions has fallen from 68% to 36% while the proportion of 4G subscriptions has increased from 8% to 50% over the same period.[828]

3.6 GHz Award

A 6.15 The 3.6 GHz Award resulted in the successful assignment of all 350 MHz of spectrum available to five winning bidders and services are beginning to be rolled out across the country.[829]

- Prior to the 3.6 GHz Award (and at the time of Document 14/65):
    - the spectrum asymmetry between Eir and Three was **80 MHz and 20%** of total spectrum holdings.
    - the spectrum asymmetry between Vodafone and Three was **60 MHz and 15%** of total spectrum holdings.
- Following the 3.6 GHz Award and the assignment of 290 MHz between MNOs:
    - the spectrum asymmetry between Eir and Three was **105 MHz and 14%** of total spectrum holdings.
    - the spectrum asymmetry between Vodafone and Three was **55 MHz and 8%** of total spectrum holdings.

Market shares

A 6.16 The market share of the three MNOs have been relatively static over the period since the merger, although Three and Eir have a marginally reduced

[827] https://ec.europa.eu/digital-single-market/en/news/study-broadband-coverage-europe-2017
[828] ComReg Quarterly Reports.
[829] https://www.comreg.ie/industry/radio-spectrum/spectrum-awards/3-6ghz-band-spectrum-award/

market share (subscribers).[830] For example[831]:

- Vodafone's market share remains at 38% and it has added 208,159 subscribers.
- Three's market share has fallen by 1% to 35% and it has added 125,270 subscribers.
- Eir's market share has fallen 1% to 17% and it has lost 10,757 subscribers.

Additional rights of use

A 6.17 As noted by DotEcon, the views of respondents, was at a time when the future availability of additional spectrum included in the proposed scope of this award was unclear and still some way off.[832] However, ComReg notes that proposals to assign additional liberalised rights of use have significantly progressed with this Proposed Award due to take place in 2020. An additional 350 MHz of liberalised rights of use is proposed to be released in the Proposed Award (including 2.3 GHz and 2.6 GHz Bands, which are substitutable to the 2.1 GHz Band). This follows the 350 MHz already released in the 2017 3.6 GHz Award.

Technical benefits of liberalisation

A 6.18 ComReg notes that any distortions to competition that may arise would be related to the particular benefits that could be obtained from liberalisation. By allowing the deployment of technologies other than UMTS (and LTE in particular), liberalisation should provide a number of technical benefits that would result in (a) higher speeds and (b) increased capacity.

- **In relation to (a)**, higher peak data rates and user throughput is primarily the result of wider channel bandwidths and carrier aggregation. This allows operators to provide higher speed services. For example:
  - The peak data rate for HSDPA (Release 7) is 14.4 Mbit/s, with a peak user data rate of 13.4 Mbit/s.[833]
  - The peak data rate for LTE Advanced (Release 10) is 3 Gbps (DL) and 1.5 Gbps (UL).[834]
- **In relation to (b)**, improved spectrum efficiency provides greater capacity in a cell. Spectral efficiency is a good indicator of the capacity of a

[830] Tesco gained over 2% (Q2 2014 – Q4 2018).
[831] ComReg Quarterly Reports (Q2'14 – Q4'18).
[832] DotEcon Award Design Report, p21.
[833] http://www.3gpp.org/technologies/keywords-acronyms/99-hspa
[834] http://www.3gpp.org/technologies/keywords-acronyms/97-lte-advanced

particular technology and the ability of operators to deliver additional capacity at a site. This allows operators to increase capacity and reduce or eliminate capacity constraints in certain areas. For example:

- A maximum spectral efficiency of 30 bit/s/Hz for LTE Advanced (Release 10). [835]
- A maximum spectral efficiency of 4.5 bit/s/Hz for HSDPA (Release 7).[836]

Identify the policy issues and identify the objectives (Step 1)

Policy issues

A 6.19 The primary policy issue is to determine whether and, if so, when existing rights of use in the 2.1 GHz Band should be liberalised to enable the deployment of technologies compatible with the technical conditions set out in Decision 2012/688/EC, in the context of ComReg's statutory functions, objectives and duties in relation to the radio frequency spectrum.

Objectives

A 6.20 The focus of this draft RIA is to assess the impact of the proposed measure(s) (see regulatory options below) on industry stakeholders, and on competition and consumers. In that way, it allows ComReg to identify and implement the most appropriate and effective means to assign spectrum rights of use, while still allowing ComReg to achieve its objectives of:

- liberalisation of the 2.1 GHz Band for terrestrial systems capable of providing ECS, in compliance with the parameters set out in 2.1 GHz Decision;
- assigning liberalised rights of use in the 2.1 GHz Band with other complementary and substitutable bands in the Proposed Award (e.g. 700 MHz Duplex, 2.3 GHz Band and 2.6 GHz Band);
- promoting competition and ensuring that there would be no distortion or restriction of competition in the electronic communications sector by, amongst other things:
  - ensuring that users derive maximum benefit in terms of choice, price and quality;

[835] 3GPP TR 36.913 V10.0.0 (2011-03) Technical Report. P9.
[836] ftp://www.3gpp.org/tsg_ran/WG1_RL1/...20/.../R1-01-0471.pdf

- ensuring that there is no distortion or restriction of competition in the electronic communications sector;
- encouraging efficient use and ensuring effective management of radio frequencies;

- encouraging efficient investment in infrastructure, promoting innovation and ensuring the efficient use and effective management of the radio frequency spectrum; and
- promoting the interest of economic development of the State and electronic communications sector.

A 6.21 ComReg's other overarching objectives are to contribute to the development of the internal market and to promote the interests of users within the Community. ComReg also notes that, in achieving its objectives, its ultimate aim is to choose regulatory measures which maximise the benefits for consumers in terms of price, choice and quality.

Identifying the regulatory options

A 1.1 The two broad options available are to liberalise, or not, some or all 2.1 GHz rights of use. In relation to the timing of any such liberalisation, ComReg is of the view that the earliest time at which such liberalisation could be provided for would be around the time of time of the substantive decisions concerning the proposed award of a limited number of individual rights of use in the proposed frequency bands. This view is informed by a number of factors, including that:

- any decision to liberalise existing rights of use in the 2.1 GHz Band (by way of licence amendment) is subject to consultation and response to same which could take up to 1 year;
- the potential for distortions to competition from any liberalisation would reduce as one gets closer to the time of the Proposed Award; and
- the views of DotEcon that it may be preferable to wait until at least the point at which substantive decisions have been made regarding this award and the liberalisation process, to ensure that all operators will have reasonable clarity in advance over the terms of liberalising their own licences.[837]

A 6.22 In light of the above, three regulatory options appear available:

[837] DotEcon Award Design Report, p20.

- **Option 1**: Do not liberalise any 2.1 GHz rights of use prior to expiry of same[838];

- **Option 2A:** Provide the option for all existing licensees to liberalise some or all existing 2.1 GHz rights of use from the time of the substantive decisions concerning the present Proposed Award; and

- **Option 2B:** Provide the option for all existing licensees to liberalise some or all existing 2.1 GHz rights of use following the assignment of new rights of use in the proposed frequency bands in the Proposed Award.

A 6.23 In relation Options 2A and 2B, ComReg considers whether a material distortion to competition would be likely to arise from the liberalisation of all 2.1 GHz rights of use. ComReg only considers it necessary to assess whether to liberalise a portion of an existing licensee's rights of use (i.e. 2×15 MHz each as suggested by Eir) if a material distortion to competition would be likely to arise from liberalising all rights of use.

A 6.24 Further, ComReg notes that a relevant consideration in determining the preferences of stakeholders relates to whether liberalisation fees should apply and, if so, how and when such fees should be calculated. In that regard, Chapter 5 sets outs ComReg's views on the liberalisation fees that would apply in the event of liberalisation being the preferred option. In summary, ComReg is of the preliminary view that:

- for the period up until 15 October 2022 it would not be appropriate to apply fees for the early liberalisation of licences; and

- while liberalisation fees are unlikely to be required for Eir for the period 16 October 2022 – 11 March 2027, it would be prudent to have in place a process that would apply appropriate liberalisation fees, if in the unlikely event, the new 2.1 GHz liberalised rights of use were higher than fees currently being paid by Eir for unliberalised rights of use.

A 6.25 Finally, ComReg notes the following assumptions are relevant to the timing of Option 2A and Options 2B:

- ComReg's proposal to align the expiry of Vodafone's and Three's

[838] The various licence expiries are set out below.
- Three Ireland Hutchison Limited rights of use in its "A licence" expire on 24 July 2022, and its "B Licence" expire 1 October 2022;
- Vodafone Ireland Limited rights of use expire 15 October 2022; and
- Meteor Mobile Communications Ltd rights of use expire 11 March 2027;

existing rights to October 2022[839];

- Any liberalised existing rights of use would be available to Three and Vodafone until October 2022 and until October 2027 for Eir;
- ComReg's substantive decisions on the Proposed Award would be made in 2020; and
- The time between ComReg's substantive decisions on the Proposed Award and the commencement date of any new rights of use granted on foot of the Proposed Award would be circa 6-12 months (noting that this period was around 9 months in the 2012 MBSA).

Identification of stakeholders

A 6.26 Stakeholders consist of two main groups:

iii. consumers (for the purposes of this draft RIA, consumers include both business and residential consumers), and

iv. industry stakeholders.

A 6.27 There are a number of key industry stakeholders in relation to the matters considered in this Annex:

- existing MNOs who have spectrum rights of use in the 2.1 GHz Band[840]); and
- MVNOs.

Impact on stakeholders

Option 1

A 6.28 MNOs are unlikely to prefer Option 1 as they would continue to be prevented from deploying and using technologies compatible with the technical conditions in Decision 2112/688/EU in the 2.1 GHz Band (such as LTE). As noted by DotEcon[841], in addition to significant benefits for consumers, liberalisation may bring about and potential cost savings for operators by facilitating transition to more spectral efficient technologies. All MNOs have expressed a preference for liberalisation and the increased demand for data-intensive services (e.g. see draft 'Spectrum for Award' RIA) means that liberalisation, even for a short period of time prior to expiry of existing

[839] See Annex 5.
[840] Meteor Mobile Communications Ltd, Three Ireland Hutchison Limited, Vodafone Ireland Limited.
[841] DotEcon award Design Report, p19

licences could be beneficial to MNOs.

A 6.29 Under Option 1, MNOs would have to delay providing LTE services in the 2.1 GHz Band until the expiry of existing licences. This poses a number of difficulties, including that:

- for Vodafone and Three, the rollout of LTE 2100 would be delayed until the commencement of new rights of use in the 2.1 GHz Band in 2022 (i.e. Time Slice 1), which would be 1 - 2 years after the proposed assignment of rights of use in the 2.3 GHz Band and 2.6 GHz Band;

- there is the potential for inefficient rollout if operators would have preferred to use 2.1 GHz rights of use but instead had to use alternative liberalised rights of use (e.g. 2.3 GHz and 2.6 GHz instead) because liberalised 2.1 GHz rights of use were unavailable due to a licence condition;

- Eir would either have to wait until 2027 (until its existing rights of use expired) or obtain new 2.1 GHz rights from 2022, which may be inefficient if it did not need its entire existing spectrum rights to support UMTS services (i.e. could have made use of some or all of its existing rights for the provision of LTE services); and

- some or all operators may already be capacity constrained in certain areas and liberalisation at the earliest opportunity would allow it to remedy some of these concerns prior to the assignment of additional rights of use in the Proposed Award.

A 6.30 Similarly, other stakeholders, such as MVNOs, would prefer liberalisation as it would provide additional LTE services to its customers.

A 6.31 Therefore, ComReg is of the preliminary view that stakeholders generally would be unlikely to prefer Option 1.

Option 2A v Option 2B

A 6.32 Whilst stakeholders would likely generally prefer liberalisation than not, they are likely to have different views about the nature and timing of any such liberalisation.

A 6.33 Based on its response to Document 14/65, Three would prefer Option 2B over Option 1 but it is likely to prefer Option 2A over Option 2B as this would allow it to liberalise all of its existing rights at the earliest opportunity.

A 6.34 In response to Document 14/65, Vodafone's expressed its cautious support for the liberalisation of the 2.1 GHz Band. Similarly, in response to Document 18/60 it submitted that it would be possible to construct an "early liberalisation option" to allow some or all the existing licensees the option to liberalise via the Proposed Award.

A 6.35 Given its concerns about the potential negative impacts of the spectrum asymmetry (between it and Three) it might prefer an Option that would limit the extent to which Three could liberalise its 2.1 GHz rights of use. For example, it would likely prefer Option 2A if liberalisation was only available to Vodafone and Eir or if only 2×15 MHz was available to Three for liberalisation (as suggested by Eir).

A 6.36 Alternatively, if all rights of use are to be liberalised it may prefer Option 2B over Option 2A as this would prevent Three potentially taking advantage of liberalisation between the time of the substantive decision and the Proposed Award. At the same time, it would also allow Vodafone the opportunity to reduce the spectrum asymmetry between it and Three at the time of the Proposed Award, noting that it would be permitted to be assigned more rights of use than Three under the competition cap proposals, given Three's existing spectrum holdings in other bands.

A 6.37 However, given the likely proximity of Option 2A to the Proposed Award (circa 6 -12 months) Vodafone may prefer to liberalise its rights of use at the earliest possible opportunity. For example, it may be capacity constrained in particular areas and liberalised rights of use may be helpful in alleviating such constraints in the run up to the Proposed Award. It could also allow Vodafone to proceed with its rollout of LTE 2100 with the expectation that it would at least retain 2×15 MHz rights of use, unlike Three where its long term 2.1 GHz holdings are less certain. Further, as noted below (Impact on Competition), the extent to which Three could take advantage of liberalised rights of use between the substantive decision and time of the award is likely to be very limited.

A 6.38 Eir would likely prefer either Option 2A or Option 2B over Option 1 and the opportunity to liberalise its rights of use. However, Eir has expressed concerns about the potential negative impacts of the spectrum asymmetry (between it and Three). In response to Document 14/65, Eir contends that a decision to liberalise all the 2.1 GHz rights of use would severely compromise Eir's ability to maintain a sustainable position on the market. In line with its 2014 submission, Eir would likely prefer that each MNO would only have the opportunity to liberalise up to 2×15 MHz rights of use.[842]

[842] In effect, Three would have 2×15 MHz liberalised and another 2×15 MHz unliberalised.

A 6.39 In relation to the timing of any liberalisation, as noted above there would be no liberalisation fees for the period 2020 – 2022. However, any fees for 2022 - 2027 (Time Slice One) would depend on the extent to which the prices achieved in the Proposed Award for Time Slice 1 exceeded the current fees being paid by Eir[843] (See above and Chapter 5 for further discussion). While DotEcon does not expect this situation to occur[844] there remains the possibility (albeit slim) that additional liberalisation fees may apply. Under Option 2A, any liberalisation by Eir would be in the knowledge that unspecified liberalisation fees may be payable for Time Slice One, post award.

A 6.40 While Eir is likely to prefer Option 2A over Option 1, it would have concerns regarding potential liberalisation fees and the potential impact of the spectrum asymmetry. Alternatively, under Option 2B, Eir would have full knowledge of any liberalisation fees that would apply, prior to a decision to liberalise 2.1 GHz rights of use.

A 6.41 Further, to the extent that Option 2A or Option 2B would involve the liberalisation of all rights of use, it would likely prefer Option 2B as this would allow it the opportunity to reduce the asymmetry between it and Three during the Proposed Award, noting that it would be permitted to be assigned more rights of use than Three or Vodafone under the competition cap proposals, given their speculative spectrum holdings in other bands held by Vodafone and Three.

Impact on competition

A 6.42 In Document 14/65, ComReg sought views on whether liberalisation would give rise to a material risk of a distortion of competition to the detriment of consumers such that any benefits resulting from liberalisation would be outweighed by the detriment to consumers resulting from any such a distortion of competition.

A 6.43 However, as outlined above, (policy issues and objectives) there are different elements to competition that are relevant in determining the impact of any of the preferred options. In that regard, ComReg considers the following to be particularly relevant in assessing the impact on competition across each option below:

[843] As noted by DotEcon, it would be questionable to have a situation in which the Meteor licence is liberalised for 2020 – 2022 but then usage restrictions are reinstated from 2022 until the licence expires; this would go against the ECC Decision to make the 2.1 GHz spectrum available on a technology and service neutral basis.
[844] DotEcon notes that the value of the liberalised spectrum is likely to be less than the fees for the current 3G licences set in 2002/2007.

- Ensuring that there is no restriction or distortion of competition in the electronic communications sector[845];
- Safeguarding competition to the benefit of consumers and promoting, where appropriate, infrastructure based competition[846];
- Encouraging efficient use and ensuring the effective management of radio frequencies and numbering resources[847].
- Promoting efficient investment and innovation in new and enhanced infrastructures[848]; and
- Promoting competition during the award.

Option 1

A 6.44 Under Option 1, existing levels of competition would remain the same until the assignment of new rights of use in the Proposed Award. However, Option 1 could create distortions to competition in the future. In particular, post award, it is likely that Option 1 would create a situation where different MNOs would have to compete on a different basis using the same spectrum (i.e. 2.1 GHz rights of use). For example, Eir would likely have unliberalised rights of use for the period up to the expiry of its existing licence in 2027. At the same time, Vodafone and Three could have been assigned liberalised rights of use in Time Slice 1 (up to 2027) and Time Slice 2 (up to expiry). While Eir could bid for new liberalised 2.1 GHz rights in Time Slice 1, this would not be an efficient use of the radio spectrum or an efficient investment and could create competition concerns during the award.

A 6.45 Under Option 1, infrastructure based competition would not be best promoted in the period between 2022 and 2027. Vodafone and Three would likely be able to roll out LTE 2100 on their networks while Eir would be restricted to providing 3G and GSM mobile telephony services in the 2.1 GHz band until 2027. While Eir could continue to provide LTE services using existing and newly assigned rights of use in the Proposed Award, LTE 2100 could not be rolled out on its network. This would not contribute to users deriving maximum benefits in terms of choice, price and quality.

[845] Section 12(2)(a) of the 2002 Act
[846] Regulation 16(2) of the Framework Regulations
[847] ibid
[848] ibid

A 6.46 Further, under Option 1, the rollout of LTE 2100 would be delayed for all MNOs until 2022 when new liberalised 2.1 GHz rights of use would become available (being 1 - 2 years after the proposed assignment of rights of the 2.6GHz and 2.3 GHz bands). This would not encourage the efficient use of the radio spectrum as a more efficient mobile technology (LTE) would be not be permitted due to a restriction of existing licence conditions, despite a likely preference for operators to rollout that technology.

A 6.47 Such a situation would also increase the risk of inefficient investment and rollout as operators who would prefer to rollout LTE 2100 in certain areas would either have to wait until 2022 or use 2.6 GHz and/or 2.3 GHz which may be a less efficient way of achieving its desired network rollout. It would also shield any less efficient operators who currently would prefer the existing usage restrictions in order to delay other MNOs from expanding LTE 2100 services.

A 6.48 Finally, given the later expiry of Eir's 2.1 GHz rights, Option 1 could create artificial competition in the Proposed Award if Eir was required to bid for new liberalised 2.1 GHz rights in Time Slice 1 when it could have otherwise met its demands for the rollout of LTE 2100 with its existing (but liberalised) rights of use. ComReg also observes that such a scenario would be unlikely to promote the efficient use of spectrum.

A 6.49 In light of the above, ComReg is of the preliminary view that competition is unlikely to be best promoted under Option 1.

Option 2A v Option 2B

A 6.50 Option 2A and Option 2B both involve the liberalisation of the 2.1 GHz Band. In that regard, DotEcon is of the view[849] that there would appear to be clear potential benefits in liberalising the 2.1 GHz licences such that operators are able to use the frequencies on a service and technology neutral basis. This would allow all operators (if successful during award) to use 2.1 GHz rights of use without any restriction on what services could be rolled out. This should promote competition in downstream markets by increasing the availability of liberalised rights of use which allows all operators to provide more advanced service. This should contribute to users deriving maximum benefits in terms of choice, price and quality.

A 6.51 Both options would also have a positive impact on other elements of competition for the following reasons:

[849] DotEcon Award Design Report, p39

- infrastructure based competition would be better promoted as all MNOs would be able to roll out LTE 2100 on their networks at the same time;
- the rollout of LTE 2100 could begin no later than the availability of other liberalised rights of use (2.6 GHz and 2.3 GHz) promoting more efficient use of the radio spectrum and more efficient investment;
- any less efficient operators who currently prefer the existing usage restrictions would not be shielded from more efficient operators who wish to rollout LTE 2100 at the earliest opportunity; and
- competition during the award would be based on actual demand rather than some artificial demand as a result of the restriction on existing rights of use.

A 6.52 Therefore, Options 2A and 2B should, absent any other concerns, better promote competition than Option 1 by allowing MNOs to rollout LTE 2100 in the 2.1 GHz Band. In that regard, ComReg assess the following:

- **First**, ComReg assesses whether liberalisation of all 2.1 GHz rights of use would confer a material advantage on Three under Options 2A and Option 2B as it would have the option to liberalise an additional 2×15 MHz rights of use.
- **Second**, ComReg assesses whether liberalisation at the earliest possible opportunity (i.e. at the time of the substantive decision (Option 2A)) would create competition concerns such that liberalisation following the assignment of new rights of use in the proposed award would better promote competition.

1. Would the liberalisation of an additional 2×15 MHz confer a material advantage on Three?

A 6.53 The main theory of harm associated with liberalisation appears to be that Three would be permitted to liberalise 2×30 MHz 2.1GHz rights of use, allowing it to obtain a material advantage that could not be efficiently/effectively replicated by Vodafone and/or Eir who would only have the option to liberalise 2×15 MHz 2.1GHz rights of use. In this regard, an important consideration is the extent to which the availability of an additional 2×15 MHz 2.1 GHz liberalised rights of use could create a material distortion to competition under Option 2A or Option 2B.

A 6.54 ComReg would note the technical benefits of liberalisation referred to above would be available to all MNOs. However, Three could theoretically be able to exploit these advantages more readily given the availability of an additional 2×15 MHz rights of use. For example, the liberalisation of 2.1 GHz would allow Three to deploy two 2×15 MHz LTE carriers in the 2.1 GHz Band. This could support higher user data speeds, improve capacity, and quality of service and potentially give it a headline speed advantage in the near term over both Eir and Vodafone. Alternatively, it could, rollout LTE in part of the spectrum and maintain UMTS services using some of its 2.1 GHz spectrum, in a manner that would not be available to other operators.

A 6.55 However, ComReg is of the preliminary view that Three is unlikely to be able to obtain a material advantage for a number of reasons.

i. The time between the proposed award and expiry of 2.1 GHz rights of use is narrow (i.e. circa 18 months).

ii. Vodafone and Eir would both have the opportunity to be assigned other liberalised rights of use across both Time Slices in the Proposed Award.

iii. Three is unlikely to have the ability or incentive to exploit any advantages of an additional 2×15 MHz.

A 6.56 **In relation to (i),** Three is unlikely to provide additional high speed services across its network using all 2×30 MHz rights of use, if the spectrum on which those services depend is due to expire over a short period. Even if Three provided such services, it would take time before the benefits to Three in terms of consumer switching (even if it occurred) could be realised.

A 6.57 **In relation to (ii),** the proposed award would provide Vodafone and Eir with the opportunity to compete for 350 MHz of additional rights of use in other liberalised bands (e.g. 2.3 GHz and 2.6 GHz). Further, because existing holdings (other than 2.1 GHz) are considered as part of the competition cap, bidders with lower existing holdings having greater capacity to add spectrum to close the spectrum asymmetry. For example, if an overall competition cap of 375 MHz was used (noting that this is for illustration purposes only and the same general arguments apply for other caps within the recommended range).

- Eir could bid for up to 190 MHz (375 MHz less 185 MHz) in Time Slice 1 and up to 195 MHz in Time Slice 2.

- Vodafone could bid for up to 180 MHz (375 MHz less 180 MHz) in Time Slice 1 and 2

- Three could bid for up to 155 MHz (375 MHz less 220 MHz) in both

Time Slices.

A 6.58 **In relation to (iii),** ComReg is of the preliminary view that a number of factors means that Three has neither the ability nor incentive to exploit the advantages of an additional 2×15 MHz rights of use over a short period.

- There is no certainty that Three would retain 2×30 MHz in the 2.1 GHz Band following the Proposed Award, it is also uncertain how extensively Three may choose to deploy LTE 2100 in advance of knowing what its long term holdings in the band would be.
- Any significant rollout of LTE 2100 prior to the proposed award would risk inefficient investment, if lesser, or no, rights of use were subsequently assigned in the Proposed Award.
- Three currently uses 2.1 GHz rights of use for 3G services and it will likely require some of those rights of use for UMTS beyond the Proposed Award in order to facilitate transition to LTE over an extended period.
- Three seems unlikely to advertise based on higher theoretical speeds (as claimed by Eir) as the spectrum holding on which such claims would be based could be lost post award and Three typically does not advertise on the basis of the speed of its services in any event but rather on the size of its data caps (i.e. All You Can Eat)[850].
- Notably, Three has held more spectrum rights in other liberalised bands than Vodafone and Eir for the past four years (e.g. in the 1800 MHz Band which is already use to provide 4G services) but added fewer subscribers than Vodafone over the same period[851];

A 6.59 In light of the above, ComReg is of the preliminary view that liberalisation of all rights of use is unlikely to confer a material advantage on Three.

2. Would liberalisation at the earliest opportunity create any competition concerns?

A 6.60 Option 2A would permit the liberalisation of all existing 2.1 GHz Band rights of use but at an earlier date than Option 2B (i.e. from the time of ComReg's substantive decisions regarding the Proposed Award, instead of following the Proposed Award). In effect, competition could be better promoted as the benefits of liberalisation would occur earlier and

[850] www.three.ie
[851] Assessment of ComReg Quarterly Data Q4'14 – Q4'18.

A 6.61 However, earlier liberalisation of all existing rights under Option 2A (compared to Option 2B) raises two additional issues for consideration.

iv. MNOs would not be able to be obtain new rights of use in the bands proposed for award (e.g. 2.6 GHz Band and 2.3 GHz Band) prior to or at the same time as the liberalisation of existing 2.1 GHz rights; and

v. Eir may wish to wait until after the Proposed Award to determine whether or not to liberalise its existing 2.1 GHz rights of use. This would occur in circumstances where Vodafone and Three would have availed of liberalisation of their respective 2.1 GHz rights soonest after ComReg's substantive decisions regarding the Proposed Award (circa 6-12 months earlier).[852]

A 6.62 **In relation to (i)**, ComReg firstly notes the main use of 2.1 GHz liberalised rights of use between the time of the substantive decision and the time of the Proposed Award would be to alleviate any capacity constraints in specific areas. In that context, an additional 2×15 MHz of liberalised rights could confer an advantage on Three if such capacity constraints could be addressed by it but not by other rival operators.

A 6.63 Based on the available information, however, ComReg does not consider that any such advantage would give rise to a material risk of a distortion of competition to the detriment of consumers, such that any benefits resulting from liberalisation would be outweighed by the detriment to consumers resulting from any such a distortion of competition. This is informed by the same assessment provided in Paragraph A6.58, and the following.

- Any advantage that may accrue to Three would be of a limited duration (likely circa 6 - 12 months);
- The benefits of reducing capacity constraints would only apply to certain areas of high density areas such as the cities and not on a scale likely to distort or restrict competition. Further, Vodafone and Eir would be similarly able to address such constraints (although to a lesser degree).

A 6.64 **In relation to (ii)**, under Option 2B any liberalisation fees that would apply to Eir's existing rights in Time Slice 1 (on the basis of ComReg's proposed potential spectrum liberalisation fee mechanism) would be known to Eir prior to making any decision to liberalise, reducing the risk that Eir would not liberalise at the time of the substantive decision. This may create competition concerns such that Eir would have unliberalised rights of use for a short period (6 – 12 months).

[852] Three and Vodafone would be very likely to liberalise at the earliest opportunity because there would not be uncertainty over the fees that would apply to the liberalisation of their respective rights (i.e. these fees would be zero).

A 6.65 However, under Option 2A, Eir may, because of any financial exposure that may result from the potential spectrum liberalisation fee mechanism in respect of the liberalisation of its existing 2.1 GHz rights in Time Slice 1, choose to wait until after the Proposed Award to liberalise its existing rights, ComReg observes:

- based on the available information, it is unlikely that any liberalisation fees would apply. [853]
- furthermore, other substitutable bands are proposed to be awarded alongside the 2.1 GHz Band; and
- in light of the above factors and recalling that Time Slice 1 is circa 5.5 years, it is unlikely that Eir would choose not to liberalise its existing rights in Time Slice 1 at market-determined rates and may therefore avail of any liberalisation option at the time of the ComReg's substantive decision.

A 6.66 Even if Eir decided not to liberalise at the same time as Vodafone and Three, ComReg does not believe that any material distortion to competition would arise given the reasons identified above in respect of **issue (i)** and, in particular, that any advantage Three or Vodafone would gain would be of limited duration (circa 6 – 12 months) until the proposed availability of a large quantum of new and substitutable liberalised rights in the 2.3 GHz and 2.6 GHz bands became available.

A 6.67 Therefore, ComReg is of the view that Option 2A would be unlikely to create a material distortion to competition and is preferable to Option 2B because this would give operators the option to liberalise all of their existing 2.1 GHz rights of use at the earliest opportunity and, based on the available information, without creating material distortions of competition.

Impact on Consumers

A 6.68 It can be assumed that what is good for competition, and what promotes innovation and efficient investment in infrastructure, is, in general, good for consumers. This is because increased competition between MNOs brings benefits to their customers in terms of price, choice and quality of services.

[853] DotEcon Award Design Report, p22-23

A 6.69 Consumer demand for wireless data services has grown significantly in recent years and is expected to grow exponentially, in data volume terms, over the coming years. This has and will increase the demand for liberalised rights of use suitable for WBB services. Consequently, consumers would prefer the option that increases the supply of liberalised rights of use at the earliest possible opportunity, subject to no material distortions of competition arising in circumstances where the benefits resulting from liberalisation would be outweighed by the detriment to consumers resulting from any such a distortion of competition.

A 6.70 Whilst Option 1 would preserve existing competition up until 2022, consumers are unlikely to prefer Option 1 because new liberalised rights in the 2.1 GHz Band would not become available until October 2022 (for the 2×45 MHz currently assigned to Vodafone and Three) and until March 2027 for the remaining 2x15 MHz (currently assigned to Eir) and, based on the available information, there is no reason to believe that Options 2A or 2B would result in a material distortion to competition to their overall detriment. Under Option 2A or 2B, consumers would be able to better utilise user devices which are compatible with LTE 2100 and benefit higher speeds and greater quality of service as described above.

A 6.71 As between Options 2A and 2B, consumers are likely to prefer Option 2A because this would give operators the option to liberalise all of their existing 2.1 GHz rights of use at the earliest opportunity and, based on the available information, without creating material distortions of competition.

A 6.72 Therefore, ComReg is of the preliminary view that consumers are likely to prefer Option 2A.

Preferred option

A 6.73 Based on the information currently before it, ComReg is of the preliminary view that Option 2A would be appropriate in the context of ComReg's statutory framework, including being objectively justified and proportionate. Factors informing this view are outlined below.

A 6.74 First, Option 2A would accord with the objective of promoting competition because, among other things:

- it would be unlikely to result in a distortion or restriction of competition to the detriment of users because:

- Any potential advantages that would accrue to Three from liberalisation would be of very limited duration (circa 6-12 months) before an additional 350 MHz of liberalised spectrum rights of use (including substitutable spectrum rights in the 2.3 GHz and 2.6 GHz bands) would be made available to all MNOs (and other interested parties) in the Proposed Award;

- the avoidance of inefficient investment costs by all operators from having to rollout LTE 2100 after should not distort or restrict competition to the detriment of consumers generally; and

- it would facilitate MNOs LTE 2100 roll-out programme in an efficient manner, the outcome of which should contribute to users deriving maximum benefits in terms of choice, price and quality.

A 6.75 Second, Option 2A would encourage the efficient use of the radio spectrum by facilitating the commencement of LTE 2100 earlier and in a more efficient manner than other options. In particular, by avoiding inefficient investment costs caused rolling out 2.6 and 2.3 GHz when 2.1 GHz would have been preferable had it been available.

A 6.76 Third, Option 2A would also accord with the relevant regulatory principles which ComReg is obliged to apply in pursuit of its objectives. In particular:

- it would promote efficient investment and innovation in new and enhanced infrastructures by enabling additional LTE capacity to be provided using spectrum rights which might otherwise be underutilised.

- it would not give rise to undue discrimination in the treatment of undertakings providing ECN and ECS because all existing licensees would be able to avail of liberalised 2.1 GHz rights of use at the same time.

- it would accord with the principle of safeguarding competition to the benefit of consumers and promoting, where appropriate, infrastructure based competition for the reasons identified above (in relation to distortion and restriction of competition).

A 6.77 Fourth, Option 2A would be proportionate because, among other things:

- Liberalisation of existing 2.1 GHz band rights generally accords with the principle and requirements of technology neutrality in the Common Regulatory Framework.

- it would achieve the earliest liberalisation of existing rights in the 2.1 GHz Band without giving rise to a material distortion to competition in

circumstances where the benefits resulting from liberalisation would be outweighed by the detriment to consumers resulting from any such a distortion of competition; and

- there do not appear to be less onerous means by which these objectives and principles could be achieved.

Annex: 7 Draft Coverage RIA – 700 MHz Duplex rights

Introduction

A 7.1 Telecommunication services are constantly evolving and the widespread adoption of consumer devices which offer ever more advanced features and applications has changed how and where consumers communicate with each other. Connectivity is supplied by an overlapping set of networks, devices and technologies whose use depends on the services being provided and where those services are required. Mobile is an important element of providing connectivity to consumers and 700 MHz Duplex rights of use are important in this regard given its excellent propagation characteristics.

A 7.2 In particular, the 700 MHz Duplex band is the only band capable of providing wide area coverage in the Proposed Award and will be an important part of the solution to address the continually growing demand in Ireland for wireless broadband services and increased connectivity. The 700 MHz Duplex Band is also important for the provision of new 5G services over widespread areas as noted by the RSPG[854] and the EU[855]. This Annex sets out the draft Coverage RIA with regard different approaches to coverage obligations for new 700 MHz rights of use.

RIA Framework

A 7.3 In general terms, a RIA is an analysis of the likely effect of a proposed new regulation or regulatory change, and, indeed, of whether regulation is necessary at all. A RIA should help identify the most effective and least burdensome regulatory option and should seek to establish whether a proposed regulation or regulatory change is likely to achieve the desired objectives, having considered relevant alternatives and the impacts on stakeholders. In conducting a RIA, the aim is to ensure that all proposed measures are appropriate, effective, proportionate and justified.

[854] See RSPG 1st, 2nd and 3rd opinions on 5G, RSPG 16-032 Final, RSPG 18-005 Final and RSPG19-007 Final.

[855] See for example, Recitals 9 and 10 of Decision (EU) 2017/899 UHF

Structure of a RIA

A 7.4 As set out in ComReg's RIA Guidelines[856], there are five steps in a RIA. These are:

- Step 1: Identify the policy issues and identify the objectives.
- Step 2: Identify and describe the regulatory options.
- Step 3: Determine the impacts on stakeholders.
- Step 4: Determine the impacts on competition.
- Step 5: Assess the impacts and choose the best option.

A 7.5 In the following sections, ComReg identifies the specific policy issues to be addressed and relevant objectives for the Proposed Award (i.e. Step 1 of the RIA process). This results in the identification of two fundamental policy issues which are then considered in in this draft RIAs, following Steps 2 to 5 above of ComReg's RIA process.

A 7.6 Before moving on to Step 1 of the RIA, ComReg first makes some relevant observations below on the stakeholders involved and on ComReg's approach to Steps 3 and 4.

Identification of Stakeholders and approach to Steps 3 and 4

A 7.7 The focus of Step 3 is to assess the impact of the proposed regulatory options available to ComReg on stakeholders. A precursor to the subsequent steps in the RIA, therefore, is to identify the relevant stakeholders. Stakeholders consist of two main groups:

i. consumers (for the purposes of this draft RIA, consumers include both business and residential users of spectrum), and
ii. industry stakeholders.

A 7.8 There are a number of key industry stakeholders in relation to the matters considered in this chapter:

- existing service providers who have spectrum rights of use in the bands 800 MHz and 900 MHz (i.e. existing coverage bands[857]);
- potential new entrants who do not currently provide any services using spectrum in the State. This group may include companies that

[856] See Document 07/56a – Guidelines on ComReg's approach to Regulatory Impact Assessment – August 2007.
[857] Meteor Mobile Communications Ltd, Three Ireland Hutchison Limited, Vodafone Ireland Limited.

are already otherwise engaged in the electronic communications sector in the state, in other Member States or further afield;

- MVNOs;
- economic or industrial sectors who have the potential to change business models for MNOs relative to the current marketplace, (largely standardised services) with differentiation limited to pricing (so called 'verticals'); and
- other government and state agencies taking actions to provide complimentary connectivity solutions[858].

A 7.9 The focus of Step 4 is to assess the impact on competition of the proposed regulatory options available to ComReg. In that regard, ComReg notes that it has various statutory functions, objectives and duties which are relevant to the issue of competition. With regard, to this draft RIA, the objective of safeguarding and promoting competition, refers to the following.

- ensuring that users derive maximum benefits in terms of choice, price and quality;
- preventing destabilising competition via "cherry-picking" or tacit collusion;
- ensuring that coverage and/or roll-out obligations do not unduly restrict or impede potential new entry;
- taking due account of the variety of conditions relating to competition and consumers that exist in the various geographic areas within the State; and
- promoting efficient investment and innovation in new and enhanced infrastructures, which includes considering the potential for the appropriate use of other spectrum rights/bands and/or leasing to count towards coverage and/or roll-out obligations.

A 7.10 Of themselves, the various RIA guidelines and the RIA Policy Direction provide little guidance on how much weight should be given to the positions and views of each stakeholder group (Step 3), or the impact on competition (Step 4). Accordingly, ComReg has been guided by its statutory objectives which it is obliged to seek to achieve when exercising its functions. ComReg's primary statutory objectives in managing the radio frequency

[858] For example, the Mobile Phone and Broadband Taskforce (MPBF) aims to identify solutions to broadband and mobile phone coverage deficits.

spectrum, are set out in Annex 2 include:

- the promotion of competition;
- contributing to the development of the internal market; and
- the promotion of the interests of users within the Community.

A 7.11 In this document, ComReg has adopted the following structure in relation to Step 3 and Step 4 – the impact on industry stakeholders is considered first, followed by the impact on competition, followed by the impact on consumers. The order of this assessment does not reflect any assessment of the relative importance of these issues but rather reflects a logical progression. For example, a measure which safeguards and promotes competition should also, in turn, impact positively on consumers. In that regard, the assessment of the impact on consumers draws substantially upon the assessment carried out in respect of the impact on competition.

Identify the policy issues and identify the objectives (Step 1)

Background and Policy Issues

A 7.12 ComReg sets out the background, context and policy issues that are relevant and inform the establishment of the options in Chapter 8 and does not propose to set them out again here.

A 7.13 As described in Chapter 8, ComReg is of the preliminary view that :

- a coverage obligation should **focus on delivering coverage to the population** rather than a focus on geographic or area coverage;
- there are good solutions for providing indoor coverage (i.e. Native Wi-Fi and mobile phone repeaters) and as such a coverage obligation should **focus on outdoor coverage only**; and
- in terms of the quality of service the proposed outdoor population coverage should primarily focus on **a minimum data rate of 30 Mbit/s for a single user at cell edge.**

Proposed regulatory options

A 7.14 ComReg has identified the following options for consideration:

- **Option 1 -** Impose no coverage obligation.

- This would mean that all licensees would have full flexibility to choose how extensive their rollout would be regardless of the amount of spectrum rights of use it was assigned in the 700 MHz Duplex band. For example, a licensee could choose to provide no services, only to provide services in high density areas, or choose to differentiate itself as a provider with an extensive network footprint.

- **Option 2 -** Impose a coverage obligation which would require a licensee with 700 MHz Duplex rights of use to provide a minimum level of coverage sufficient to serve between 70% to 90% of the population, together with a minimum data rate of 30 Mbit/s for a single user at cell edge. The development of Option 2 has been informed by, among other things:

  - that, in the 2012 MBSA, a 70% coverage obligation was considered necessary given, among other things, there was no guarantee that market forces alone would ensure the efficient use of spectrum and that this level would prevent cherry picking (such as in densely populated areas)[859]; and

  - Oxera's view that operators providing coverage of 90% population at 30 Mbit/s appears likely even if no coverage obligation were set. [860]

- **Option 3 -** Impose a coverage obligation which would require a licensee with 700 MHz Duplex rights of use to provide a minimum level of coverage to serve between 90% to 95% of the population, together with a minimum data rate of 30 Mbit/s for a single user at cell edge.

  - This option is informed by Oxera's view that such a coverage obligation would appear feasible for an existing MNO to meet.[861]

- **Option 4 -** Impose a coverage obligation which would require a licensee with 700 MHz Duplex rights of use to provide a minimum level of coverage to serve 95 – 99.5% of the population, together with a minimum data rate of 30 Mbit/s for a single user at cell edge.

  - This option would provide high speed services to very high levels of the population.

[859] 70% of the population corresponds all cities and towns with towns under 500 but with at least 50 inhabited houses
[860] Future Mobile Connectivity in Ireland - a report (Document 18/103c) from Oxera Consulting LLP ("Oxera"), with Real Wireless Ltd – p6.
[861] Ibid, p7

A 7.15 Each of the above options are symmetric[862] such that all 700 MHz licensees are required to meet the same minimum coverage targets under the same conditions. As discussed in Chapter 8, ComReg intends to impose Native Wi-Fi and VoLTE obligations which would be imposed in the case of Options 2 – 4.

A 7.16 The following sections of the draft 'Coverage RIA' consider the impact of the aforementioned regulatory options on:

i. industry stakeholders (being existing operators and potential new entrants)

ii. competition, and

iii. consumers.

A 7.17 ComReg notes that it intends to further develop this draft RIA in light of feedback from all stakeholders to this consultation.

Impact on industry stakeholders

A 7.18 As noted above, industry stakeholders can generally be split between those operators that are currently active in the electronic communications sector and potential new entrants that may be considering entry into the electronic communications sector in the State.

A 7.19 At the outset, ComReg observes that stakeholder views are likely to be informed by the costs of delivering coverage above existing levels (i.e. 63% at 30 Mbit/s)[863]. In particular, the Oxera Report finds that, while certain levels of coverage can be achieved with low levels of investment, the cost of coverage rises exponentially at high levels of coverage (across all scenarios). The figure below shows how the cost of providing 30Mbit/s population coverage rises exponentially after 95% coverage.

[862] See Chapter 8 for ComReg's views in relation to interventionist coverage obligations and potential asymmetric coverage obligations.
[863] See Table 5.1 (Oxera Report – Document 18/103c) which predicts that around 65% of the population have a 30 Mbit/s service.

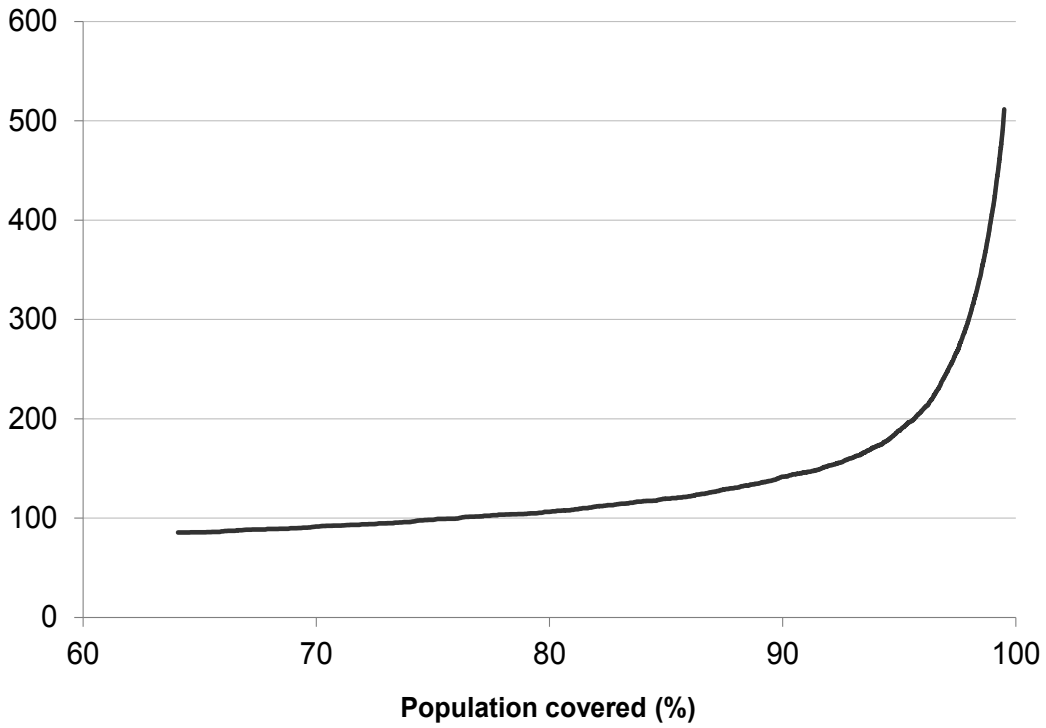

Figure 20: Estimated cost of targeting 30Mbit/s population coverage, starting 2020[864]

A 7.20 ComReg assesses the views of various stakeholders below.

Option 1 – no coverage obligation

Incumbent MNOs

A 7.21 Under Option 1, a winning bidder would have full flexibility to choose how extensive their network coverage would be and what QoS standards (e.g. speed) would apply. As such, any rollout obligations set below this level (e.g. Option 1), as a minimum requirement would not likely impose any obligation on these providers.

A 7.22 However, given the potential for new entry (e.g. a mix of spectrum above and below 1 GHz), existing operators are likely to favour some form of obligation in order to ensure that potential new entrants do not cherry pick more profitable areas forcing MNOs to compete against the cherry-picker's lower price in the more profitable urban areas. Therefore, MNOs may not prefer Option 1 and would prefer some coverage obligation. In that regard, ComReg notes that MNOs are already providing 30 Mbit/s coverage to various parts of the State. For example, the Oxera Model predicts that the synthetic mobile

[864] Future Mobile Connectivity in Ireland - a report (Document 18/103c) from Oxera Consulting LLP ("Oxera"), with Real Wireless Ltd – p6

network operator would have achieved 64% population coverage of 30 Mbit/s by 2020[865] (62.4% in 2017)[866].

A 7.23 Therefore, on balance, MNOs are unlikely to prefer Option 1 as services would already be provided at 30 Mbit/s to circa 64% of the population and a new entrant may use rights of use to cherry pick if the obligation is set too low.

New entrants

A 7.24 Potential new entrants are likely to prefer an option with as low a rollout obligation as possible, and therefore Option 1 could be their preferred option. This would give an entrant maximum flexibility in its choice of business model, including potentially allowing it to offer services focused on limited geographical areas, such as services targeting urban areas. However, given that such entrants would rollout a network to some degree, regardless of any obligation, a new entrant might well be indifferent between Option 1 and Options that would allow it to rollout coverage at 30 Mbit/s (or lower where it is assigned less than 2×30 MHz) in line with its commercial strategy.

MVNOs

A 7.25 MVNOs would likely prefer the option that maximises the level of coverage that it would be available to provide to its consumers. In that regard, it would be unlikely to prefer Option 1 as this could lead to sub-optimal levels of coverage as described in 'Impact on Competition' below.

Assessment of Options 2, 3 and 4.

A 7.26 The extent to which a stakeholder would likely prefer an option is largely dependent on the extent to which an obligation would be commercially achievable in a competitive market. In that regard, the remainder of the stakeholder assessment refers to Oxera's observations on likely commercial deployment by MNOs following an award process for 700 MHz Duplex rights of use. Oxera's observations have been informed by a number of factors, including:

- The availability of three-band carrier aggregation from mid-2020 and deployment of same by operators using 2×10 MHz of 700MHz spectrum, 2×10 MHz of 800 MHz spectrum, and 2×10 MHz of 900MHz spectrum[867];

[865] Ibid, p61.
[866] Ibid, Table 4.3.
[867] The 700MHz band and Carrier Aggregation reduces the cost of providing coverage (as site upgrades cost less than building new sites).

- The number of additional sites and upgrades to existing sites required to provide a given level of coverage;
- The cost of rollout at a given rollout rate (i.e. 2.5% up to mid-2020 and 8.04% from mid-2020 onwards to allow the roll-out to be completed within 10 years);
- Interviews with stakeholders and historic investment trends of Irish MNOs.[868]

A 7.27 ComReg notes that Oxera's observations on likely commercial deployment refers to all incumbent MNOs regardless of their existing network. As noted above, the assessment is based on historic investment trends and interviews with MNOs. Further, the synthetic network is based on the licensed site numbers, site locations, and licensed frequency bands of Vodafone and Eir. In particular, the starting number of base stations in the synthetic network (1,890) is almost identical to Eir's (1,876) and slightly below Vodafone (1,931).[869] Finally, according to Oxera, achieving up to 95% coverage requires an additional 378 sites, [✂ [redacted]]. In effect, Oxera's observations could be achieved by all MNOs regardless of size.

A 7.28 MNO's likely views are informed by a number of factors including:

- The likely level of network investment that would be spent on improving mobile coverage. Based on historic investment data, Oxera estimates that this would yield an annual investment to improve mobile coverage of €8m – €19m, for each MNO.[871]
  - The €8mn - €19mn investment range is the same for each option below.
- The total capex cost to rollout coverage to certain levels of population. Total Capex arises from investment in new sites and upgrades to existing sites.
  - The total Capex cost varies across each option below.
- The total number of sites and upgrades required over specified periods.

[868] Mobile investment data used from the European Commission (European Commission 'Telecommunications data files').These figures includes investments other than improving the coverage of connectivity therefore, represent an upper-bound estimate of the historical level of capital investment in improving mobile coverage.
[869] Future Mobile Connectivity in Ireland - a report (Document 18/103c) from Oxera Consulting LLP ("Oxera"), with Real Wireless Ltd – Table 4.1
[870] [✂ [redacted]].
[871] Using a conservative estimate of only 10 – 20% of network investment being spent on improving mobile coverage.

- The number of sites and upgrades varies across each option below.

- When coverage levels would be achieved by. Oxera use a rollout rate of 2.5 % which is based on historical site rollout after the 2012 MBSA.[872]
  - The rollout rate is the same for each option below.

A 7.29 The remaining options are assessed against the extent to which the Capex costs required fall within the likely coverage investment range.

Option 2 – 70 to 90% population at 30 Mbit/s cell-edge

MNOs

A 7.30 Oxera considers that it is **likely** that MNOs will expand coverage up to 90% of population (based on purely commercial incentives). Oxera forms this view based on the observation that the incremental cost of expanding 30 Mbit/s coverage from current levels (i.e. circa 65%) to 90% is low (compared to the incremental cost at higher levels of coverage) and it is likely that the commercial case for expanding 30 Mbit/s coverage would exceed the costs of doing so. The investment required is likely to be well within that which was invested by MNOs in the period 2010–16, implying that the level of investment is not unprecedented.

- A total Capex cost of €44m would be required to rollout to 90% of population over a 3 – 4 year period.[873]

- An annual investment of €11mn (at the lower end of the €8m - €19m investment range) would achieve 90% coverage.

- Coverage to 90% would require 270 new sites and 825 upgrades to the existing network.[874]

- Coverage to 80%, 85% and 90% would be achieved in 2022, 2023 and 2024 using the historical rollout rate.

[872] Based on a four-year growth rate (2013–2017) of licensed sites in the frequency bands with the highest number of sites (i.e. the 900MHz band for Vodafone and the 900MHz and 2100MHz bands for Meteor).
[873] €16mn would be required for 80% coverage and €27mn for 85% coverage.
[874] Coverage to 80% would require 204 sites and 363 upgrades. Coverage to 85% would require 227 sites and 568 upgrades.

A 7.31 Only at low levels of annual investment within the €8 – €19m investment range (i.e. €10 m or less per year) would 90% coverage not be commercially achieved which is unlikely to arise given an operators decision to invest in 700 MHz rights of use (2×10 MHz likely to exceed €50m)[875] and competition between operators to provide better coverage and higher quality of service.

A 7.32 Therefore, MNOs would likely be indifferent to Option 2 because such obligations coincide with likely commercial rollout and would impose little if any cost and could be achieved using a rollout rate consistent to what was achieved after the 2012 MBSA.[876]

New entrants

A 7.33 Given the need to provide coverage on a new network rather than an existing one, new entrants are likely to prefer a lower coverage obligation compared to MNOs.

A 7.34 In order to assess a new entrant's likely commercial rollout, Oxera models two variants[877] for the network evolution of a new entrant targeting 30 Mbit/s (moderate and aggressive). Oxera[878] is of the view that an initial rollout across both scenarios of 1,084 macrosites would correspond to coverage of:

- 75% population in 2 years.
- 85% population in 5 years.
- 90% population in 9 years.

A 7.35 Therefore, an entrant competing directly with existing MNOs with a national network would likely not be significantly constrained by Option 2, as it would anyway choose to provide these coverage levels. An obligation set within this range reflects the likely network rollout of a new entrant targeting 30 Mbit/s. The new entrant obligation is described in more detail in Chapter 8.

MVNOs

[875] See Section 4.2.2 Document 18/103d.
[876] Increasing coverage from 64% to 90% would require an additional 98 sites and 565 upgrades to existing sites.
[877] Future Mobile Connectivity in Ireland - a report (Document 18/103c) from Oxera Consulting LLP ("Oxera"), with Real Wireless Ltd – Figure A3.8.
[878] This corresponds to a new entrant winning 2×10 MHz (700 MHz) and 2×20 (2.6 GHz). See Future Mobile Connectivity in Ireland - a report (Document 18/103c) from Oxera Consulting LLP ("Oxera"), with Real Wireless Ltd – Table 4.6

A 7.36 MVNOs are likely to prefer Option 2 over Option 1 as 30 Mbit/s coverage would be provided across a wider area allowing it to attract customers from outside the urban centres.

Option 3 - 90 to 95% population at 30 Mbit/s cell-edge

MNOs

A 7.37 Oxera considers that expanding coverage up to 95% of population would appear feasible given cost and network roll-out considerations is **possible**, for MNOs given cost and network roll-out considerations. Under Option 3, the incremental cost (i.e. cost of serving additional population) increases as the coverage rises (especially above 90%), as more investments (particularly in new sites) are required to achieve incremental increases in coverage. See Figure 20 above.

- A total Capex cost of €82m would be required to rollout to 95% of population over a 7 period.[879]
- An annual investment of around €12m (at the lower end of the conservative investment range) would achieve 95% coverage.
- Coverage to 95% would require an additional 378 new sites and 1,197 upgrades to the existing network.
- Coverage to 95% would be achievable by 2027 using the historical rollout rate

A 7.38 Only at low levels of annual investment within the €8 – €19m investment range (i.e. €11m or less per year) would 90% coverage not be commercially achieved. At these levels investment would be €77m over a 7 year period which is less than the €82m Capex that is required. Alternatively, an investment of €12m over 7 years would result in an overall investment of €84m above the investment level required to achieve 95%.

A 7.39 While there is less certainty that the commercial case for expanding 30 Mbit/s coverage to 90-95% would exceed the costs of doing so, those costs are lower than for higher levels of coverage. In that regard, MNOs may be willing to compete up to 95% of the population given that coverage up to 90% is highly likely. Each MNOs makes their own network rollout plans and some might prioritise greater coverage levels and in different areas than others. However, all operators compete against each other in the same market and, over time, it is reasonable to expect all operators to reach a broadly similar

[879] €16mn would be required for 80% coverage and €27mn for 85% coverage.

coverage range.

A 7.40 Further, some important features of the market that have limited existing levels of coverage may be remedied over time. In particular, the Mobile Broadband Taskforce (See Chapter 8) has identified constraints which can impede connectivity and its activities are therefore important in removing bottlenecks and improving efficiency reducing the costs of roll out. Actions include:

- Streamlining planning processes for the deployment of telecommunications infrastructure.
- Installing ducting on new national primary/secondary roads.
- Developing and publishing a policy for all local authorities around access to and use of state infrastructure

A 1.2 The implementation of these actions should remove constraints that would have limited the extent to which coverage could be extended beyond 90% (and have restricted the extent to which operators have extended coverage to date). As noted by DotEcon, coverage roll-out will also be encouraged by the reduction of such impediments.[880] In particular, access to road ducting should provide opportunities for operators to expand road coverage. Additional road coverage would also lead to incidental coverage of population and geography.

A 1.3 Therefore, while some operators may prefer Option 2, commercial plans would be likely to rollout coverage to more than 90% of population and operators may well be indifferent at a coverage obligation of 95%.

New entrants

A 7.41 As noted above, a new entrant coverage of 75% population would be possible over a 2 year period increasing, to 90% over 9 years. In that regard, a coverage obligation set above 90% would likely exceed what a credible new entrant could commercially choose. New entrants are therefore unlikely to prefer Option 3 over Option 1 and Option 2.

MVNOs

A 7.42 MVNOs are likely to prefer Option 3 over Option 2 as 30 Mbit/s coverage would be provided across a wider area allowing it to attract customers from outside the urban centres.

[880] DotEcon Report, p 35.

Option 4

Existing operators

A 7.43 Oxera considers that expanding coverage beyond 95% of population, absent external intervention (e.g. government procurement/subsidy), is **unlikely**, for MNOs given cost and network roll-out considerations. Under Option 4, the incremental cost of expanding coverage is much greater than that for increasing coverage at lower levels because more investments in new sites as opposed to upgrades of existing sites are required.

- A total Capex cost of €82 - €397m would be required to rollout to 95 – 99.5% of population over a 7 period.[881]
- An annual investment of €18m (at the extreme end of the investment range) would be required to achieve up to 95%.
- Coverage to 99.5% would require an additional 1,466 sites and 1,603 upgrades to the existing network.
- Coverage to 99.5% would be achievable by 2042 using a historical rollout rate. Increasing the speed of rollout would increase costs substantially.

A 7.44 Only at outer boundary of the annual investment range of the €8 – €19m investment range would 99.5% coverage be commercially achieved. This is unlikely to arise given previous historical investment the low levels of additional population such coverage would cover and given that competition between operators to provide better coverage and higher quality of service would be unlikely to drive it to such levels. Option 4 would potentially involve constraining the commercial choices of at least some network operators and force coverage in excess of competitively determined levels.

[881] €16mn would be required for 80% coverage and €27mn for 85% coverage.

A 7.45 Oxera is of the view that these costs arise because the cost of providing coverage increases exponentially for the last 5% of population[882]. While the last 5% will be the most costly 5% of coverage given the falling population density, the exponential increase in cost is significant when targeting 30 Mbit/s population coverage. It is therefore much less likely that the commercial case for expanding 30 Mbit/s coverage will exceed the costs of doing so. Further, while the cost of serving the last 5% is significantly higher the additional revenue likely to be generated from serving the additional population is significantly lower.[883] In addition, the investment required may exceed that which was invested by the Irish MNOs in the period 2010–16, implying that the required level of investment seems unlikely

A 7.46 Further, coverage levels above 95% would take significant periods of time to deliver. For example, increasing coverage from 95% to 97.6% would take around 4 years), the same time required to go from 64% to 90% of population. Operators are also unlikely to continually rollout additional sites incrementally to increase coverage at these high levels, particularly where each site is associated with ever decreasing levels of population. Therefore, while some MNOs with high levels of investment may extend marginally coverage beyond 95%, to a greater or lesser extent operators, MNOs are unlikely to prefer Option 4.

New entrants

A 7.47 New entrant coverage of 75% population would be possible over a 4 year period increasing, to 90% over 10 years. In that regard, a coverage obligation set above 95% would likely exceed what a credible new entrant could reasonably achieve (for the same reasons noted in relation to incumbent MNOs above). New entrants are therefore unlikely to prefer Option 4 over Option 2.

MVNOs

[882] This arises because the last percentages of the population live in the least dense areas which tend to be topographically challenging, and the cost of expanding the network to those areas is greater. For example, the last 3% of the population live in 28% of the area of Ireland meaning the cost per population increases and more base stations are needed to cover the same number of households.

[883] Even where the population may be sufficient an operator would find it difficult to extract revenue from those who benefit most. As noted by DotEcon, the MNO cannot discriminate its pricing between customers who benefit from the coverage increment and those who do not. MNOs would need to raise prices slightly for all customers to extract any of the additional value created by its greater coverage footprint, which means it will potentially lose some customers who do not value the additional coverage. Mobile consumer experience survey suggests that consumers have a very limited willingness to pay more for a service even if it did have greater coverage.

A 7.48 While MVNOs may prefer Option 4 over Option 3 as 30 Mbit/s coverage would be provided across a wider area thereby allowing MVNOs to attract customers from outside the urban centres, it is likely that the costs of providing coverage beyond what is commercially viable would be passed on to MVNOs. Therefore, MVNOs are unlikely to prefer Option 4.

Impact on Competition

Background information

A 7.49 ComReg first sets out background information that is relevant to the competition assessment in each of the regulatory options below.

A 7.50 Competition in the retail mobile communications market is multi-faceted and operators compete across a range of factors including, price, handsets, bundles, and coverage. Network operators have clear competitive incentives to build out coverage in order to attract new subscribers and increase the benefits of all subscribers using the network. Normally, precautionary type coverage obligations imposed by regulators are exceeded as coverage is driven by competition between network operators.

A 7.51 For example, in the 2012 MBSA, existing MNO winning bidders were obliged to achieve and maintain a minimum coverage obligation of 70% of the population of Ireland within 3 years from the commencement date of the licence. ComReg's Summer 2016 Drive Test confirmed that all operators were in compliance with their licence conditions after three years, with coverage in excess of the 70% obligations.[884] The results of the latest round of Drive Testing, indicate that the minimum coverage by population achieved during the Drive Test was greater than 90%[885].

A 7.52 Thus, it may not be necessary to impose any coverage obligation as competition could push coverage to competitive levels that would be commercially achieved by all operators. However, even in competitive markets there is no guarantee that competition will deliver and maintain an acceptable level of coverage across the country. DotEcon[886] advises that coverage obligations may still be necessary to reduce the risks of competitive failures for a number of reasons, including but not limited to (i) tacit collusion and (ii) cherry picking.

[884] Document 16/113, 'Assessment of Mobile Network Operators' Compliance with Licence Obligations (Coverage) Summer 2016' published December 2016.
[885] Document 18/26R, 'Assessment of Mobile Network Operators' Compliance with Licence Obligations (Coverage) Winter 2017' published April 2018.
[886] Document 18/103d,'Coverage obligations and spectrum awards a report from DotEcon Ltd, published November 2018 – Section 2.3.1 and 2.3.2.

(i) Tacit Collusion

A 7.53 DotEcon advises that MNOs could have collective incentives to come to a tacit understanding to maintain the status quo and not make significant network investments, such as might be needed to increase coverage. Tacit collusion may be more prevalent with repeated interaction between a stable set of competitors unchallenged by new entry with high levels of transparency about the conduct of rivals. For example:

- The Irish market has recently been reduced from four to three MNOs and if no new entrant arose from this proposed award, entry is unlikely to occur until after 2030 when new rights of use (particular coverage spectrum) will be assigned.

- MNOs are likely to be able to monitor any significant coverage expansion by a rival operator (indeed operator's coverage is already publicly monitored by ComReg)[887].

A 7.54 Operators are likely to benefit from expanding coverage where the costs of incremental increases in coverage are relatively low and each base station serves a relatively large population. However, as the cost per population increases, so do the incentives for operators to collude tacitly to avoid or delay the cost of network investments that they would otherwise have made.[888] This would have the effect of keeping coverage below levels that would have been achieved under effective competition.

A 7.55 Table 32 below shows that at higher levels of coverage the cost of each additional percentage of coverage increases meaning that more base stations are needed to cover the same number of households and therefore the cost per population increases. Therefore, the risk of tacit collusion is higher at higher levels of coverage and cost.

[887] https://www.comreg.ie/outdoor-mobile-coverage-map/
[888] DotEcon note that the costs involved in expanding coverage in certain cases may create incentives not to be a first-mover and only to respond if others move first. When costs get to a certain level, operators may wait to see what other operators do i.e. it would only be worth expanding coverage if other operators were there first.

Table 32: Sites, Upgrades & Costs required for incremental coverage per operator[889]

Coverage	Sites	Upgrades	Cost, €m
85%	23	205	11
90%	43	257	17
95%	108	372	38

A 7.56 Coverage obligations are required to guard against tacit collusion which deters investment by not extending coverage to save on the costs of incremental network rollout.

(ii) Cherry Picking

A 7.57 DotEcon observes that coverage obligations can protect against the possibility of one network operator 'cherry-picking' by covering only the most profitable locations (e.g. urban areas). There are two versions of cherry picking relevant to the assessment in this draft RIA.

i. Coverage 'cherry-picking' where coverage is provided in urban areas such as cities or large towns and not provided elsewhere. In the 2012 MBSA, ComReg considered it appropriate to set a 70% population coverage obligation as, among other things, this would prevent cherry picking in densely populated areas.

ii. Quality of Service (QoS) 'cherry picking' where an MNO only provides high speed service (30 Mbit/s) in urban areas and a basic service elsewhere. Given that MNOs are already serving large portions of the population with basic 4G services, higher speed services could be provided in urban areas while consumers in rural areas would only be provided with more basic connectivity.

A 7.58 ComReg refers to tacit collusion, cherry-picking, new entry and commercial viability in order to inform its assessment of each option below.

Option 1

A 7.59 Option 1 would impose no coverage obligation and operators would have full flexibility to choose how extensive their rollout would be.

Tacit Collusion

[889] Document 18/103d,'Coverage obligations and spectrum awards a report from DotEcon Ltd, published November 2018 - based on Table 5. 8

A 7.60 MNOs could come to a tacit understanding to not make network investments to increase coverage to certain levels in order to save on network rollout costs. While certain levels of coverage can be achieved with low levels of investment, the cost of coverage rises exponentially at higher levels of coverage increasing the potential gains from a tacit arrangement. In that regard, requirements to roll-out services to a certain level within a certain timeframe may be sufficient to destabilise tacit understandings to delay or reduce rollout.

Cherry Picking

A 7.61 In relation to 'cherry picking' given that incumbent MNOs are already providing a service to high levels of population, cherry picking refers to QoS 'cherry picking' where an operator only provides high speed services (30 Mbit/s) in urban areas and a basic service elsewhere. As noted by DotEcon there could be a risk of the mode of competition changing to one where the emphasis is on targeting urban customers with higher speed services. Such a strategy can undermine provision to rural areas as such an operator would not be exposed to the costs of expanding into the less profitable rural areas, but rivals would nevertheless need to compete against the lower price in the urban areas. A coverage obligation can protect against the possibility of one or more MNOs only delivering a 30 Mbit/s services to higher density areas to the detriment of more rural areas.

New entry

A 7.62 Tacit understandings are unlikely to be relevant to new entrants whose main priority would be rolling out a new network. Further, Option 1 could promote competition because it would not run the risk of precluding new entry through setting an obligation that could not reasonably be obtained by a new entrant. However, there would be a risk of a new entrant only serving the more profitable urban areas. Such entrants would not be exposed to the costs of expanding into the less profitable rural areas, but existing MNOs would nevertheless need to compete against the cherry-picker's lower price in the urban areas. Therefore, some form of coverage obligation is also necessary for any new entrants to prevent coverage 'cherry picking'.

Commercial viability (MNOs)

A 7.63 There are no concerns about the commercial viability of Option 1 since no obligation would be imposed.

Preliminary view on Option 1

A 7.64 While ComReg considers competition would likely drive actual coverage to high levels, it is nevertheless appropriate to set a coverage obligation given that there is no guarantee that market forces alone would ensure the efficient use of the radio spectrum. Setting a coverage obligation would prevent QoS 'cherry picking' and reduce the incentives for tacit collusion to keep coverage lower than should be reasonably expected from a well-functioning market.

A 7.65 Therefore, ComReg is of the preliminary view that Option 1 would risk distortions to competition which could deliver sub-optimal coverage outcomes to the detriment of consumers, particularly those in less dense areas outside the major urban centres.

Option 2

Cherry picking

A 7.66 Under Option 2, the opportunities for QoS 'cherry picking' are reduced as an MNO would be obliged to provide 30 Mbit/s population coverage to between 70 and 90% of the population. A coverage obligation, particularly at the higher end of the 70 – 90% range would remove the incentive for operators to cherry pick the most profitable high density areas and provide higher speed service in urban areas only. For example, all areas with a population of at least 50 persons accounts for 70% of the population.[890] Setting the coverage obligation at levels beyond 70% would likely result in all operators serving all towns above a population of 50 and some of the remaining population with a 30 Mbit/s service.

A 7.67 While parts of the remaining 10% - 30% of the population could be served under effective competition these are the least profitable areas given the lower population densities and would unlikely be a target for a cherry-picking strategy. Because the obligation includes a requirement to provide speeds of 30 Mbit/s, an obligation set at the higher end of the range (i.e. closer to 90%) would also reduce the possibility of only providing a high speed 30 Mbit/s in more densely populated areas and a basic service elsewhere (although there remains a residual risk of this particularly at the lower end of the range). For example, if the obligation was set at 70% of population an operator could target all towns above a population of 50 with a high speed service (30 Mbit/s) and a lower speed service (3 Mbit/s) in more rural areas, including terrestrial routes. However, given that 70% of the population covers just 3% of the area there could still be large parts of rural Ireland that would not be served with a 30 Mbit/s service if the obligation was set in this range.

[890] Census 2016.

Tacit collusion

A 7.68 The risk of tacit collusion is highest for higher levels of coverage because the network costs to be avoided are higher. In the 90 – 95% range operators would retain a higher level of costs compared to lower levels of coverage. For example, the cost of extending coverage at 30 Mbit/s from 90% to 95% is double the cost of going from 65% to 90%, providing incentives for operators to keep coverage at around 90%. Under Option 2 there would remain a risk of tacit collusion between network operators to defer investment and not extend coverage beyond 90%.

New entry

A 7.69 Higher levels of coverage run the risk of acting as a barrier to entry for new entrants. Nevertheless, as noted above, 30 Mbit/s coverage of 75 - 90% over 3 to 9 years is likely to be achievable, on a commercial basis, for a new entrant. In effect, Option 2 would be unlikely to act as a barrier to entry. Further, Option 2 would prevent any new entrant from cherry picking urban areas and avoiding the costs of expanding into the rural areas. If a new entrant was permitted to cherry pick in this way other MNOs would need to compete against the cherry-picker's lower price in the urban areas thereby undermining the viability of extending coverage to rural areas to the extent that this relies on cross-subsidisation[891] from urban areas.

Commercial viability (MNOs)

A 7.70 A coverage obligation set in the 70 – 90% range would not be in excess of what could be provided by MNOs given the factors assessed by Oxera, including the availability of carrier aggregation, cost of rollout, previous network investments and stakeholder interviews. ComReg is of the preliminary Option 2 would not oblige operators to achieve coverage levels above what could be expected from effective competition.

Preliminary view on Option 2

A 7.71 While Option 2 would be better for competition than Option 1 there are residual risks that competition could be weakened. In particular, while Option 2 largely addresses cherry picking concerns there remains a risk of tacit collusion resulting in sub-optimal levels of coverage to the detriment of consumers, particularly those in more rural areas.

[891] A coverage obligation can be used as a tool to ensure the coverage of rural areas, in that licensees are obliged to cross-subsidise services in less profitable geographical areas from those in more profitable areas. In such a case, there is a strong argument for applying a coverage obligation homogeneously to all licensees so as not to distort service market competition. All operators would face similar constraints on the pricing of services created by the same coverage obligation and would compete to dispatch the obligation at least cost.

Option 3

Cherry Picking

A 7.72 No opportunity for cherry picking exists under Option 3 since an operator would be obliged to provide 30 Mbit/s population coverage up to 95% of the population which is close to the limits of competition. The remaining 5% or so would be unlikely to be profitable providing no further opportunities for cherry picking and this Option would also reduce the possibility of providing a high speed 30 Mbit/s in urban areas and a basic service elsewhere (except for those areas that would be beyond the limits of competition which would be some or all of the remaining 5%).

Tacit collusion

A 7.73 Under Option 3, no real opportunity for tacit collusion aimed at avoiding or delaying the costs of expanding coverage would likely exist as all operators would be required to provide coverage up to 95% coverage. Opportunities for tacit collusion are likely to be limited since 95% is already likely approaching the limits of competition in a well-functioning market. Indeed, under Option 3 the incentive for operators would be to reach 95% rather than expanding beyond it.

New entry

A 7.74 Option 3 would likely act as a barrier to entry as coverage set at these levels would be above what Oxera considers possible for new entrant (75 - 90% over 3 to 9 years).

Commercial viability (MNOs)

A 7.75 A coverage obligation set in the 90 – 95% range would not be in excess of what could be provided by MNOs given the factors assessed by Oxera, including the availability of carrier aggregation, cost of rollout, previous network investments and stakeholder interviews. ComReg is of the preliminary view that Option 3 would not oblige operators to achieve coverage levels above what could be expected from effective competition.

Preliminary view on Option 3

A 7.76 In relation to existing MNOs, Option 3 would better promote downstream competition than Option 2. However, Option 3 would likely be too high for new entrants and a lower coverage obligation would likely be needed to promote new entry.

Option 4

Cherry picking and tacit collusion

A 7.77 Under Option 4, tacit collusion and/or cherry picking would be very unlikely as operators would be obliged to provide coverage at levels above what would likely be provided on a commercial basis under effective competition.

New entry

A 7.78 Option 4 would likely act as a significant barrier to entry as coverage set at these levels would be significantly above what Oxera considers possible for a new entrant (75 - 90% over 3 to 9 years).

Commercial Viability (MNOs)

A 7.79 Given the factors assessed by Oxera a coverage obligation set in the 95% + range would run the risk of being in excess of what could be viable for MNOs. Oxera notes that the incremental cost of expanding coverage is much greater than that for increasing coverage to the levels specified in the other options. It is therefore much less likely that the commercial case for expanding 30Mbit/s coverage will exceed the costs of doing so.

A 7.80 For example, the estimated cost of increasing coverage from 99.0% to 99.5% is €102m. This is over four times greater than the estimated cost of increasing coverage from 97.0% to 97.5%, which is €24m[892]. Further, the investment required may exceed that which was invested by the Irish MNOs in the period 2010–16, implying that the required level of investment to support such coverage levels appears unlikely.

A 7.81 While some MNOs may marginally extend coverage beyond 95%, the extent of this is likely to be limited given the costs on rollout. Further, other MNOs with alternative commercial footprints may be able to effectively compete at around 95% and a higher obligation would possibly favour some MNOs over others Therefore, an obligation set above 95% would run the risk of extending coverage beyond the limits that competition alone might deliver. DotEcon refers to such obligations as 'interventionist coverage obligations' and are discussed below. [893]

[892] Document 18/103d,'Coverage obligations and spectrum awards a report from DotEcon Ltd, published November 2018, p72 -73.
[893] Document 18/103d,'Coverage obligations and spectrum awards a report from DotEcon Ltd, published November 2018, Section 2.4.

Interventionist coverage obligations

A 7.82 DotEcon advises that 'interventionist' coverage obligations may distort spectrum awards and reduce competition in a number of ways including:

i). the cost of providing the coverage obligation could be in excess of the value of the spectrum to which the obligation is imposed, resulting in lots going inefficiently unsold[894];

ii). some bidders may be better able to meet the obligations than others, leading to reduced competition[895] for any coverage lots (allowing an operator to pick up spectrum below its value) and possibly leaving a portion of the spectrum unsold.[896]

iii). spectrum being sold at a price which no longer ensures its optimal use or represents poor value in the procurement of coverage (i.e. reduced competition from a limited field of potential suppliers); [897]

iv). a coverage obligation may need to be bundled with a disproportionately large share of the available spectrum to ensure the obligation can be met and has positive value for at least some bidders, leading to a possible skewed and inefficient distribution of the available spectrum[898]; and

v). uncertainty about the value of coverage lots could make it difficult to set reserve prices, depriving the auction designer of a useful instrument against gaming and collusion within the proposed spectrum award. [899]

[894] Ibid, p58
[895] The reduction in competition arises regardless of the auction format, being ultimately due to the harsh coverage obligation.
[896] Document 18/103d,'Coverage obligations and spectrum awards a report from DotEcon Ltd, published November 2018, p 48.
[897] Ibid, p3
[898] Ibid.
[899] Ibid.

A 7.83 In relation to (i), the likely value of the 700 MHz band is small relative to the cost of extending coverage beyond 95%. As noted by DotEcon, benchmarks suggest that it would be unlikely for the market price of a 2×10 MHz block at 700 MHz to exceed €50m.[900] In contrast, Oxera estimate the cost of extending one mobile network to 99.5% population coverage at 30 Mbit/s to be in the order of €500m or €1.8 billion over a ten year period. Even small coverage increases above 95% could quickly erode the value of the spectrum. For example, and even using historical rollout rates, the cost of extending coverage beyond 97% could exceed the value of unencumbered spectrum.

A 7.84 In relation to (ii) and (iii), the point at which population coverage ceases to be commercially viable is likely to be different for different operators.[901] It should be noted that although modelling usefully provides a broadly representative picture of population coverage at a generic network level, in reality, the point at which individual MNOs determine commercial viability is likely to be different. Under Option 4, some, but not all, operators may have a reduced value, or no value at all for 700 MHz rights of use. This would create a risk of spectrum going unsold and/or spectrum being sold to alternative bidders at a price that would not ensure its optimal use because it benefitted from a lack of competition due to a high coverage obligation.

A 7.85 Even where high coverage obligations were assigned to some but not all operators this could create significant distortions to competition downstream. For example, in a three operator market (A, B & C), where Operator A and B are able to meet the coverage obligation[902] (e.g. 99%) and Operator C is not because the costs of providing that coverage significantly exceed the value of the spectrum to it[903]. Operators A and B would obtain all rights of use (subject to competition caps) while Operator C would obtain no rights of use, when it would likely have done, if the obligation was set at the 90 – 95% level. This would create a significant bifurcation in the market with Operators A and B able to provide significantly improved coverage and speeds. In particular, Operators A and B would be able to increase 30 Mbit/s population coverage to 99% while Operator C would not be able to use 700 MHz spectrum to expand its coverage, when it would have been able to provide 30 Mbit/s population coverage to 95% population if the coverage obligation had been

[900] Ibid, p47.
[901] For example:
- an operator might be at an advantage in trying to obtain the coverage lot if it has widespread fixed infrastructure.
- asymmetries might arise because one mobile network operator already has greater coverage or more spectrum than others, reducing the incremental cost of meeting a coverage obligation.

[902] i.e. because such operators may have a higher coverage level to begin with.
[903] Such a scenario could arise if the starting point of Operators is different or the commercial plans are somewhat though not significantly different i.e. Operator C may want to provide broad coverage while Operators A and B would prefer expansive coverage.

more modest.

A 7.86 In relation to (iv), the coverage obligation could be attached to a larger block of spectrum in order to reduce the costs of providing a high coverage obligation.[904] However, this could lead to additional competition problems if only one bidder is capable of meeting the obligation, as it could lever its strong position to win additional spectrum it might not otherwise have won, potentially distorting competition.[905] As noted by DotEcon, in auctions with package bidding, coverage obligations could create an opportunity for operators willing to exploit their position in competing for the coverage lot to leverage its cost advantage to obtain more spectrum e.g. bidding only for the coverage lot if it is packaged with a large amount of other spectrum.[906] Such a situation would restrict the ability of ComReg to select an auction format that ensures the efficient use of the radio spectrum more generally. Readers are referred to Chapter 7 where the benefits of package bidding are explained in more detail.

A 7.87 In relation to (v), spectrum fees for rights for ECS are an important tool by which ComReg can ensure the efficient use of such rights. Efficient spectrum assignment generally requires rights of use to be assigned to those users able to make the best economic use of it, and for the users of the assigned spectrum to make use of it in the way that generates the greatest social benefit. Appropriate spectrum fees can help to establish the efficient assignment of spectrum amongst bidders, based on bidders' willingness to pay and establish the opportunity costs of the assignment, setting suitable spectrum usage fees at a level encourages the winning bidder(s) to utilise the spectrum more efficiently.[907]

A 7.88 Under Option 4, it would be difficult for ComReg to make an accurate assessment of an appropriate reserve price that accurately reflects the value of the obligation compared to the spectrum (i.e. competitive benchmarks are based on awards without excessive obligations). This is exacerbated to the

[904] As noted in the 'Spectrum for Award' RIA, the construction of base stations deploying more radios and antennas as well as extending additional backhaul links to new sites is expensive. Expanding capacity in this way typically costs several times more than adding additional spectrum to existing base stations.
[905] Document 18/103d,'Coverage obligations and spectrum awards a report from DotEcon Ltd, published November 2018, p 3.
[906] Document 18/103d,'Coverage obligations and spectrum awards a report from DotEcon Ltd, published November 2018, p 48.
[907] In the long run, spectrum usage fees (SUFs) serve an important role in ensuring the efficient use of spectrum by incentivising and encouraging the return of unused or underutilised spectrum rights. In order for SUFs to be effective, they should be set at a level that reflects the opportunity cost of holding the spectrum rights. In terms of the SUF, this cannot be known prior to the award (as SUFs are paid at a future date). However, in setting the SUF as a proportion of the minimum price, and ultimately the final price, which would reflect the opportunity cost of the spectrum, the SUF should encourage return of unused or underused spectrum to ComReg.

extent that usage fees, if any, prescribed under Option 4 are unlikely to encourage the licensee to return unused or underused spectrum if they do not reasonably reflect the opportunity cost of the reserved use. As such, under Option 4 long-term competition could be restricted because there is less of an incentive to return the spectrum over the duration of the licence.

Preliminary view on Option 4

A 7.89 Therefore, and for the reasons outlined earlier, Option 4 would, in ComReg's view, run the risk of creating distortions to competition and increasing prices to consumers.

Impact on Consumers

A 7.90 The Mobile Consumer Experience Survey[908] highlighted a number of issues that impact consumer's connectivity experience. In particular,

- the incidence of service issues is higher indoors with nearly a third of consumers experiencing service issues indoors in the past month.
- The biggest service issues indoors and outdoors relates to the ability to make and receive a call.

A 7.91 ComReg has earlier considered that such issues could be more appropriately dealt with through a 700 MHz Licence condition that would oblige licensees to (a) rollout out Native Wi-Fi on its network within one year of licence commencement and (b) provide VoLTE services within 2 years of licence commencement. Both of these measures are in addition to the population coverage obligation assessed in this draft RIA.

A 7.92 The remainder of this section is cognisant of service issues experienced by consumers outdoors. While consumers would prefer widespread coverage their views will primarily relate to the localities where they live, work and travel. In that regard, the Mobile Consumer Experience Survey provides information across five different 'Samples' in different geographic areas of decreasing density (Sample 1 – most dense Sample 5 – least dense). This is helpful to determine service issues and views of consumers in different areas. In that regard, ComReg notes that[909].

- Samples 1 and 2 covers up to 75% of the population and would cover all urban areas.
- Samples 3 approximately covers the next 15% of the population and

[908] Mobile Consumer Experience Survey, Document 17/100a.
[909] Mobile Consumer Experience Survey, Document 17/100a – Slide 11.

cover both urban and rural areas.

- Samples 4 and 5 approximately covers the remaining 10 % of the population which would be mostly rural.

Option 1, 2 and 3.

A 7.93 It can be assumed that what is good for competition, and what promotes investment in infrastructure, is, in general, good for consumers. This is because increased competition between operators brings benefits to their customers in terms of price, choice and quality of services. Therefore, options that are preferred for competition above are likely to be preferred by consumers. For example, the distortions to competition discussed earlier (tacit collusion and/or cherry picking) could have important impacts on consumers as coverage would be lower than would have been the case under effective competition. Given that MNOs already provide coverage to around 97% of the population consumers would prefer options that best provide for the upgrade of existing services to 30 Mbit/s.

A 7.94 Under Option 1, there is no minimum level of coverage an operator would need to provide and the distortions to competition described above could reduce service provision in certain areas. While urban areas are likely be covered regardless of any coverage obligation, consumers in these areas also experience service issues (though at a lower level than rural areas). For example, data usage (outside of the home) is the only service where urban areas (Samples 1 and 2) have more service issues than rural areas (Samples 4 and 5).[910] This likely relates to the increased load on the network in certain urban areas due to higher population densities. Such areas are likely to benefit from a 30 Mbit/s obligation which utilises additional spectrum and carrier aggregation improving the QoS associated with data usage.

A 7.95 For areas outside of the main towns and cities (e.g. Samples 4 and 5) service issues occur regardless of location. The impact of QoS 'cherry picking' could be particularly high in these areas occurring across a relatively wide area. For example, the 5 cities and suburbs account for a third of the population, while 70% of the population is located in towns with greater than 50 persons (covering 1% and 3% of territory).[911] An operator may decide only to provide higher speed services (30 Mbit/s and above) in high density areas or choose to differentiate itself as a provider with an extensive network footprint or

[910] Of respondents who experienced services issues 31% of respondents cited reasons related to data usage, compared to 25% in Sample 5. See Slide 59.
[911] In Census 2016, 63% of the population is located in urban areas. Urban areas are defined The population in the **Aggregate Town Area** is defined as those persons living in population clusters of 1,500 or more inhabitants. For this purpose a **town** with a legally defined boundary is classified on the basis of its total population including any suburbs or environs.

alternatively provide higher speed services in urban areas and basic services on a national basis. Separately, a new entrant may decide to cherry pick urban areas only or expand into rural areas at a much slower rate, or not at all. This could result in a less than optimal outcome with some consumers receiving a high speed service (30 Mbit/s) in urban areas with the remainder of the population receiving an inferior service (3 Mbit/s).

A 7.96 All consumers but particularly rural consumers also have service issues when travelling in a car or bus and/or while visiting other locations away from the home. For example, all samples experienced a loss of signal (or no/poor signal/coverage) when travelling in a car/bus for voice call and texts (38%). However, such services issues were highest in the most rural samples, Samples 4 and 5 (48% - 55%)[912]. If 30 Mbit/s coverage is targeted in urban areas only, the provision of 30 Mbit/s coverage on terrestrial routes would be similarly impacted where a lower speed service may be deemed sufficient by MNOs. Because population coverage by its nature leads to incidental coverage of roads, lower population coverage would lead to reduced road coverage. In particular, while most of the population lives in urban areas most of the road network is located in rural areas and QoS 'cherry picking' or other distortions (e.g. tacit collusion) that reduce coverage would severely limit the rollout of high-speed services on terrestrial routes.

A 7.97 As previously noted, such distortions are less likely to arise under Option 2 (particularly at the higher end of the range) compared with Option 1. However, even under Option 2, there would remain areas where coverage would normally be provided, that could be avoided through a tacit understanding. This would be more likely to reduce service provision in rural areas given the avoided costs of not providing coverage to those areas. In particular, the areas not likely to be covered under such a scenario would be the most rural areas (i.e. the last 10% of population – Samples 4 and 5).

A 7.98 Alternatively, Option 3 would oblige operators to provide coverage that is sufficiently close to what would be delivered under effective competition. While MNOs would be able to provide coverage above these levels all MNOs would be obliged to serve this level of population at a minimum. Consumers are therefore likely to favour Option 3 over Option 2 since the obligation would go beyond urban areas and upgrade service provision in areas already provide with a basic 4G service.

A 7.99 Finally, while the last 5% of the population would not likely benefit from a 30 Mbit/s mobile service under Option 3, the provision of 30 Mbit/s to 95% of the population would result in incidental coverage that would provide some

[912] Mobile Consumer Experience Survey, Document 17/100a – Slide 54.

benefits to the last 5% of the population. For example:

- 99% of Ireland's population would receive incidental coverage of at least 3 Mbit/s; and
- 99% of primary roads and motorways would receive incidental coverage of at least 3 Mbit/s proving basic connectivity on transport routes.

A 7.100 Furthermore, the rollout of the National Broadband Plan will provide the ability to access high-speed internet indoors to all households and the rollout of native Wi-Fi will provide for mobile calls to be received indoors.

Option 4

A 7.101 Consumers would likely prefer a coverage obligation that maximises the extent to which operators provide coverage across the widest possible area. Consumers may therefore, on first impressions, prefer Option 4 as this provides for a high rollout obligation across the widest possible area and would likely be in excess of levels delivered commercially.

A 7.102 However, while any winning bidder would be obliged to provide additional coverage, overall consumer welfare would not likely be improved for a number of reasons.

- Under Option 4, it is costly to reach the last 5% of the population which could reduce consumer welfare in a number of ways, including:
  - diverting investment away from providing connectivity in areas where people work and travel towards areas where few people live.
  - increasing the price of mobile services, noting that for a rollout period of ten years the total cost would be €1.8 billion to serve 99.5% of the population[913]. Further, consumers have a low willingness to pay for additional coverage meaning the use of other parts of the competitive offering (data, voice text) may have to be reduced.[914]
  - that the cost of coverage would fall disproportionately on consumers who would not benefit from the increased obligation

[913] In order to compare costs across comparable periods Oxera uses a 8.04% rollout rate (over a ten year period) which corresponds to a new site every two days or three upgrades per day.
[914] The average willingness to pay for coverage throughout all of their home for consumers without a reliable service was on average €2.17 extra for calls/texts and €1.98 for data.

(i.e. prices would increase across all subscribers[915] even though most would not be willing to pay to cover the remaining 0 – 5% of population.)

- It would be unlikely to address the provision of coverage where people work outside residential areas or along transport corridors. For example, increasing motorway coverage from 90% to 99.5% would have a similar cost compared to increasing population from 95% to 97% but would likely benefit more consumers.

- There is no guarantee that any operator would be willing to bid for 700 MHz rights of use with obligations that would run the risk of going beyond what would be provided under effective competition. As noted previously, the cost of providing additional coverage is large relative to the likely value of the spectrum. The consumer harm arising from 700 MHz rights of use not being assigned or delayed would be significant for all consumers including:

    - The large number (1,200) of upgrades at sites that would otherwise occur[916], that would allow for 30 Mbit/s to be provided in more rural areas more cheaply would be delayed or not provided.

    - 30 Mbit/s would only be provided in more urban areas while rural areas would continue to be provided with a lower speed service.

- It could lead to a less than optimal outcome as described above (Impact on Competition) with some consumers receiving a reduced service from their operator because the obligation was set at an excessive level.

- Any increased coverage would only be delivered over a very long period compared to the consumer harm which would be more immediate. The base case assumption in the model is that the MNO builds new sites at a CAGR of 2.5% (which Oxera consider feasible for an MNO to achieve). At this roll-out speed, 99.5% population coverage for 30 Mbit/s would only be achieved in the year 2042 and corresponds to a new site every week.

[915] As noted by DotEcon, only a small fraction of consumers will directly benefit from the incremental coverage and might use services when in the newly covered area. The MNO needs to raise prices slightly for all customers to extract any of the additional value created by its greater coverage footprint, which means it will potentially lose some customers who do not value the additional coverage.

[916] Noting that many new features/technologies are added to ETSI/3GPP standards over time and included in the latest equipment from equipment vendors including carrier aggregation in sub 1 GHz bands.

A 7.103 Therefore Option 4 could force coverage to be extended into areas where the overall net benefit of the intervention is not maximised, because greater benefits may be obtained by extending coverage where more people spend more time (e.g. transport routes and places of work).

The 'Coverage RIA: Assessment and the Preferred Option (Step 5)

A 7.104 In light of the above assessment, ComReg is of the preliminary view that more than one preferred option may be necessary to account for the particular circumstances that might arise in the Proposed Award. In particular, an obligation suitable for MNOs would likely be excessive for new entrants. In that regard, ComReg is of the preliminary view that preferred options are required for

- Existing MNOs; and
- New Entrants.

Preferred option for existing MNOs

A 7.105 Option 3 is ComReg's preferred option for existing MNOs for a number of reasons, including:

- An obligation set within this range would not likely be above what would be achieved by effective competition in a well-functioning market and Oxera recommends that a coverage obligation of 90 – 95% would appear feasible given cost and network roll-out considerations.
- It provides the best protection against tacit collusion among network operators to defer investment and not extend coverage into rural areas.
- It discourages QoS 'cherry-picking' that would concentrate 30 Mbits/s coverage in more profitable urban areas while limiting rural areas to lower speed services.
- It avoids outcomes where spectrum goes unsold because the coverage obligation was too excessive and efficient demand would have existed at a lower level.
- It does not favour any operators who may have greater potential to rollout coverage to higher levels than rival operators (i.e. the coverage obligation is likely to be set at a level that is viable for all operators rather that one or two).

A 7.106 Option 2 is ComReg's preferred option for new entrants for a number of reasons, including:

- it should increase the potential for efficient new entry and encourage the efficient use of spectrum by those successful in the proposed assignment process.

- an obligation set within this range is unlikely to be above what would be achieved by a new entrant and Oxera recommends that a coverage obligation of 90–95% would appear feasible given cost and network roll-out considerations; and

- it discourages coverage 'cherry-picking' that would concentrate coverage in urban areas only.

A 7.107 Chapter 8 (Licence conditions) provides further details on the specifics of each coverage obligation and the associated rollout timelines.

Annex: 8 Coverage Obligations at a Specific Location

A 8.1 In Chapter 8, ComReg proposes to attach a coverage obligation to 700 MHz rights of use. This takes the form of an **outdoor 30 Mbit/s single user throughput obligation in the following categories of location**:

- **Business and Technology Parks (including Strategic Sites):** the IDA provides a list of 31 Business and Technology Parks and 9 Strategic Sites
- **Hospitals:** the Health Service Executive (HSE) provides a list of 48 public hospitals and 17 private hospitals
- **Higher Education Campuses**: the Higher Education Authority (HEA) provides a list of 8 Universities, 11 Institutes of Technology and 5 Other Colleges.
- **Ports (Air and Sea):** The Department of Transport, Tourism and Sports (DTTAS) provides a list of 7 airports and the Irish Maritime Development Office (IMDO) provides a list of 7 passenger seaports.
- **Principal Bus Stations:** Bus Éireann provides a list of the main 16 bus stations.
- **Train Stations: T**he National Transport Authority (NTA) provides a list of 144 train stations.
- **Visitor Attraction – Information Centres:** Fáilte Ireland provides a list of the top 21 fee charging and top 21 free of charge visitor attractions[917].

A 8.2 The names and locations falling within each category of location are captured in the following sections.

[917] By visitor numbers in 2017.

Business and Technology Parks (including Strategic Sites)

A 8.3 The table below contains a list of IDA Business and Technology Parks (including Strategic Sites) obtained from the IDA[918]. Where a Business and Technology Park or Strategic Site is spread across more than one location, the coverage obligations apply to each of these locations.

Table 33: IDA Business and Technology Parks including Strategic Sites

Business and Technology Parks	Location	Business and Technology Parks	Location
IDA Business and Technology Park			
1. Dublin/East - College Park Dublin	College Park, Dublin	17. South East - Clonmel Business & Technology Park	Ballingarrane, Clonmel, Tipperary
2. Dublin/East - Grange Castle Business Park	Grange Castle, Dublin	18. South East - Dungarvan Business & Technology Park	Lisfennel, Dungarvan, Waterford
3. Mid East - Arklow Business & Technology Park	Ballynattin, Arklow, Wicklow	19. South East - Kilkenny Business & Technology Park	Loughboy, Kilkenny
4. Mid East - Navan Business & Technology Park	Athlumney, Navan, Meath	20. South East - Waterford Business & Technology Park, Butlerstown	Butlerstown, Waterford
5. Mid West - National Technology Park (NTP), Limerick	Plassey, Limerick	21. South East - Wexford Business & Technology Park	Sinnottstown, Wexford
6. Midlands - Athlone Business & Technology Park	Dublin Road, Athlone, Westmeath	22. South West - Carrigtwohill Business & Technology Park	Carrigtwohill, Cork
7. Midlands - Mullingar Business & Technology Park	Dublin Road, Athlone, Westmeath	23. South West - Cork Business & Technology Park	Model Farm Road, Cork
8. Midlands - Portlaoise Business & Technology Park	Ardmore, Mullingar, Westmeath	24. South West - Fermoy Business & Technology Park	Fermoy, Cork
9. Midlands - Tullamore Business & Technology Park	Mountrath Road, Portlaoise, Laois	25. South West - Kerry Technology Park	Tralee, Kerry
10. North East - Cavan Business & Technology Park	Srah, Tullamore, Offaly	26. South West - Kilbarry Business & Technology Park	Kilbarry, Cork
11. North East - Drogheda Business & Technology Park	Killygarry, Cavan	27. West - Ballinasloe Business & Technology Park	Roscommon Road, Ballinasloe, Galway
12. North East - Dundalk Business & Technology Park	Donore Road, Drogheda, Louth	28. West - Castlebar Business & Technology Park	Drumconlan, Castlebar, Mayo
13. North East - Monaghan Business & Technology Park	Finnabair, Dundalk, Louth	29. West - Galway Business & Technology Park	Parkmore, Galway
14. North West - Carrick on Shannon Business & Technology Park	Keenaghan, Carrick-on-Shannon, Leitrim	30. West - Roscommon Business & Technology Park	Gallowstown, Roscommon

[918] https://www.idaireland.com/

15. North West - Letterkenny Business & Technology Park	Lisnennan, Letterkenny, Donegal	31. West - Tuam Business & Technology Park	Dunmore Road, Tuam, Galway
16. North West - Sligo Business & Technology Park	Finisklin, Sligo		
IDA Strategic Site			
1. Mid East - Strategic Site Greystones	Charlesland, Greystones, Wicklow	6. South West - Strategic Site Carrigtwohill	Ballyadam, Carrigtwohill, Cork
2. Mid West - Strategic Site on the National Technology Park, Limerick	Plassey, Limerick	7. South West - Strategic Site Ringaskiddy, County Cork	Ringaskiddy, Cork
3. Mid West - Strategic Site, Raheen Business Park, Limerick	Raheen Business Park, Limerick	8. West - Strategic Site Athenry	Athenry, Galway
4. North East - Strategic Site Dundalk - Dundalk Science & Technology Park	Mullagharlin, Dundalk, Louth	9. West - Strategic Site Oranmore	Oranmore, Galway
5. South East - Strategic Site, Belview, Co. Kilkenny	Belview, Waterford Port, Kilkenny/Waterford		

Source: IDA, https://www.idaireland.com/how-we-help/property.

Hospitals

A 8.4 The table below contains a list of public and private hospitals obtained from the HSE. Where a hospital is spread across more than one location, the coverage obligations apply to each of these locations.

Table 34: Public and Private Hospitals

Hospitals	Location	Hospitals	Location
Public Hospital			
1. Bantry General Hospital	Cork	25. National Maternity Hospitals, Holles Street	Dublin
2. Beaumont Hospital	Dublin	26. Nenagh Hospital: UL Hospitals	Limerick
3. Cappagh National Orthopaedic Hospital	Dublin	27. Our Lady Of Lourdes Hospital, Drogheda	Louth
4. Cavan Monaghan Hospital	Cavan, Monaghan	28. Our Lady's Hospital, Navan	Meath
5. Children's University Hospital, Temple Street	Dublin	29. Our Lady's Children's Hospital Crumlin	Dublin
6. Connolly Hospital Blanchardstown	Dublin	30. Portiuncula Hospital, Ballinasloe	Galway
7. Coombe Women's Hospital	Dublin	31. Roscommon County Hospital	Roscommon
8. Cork University Hospital	Cork	32. Rotunda Hospital	Dublin
9. Cork University Maternity Hospital	Cork	33. Royal Victoria Eye & Ear Hospital, Dublin	Dublin
10. Croom Hospital: UL Hospitals	Limerick	34. Sligo General Hospital	Sligo
11. Ennis Hospital: UL Hospitals	Limerick	35. South Infirmary-Victoria Hospital, Cork	Cork
12. Galway University Hospitals	Galway	36. South Tipperary General Hospital	Tipperary
13. Kerry General Hospital	Kerry	37. St Columcille's Hospital, Loughlinstown	Dublin
14. Letterkenny University Hospital	Donegal	38. St James's Hospital	Dublin
15. Lourdes Orthopaedic Hospital, Kilcreene	Kilkenny	39. St John's Hospital Limerick	Limerick
16. Louth County Hospital, Dundalk	Louth	40. St Luke's General Hospital Carlow / Kilkenny	Kilkenny
17. Mallow General	Cork	41. St Luke's Hospital, Rathgar (Cancer Services)	Dublin
18. Mater Misericordiae University Hospital	Dublin	42. St Michael's, Dun Laoghaire	Dublin
19. Mayo General Hospital	Mayo	43. St Vincent's University Hospital, Elm Park	Dublin
20. Mercy University Hospital, Cork	Cork	44. Tallaght Hospital	Dublin
21. Midland Regional Hospital Mullingar	Westmeath	45. University Hospital Limerick	Limerick
22. Midland Regional Hospital Portlaoise	Laois	46. University Maternity Hospital: UL Hospitals	Limerick

23. Midland Regional Hospital Tullamore	Offaly	47. University Hospital Waterford	Waterford
24. Naas General Hospital	Kildare	48. Wexford General Hospital	Wexford
Private Hospital			
1. Aut Even Hospital	Kilkenny	10. Mount Carmel Hospital	Dublin
2. Barringtons Hospital	Limerick	11. Mater Private Hospital	Dublin, Cork
3. UPMC Beacon Hospital	Dublin	12. St. Joseph's Hospital	Sligo
4. Blackrock Clinic	Dublin	13. St John of God Hospital	Dublin
5. Bon Secours Health System	Cork, Dublin, Galway, Kerry	14. St Patrick's University Hospital	Dublin
6. Clane General Hospital	Kildare	15. St Vincent's Private Hospital	Dublin
7. Galway Clinic	Galway	16. Sports Surgery Clinic	Dublin
8. Hermitage Medical Centre	Dublin	17. Whitfield Clinic	Waterford
9. Highfield Healthcare	Dublin		

Source: HSE, https://www.hse.ie/eng/services/list/3/acutehospitals/hospitals/hospitallist.html, https://www.hse.ie/eng/services/list/1/schemes/cbd/acchealthcareireland/.

Higher Education Campuses

A 8.5 The table below contains a list of higher education institutions encompassing: universities, institutes of technology and other colleges as identified by the HEA. Where a higher education campus is spread across more than one location, the coverage obligations apply to each of these locations.

Table 35: Higher Education Campuses

Higher Education Institution	Location	Higher Education Institution	Location
University			
1. Dublin City University	Dublin	5. Trinity College Dublin	Dublin
2. University College Cork	Cork	6. University College Dublin	Dublin
3. National University of Ireland, Galway	Galway	7. University of Limerick	Limerick
4. Maynooth University - Kildare	Kildare	8. TU Dublin	Dublin
Institute of Technology			
1. Athlone Institute of Technology	Westmeath	7. Institute of Technology Sligo	Sligo
2. Cork Institute of Technology	Cork	8. Institute of Technology Tralee	Kerry
3. Dun Laoghaire Institute of Art and Design	Dublin	9. Letterkenny Institute of Technology	Donegal
4. Dundalk Institute of Technology	Louth	10. Limerick Institute of Technology	Limerick
5. Galway-Mayo Institute of Technology	Galway	11. Waterford Institute of Technology	Waterford
6. Institute of Technology Carlow	Carlow		
Other College			
1. Royal College of Surgeons in Ireland	Dublin	4. National College of Art and Design	Dublin
2. Royal Irish Academy	Dublin	5. Mary Immaculate College	Limerick
3. St Angela's College	Sligo		

Source: HEA, http://hea.ie/higher-education-institutions/?v=I.

Ports (Air and Sea)

A 8.6 The table below contains a list of passenger focussed transport provided by airports and seaports. The list of airports was obtained from the DTTS, and the list of passenger seaports was obtained from the IMDO. The coverage obligations apply to areas where passengers will be waiting, embarking or de-embarking. Where these areas are spread across more than one location, the coverage obligations apply to each of these locations.

Table 36: Ports (Air and Sea)

Ports	Location	Ports	Location
Airport			
1. Dublin Airport	Dublin	5. Ireland West Airport Knock	Mayo
2. Cork Airport	Cork	6. Kerry Airport	Kerry
3. Shannon Airport	Clare	7. Waterford Airport	Waterford
4. Donegal Airport	Donegal		
Passenger Seaport			
1. Bantry Bay Port Company	Cork	5. Port of Galway	Galway
2. Dublin Port Company	Dublin	6. Rosslare Europort	Wexford
3. Dun Laoghaire Port Company	Dublin	7. Port of Waterford	Waterford
4. Port of Cork	Cork		

Source: DTTS, http://www.dttas.ie/aviation/airports; IMDO, http://www.dttas.ie/aviation/airports

Principal Bus Stations

A 8.7 The table below contains a list of 16 bus stations which serve as Bus Éireann's principal information offices. The coverage obligations apply to areas where passengers will be waiting, departing, or arriving.

Table 37: Principal Bus Stations

Bus Station	Location	Bus Station	Location
1. Athlone	Southern Station Road, Athlone	9. Galway	Ceannt Station, Eyre Square, Galway
2. Ballina	Kevin Barry Street, Ballina	10. Killarney	Fairhill, Killarney
3. Cavan	Farnham Street, Cavan	11. Letterkenny	Port Road, Letterkenny
4. Cork	Parnell Place, Cork	12. Limerick	Colbert Station, Parnell Street, Limerick
5. Drogheda	Donore Road, Drogheda	13. Monaghan	North Road, Monaghan
6. Dundalk	Long Walk, Dundalk	14. Sligo	Lord Edward Street, Sligo
7. Dublin	Busáras Central Station, Store Street, Dublin	15. Tralee	Casement Station, Tralee
8. Ennis	Clonroad More, Ennis	16. Waterford	The Quay, Waterford

Source: Bus Éireann, https://www.buseireann.ie/pdf/1473240111-Network-Map.pdf

Train Stations

A 8.8 The table below contains a list of 144 train stations by descending passenger numbers[919] as obtained from the NTA. The coverage obligations are expected to cover each station, encompassing areas where passengers will be waiting, as well as passenger platforms.

Table 38: Train Stations

Train Station	Location	Train Station	Location
1. Connolly	Dublin	73. M3 Parkway	Dublin
2. Pearse	Dublin	74. Sligo	Sligo
3. Heuston	Kildare	75. Longford	Longford
4. Tara Street	Dublin	76. Killarney	Kerry
5. Grand Canal Dock	Dublin	77. Kilcock	Kildare
6. Dun Laoghaire	Dublin	78. Dunboyne	Meath
7. Cork	Cork	79. Adamstown	Dublin
8. Bray	Dublin	80. Glounthaune	Cork
9. Lansdowne	Dublin	81. Navan Road Parkway	Dublin
10. Malahide	Dublin	82. Wicklow	Wicklow
11. Maynooth	Kildare	83. Tralee	Kerry
12. Blackrock	Dublin	84. Waterford	Waterford
13. Greystones	Dublin	85. Manulla Junction	Mayo
14. Sydney Parade	Dublin	86. Enfield	Meath
15. Coolmine	Dublin	87. Ennis	Clare
16. Balbriggan	Dublin	88. Ballinasloe	Galway
17. Howth Junction and Donaghmede	Dublin	89. Hansfield	Dublin
18. Raheny	Dublin	90. Oranmore	Galway
19. Clontarf Rd	Dublin	91. Wexford	Wexford
20. Portmarnock	Dublin	92. Castlebar	Mayo
21. Limerick Junction	Limerick	93. Clondalkin Fonthill	Dublin
22. Galway	Galway	94. Ballybrophy	Laois
23. Dalkey	Dublin	95. Carrick-on- Shannon	Leitrim
24. Docklands	Dublin	96. Muine Bheag	Carlow
25. Glenageary	Dublin	97. Edgeworthstown	Longford
26. Booterstown	Dublin	98. Carrigtwohill	Cork
27. Sallins and Naas	Kildare	99. Arklow	Wicklow
28. Skerries	Dublin	100. Clara	Offaly
29. Drumcondra	Dublin	101. Roscommon	Roscommon
30. Clonsilla	Dublin	102. Westport	Mayo
31. Kilbarrack	Dublin	103. Gorey	Wexford
32. Howth	Dublin	104. Dromod	Leitrim

[919] By number of passengers boarding and alighting on 16 November 2017 as published in NTA's *'National Heavy Rail Census Report 2017'*

33. Mallow	Cork	105. Gormanston	Meath
34. Bayside	Dublin	106. Monasterevin	Kildare
35. Donabate	Dublin	107. Kilcoole	Wicklow
36. Newbridge	Kildare	108. Ballymote	Sligo
37. Shankill	Dublin	109. Ballina	Mayo
38. Harmonstown	Dublin	110. Boyle	Roscommon
39. Salthill and Monkstown	Dublin	111. Charleville	Cork
40. Clongriffin	Dublin	112. Templemore	Tipperary
41. Sandycove and Glasthule	Dublin	113. Claremorris	Mayo
42. Limerick	Limerick	114. Ballyhaunis	Mayo
43. Drogheda	Louth	115. Millstreet	Cork
44. Killester	Dublin	116. Enniscorthy	Wexford
45. Sandymount	Dublin	117. Rushbrooke	Cork
46. Ashtown	Dublin	118. Castlerea	Roscommon
47. Portlaoise	Laois	119. Collooney	Sligo
48. Leixlip Louisa Bridge	Kildare	120. Rathdrum	Dublin
49. Killiney	Dublin	121. Woodlawn	Galway
50. Sutton	Dublin	122. Thomastown	Kilkenny
51. Castleknock	Dublin	123. Sixmilebridge	Clare
52. Rush and Lusk	Dublin	124. Rathmore	Kerry
53. Kildare	Kildare	125. Banteer	Cork
54. Athlone	Westmeath	126. Nenagh	Tipperary
55. Seapoint	Dublin	127. Craughwell	Galway
56. Carlow	Carlow	128. Carrigaloe	Cork
57. Portarlington	Laois	129. Farranfore	Kerry
58. Leixlip Confey	Kildare	130. Clonmel	Tipperary
59. Thurles	Tipperary	131. Fota	Cork
60. Tullamore	Offaly	132. Rosslare Strand	Wexford
61. Midleton	Cork	133. Foxford	Mayo
62. Mullingar	Westmeath	134. Roscrea	Tipperary
63. Littleisland	Cork	135. Attymon	Galway
64. Dundalk	Louth	136. Gort	Galway
65. Hazelhatch and Celbridge	Kildare	137. Rosslare Euro Port	Wexford
66. Broombridge	Dublin	138. Castleconnell	Limerick
67. Cobh	Cork	139. Cahir	Tipperary
68. Athenry	Galway	140. Birdhill	Tipperary
69. Kilkenny	Kildare	141. Carrick-on- Suir	Tipperary
70. Athy	Kildare	142. Ardrahan	Galway
71. Parkwest and Cherry Orchard	Dublin	143. Cloughjordan	Tipperary
72. Laytown	Meath	144. Tipperary	Tipperary

Source: National Transport Authority, 'National Heavy Rail Census Report 2017', published July 2018, https://www.nationaltransport.ie/wp-content/uploads/2018/08/National_Heavy_Rail_2018_V8_Web.pdf

Visitor Attractions - Information Centres

A 8.9 The table below contains a list of the top 21 visitor attractions (fee charging and free of charge) by visitor numbers in 2017, as obtained from Fáilte Ireland. The coverage obligations apply to the information centre/s at each attraction.

Table 39: Visitor Attraction – Information Centres

Visitor Attraction	Location	Visitor Attraction	Location
Fee Charging			
1. Guinness Storehouse	Dublin	12. Blarney Castle and Gardens	Cork
2. Cliffs of Moher Visitor Experience	Clare	13. Kilmainham Gaol	Dublin
3. Dublin Zoo	Dublin	14. Kilkenny Castle	Kilkenny
4. National Aquatic Centre	Dublin	15. Rock of Cashel	Tipperary
5. Book of Kells	Dublin	16. Dublin Castle	Dublin
6. Tayto Park	Meath	17. Bunratty Castle and Folk Park	Clare
7. St Patrick's Cathedral	Dublin	18. Old Jameson Distillery	Dublin
8. Kylemore Abbey & Gardens	Galway	19. Brú na Bóinne Newgrange	Meath
9. Muckross House Gardens and Traditional Farm	Kerry	20. Christ Church Cathedral	Dublin
10. Powerscourt Gardens and Waterfall	Wicklow	21. Glenveagh Castle and Grounds	Donegal
11. Fota Wildlife Park	Cork		
Free of Charge			
1. National Gallery of Ireland	Dublin	12. National Museum of Ireland - Natural History, Merrion St	Dublin
2. Castletown House Parklands	Kildare	13. Kilkenny Castle Parklands	Kilkenny
3. Glendalough Site	Wicklow	14. Chester Beatty Library	Dublin
4. National Botanic Gardens	Dublin	15. National Museum of Ireland - Decorative Arts and History, Collins Barracks	Dublin
5. DLR Lexicon1	Dublin	16. Connemara National Park	Galway
6. Irish Museum of Modern Art	Dublin	17. The National Library of Ireland	Dublin
7. Doneraile Wildlife Park*	Cork	18. Crawford Art Gallery	Cork
8. National Museum of Ireland - Archaeology, Kildare St	Dublin	19. Malin Head Viewing Point*	Donegal
9. Science Gallery at Trinity College Dublin	Dublin	20. Dublin City Gallery The Hugh Lane	Dublin
10. Farmleigh	Dublin	21. Sliabh Liag Cliffs*	Donegal
11. Newbridge Silverware Museum of Style Icons	Kildare		

Source: Fáilte Ireland, 'TOURISM FACTS 2017', published July 2018, http://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/5_International_Tourism_Trends/Tourism-Facts-2017_2.pdf?ext=.pdf

* There is currently no information centre at the attraction. However ComReg notes that there are plans to build one at this location. ComReg intends to consider the status of the information centre development before any decision in this regard.

Annex: 9 Draft Rollout RIA – Performance Bands

Introduction

A 9.1 This Annex sets out the draft Base Station 'Rollout' RIA for rights of use in the 2.1 GHz Band, 2.3 GHz Band and 2.6 GHz Band ("Performance Bands"[920]) and considers what obligation(s) (if any) should be set for each of the bands.

RIA Framework

A 9.2 The purpose, structure and scope of the RIA framework are discussed at the beginning of the draft 'Spectrum for Award' RIA which is contained in Chapter 4.

Policy issues and identify the objectives (Step 1)

Policy Issues

A 9.3 In the context of this RIA, the policy issue to be addressed is to determine what coverage or rollout obligations (if any) are appropriate for the Performance Bands.

A 9.4 In considering this policy issue, there are a number of objectives which ComReg must balance. Operators issued with new rights of use in the Performance Bands could potentially not use those licences to roll out services across an acceptable area in a timely manner, and that this would not be in the interests of consumers or an efficient use of the radio spectrum. This could justify the attachment of rollout obligations to those licences. In contrast, the imposition of overly onerous obligations could have negative consequences such as requiring unnecessary and therefore inefficient investment in infrastructure or even discouraging participation in the Proposed Award by parties who would otherwise efficiently deploy services.

[920] As noted in the draft 'Spectrum for Award' RIA these bands are typically used for capacity on mobile networks but provide coverage and capacity for fixed wireless networks. For the remainder of this draft RIA these bands are collectively referred to as the 'Performance Bands'.

A 9.5 Accordingly, the policy issue for ComReg is to determine whether a rollout obligation(s) would be appropriate and, if so, identify an appropriate obligation(s) which would ensure a reasonable level of rollout without significantly discouraging participation in the Proposed Award.

Objectives

A 9.6 In considering the above policy issue, ComReg is guided by what it considers to be the most relevant statutory objectives, including:

- assigning rights of use in the 2.1 GHz band in line with the 2.1 GHz EC Decision and other relevant legislation;
- assigning rights of use in the 2.6 GHz band in line with the 2.6 GHz EC Decision and other relevant legislation;
- to ensure that all end users, including disabled users, derive maximum benefit in terms of choice, price and quality;
- to encourage the efficient use and ensure the effective management of spectrum; and
- to ensure there is no distortion or restriction of competition in the electronic communications sector.

A 9.7 ComReg is also mindful of the new "connectivity" general objective (and related recitals) in the new EECC:

- "Promoting connectivity and access to, and take-up of, ***very high capacity networks***, including fixed, mobile and wireless networks, by all citizens and businesses of the Union" (Article 3(2)(a) – ***emphasis added***); and
- where "…that connectivity objective translates, on the one hand, into aiming for the highest capacity networks and services economically sustainable in a given area, and, on the other, into pursuing territorial cohesion, in the sense of convergence ***in capacity*** available in different area" (Recital 23 – ***emphasis added***).

A 9.8 ComReg's overall powers, functions, duties and objectives in relation to the management of the radio frequency spectrum in Ireland are set out in Annex 2.

Identify the regulatory options (step 2)

A 9.9 ComReg sets out the, background and key questions that are relevant and inform the establishment of the options in Chapter 8 and does not propose to set them out again here.

A 9.10 As described in Chapter 8, ComReg is of the preliminary view that :

- the main potential uses of the Performance Bands are for mobile services, small cells and fixed wireless services;
- a rollout obligation linked to a base station obligation would be more appropriate for the Performance Bands in this award, and;
- if an obligation is deemed necessary, that an asymmetric obligation would likely be required for the Performance Bands such that:
  - a mobile and non-mobile coverage obligation should be provided for each Performance Band;
  - compared to existing operators[921], new entrants who have no existing network in place should be subject to a less onerous obligation across all bands; and
  - existing 2.1 GHz Licensees should be subject to a higher rollout obligation for that band given existing rollout (and consequently already being in a position to meet a coverage condition close to existing rollout).

Regulatory options

A 9.11 In light of the key questions discussion and relevant background information as set out in Chapter 8, ComReg considers that the following regulatory options are potentially available. As elaborated further below, a mixture of options may be appropriate depending on how the spectrum is used (i.e. mobile or non-mobile) and by whom (i.e. incumbent or new entrant).

- **Option 1:** Impose no rollout obligation.
  - This would mean that each licensee would have full flexibility to choose how extensive their rollout would be regardless of the amount of spectrum rights of use assigned to it.

[921] Existing operators refers to the existing licensees in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands, noting that these operators already have rolled out existing networks/infrastructure in this bands.

- An operator could choose to provide no services, only to provide services in high density areas, or choose to differentiate itself as a provider with an extensive network footprint.

- **Option 2:** Impose a rollout obligation, with a rollout period of 3[922]- 5[923] years for 80 - 500 network controlled base stations.
  - The lower end of this range of base stations is informed by the base station rollout obligation used in the 3.6 GHz Award in Ireland.[924]
  - The upper end of this range is informed by the proposals in the 3.4-3.8 GHz award in Austria (2019).[925]
  - Under this Option, ComReg proposes to set the obligation at a minimum of **290 base stations** (i.e. the mid – point of the range) but may set the obligation in the lower or higher end of the range depending on any additional information it receives.
- **Option 3:** Impose a rollout obligation, with a rollout period of 3 – 5 years for 500 – 1,200 network controlled base stations.
  - The upper end of this range is informed by Three's existing rollout of the 1800 MHz Band to over 1,200 base stations. However, ComReg notes that part of this rollout may relate to legacy GSM services and may not therefore be reflective of an efficient 4G/5G rollout.
  - Under this Option, ComReg proposes to set the obligation at **525 base stations** (i.e. the median[926] of the existing 1800 MHz rollout) but may set it lower or higher in the range depending on any additional information or advice it receives.
- **Option 4:** Impose a rollout obligation, with a rollout period of 3 - 5 years for 1,200 – 1,900 network controlled base stations.

[922] ComReg notes that the Oxera Report (Document 18/103c) advised that for existing MNOs the standard network upgrade could be provided every two days over a 3 year period (i.e. 550 upgrades). This rollout period is sufficient to cover the suggested rollout in Options 1, 2 and 3. Option 4 refers to the 2.1 GHz Band which has already rolled out to these levels.
[923] This takes into account the longer rollout period that would be required for new entrants.
[924] In that award, if a licensee obtained rights of use up to 100 MHz across all of the regions, then the rollout obligation would be 78 base stations.
[925] ComReg proposes that the upper range of Option 2 be 500 base stations; approximately half of the obligation attached to National licences in the Austrian award. The population of Austria is approximately 8.86 million (2019) and the population density stands at approximately 106 people/km2. The population of Ireland is approximately 4.7 million (2016) while the population density is 70 people/km2.
[926] Given the existing rollout, the median is a better measure of the central tendency as it is not skewed by high Three rollout, including existing GSM which is less relevant.

- The upper end of this range is informed by Three's rollout in the 2.1 GHz Band.
- The 2.1 GHz Band was the only band licensed to provide 3G coverage prior to the 2012 MBSA. Site rollout partly reflected the lack of alternative spectrum (particularly spectrum suitable for coverage) with which to rollout 3G services. However, in the intervening period an additional 280 MHz of spectrum has been assigned to MNOs across three different bands (800 MHz, 900 MHz and 1800 MHz).
- Further, it is proposed to assign an additional 350 MHz in the Proposed Award across three more bands (700 MHz Duplex, 2.3 GHz Band and 2.6 GHz Band). The existing rollout of the 2.1 GHz Band provides useful information on what rollout could be achieved in the future. However, rollout set at these levels may exceed what could be deemed efficient for the rollout of 4G/5G services given the availability of alternative bands (particularly coverage bands) which were not available when UMTS 2100 was rolled out.
- Given the above, under this Option, ComReg proposes to set the obligation under Option 4 at **1,200 base stations** (i.e. the lower end of the range) to provide flexibility in the rollout of 4G/5G services but may set it lower or higher in the range depending on any additional information or advice it receives.

- **Option 5:** Impose a rollout obligation, with a rollout period of 3 – 5 years for over 1,900 network controlled base stations.
  - This option would require base station deployment in excess of network deployment for existing 1800 MHz and 2.1 GHz Bands.
  - This obligation would be aligned with the likely rollout of sub 1 GHz bands.

A 9.12 The following sections of the draft 'Rollout RIA' consider the impact of the aforementioned regulatory options on:

iii. industry stakeholders (being existing operators and potential new entrants);

iv. competition; and

v. consumers

A 9.13 ComReg notes that it intends to further develop this draft RIA in light of feedback from all stakeholders to this consultation.

Impact on industry stakeholders (step 3)

A 9.14 There are a number of key industry stakeholders in relation to the matters considered in this chapter:

- Mobile Network Operators (MNOs)
- Other service providers (e.g. FWA providers)[927]
- Potential new entrants
- These are assessed separately under each of the options below. For the purposes of this RIA, ComReg assumes that each operator would likely prefer the rollout obligation that has the least impact on their commercial strategy, particularly if such obligations significantly differ from what they would choose to do independently of any obligation.

Option 1 (no rollout)

MNOs/Other Service Providers

A 9.15 Under Option 1, each new licensee would have full flexibility to choose how extensive their network rollout would be and what areas would be covered. A licensee could choose not to rollout any of the Performance Bands on its network, or choose a rollout in line with demand for services. ComReg is of the preliminary view that existing MNOs and other service providers may, on the one hand, prefer that no obligation is imposed but, on the other, that the design of the award does not facilitate speculative bidding[928] or spectrum hoarding[929], either of which could be more likely under Option 1.

A 9.16 However, a stakeholder's preference for a rollout obligation to prevent such behaviour would need to be balanced against the desire to have flexibility in providing services in line with its commercial strategy.

A 9.17 For the rest of this section, ComReg divides its assessment of likely MNO preferences in two sections because MNOs already have rights of use in the 2.1 GHz Band:

vi. 'Brownfield spectrum' where rights of use have already been deployed (i.e. 2.1 GHz Band).

[927] ComReg notes that currently Imagine is the only operator offering national fixed wireless services. Other FWA operators are regional, however, ComReg is not discounting the possibility of such operators forming a bidding group in the proposed award and bidding on a national basis.
[928] Speculative bidding refers to bidders attempting to acquire the spectrum at a low price in the hopes that the value will increase in the future and the spectrum can be sold on at a profit.
[929] This is where a rival is assigned spectrum and does not use it denying its use to alternative users

vii. ‘Greenfield Spectrum’ where rights of use have not been deployed (i.e. 2.3 GHz Band and 2.6 GHz Band).

New entrants

A 9.18 Potential new entrants are likely to prefer an option with as low a rollout obligation as possible, and therefore Option 1 could be their preferred option.

Option 2 (290 base stations)

MNOs

I. 2.1 GHz rollout

A 9.19 In relation to the 2.1 GHz Band, a proposed rollout to 290 base stations would be significantly less than MNOs existing deployment of the band. Further, it would provide MNOs flexibility to scale back the footprint of its existing 2.1 GHz network if the deployment of newly assigned bands was preferred from a network planning perspective.[930] For example, it may be preferable to use 700 MHz to provide coverage where it previously used the 2.1 GHz Band[931].

A 9.20 Therefore, in relation to the 2.1 GHz Band, MNOs are likely to look favourably at Option 2 because such obligations are below the existing 2.1 GHz deployment and are unlikely to go beyond what MNOs would provide independently.

II. 2.3 GHz and 2.6 GHz rollout

[930] This could also allow MNOs the opportunity to spread investment decisions across a portfolio of spectrum holdings more efficiently, promoting infrastructure based competition.
[931] Depending on the asset life of the various pieces of equipment, it may be more efficient to add 700 MHz capability to a site rather than installing new 2.1 GHz compatible equipment, noting that equipment in generally not retunable above and below 1 GHz.

A 9.21 In relation to the 2.3 GHz Band and 2.6 GHz Band, a proposed rollout to 290 base stations under Option 2 would be less than MNOs existing deployment across the 1800 MHz Band (which is used to provide LTE services). Therefore, in relation to the 2.3 GHz Band and 2.6 GHz Band, MNOs are likely to look favourably at Option 2 because such obligations are below the existing 1800 MHz deployment and are unlikely to go beyond what MNOs would provide independently. Noting also that unlike the 1800 MHz Band, the Performance Bands can be added with a software upgrade rather than an equipment change at some sites, which should reduce the cost of rollout[932].

A 9.22 Therefore, ComReg is of the preliminary view that MNOs are likely to look favourably at Option 2 for all of the Performance Bands.[933]

Other service providers

A 9.23 Other service providers (e.g. FWA operators) would likely prefer Option 2 because it would prevent speculative FWA entry and such obligations would likely coincide with any commercial FWA rollout. For example, Imagine propose to rollout fixed wireless services to rural parts of Ireland with 325 sites[934] live by June 2020[935].

A 9.24 Therefore, ComReg is of the preliminary view that other service providers would likely look favourably on Option 2 for all of the Performance Bands.

New entrants

A 9.25 While potential new entrants may prefer Option 1, such entrants would rollout a network to some degree, regardless of any obligation, and may prefer some rollout obligation that would be in line with its commercial rollout.

- A mobile entrant is likely to look favourably on Option 2 as rollout to 290 sites is unlikely to be above what it would undertake regardless of any obligation.

[932] As previously noted in the draft 'Spectrum for Award' RIA, base station equipment at some sites are multi-band and cover existing bands such as 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz Band but also cover the 700 MHz Duplex, 2.6 GHz band, and to a lesser extent the 2.3 GHz band.
[933] FWA providers would likely prefer a separate and higher rollout obligation if the Performance Bands are used for mobile services reflecting the different network deployment for those services. For example, some respondents to Document 18/60 expressed concern that certain operators might hoard spectrum damaging the FWA sector. In particular, Imagine expressed concern that mobile operators may seek to hoard spectrum leading to a long-term inability to deliver non-mobile services.
[934] 155 sites live by June 2019
[935] https://www.rte.ie/news/business/2019/0213/1029304-imagine-to-bring-high-speed-broadband-to-rural/

- A non-mobile entrant would also likely prefer Option 2 but in the lower end of the range and closer to the 3.6 GHz Award obligations **(80 sites)** which resulted in new entry in that award.

A 9.26 Given a likely preference at the lower end of Option 2, a non-mobile new entrant is unlikely to prefer Options 3, 4 and 5 all of which have a higher rollout obligation than Option 2. Therefore, the views of non-mobile new entrants are not considered in the assessment of those options below.

A 9.27 In light of the above, ComReg is of the preliminary view that non-mobile new entrants would likely prefer **Option 2 (80 sites)** over all other options for all of the Performance Bands.

Option 3 (525 base stations)

MNOs

I. 2.1 GHz rollout

A 9.28 In relation to the 2.1 GHz Band, a proposed rollout to 550 base stations under Option 3 would be significantly less than MNOs existing deployment in the band. Further, it would provide MNOs with the flexibility to scale back the footprint of its existing 2.1 GHz network if the deployment of newly assigned bands was preferred from a network planning perspective. For example, it may be preferable to use 700 MHz where it previously used the 2.1 GHz Band. Therefore, in relation to the 2.1 GHz Band, MNOs are likely to be indifferent between Option 2 and Option 3 because such obligations would likely be below the commercial rollout of the 2.1 GHz Band under new licences.

II. 2.3 GHz and 2.6 GHz rollout

A 9.29 In relation to the 2.3 GHz Band and 2.6 GHz Band, a proposed rollout to 550 sites would be below Vodafone's and Three's existing deployment in the 1800 MHz Band. However, Option 3 would be above the existing 1800 MHz rollout for Eir and it may therefore prefer Option 2 where a lower rollout obligation would apply. However, Eir has recently announced[936] an expansion of 4G voice and data coverage, including "*hundreds of additional mobile base stations and upgrades to existing sites*". In order to maintain sufficient capacity across its expanded network Eir seems likely to increase rollout of 1800 MHz and, in doing so, a rollout of at least 550 base stations for the 2.3 GHz and 2.6 GHz Bands would appear feasible for Eir.[937]

[936] https://www.rte.ie/news/business/2018/1112/1010284-eir-network-investment/

[937] [redacted]

A 9.30 Therefore, in relation to the 2.3 GHz Band and 2.6 GHz Band, MNOs would likely be indifferent between Option 2 and Option 3 because such obligations would likely be below the commercial rollout of both bands.

Other service providers

A 9.31 Other service providers are unlikely to prefer Option 3 because this option is informed by the rollout of the 1800 MHz band which is used to deliver mobile services, and such a rollout would not be suitable for a FWA network. It is likely that Option 3 would require existing FWA operators to rollout additional base stations in areas where they may not necessarily have additional demand. This could also potentially result in such operators having to make inefficient investments in their network. Similarly, other service providers would be unlikely to prefer Options 4 or 5 where higher obligations would apply. Therefore, the views of other service providers are not considered further in the assessment of those options below.

A 9.32 In light of the above, ComReg is of the preliminary view that other service providers would likely prefer Option 2 over all other options for all of the Performance Bands.

Mobile entrants

A 9.33 Mobile entrants are unlikely to prefer Option 3 over Option 2. A new entrant could also have a 700 MHz obligation[938] to provide a 30 Mbit/s service to 90% of population and would likely use the Performance Bands to achieve that obligation where required. However, a new entrant would likely have a lightly loaded network until it gained a sufficient market share and therefore would have little justification in rolling out Performance Bands beyond the more dense areas of the country over the rollout period.

A 9.34 Similarly, a high rollout obligation could act as a significant barrier to entry for a new entrant as such an obligation is unlikely to correspond to the market share and business needs of a new entrant at least in the short to medium term. Accordingly, the higher rollout obligation could negatively impact on the willingness of mobile new entrants to participate in an award and ultimately provide services

A 9.35 Therefore, mobile new entrants are unlikely to prefer Option 3 over Option 2. Similarly, mobile entrants would be unlikely to prefer Options 4 or 5 where higher obligations would apply. Therefore, the views of mobile entrants are not considered further in the assessment of those options below.

[938] ComReg notes that any new entrant would likely need 700 MHz rights of uses rather than rights of use to the Performance Bands in isolation.

A 9.36 In light of the above, ComReg is of the preliminary view that mobile entrants would likely prefer Option 2 (290 sites or smaller) over all other options for all the Performance Bands.

Option 4 (1,200 base stations)

MNOs

I. 2.1 GHz rollout

A 9.37 In relation to the 2.1 GHz Band, a proposed rollout to 1,200 base stations under Option 4 would be close to but below MNOs existing deployment in the band. Further, it would still provide MNOs some flexibility to scale back the footprint of its existing 2.1 GHz network if the deployment of newly assigned bands was preferred from a network planning perspective. For example, it may be preferable to use 700 MHz Duplex where it previously used the 2.1 GHz Band. The extent to which MNOs would prefer Option 4 would likely depend on how much MNOs preferred to scale back existing 2.1 GHz deployment, if at all.

A 9.38 Therefore, in relation to the 2.1 GHz Band, MNOs would likely be indifferent between Option 3 and Option 4 because such obligations would likely be below the current commercial rollout of the 2.1 GHz Band. However, as noted above, an MNOs preference might be swayed one way or another by how much it wished to scale back existing 2.1 GHz deployment.

II. 2.3 GHz and 2.6 GHz rollout

A 9.39 In relation to the 2.3 GHz Band and 2.6 GHz Band, a proposed rollout to 1,200 sites would be above each MNOs existing rollout in the 1,800 MHz Band and significantly so for Vodafone and Eir. Therefore, MNOs are unlikely to prefer Option 4 over Option 3 and Option 2. Similarly, MNOs are unlikely to prefer Option 5 where higher obligations would apply. Therefore, the views of MNOs in relation to the 2.3 GHz Band and 2.6 GHz Band are not considered further in the assessment of that option below.

A 9.40 In light of the above, ComReg is of the preliminary view that MNOs would likely prefer Option 2 or Option 3 over all other options for all of the Performance Bands.

Option 5

I. 2.1 GHz rollout

A 9.41 In relation to the 2.1 GHz Band, a proposed rollout to 1,900 + base stations would be significantly in excess of Vodafone's and Eir's existing rollout of the band. Such a rollout would be in line with Three's existing rollout of the band. However, Three's large deployment in the 2.1 GHz Band likely arises from its entry as a 3G only network using the 2.1 GHz MHz Band and its subsequent merger with Telefonica. A rollout of 2.1 GHz at these levels would provide Three little flexibility to rollout using other bands (e.g. sub 1 GHz Bands) where it previously used the 2.1 GHz Band. Three would likely prefer to have more control over when and how it rolls out its network across multiple bands.

A 9.42 Under Option 5, MNOs would be required to rollout and maintain a more extensive network than the other options when it could be more efficient for each to spread their investment across other spectrum bands, particularly in non-urban regions where sub 1 GHz bands are more conducive to providing wide area coverage.

A 9.43 Therefore, in relation to the 2.1 GHz Band, MNOs would be unlikely to prefer Option 5 over Options 2, 3 and 4.

Impact on Competition (step 4)

A 9.44 A coverage/rollout obligation should promote competition such that operators deliver and maintain an acceptable level of coverage/rollout across the country. In that regard, ComReg notes that MNOs would also be subject to the coverage obligation attached to the 700 MHz Duplex (should such rights of use be assigned to all MNOs). The 700 MHz obligation would already provide connectivity over a widespread area and MNOs would appear to have clear competitive incentives to add capacity to the coverage layer (using the Performance Bands) in order to attract new subscribers and increase the benefits for all subscribers using the network.

A 9.45 Further, in order to provide the proposed 30 Mbit/s obligation, MNOs would also likely require the use of the Performance Bands in certain areas of the country. In that context, concerns around cherry picking and tacit collusion (as described in the 'Coverage' RIA) of mobile services are unlikely to be relevant with regard to the Performance Bands in this award.[939]

[939] ComReg notes that cherry picking and tacit collusion are only likely to be relevant to mobile services. In relation to Fixed wireless services the most profitable urban areas are already covered

A 9.46 However, given the variety of bands available in the Proposed Award there remains a number of concerns relevant to competition.

- The 700 MHz obligation only applies to mobile services and coverage/rollout obligations may be required for other potential uses of the Performance Bands (e.g. fixed wireless).
- Spectrum hoarding could deny the use of the Performance Bands to other users (MNOs or non-mobile users).
- The efficient use of the radio spectrum might not be best provided for if rollout only occurred at low levels but displaced more efficient uses/users.

Option 1

A 9.47 Option 1 could promote competition because it would not run the risk of precluding new entry through setting an obligation that could not reasonably be achieved by a new entrant. Winning bidders would also have a high degree of flexibility and could choose their own rollout levels allowing customers to make a choice of provider based on the services provided.

A 9.48 However, Option 1 may harm competition to the extent that it could increase the risks of spectrum hoarding as bidders would be under no obligation to rollout any services using the Performance Bands. For example, some respondents to Document 18/60 expressed concern that certain operators might hoard spectrum damaging the FWA sector and or displacing future uses. Similarly, Option 1 could result in strategic bidding denying rights of use to more efficient users who would provide services to consumers. Setting rollout obligations would better provide for the efficient use of the Performance Bands by ensuring that the spectrum is used to deploy services more efficiently than may otherwise be the case.

A 9.49 Given that such entrants should rollout a network to some degree, regardless of any obligation, competition and the efficient use of the radio spectrum would be better promoted by having a rollout obligation that reflected the likely commercial deployment. Therefore, ComReg is of the preliminary view that an appropriate rollout obligation is necessary for the Performance Bands and, depending on the use case, Option 2, 3 or 4 would, on balance, have a more positive impact on competition than Option 1.

using traditional fixed (fibre) services and tacit collusion is unlikely in rural areas as the cost of extending fixed wireless across a wider area is significantly lower compared to mobile services.

Option 5

A 9.50 Option 5 removes the prospect of spectrum going unused inefficiently and could lead to a more comprehensive rollout of services which could have a positive impact on competition. However, Option 5 would be in excess of all operators (mobile and non-mobile) existing rollout in similar bands. By imposing a high rollout obligation, Option 5 is more likely than other options to discourage participation and dampen competition within the Proposed Award.

A 9.51 Further, setting a rollout obligation which is too high could result in the spectrum going unsold which could significantly harm infrastructure based competition given the large amount of spectrum available. It could also negatively impact on competition at the retail level by increasing the likelihood that any winning bidders would make inefficient investment in the network.

A 9.52 Therefore, ComReg is of the preliminary view that Option 5 would not be appropriate for any use type in the Proposed Award, it is likely that Options 2, 3 or 4 would have a more positive impact on competition than Option 5.

10.2.1 Options 2, Option 3 and Option 4

A 9.53 Provided any obligation was not out of line with operators 'investment plans' (both incumbents and new entrants), a coverage obligation is unlikely to have a negative impact on competition. In that regard, and noting the assessment of stakeholders likely deployment above, ComReg is of the preliminary view that, on balance:

- Option 2 would have a more positive impact on competition with respect to **other service providers and new entrants (mobile and non-mobile)** compared to other options because:
    - Rollout would not be set at levels[940] above what these operators could achieve commercially. Options 3 and 4 would likely act as a significant barrier to entry as rollout set at these levels would likely be significantly above what could be achieved commercially.
    - Options 3 and 4 could also negatively impact on competition at the retail level by increasing the likelihood that winning bidders would make inefficient investment in infrastructure.

[940] 290 sites mobile and 80 non-mobile (e.g. fixed wireless)

- Option 3 would have a more positive impact on competition with respect to the **mobile rollout of the 2.3 GHz Band and 2.6 GHz Band** compared to other options because:
    - It would better encourage efficient use of the radio frequencies compared to Option 2.
    - Options 4 and 5 would likely act as a significant barrier to entry as rollout set at these levels would be significantly above what could achieve commercially in other related bands (e.g. 1800 MHz).
    - Further, these options would likely limit competition during the award and could also negatively impact on competition at the retail level by increasing the likelihood that winning bidders must make inefficient investment in the network.
- Option 4 would have a more positive impact on competition with respect to the 2.1 GHz Band compared to other options because would it would better encourage the efficient use of the radio frequencies compared to Options 2 and 3 and rollout would not be excessively scaled back below levels necessary to achieve an efficient rollout.

Impact on Consumers

A 9.54 It can be assumed that what is good for competition, and what promotes investment in infrastructure, is, in general, good for consumers. This is because increased competition between operators brings benefits to their customers in terms of price, choice and quality of services. In that regard, options that are good for competition above are likely to be good for consumers. For example, consumers are likely to prefer those options which maintain or improve services and coverage while at the same time not deterring entry or efficient investment.

10.2.2 Option 1

A 9.55 From the perspective of all consumers, whilst Option 1 is likely to make entry more attractive compared to other options, it leaves the risk that spectrum will not be used or used inefficiently denying spectrum to more efficient users who would provide services that consumers need. Therefore, consumers are unlikely to prefer Option 1.

10.2.3 Option 5

A 9.56 Consumers may, on first impressions, prefer Option 5 as this provides for a high rollout obligation for all services. However, Option 5 could reduce consumer welfare in a number of ways, including:

- restricting the extent to which providers including new entrants would be willing to participate in the Proposed Award and therefore provide services at all.

- diverting investment away from providing sites in areas where capacity constraints exist now or in the future.

- increasing the price of mobile services, if the cost of inefficient investment is passed on. As previously noted, consumers have a low willingness to pay for additional coverage meaning the use of other parts of the competitive offering (data, voice text) may have to be reduced.

A 9.57 In light of the above, consumers are unlikely to be in favour of Option 5 as it would not have the greatest positive impact on users.

Option 2, Option 3 and Option 4.

A 9.58 Given the different uses likely to arise from the Performance Bands, consumers are likely to prefer different options depending on the services provided by winning bidders and whether new entry is promoted. In that regard, consumers are likely to prefer options that strike the right balance between encouraging rollout to the greatest extent (ensuring that spectrum is used efficiently) and promoting competition.

A 9.59 For **fixed wireless** services, consumers would likely prefer Option 2 over other options for a number of reasons.

- It would provide for fixed wireless services to be rolled across a meaningful area.

- It would best encourage potential new FWA entry which could provide more choice for consumers.

- It is unlikely to place an onerous obligation on FWA service providers requiring inefficient investment or leading to higher prices.

A 9.60 Consumers would also prefer Option 2 as an obligation for new mobile entrants as this would ensure any new entrants would be required to provide services to a minimum level.

A 9.61 For **mobile services**, consumers would likely prefer that the 2.3 GHz Band and 2.6 GHz Band were subject to Option 3.

- It would increase the potential for these bands to be assigned to users than would provide services that consumer's value over a long period.

- It would not discourage MNOs from potentially acquiring additional additional spectrum which enables considerably higher user data rates and supports a greater number of users, all of which will substantially enhance the consumer experience

- The greater connectivity benefits would be achieved across a wider area benefiting more consumer than Option 2.

A 9.62 For **mobile services**, consumers would likely prefer that the 2.1 GHz Band is subject to Option 4 because it is best aligned with the existing deployment of the 2.1 GHz Band (compared to other options) and ensures that any scaling back is limited to the efficient rollout of services across its network.

The Draft Rollout RIA: Assessment and Preferred Option (step 5)

A 9.63 In light of the above, ComReg is of the preliminary view that a combination of the options are required rather than applying one option uniformly to all new rights of use.

A 9.64 Table below summarises ComReg's preliminary view on the preferred options.

Table 40: Summary of Preferred Options following the Draft Rollout RIA

Service	New Entrant Obligation			Existing Operator[941] Obligation		
	2.1 GHz	2.3 GHz	2.6 GHz	2.1 GHz	2.3 GHz	2.6 GHz
Mobile	Option 2 (290)	Option 2 (290)	Option 2 (290)	Option 4 (1,200)	Option 3 (550)	Option 3 (550)
Other	Option 2 (80)	Option 2 (80)	Option 2 (80)	Option 2 (290)	Option 2 (290)	Option 2 (290)

[941] Existing operator refers to the existing licensees in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands.

Annex: 10 Draft Voice Call Services and Network Availability RIAs

A10.1 Introduction

A 10.1 In Chapter 4 of this document, ComReg sets out its preliminary view that the 700 MHz Duplex, 2.1 GHz, 2.3 GHz and 2.6 GHz bands should be included in the Proposed Award.

A 10.2 This chapter sets out ComReg's draft RIAs which considers whether:

- a voice call service licence condition should be attached to spectrum rights issued in the 700 MHz Duplex, the 2.1 GHz Band, the 2.3 GHz Band, and the 2.6 GHz Band (draft 'Voice Call Services' RIA); and
- a network availability licence condition should be attached to spectrum rights issued in the 700 MHz Duplex, the 2.1 GHz Band, the 2.3 GHz Band, and the 2.6 GHz Band (draft 'Network Availability' RIA)

RIA Framework

A 10.3 The purpose, structure and scope of the RIA framework are discussed at the beginning of the draft 'Spectrum for Award' RIA which is set out in Section 4.2.

A10.2 The draft 'Voice Call Services' RIA

A 10.4 This section sets out the draft 'Voice Call Services' RIA. The focus of this draft RIA is to identify the impact of the regulatory options under consideration on stakeholders (including existing operators, potential new entrants, and consumers) and on competition and, in so doing, to identify the option that would best achieve ComReg's objectives. ComReg notes that such an obligation would only apply to operators providing voice call services.

A 10.5 As set out in Chapter 8 of this document, the voice call licence condition proposed only applies to 'managed' voice call services, and this draft RIA therefore only considers 'managed' services. 'Managed' voice call services includes the traditional voice call services carried over circuit-switched connections and the 'managed' packet-switched voice call services (e.g. using VOIP[942] or some other similar protocol) which can be provided over different technologies (e.g. VoLTE[943], Native Wi-Fi, etc.).

A 10.6 'Unmanaged' voice call services[944] are not considered in this proposed licence condition. Such services include voice call services provided by over the top (OTT) applications that do not use session initiation protocol/IP multimedia subsystem (SIP/IMS) signalling and are delivered in best effort manner through the Internet access service (i.e. with no prioritisation).[945]

Policy issue and objectives

A 10.7 The policy issue to be addressed is whether it is appropriate to impose QoS obligations on voice call services to ensure that users are offered a minimum service level by operators who are granted licences for the 700 MHz Duplex, the 2.1 GHz Band, the 2.3 GHz Band, and the 2.6 GHz Band. The focus of this draft RIA is to assess the impact of the proposed measure(s) (see regulatory options below) on industry stakeholders, competition and consumers.

A 10.8 ComReg's overall powers, functions, duties and objectives in relation to the management of the radio frequency spectrum in Ireland are set out in Annex 2. The most relevant objectives in terms of QoS (Voice Call Services) is to ensure that all users derive maximum benefit in terms of price, choice and quality from the spectrum to be made available in the Proposed Award.

Identifying the regulatory options

A 10.9 ComReg has identified the following options:

[942] Voice over Internet Protocol.
[943] VoLTE is a managed voice service that benefits from prioritisation over other traffic.
ITU, 'Quality of Service Regulation Manual' (2017), Section 5.4.4.
https://www.itu.int/dms_pub/itu-d/opb/pref/D-PREF-BB.QOS_REG01-2017-PDF-E.pdf
[944] 'Unmanaged' voice call services are provided over the applications and/or networks of third parties which the licensee would have very limited control over the quality of the service experienced by the end user.
[945] ITU, 'Quality of Service Regulation Manual' (2017), Section 5.4.4.

- **Option 1**: Do not impose QoS licence conditions on 'managed' voice call services, provided using the 700 MHz Duplex, the 2.1 GHz Band, the 2.3 GHz Band, and the 2.6 GHz Band.

- **Option 2**: Impose QoS conditions on 'managed' voice call services, provided using the 700 MHz Duplex, the 2.1 GHz Band, the 2.3 GHz Band, and the 2.6 GHz Band in line with licence condition in the 3.6 GHz Band Liberalised Use Licences[946].

Impact on stakeholders

Option 1

A 10.10 While an operator can guarantee a QoS for voice calls made between subscribers on its own network, it cannot guarantee a QoS for voice calls when its subscribers make/receive calls to/from a different network, as such voice calls to/from a network can originate/terminate on a different network (either fixed or mobile). In Q4 2018, 45% of all mobile-to-mobile calls were made to networks other than the dialling party (i.e. off-network).[947] In effect this indicated that nearly half of all mobile to mobile calls made would have required both MNOs to have a sufficient QoS voice call standard in order to provide a good quality services to consumers.

A 10.11 However, in the event that consumers experience a poor quality voice call service, it is often not clear to consumers which network does not have sufficient voice call QoS standard meaning, that under Option 1, MNOs could avoid the costs of improving voice call standards across its network given this lack of clarity.

[946] See S.I. No. 532/2016 - Wireless Telegraphy (3.6 GHz Band Licences) Regulations 2016.
[947] ComReg Quarterly Key Data Report Q4 2018.

A 10.12 As a result of this feature of the market, the non-imposition of a minimum standard for a voice call could create an incentive for a licensee (or other third party providers such as an MVNO) to engage in behaviour which resulted in the quality of its voice calls falling below the current standards (e.g. through lack of investment or poor network planning). In addition, other operators with higher quality standards would not be able to isolate the higher quality standards applied to voice calls on their own network from the lower quality standards applied on other networks. Such high quality operators might then have less incentive to maintain this higher QoS and may allow the quality of their voice calls to fall. Such an overall reduction in quality for voice calls could result in lower consumer demand for voice calls, which in turn would negatively impact all providers of voice call services, though no individual provider would have an incentive to unilaterally increase quality back to previous levels.

A 10.13 The imposition of minimum QoS conditions for voice calls would prevent such a situation from arising, and ensure that all operators would be subject to the same minimum standard and, as such, each would be assured that no other operator could avoid meeting these minimum standards.

Option 2

A 10.14 Under Option 2, the obligation to provide a minimum QoS standard on voice call services would apply equally to all MNOs. It would provide some assurance that any investment in voice services would be based on minimum standards being implemented by other MNOs. This would reduce the extent to which the negative consequences referred to above under Option 1 could arise.

A 10.15 ComReg acknowledges that Option 2 may involve some compliance costs for incumbents or new entrants which would not arise under Option 1.

A 10.16 However, incumbent MNOs are already subject to minimum voice call QoS obligations under current Liberalised Use Licences (800 MHz, 900 MHz, 1800 MHz and 3.6 GHz Frequency bands) so the extension of the voice call QoS obligations to the bands covered by the Proposed Award is unlikely to impose a significant cost to incumbent MNOs.

A 10.17 In relation to new entrants, ComReg observes that in the 3.6 GHz Award, six of the seven respondents (including new entrants) agreed that a QoS obligation was necessary[948]. Therefore operators may be of the view that Option 2 provides good incentives for all operators to maintain a good voice call standard. Operators may also be of the view that such conditions improve the perception of the network and such benefits are likely to exceed any compliance costs.

A 10.18 Noting the above, ComReg does not consider that the compliance costs involved for Licensees with Option 2 would be disproportionate in terms of the consumer protection objective to be achieved.

A 10.19 In light of the above, ComReg is of the preliminary view that, on balance, stakeholders would prefer Option 2 over Option 1.

Impact on competition

A 10.20 QoS is an important aspect of competition and represents a key non-price consideration that determines how consumers choose their mobile phone provider and/or switch away from existing providers. While 31% of consumers cite price as a reason for selecting its preferred mobile operator, 21% of respondents cite quality of service issues such as coverage and network reliability.[949] In effect, both quality and price are important aspects of competition in mobile markets and a decrease in QoS (where price is unchanged) can be as harmful to consumer welfare as an increase in price (where QoS is unchanged).

A 10.21 Competition in relation to prices is normally straightforward (i.e. prices fall as competition increases). Typically, competition also has a positive impact on QoS as operators begin to compete more vigorously in relation to quality attributes. Moreover, quality considerations can also drive innovation within the market, thereby improving dynamic efficiency. For example, in an effort to improve efficiencies as well as the QoS provided to consumers, operators are looking to other solutions and technologies such as VoLTE[950] and Native Wi-Fi[951] to improve their voice call service. Further the rollout of Native Wi-Fi and/or VoLTE by certain operators has also encouraged others to do the same, increasing competition further.

[948] The only respondent who disagreed at that time was Three, who was not in favour type of obligation which it considered to be more appropriate to a “core” mobile band.
Source: Document 15/140 – Para A9.90 and A9.91.
[949] Mobile Consumer Experience Survey, Document 17/100a, Slide 31.
[950] https://n.vodafone.ie/network.html
[951] https://www.eir.ie/wificalling/

A 10.22 However, under certain circumstances, increased competition could cause a stagnation or a reduction in QoS, if price competition becomes too intense and the need to reduce prices for less efficient operators causes it to sacrifice investment or reduce costs to the detriment of quality. While such a such a scenario would appear unlikely to arise, given the preference consumers place on quality in relation to mobile services, it cannot be ruled out in the future particularly with new entrants who would be looking to establish market share.

A 10.23 The provision of a minimum voice call standard would ensure that any competition on price would not come at the cost of unacceptably low QoS levels.

Option 1

A 10.24 Under Option 1, the subjective nature of QoS could harm competition because of the difficulty in identifying the source of poor voice call standards. For example:

i. Individual MNOs may find it difficult to isolate the higher quality standards applied to voice calls on their own network from the lower quality standards applied on other networks; and

ii. Consumers who experience poor voice call quality cannot determine whether the problem relates to his/her own network or to the network of the person on the other end of the line.

A 10.25 In relation to (i), low levels of QoS on a rival's network could be ongoing for a period of time and users may not raise concerns until voice call standards falls below a certain threshold of acceptability. A MNO with a high level of QoS may not reap the rewards from efficient investments or be aware that voice calls are not being delivered in line with its network expectations. This could result in consumers forming views on voice call QoS that may not be related to the underlying performance of the network but rather the poor QoS from a different MNO.

A 10.26 In this scenario, consumers could choose or switch to an alternative operator because of an incorrect perception of poor voice quality with its existing service provider. This scenario can be particularly damaging to competition because a consumer's decision to switch would be based on a substantial information asymmetry (namely that the consumer would not be aware that poor voice QoS relates to the other callers network).

A 10.27 Moreover, reputational impacts, in and of themselves, are an important aspect of competition. For example, 27% of consumers cite 'Good Reputation' as a reason for choosing their current mobile provider.[952] However, competition requires that such reputations are based on actual performance or perceptions of same rather than consumers being uninformed about a particular aspect of their service provision.

A 10.28 Finally, given that the mix of spectrum available in this award may be attractive to a new entrant, any such new entrant under Option 1 would not be obliged to have any minimum QoS standards. Such a new entrant may decide to compete strongly on price to the detriment of QoS in order to gain market share. This would create a situation where incumbent MNOs are obliged to provide a minimum QoS under existing licences[953] and compete with a new entrant that has no such obligation.

Option 2

A 10.29 Under Option 2, all MNOs (incumbents and new entrants) would be subject to a minimum QoS obligation. This would provide a number of benefits that would likely promote competition better than Option 1. For example:

- It would allow price competition to take place without QoS falling below certain minimum standards.
- Consumers would make better selection and switching decisions by reducing the extent to which such decisions would be based on unreliable or incorrect information.
- New entrants would have the same QoS obligation as incumbent MNOs using other bands and would have to compete on the same basis.
- MNOs could make efficient investments in the knowledge other MNOs would be subject to a minimum obligation in relation to QoS, which should contribute to users deriving maximum benefits in terms of choice, price and quality.

A 10.30 Therefore ComReg is of the preliminary view that Option 2 would have the most positive impact on competition.

[952] Mobile Consumer Experience Survey, Document 17/100a, Slide 31.
[953] As noted above, MNOs are already subject to minimum QoS standards under current Liberalised Use Licences.

Impact on consumers

A 10.31 The ability to make or receive voice calls remains a highly utilised service and a key priority for consumers. Voice remains the most popular service used by consumers when using their mobile phones with 96% of consumer using their mobile phone to make voice calls (higher than text 89% and data 75%).[954] For example, in Q4 2018, mobile minutes reached peak levels at nearly 3.2 billion minutes for that quarter.[955] Further the main outdoor service issues across all types of consumers (rural and urban) relate to voice calls. For example, of respondents who experienced service issues 54% noted that the quality of reception deteriorated when on a call.[956]

A 10.32 Consumers would likely prefer any option which ensures that they receive a minimum QoS (Option 2) over an option which relies solely on market forces or the goodwill of individual operators (Option 1), as long as the preferred option does not otherwise result in reduced benefits in terms of price, choice and quality.

Option 1

A 10.33 While operators are likely to aim to prevent any disruption to services in order to retain and attract consumers there are situations where, due to information asymmetries, the setting of minimum QoS standards may be necessary in order to protect consumers. For example, under Option 1, voice call service issues that consumers already have could be worsened.

A 10.34 Further, as voice calls can originate and terminate on different networks, under Option 1 a consumer who experiences poor voice call quality cannot determine whether the problem relates to his/her own network or to the network of the person on the other end of the line. Consequently consumers would not be in a position to make informed choices based on the quality of voice calls.

Option 2

A 10.35 Alternatively, under Option 2, setting minimum QoS standards for voice calls can safeguard the interests of consumers.

- This allows consumers to make more informed decisions about choosing a service provider and/or switching to an alternative provider.

[954] Slide 35, Document 17/100a
[955] ComReg Quarterly Report Q4 2018.
[956] Mobile Consumer Experience Survey, Document 17/100a, Slide 31.

- It provides a minimum QoS voice call obligation to all MNOs which should ensure that the standard of voice calls does not fall below a certain level.
- The standards under current Liberalised Use Licences[957] would be applied to future technologies maintaining voice call standards at current levels, at a minimum.
- It would ensure that services provide by new entrants would be subject to a minimum voice call QoS standard.

A 10.36 Further, the voice call QoS obligation would apply to any technology used by operators to deliver the managed voice service (e.g. VoLTE, Native-Wi-Fi, etc.). This would encourage operators to appropriately validate and test new technologies prior to rollout. The imposition of minimum QoS conditions for voice calls would ensure that all operators would be subject to the same minimum standard regardless of the technology used and, as such, each would be assured that no other operator could avoid meeting these minimum standards.

A 10.37 Therefore, ComReg is of the preliminary view that consumers are likely to have a preference for Option 2 over Option 1.

Preferred Option

A 10.38 In light of the preceding discussion, ComReg is of the preliminary view that Option 2 is the preferred option in terms of the imposition of a 'managed 'voice call' QoS licence condition.

A10.2 The draft 'Network Availability' RIA

A 10.39 This section sets out the draft 'Network Availability' RIA. The focus of this draft RIA is to identify the impact of the regulatory options under consideration on stakeholders (including existing operators, potential new entrants, and consumers) and on competition and, in so doing, to identify the option that would best achieve ComReg's objectives.

[957] The Liberalised Use Licences in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz Frequency bands.

Policy Issue and Objectives

A 10.40 The policy issue to be addressed in this draft RIA is whether a network availability condition should be imposed on holders of liberalised licences in the 700 MHz Duplex, the 2.1 GHz Band, the 2.3 GHz Band, and the 2.6 GHz Band, in order to ensure that any periods during which a licensee's network is unavailable do not exceed a specified level.

A 10.41 ComReg's overall powers, functions, duties and objectives in relation to the management of the radio frequency spectrum in Ireland are set out in Annex 2. The most relevant objectives in terms of QoS (Network Availability) is to ensure that all users derive maximum benefit in terms of price, choice and quality from the spectrum to be made available in the Proposed Award. Identifying the regulatory options.

Identifying the regulatory options

A 10.42 ComReg has identified the following options:

- **Option 1**: Do not impose minimum QoS conditions in respect of the availability of the network
- **Option 2**: Set minimum QoS conditions in respect of the availability of the network, based on current liberalised use licence conditions, such that each licensee shall ensure that service unavailability shall be less than 35 minutes[958] (based on weighting factors) per six month period.

Impact on stakeholders

A 10.43 Option 1 would allow operators full discretion over how often and how long their networks may be unavailable (e.g. for the purposes of systems upgrades etc.).

A 10.44 Option 2 may require operators to incur additional expenditure in their network to ensure compliance with obligations (e.g. back-up systems) over and above the level which they would choose to incur, absent the licence condition.

[958] This is based on the network availability licence condition in the Liberalised Licences for spectrum rights in the 800 MHz, 900 MHz, 1800 MHz and 3.6 GHz bands.

A 10.45 Operators may be of the view that such conditions improve the perception of the network and such benefits are likely to exceed any compliance costs. As noted above, respondents to the consultation on the 3.6 GHz Award[959] were generally in favour of such obligations. Therefore, most operators are likely to have a preference for Option 2.

Impact on competition

A 10.46 Neither option is likely to impact materially on competition as any conditions imposed would apply equally to all licensees. Option 1 could, however, result in less competitive intensity in terms of network availability than would occur under Option 2, for the reasons described in the above draft 'Voice Call Services' RIA.

Impact on consumers

A 10.47 Network availability is of fundamental importance to consumers. If any network is unavailable, subscribers on that network cannot use services. Consumers face serious disruption if the network to which they are subscribed is unavailable. The longer the period of unavailability, the greater the level of disruption. Setting a licence condition relating to network performance would safeguard the interests of consumers against operators who might otherwise have an unacceptably high level of network unavailability;

A 10.48 Option 2 would ensure that consumers would be protected against an unreasonable level of disruption to services. Under Option 2, customers could refer the matter to ComReg if their service provider did not meet its obligations. ComReg would act as a watchdog for consumers by ensuring that the overall duration of network unavailability is within the specified range.

A 10.49 Under Option 1, operators may, amongst other things, have an incentive to undertake lower levels of investment in their networks in terms of operability than would otherwise be the case, or to impose unreasonable levels of disruption on their customers when undertaking systems upgrades, etc.

A 10.50 The QoS obligation imposed under Option 2 would apply to licensees which means, in turn, that licensees would need to ensure that third parties using their network assist it in achieving compliance as appropriate. As a result, all consumers regardless of the provider would benefit from the obligation.

[959] See Document 15/140.

A 10.51 For these reasons, consumers would most likely prefer Option 2 whereby all Licensees are required to ensure that the overall duration of network unavailability does not exceed a specified level.

Preferred Option

A 10.52 Having considered the impacts on stakeholders, competition and consumers, ComReg considers Option 2 to be the better option by which to achieve its objectives.

Annex: 11 Transition in the 2012 MBSA

A 11.1 The following summarises the approach taken to considering the need for transitions in the 2012 MBSA and provides an overview of the two transitions which eventually took place following the 2012 MBSA:

- the first in 2013 to align spectrum usage with the rights of use won by bidders in Time Slice 1 (the "2013 Transition"); and
- the second in 2015 to realign spectrum usage with rights of use won by bidders in Time Slice 2 (the "2015 Transition").

A 11.1 Understanding the potential transition scenarios and timings in advance of the award

A 11.2 In the 2012 MBSA there were a number of existing GSM licensees in the 900 MHz and 1800 MHz bands whose licences would expire in advance of the commencement of new licences.

A 11.3 The circumstances of that award were such that there was a potential for significant consumer disruption in the 900 MHz band, given among other things the importance of the 900 MHz band to the provision of widespread GSM services, and the number of consumer devices which were GSM-only at that time.

A 11.4 ComReg commissioned expert advice from Red-M/Vilicom[960] on the potential transition scenarios that could arise in the 2012 MBSA and the potential "worst case" timings associated with these scenarios

A 11.5 Red-M/Vilicom provided estimated timeframes for various transition scenarios.

A 11.6 For a transition scenario where existing licensees won an equal or greater amount of spectrum in a band, but where the spectrum location was different.[961] Red-M/Vilicom estimated that it would take:

- approximately 5 months to transition the 900 MHz band by itself;

[960] See ComReg Documents 10/71c, 10/105b and 12/22

[961] This was termed "relocation" in the 2012 MBSA

- 4 to 5 months to transition the 1800 MHz band by itself, depending upon the inter-dependency between operators; and
- 6 months in the case of simultaneous transitions in both the 900 MHz and 1800 MHz bands; and
- 9-10 months in the case of sequential transitions in both the 900 MHz and 1800 MHz bands.

A 11.7 For a transition scenario where an existing licensee in the 900 MHz band won a reduced amount of spectrum[962], Red-M/Vilicom estimated that:

- a period of 2 years would be sufficient for that operator to take mitigating steps, based on "the worst case scenario" of re-engineering the existing 900 MHz network and deploying additional 1800 MHz GSM base stations.

A 11.8 Red-M/Vilicom did not provide advice for a transition scenario where an existing licensee in the 900 MHz or 1800 MHz band did not win any spectrum in the band. Estimating such timeframes would have been very difficult , as any such estimated timeframes would have varied in line with the particular characteristics of each operator's network, such as:

- the network's intrinsic traffic capacity, and
- the dependency of a network upon a specific frequency band for both coverage and traffic loading in a given area.

A 11.9 Noting this ComReg stated at that time that it would be inappropriate to set detailed timeframes for the scenario where an existing licensee won no spectrum in a band, in advance of the award, as details pertinent to ComReg's assessment of the timeframes necessary for such a situation, namely the operator affected and the specifics of the scenario, would only become available once the outcome of the auction was known. However, ComReg observed that should a scenario arise as a result of the auction, it would be appropriate for it to set a timeframe at that stage in light of updated information.[963]

A 11.2 Detailing appropriate award and transition rules

A 11.10 Understanding potential transition scenarios and timings informed various aspects of the 2012 MBSA including:

[962] Transition to a reduced amount of spectrum was termed "retuning" in 2012 MBSA.

[963] Para 6.68 of ComReg Document 12/25

- the setting of transition rules for the Proposed Award and requiring all existing licensees and winning bidders in the Proposed Award to abide by these. Among other things, these transition rules provided for the submission of transition proposals by existing licensees and winning bidders and appropriate consultation, following which ComReg formulated a transition plan. Principles to guide ComReg in setting out this final transition plan included:
    - the minimisation of the potential for significant disruption to existing consumer services; and
    - the commencement of new spectrum rights as soon as practicable, thereby not unnecessarily delaying the delivery of new services to end users.
- the putting in place of provisions for the potential delayed commencement of liberalised rights and appropriate refunds to new licensees in respect of same. Among other things, this recognised the relatively short period of time from the 2012 MBSA award to the commencement date of new rights on 1 February 2013 and the potential for transition activities to delay commencement; and
- specific provisions in the assignment round of the spectrum award to eliminate the possibility of transition between Time Slice 1 and Time Slice 2 for winning bidders who win the same amount of spectrum in a spectrum band in both time slices.[964]

A 11.3 Implementation of the 2013 Transition

A 11.11 In the 2012 MBSA, the existing GSM licensees all won an equal or greater amount of spectrum in the 900 MHz and 1800 MHz bands in Time Slice 1 as illustrated in Figure 21 below.

[964] In the 2012 MBSA, a provision was included in the assignment round where winning bidders who won the same amount of spectrum in a spectrum band in both time slices would only be provided spectrum options with contiguous spectrum assignments across the two time slices (i.e. no transition would be required)

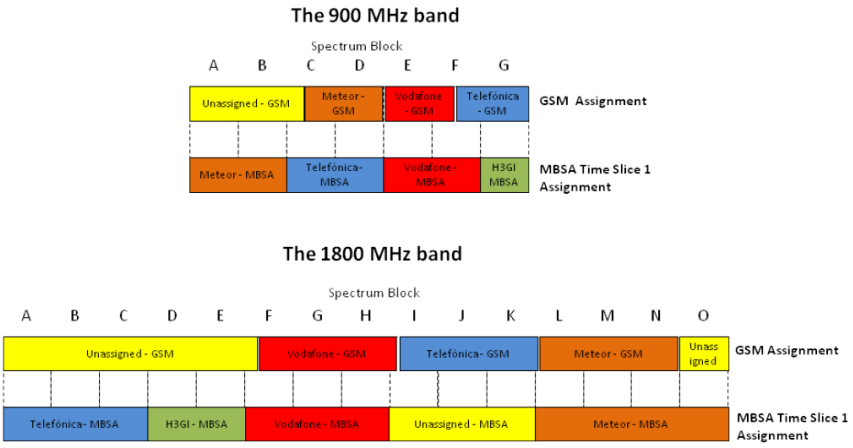

Figure 21: The 2013 Transition for the 900 MHz and 1800 MHz bands

A 11.12 However, as the frequency location of spectrum rights in Time Slice 1 of the 2012 MBSA, as finalised on 5 December 2012[965], differed to the frequency location of existing GSM rights, transition activities were required for:

- Meteor in the 900 MHz band;
- Telefónica in the 900 MHz and 1800 MHz bands; and
- Vodafone in the 1800 MHz band.

A 11.13 In early December 2012, ComReg requested transition proposals from the existing licensees and winning bidders in order to formulate a transition plan. Following receipt of same, a draft transition plan was subsequently set out by ComReg in late December 2012 and this was consulted upon with existing and new licensees.

A 11.14 Following receipt of submissions to the draft plan, the final transition plan was determined and published.[966] Among other things this set out transition completion dates for the 900 MHz and 1800 MHz bands, a grace period in respect of liquidated damages, and a reporting method to keep ComReg, other existing GSM licensees and winning bidders informed of progress.

[965] ComReg Document 12/131, "Frequency Arrangements and Results of the Multi-Band Spectrum Award Process", published 5 December 2012

[966] ComReg Document 13/19, "ComReg's Transition Project Plan for Time Slice 1 of the Multi-Band Spectrum Award (MBSA) process", published 25 February 2013.

A 11.15 To the credit of all parties, the 2013 Transition was completed by 19 April 2013[967], in a timeframe that was broadly in line with 900 MHz transition completion dates, and six weeks[968] in advance of the 1800 MHz transition completion dates as set out in the final transition plan.

A 11.16 Overall, circa 4½ months was required to complete the 2013 Transition. This was notably faster that the "worst case" timeframes advised by Red-M/Vilicom of circa 6 to 10 months.

A 11.4 Implementation of the 2015 Transition

A 11.17 Following the outcome of the 2012 MBSA a transition process was also required for the 1800 MHz band[969], as the spectrum rights for Meteor and Three differed between Time Slice 1 and Time Slice 2, as illustrated in Figure 22 below.

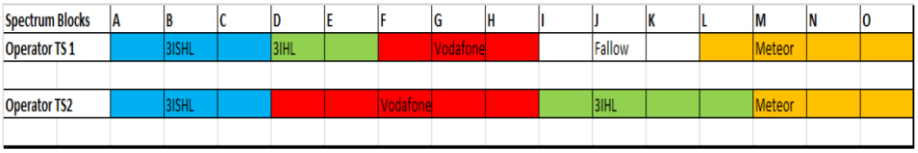

Figure 22: The 2015 Transition for the 1800 MHz band

A 11.18 Specifically, in the 2015 Transition:

- Meteor was required to reduce its use of 1800 spectrum rights from 2×20 MHz to 2×15 MHz; and
- Three was required to move its spectrum rights from spectrum blocks D and E to spectrum blocks I, J, K and L.

A 11.19 Following submissions from existing licensees in July 2014 (i.e. one year in advance of the 13 July 2015 commencement date for Time Slice 2) and further submissions in March and April 2015, a transition plan for the 1800 MHz band was finalised and published in May 2015[970].

[967] ComReg Document 13/55, "Update on the Multi-Band Spectrum Award process", published 12 June 2013.

[968] Specifically Telefonica competed its 1800 MHz transition activities on 10 April 2013 six weeks in advance of the transition completion date of 21 May 2013 as set out in the transition plan.

[969] A transition process for Time Slice 2 was not required for the 800 MHz and 900 MHz bands as all winning bidders won the same amount of spectrum in time slices 1 and 2.

[970] ComReg Document 15/41, "ComReg's Transition Project Plan for Time Slice 2 of the Multi-Band Spectrum Award (MBSA) process", published 8 May 2015.

A 11.20 Among other things, this plan noted specific aspects of the transition and that:

- Three required a period of just over 5 weeks (from 9 April 2015 to 16 May 2016) to complete its move from spectrum blocks D&E to blocks J&K; and
- Meteor required a period of 4 *"plus some"* months to cease its use of block L at 291 sites.[971]

A 11.21 ComReg notes that above timings are unlikely to represent the full time required to carry out these transitions, as certain activities such as the time required for planning, are not captured.

A 11.22 To the credit of the parties concerned, the 2015 Transition was completed by 12 July 2015 in line with the finalised transition plan.

[971] In its 9 March 2015 submission to ComReg, Meteor indicated that its' project to clear the use spectrum block L at 291 sites had been in operation for some months and that it would require the full term of its spectrum rights in block L (i.e. until 12 July 2015) to complete its transition.

Annex: 12 Technical Conditions

Technical Conditions

A 12.1 This Annex outlines ComReg's technical conditions proposals for the Proposed Bands considered under this award in addition to those discussed in Chapter 6 of this document.

A 12.2 These technical condition are considered in relation to:

- The EC Decisions[972] relevant to each spectrum band applicable for new rights of use in the specific band. In the case of the 2.3 GHz band, of which there is no EC Decision, the technical conditions are set-out in ECC Decision (14)02[973].
- an FDD mode of operation applicable to all spectrum bands considered in this proposed award, except for the 2.3 GHz and the 2.6 GHz duplex gap which would operate in a TDD mode of operation with consideration to inter-network synchronisation for TDD networks; and
- compatibility with existing services operating in adjacent and co-channel spectrum bands.

A 12.3 The technical conditions set out in these technical documents take the form of a block edge mask (BEM) for different usage scenarios and channelling arrangements. In general the BEM definition includes the following and are as defined in the EC Decisions for each of the relevant bands, and as per the ECC Decision in the case of 2.3 GHz:

- In-block:
  - base station power limits; and
  - terminal station power limits;
- Out-of-block:
  - baseline power limits;

[972] Namely the 2.1 GHz EC Decision, 700 MHz EC Decision and 2.6 GHz EC Decision, available at https://eur-lex.europa.eu/.

[973] ECC Decision (14)02, available at https://www.ecodocdb.dk.

- transitional region power limits i.e. power limits for a range of frequencies above and below the block assigned to the operator; and
- Guard band emission limits (specifically for FDD channelling arrangement).

MFCN Cross Border Compatibility

A 12.4 ComReg is currently engaging with neighbouring administrations in relation to updating the cross border agreements to include the deployment of MFCN/ECS in the Proposed Bands.

A 12.5 These cross border agreements take the form of a Memorandum of Understanding (MoU) and aims to cater for the deployment of both 4G and 5G services taking into account the latest CEPT reports[974] regarding cross border coordination of these systems.

A 12.6 For each of the Proposed Bands there will be a requirement that deployments will be subject to the co-ordination thresholds and corresponding procedures as set out in the respective memorandum of understanding.

700 MHz Duplex Band

A 12.7 The 700 MHz EC Decision[975] sets out a number of technical conditions in the form of frequency arrangements and BEMs. These technical conditions provide the basis for the 700 MHz technical conditions to be applied in Ireland.

In-block Power Limits

Base Station Power Limits

A 12.8 The 700 MHz EC Decision sets out a non-obligatory in-block power limit. If an administration wishes to apply an upper bound power limit, the 700 MHz EC Decision states that such a limit must not exceed 64 dBm/5 MHz per antenna. The in-block power limit, if one is set, would be applicable to all base stations within the operators assigned blocks.

[974] ECC Rec (11)05 in the frequency band 2500-2690 MHz, ECC Rec (01)01 in the frequency band 1920-1980 MHz and 2110-2170 MHz, ECC Rec (15)01 includes frequency bands 694-790 MHz and ECC Rec (14)14 in the frequency band 2300-2400 MHz. Available at www.ecodocdb.dk

[975] The 700 MHz EC Decision, available at https://eur-lex.europa.eu/.

A 12.9 ComReg is proposing to set an in-block power limit of 64 dBm/5 MHz, given that this limit is considered to be of a magnitude sufficient for the provision of likely services in the band.

Out-of-block Power Limits

Baseline Power Limits

A 12.10 The 700 MHz EC Decision provides some discretion in relation to setting of a measurement bandwidth for EIRP out-of-block emissions. ComReg intends to award the 700 MHz band in 5 MHz blocks, as such, the 700 MHz EC Decision identifies a measurement bandwidth of 5 MHz[976]. ComReg proposes to apply this measurement bandwidth to out-of-block emissions in both the uplink blocks in the range of 703-733 MHz and the downlink blocks in the range of 758-788 MHz. The base station baseline power limit applies as follows:

- for uplink frequencies in range 698-736 MHz, an EIRP limit of -50 dBm per cell[977] shall apply;
- for uplink frequencies as defined in Decision 2010/267/EU (i.e. 832-862 MHz), an EIRP limit of -49 dBm per cell shall apply;
- for downlink frequencies in the range 738-791 MHz, a maximum mean EIRP of 16 dBm per antenna shall apply;
- for downlink frequencies as defined in Decision 2010/267/EU (i.e. 791-821 MHz), an EIRP limit of 16 dBm per antenna shall apply; and
- for frequencies below 694 MHz where DTT broadcasting is protected, a maximum EIRP limit of -23 dBm per cell[977] across 8 MHz bandwidth is required.

Transitional Power Limits

A 12.11 The 700 MHz EC Decision defines transitional power limits for downlink only blocks in the frequency range 733 – 788 MHz, as follows:

- for -10 to -5 MHz offset from lower block edge or 5 to 10 MHz offset from the upper block edge, a limit of 18 dBm per antenna shall apply across a 5 MHz measurement bandwidth; and

[976] The 700 MHz EC Decision also provides for a measurement bandwidth of 3 MHz or 200 kHz for the protection of block size of 3 MHz depending on the national implementation options.

[977] In a multi-sector site, the value per “cell” corresponds to the value for one of the sectors.

- for -5 to 0 MHz offset from lower block edge or 0 to 5 MHz offset from the upper block edge, a limit of 22 dBm per antenna shall apply across a 5 MHz measurement bandwidth.

A 12.12 For a block in frequency range 788-791 MHz, with an upper edge at:

- 788 MHz, a 21 dBm limit per antenna shall apply across a 3 MHz measurement bandwidth;
- 783 MHz, a 16 dBm limit per antenna shall apply across a 3 MHz measurement bandwidth;
- 788 MHz for protection of systems with bandwidth < 3 MHz, a 11 dBm per antenna limit shall apply across a 200 kHz measurement bandwidth; and
- 783 MHz for protection of systems with bandwidth < 3 MHz, a 4 dBm per antenna limit shall apply, across a 200 kHz bandwidth.

A 12.13 For a block in the frequency range 791-796, with upper edge at:

- 788 MHz, a 19 dBm per antenna limit shall apply across a 5 MHz measurement bandwidth; and
- 791-796 MHz for a block with upper edge at 783 MHz, a 17 dBm per antenna limit shall apply across a 5 MHz measurement bandwidth.

A 12.14 For a block in the frequency range 796-801 MHz, with upper edge at 788 MHz, a 17 dBm per antenna limit shall apply across a 5 MHz measurement bandwidth.

Guard Band Base Station Power Limits

A 12.15 The 700 MHz EC Decision provides for base station limits for part of the guard bands not used for PPDR or M2M radio communications, i.e. 694-703 MHz and 788-791 MHz. These limits are implemented as follows:

- A power limit of -32 dBm per cell across 1 MHz shall apply to spectrum between the lower band edge of the 700 MHz frequency band and FDD uplink lower band edge (i.e. 694-703 MHz); and
- an EIRP limit of 14 dBm per antenna across 3 MHz shall apply to spectrum between FDD downlink upper band edge and the FDD downlink lower band edge as defined in Decision 2010/267/EU (i.e. 788-791 MHz).

Duplex Gap Power Limit

A 12.16 A base station power limit is defined in the 700 MHz EC Decision for part of the duplex gap not used for PPDR or M2M. Although provision for these services in the paired frequency range 733-736 / 788-791 MHz has not been made as part of this process, ComReg intends to implement the following power limits of the duplex gap (733-738 MHz), in line with the 700 MHz EC Decision. These limits are implemented as follows:

- for – 10 to 0 MHz offset from FDD downlink lower band edge or lower edge of the lowest downlink-only block, but above FDD uplink upper band edge, a 16 dBm per antenna limit shall apply across 5 MHz; and
- for more than 10 MHz offset from FDD downlink lower band edge or lower edge of the lowest downlink-only block, but above FDD uplink upper band edge, a – 4 dBm per antenna limit shall apply across 5 MHz.

Terminal station in-block power limit

A 12.17 The 700 MHz EC Decision defines a maximum mean in-block power limit of 23 dBm[978] for terminal stations. ComReg may relax this in-block power limit in certain situations including for fixed terminal stations in rural areas provided that protection of other services, networks and applications is not compromised and cross-border obligations are fulfilled.

Terminal station out-of-block (lower edge) power limit

A 12.18 A Total Radiated Power[979] (TRP) limit is proposed for terminal stations operating in the uplink band (i.e. 703-733 MHz) applicable to the guard band between the upper limit of spectrum used for television broadcasting (694 MHz) and FDD uplink (694-703 MHz) and used for television broadcasting (below 694 MHz) as follows:

- for 694-698 MHz, a -7 dBm maximum mean out-of-block EIRP across 4 MHz;
- for 698-703 MHz, a 2 dBm maximum mean out-of-block EIRP across 5 MHz; and

[978] This value is subject to a tolerance of up to +2 dB, to take account of the operation under extreme environmental conditions and production spread.

[979] TRP is a measure of how much power the antenna actually radiates. The TRP is defined as the integral of the power transmitted in different directions over the entire radiation sphere.

- for 470-694MHz, a -42 dBm maximum mean out-of-block power across 8 MHz.

Terminal station out-of-block (upper edge/duplex gap) power limit

A 12.19 The 700 MHz EC Decision also provides for a terminal station power limits for the duplex gap between FDD uplink and FDD downlink as follows:

- for 733 -738 MHz, a 2 dBm maximum mean out-of-block EIRP across 5MHz;
- for 738-753 MHz, a -6 dBm maximum mean out-of-block EIRP across 5Mhz; and
- for 753-758 MHz, a -18 dBm maximum mean out-of-block EIRP across 5MHz.

A 12.20 ComReg notes that the derived spectrum mask described above is specified in clause 4.2.3 of ETSI EN 301 908-13 v6.2.1[980] which ensures that LTE based equipment will inherently comply with these limits.

2.1 GHz Band

In-block Power Limits

Base Station Power Limits

A 12.21 The 2.1 GHz EC Decision[981] sets out a non-obligatory in-block EIRP limit. However, if an upper bound power limit is required then such a limit should be between 61 dBm/5 MHz and 65 dBm/5 MHz in the FDD downlink band. If such a limit is set, it would be applicable to all base stations within the operator's assigned blocks.

A 12.22 ComReg is proposing to set an in-block power limit of 64 dBm/5 MHz, given that this limit is considered to be of a magnitude sufficient for the provision of likely services in the band taking into account current base station deployment in the 2.1 GHz band.

[980] ETSI Standard EN 301 908-13 v6.2.1, available at www.etsi.org

[981] 2.1 GHz EC Decision, available at https://eur-lex.europa.eu/

Out-of-block Power Limits

A 12.23 The band plan as outlined in Chapter 6 sets out a 5 MHz block size. As such the maximum mean EIRP limit shall be measured across 5 MHz bandwidth for both uplink and downlink frequencies in the 2.1 GHz band.

Baseline Power Limits

A 12.24 For frequencies spaced more than 10 MHz from the lower or upper block edge, a 9 dBm EIRP limit per antenna shall apply.

Transitional Requirements

A 12.25 The 2.1 GHz EC Decision defines transitional power limits, as follows:

- for -10 to -5 MHz offset from lower block edge or +5 MHz to +10 MHz offset from the upper block edge, a 11 dBm per antenna limit shall apply; and
- for -5 to 0 MHz offset from lower block edge or 0 to +5 MHz offset from the upper block edge, a 16.3 dBm per antenna limit shall apply.

Terminal station BEM in-block power limit

A 12.26 The maximum mean in-block power is defined as 24 dBm for terminal stations emission limit over frequencies of FDD uplink.

2.3 GHz Band

A 12.27 In the absence of a 2.3 GHz EC Decision, ComReg proposes that the technical conditions applicable for any new rights of use in the 2.3 GHz band are as set out as per the ECC Decision (14)02[982]. In considering these technical conditions, ComReg intends to release the band on an exclusively TDD basis as proposed in Chapter 6.

[982] ECC Decision (14)02, available at https://www.ecodocdb.dk.

In-block Power Limits

Base Station Power Limits

A 12.28 The 2.3 GHz ECC Decision sets out a non-obligatory in-block power limit. If an administration wishes to apply an upper bound power limit, the 2.3 GHz ECC Decision states that such a limit must not exceed 68 dBm/5 MHz e.i.r.p. per antenna. The in-block power limit, if one is set, would be applicable to all base stations within the operators assigned blocks.

A 12.29 ComReg is proposing to set an in-block power limit of 68 dBm/5 MHz, given that this limit is considered to be of a magnitude sufficient for the provision of likely services in the band. Additionally, it is proposed that all base stations would still be subject to baseline power limits, and transitional region power limits where applicable.

A 12.30 A reduced in-block[983] EIRP limit in the upper 10 MHz of the 2.3 GHz band (2 390-2 400 MHz) of not more than 45 dBm/5 MHz is required to ensure coexistence with systems above 2.4 GHz. These restricted blocks are identified in Figure 23 below.

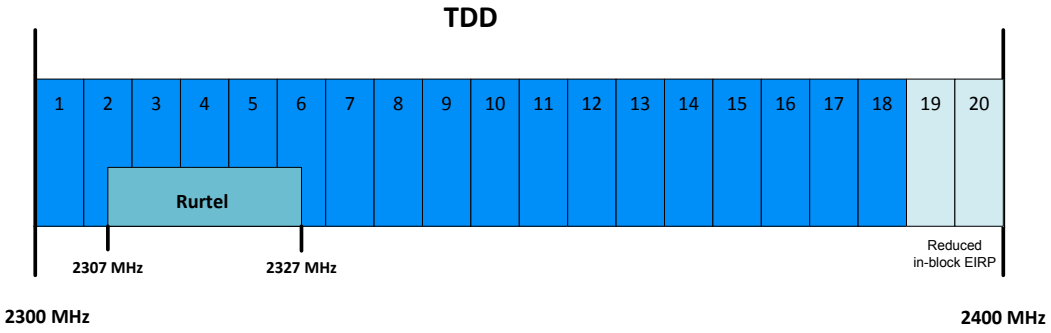

Figure 23: The 2.3 GHz Band (RurTel and Restricted Blocks)

A 12.31 For femto base stations, the use of power control is mandatory in order to minimise interference to adjacent channels.

Out-of-block Power Limits

Baseline requirements for TDD base stations

A 12.32 Baseline power limits apply to synchronised and unsynchronised TDD blocks outside of in-block and transitional frequencies.

[983] Block for which the BEM is derived.

A 12.33 There are two TDD baseline power limit values set out in the 2.3 GHz ECC Decision:

- for synchronised TDD blocks a limit of Min(PMax[984] - 43,13) dBm/5 MHz EIRP per antenna shall apply; and
- for unsynchronised TDD blocks -36 dBm/5 MHz EIRP per cell shall apply.

A 12.34 Additional baseline requirements are necessary above 2 403 MHz for unsynchronised and synchronised MFCN base stations, these are:

- for Pmax > 42 dBm, power limit of 1dBm/5 MHz applies;
- for 24 dBm < Pmax ≤ 42 dBm, power limit (Pmax -41) dBm / 5 MHz applies; and
- for Pmax ≤ 24 dBm, a power limit of -17 dBm / 5 MHz applies.

A 12.35 The TDD inter-network synchronisation section below sets out further details as to how these limits are proposed to apply to rights of use awarded.

Transitional region requirements for MFCN base stations

A 12.36 For TDD blocks, the transitional region applies in case of synchronised adjacent blocks, and in-between adjacent TDD blocks that are separated by 5 or 10 MHz typically due to an unsynchronised network operating in an adjacent block. The transition regions do not apply below 2 300 MHz or above 2 400 MHz.

A 12.37 The transitional limits set out in the 2.3 GHz ECC Decision are, as follows:

- for – 5 to 0 MHz offset from lower block edge or 0 to 5 MHz offset from upper block edge a limit of Min(PMax - 40,21) dBm/5 MHz EIRP per antenna shall apply; and
- for – 10 to – 5 MHz offset from lower block edge or 5 to 10 MHz offset from upper block edge a limit of Min(PMax - 43,15) dBm/5 MHz EIRP per antenna shall apply.

A 12.38 The inter-synchronisation Section below describes the synchronisation options relating to guard blocks and transitional BEMs as proposed for this award.

[984] Where PMax is the maximum mean power of the base station in question, measured as EIRP per carrier

Guard band emission limits

A 12.39 As set out in the Chapter 6, ComReg does not support the introduction of guard bands between the assignments of TDD networks so these limits will not apply.

Terminal station BEM in-block power limit

A 12.40 The 2.3 GHz ECC Decision sets out a maximum in-block power limit for terminal stations of 25 dBm[985]. The 2.3 GHz ECC Decision does allow for Member States to relax the limit under certain circumstances, particularly citing the example of fixed terminal stations.

The 2.6 GHz Band

A 12.41 The 2.6 GHz EC Decision sets out the technical conditions applicable for any new rights of use in the paired 2.6 GHz band. In considering these technical conditions, ComReg intends to award the paired 2.6 GHz band on an FDD basis and the 2.6 GHz duplex gap on a TDD basis, as proposed in Chapter 6 of this document.

Unrestricted BEM For Base Stations

A 12.42 The BEM for unrestricted spectrum block is built up by combining Baseline power limits, in-block power limits and transitional power limits in such a way that the limit for each frequency is given by the higher value.

[985] This power limit is specified as EIRP for terminal stations designed to be fixed or installed and as total radiated power (TRP) for terminal stations designed to be mobile or nomadic. A tolerance of up to + 2 dB has been included in this limit, to reflect operation under extreme environmental conditions and production spread. Administrations may relax this limit in certain situations, for example fixed UE in rural areas, providing that protection of other services, networks and applications is not compromised and cross-border obligations are fulfilled.

In-block Power Limits

Base Station Power Limits

A 12.43 The 2.6 GHz EC Decision[986] sets out an in-block power limit which would not exceed 61 dBm/5 MHz[987]. This in-block power limit is applicable to all base stations assigned to an operator within the unrestricted blocks.

A 12.44 ComReg is proposing to set an in-block power limit of 61 dBm/5 MHz, given that this limit is considered to be of a magnitude sufficient for the provision of likely services in the band.

Out-of-Block Power limits

Baseline Power Limits

A 12.45 The 2.6 GHz EC Decision defines baseline power limit values for frequencies allocated to FDD blocks and for those operating in TDD allocated blocks:

- for frequencies allocated to FDD downlink and ±5 MHz outside the range of frequency blocks allocated to FDD down link (including SDL blocks), such as 2 615-2 620 MHz, a limit of +4 dBm/ MHz applies; and
- for frequencies in the 2.6 GHz band, not covered by above, a -45 dBm/MHz limit applies.

Transitional Power Requirements

A 12.46 The transitional power limits set out in the 2.6 GHz EC Decision are, as follows:

- for start of band (2 500 MHz) to -5 MHz offset from lower block edge, or +5 MHz offset from upper block edge to end of band (2 690 MHz), the baseline requirement level is applied;
- for – 5 to -1 MHz offset from lower block edge or +1 to +5 MHz offset from upper block edge a limit of +4 dBm/MHz applies;

[986] The 2.6 GHz EC Decision, available at https://eur-lex.europa.eu/.

[987] Member States can relax this limit to 68 dBm/5 MHz for specific deployments, e.g. in areas of low population density provided that this does not significantly increase the risk of terminal station receiver blocking.

- for -1 to -0.2 MHz offset from lower block edge a limit of +3+15(ΔF+0.2) dBm/30 kHz applies[988];
- for +0.2 to +1 MHz offset from upper block edge a limit of +3-15(ΔF-0.2) dBm/30 kHz applies; and
- for -0.2 to 0 MHz offset from lower block edge or 0 to + 0.2 MHz offset from upper block edge a limit of +3dBm/30 kHz applies;

Restricted BEM for Base Stations

A 12.47 The BEM for a restricted spectrum block is built up by combining the value from Baseline power (above) and in-block power limit (below) in such a way that the higher value gives the limit for each frequency.

In-block Power Limits

Base Station Power Limits

A 12.48 The 2.6 GHz EC Decision sets out a base station in-block power limit for restricted blocks not exceeding 25 dBm/5 MHz.

BEM For Base Stations with restrictions on antenna placement

A 12.49 In cases where antennas are placed indoors or where the antenna height is below a certain height, the 2.6 GHz EC Decision allows for alternative parameters in line with the Transitional Power Requirements described below, provided that at geographical borders to other member states the Baseline Requirements described above applies and that the above in-block power limits for restricted blocks remains valid nationwide.

Transitional Power Requirements

A 12.50 Base station out-of-block EIRP BEM for restricted block with additional restrictions on antenna placement:

- for start of band (2 500 MHz) to -5 MHz offset from lower block edge, or +5 MHz offset from upper block edge to end of band (2 690 MHz), a limit of -22 dBm/MHz applies;
- for – 5 to -1 MHz offset from lower block edge or +1 to +5 MHz offset from upper block edge a limit of -18 dBm/MHz applies;

[988] Where: Δf is the frequency offset from the relevant block edge (in MHz)

- for -1 to -0.2 MHz offset from lower block edge a limit of -19+15(ΔF+0.2) dBm/30 kHz applies[989];
- for +0.2 to +1 MHz offset from upper block edge a limit of -19-15(ΔF-0.2) dBm/30 kHz applies; and
- for -0.2 to 0 MHz offset from lower block edge or 0 to + 0.2 MHz offset from upper block edge a limit of -19 dBm/30 kHz applies;

Terminal station BEM in-block power limit

A 12.51 The maximum mean in-block power is defined as 31 dBm/5 MHz TRP, and 35 dBm/5 MHz EIRP, for terminal stations[990].

TDD inter-network synchronisation

A 12.52 Time Division Duplex (TDD) allows base stations to transmit and receive on the same frequency; synchronised networks aligns all transmit and receive timeslots across the network removing the risk of network base stations ('BS') transmitting when its neighbouring BS is receiving leading to interference. TDD technology relies upon synchronisation across a network to minimise intra-network interference and maximise frequency re-use.

A 12.53 Where TDD networks are being operated in the same area on adjacent channels, guard bands are required to minimise the risk of BS to BS interference unless synchronisation is utilised. Where inter-operator synchronisation is utilised, the BS to BS adjacent channel interference path is removed allowing the networks to co-exist without the need for guard bands.

A 12.54 ECC Report 216[991] sets out practical guidance for TDD inter-network synchronisation. The report outlines the requirements for synchronisation to be achieved, including cross-technology[992] inter-network synchronisation. In the simplest terms, in order to achieve synchronisation operators must:

[989] Where: Δf is the frequency offset from the relevant block edge (in MHz)

[990] This limit includes Automatic Transmitter Power Control (ATPC) range.

[991] ECC Report 216, "Practical guidance for TDD networks synchronisation", available at www.ecodocdb.dk

[992] Report 216 focuses on TD-LTE/WiMax synchronisation as these are the most likely TDD MFCN technologies to be deployed

- have a common reference phase clock to ensure the alignment of the start of frame; and
- have compatible frame structures (see frame structures section below)

A 12.55 Noting the advantages of synchronisation, particularly in relation to spectrum efficiency, the BEMs for the 2.3 GHz band and the 2.6 GHz duplex gap are set out in the 2.3 GHz ECC Decision and 2.6 GHz EC Decision respectively. These BEMs are more permissive for synchronised TDD networks and more restrictive for unsynchronised networks as follows:

- The baseline power limit is higher for synchronised TDD network; and
- the transitional region (and associated power limits) applies to adjacent TDD blocks assigned to other operators (i.e. outside an operators assigned block) if networks are synchronised.

A 12.56 Given the benefits of synchronisation, ComReg is of the preliminary view that it should put structures in place to encourage inter-network synchronisation while at the same time maintaining the principle of service and technology neutrality. This can be achieved by:

- Not setting guard bands between assignments: This would require unsynchronised networks to internalise guard bands to meet the relevant technical conditions;
- Setting a permissive BEM for synchronised networks and restrictive BEM for unsynchronised networks where the restrictive BEM would assume the internalising of guard bands; and
- Setting a default frame structure.

A 12.57 ComReg is aware that inter-network synchronisation can only be achieved through coordination between operators and so would encourage operators to utilise ECC Report 216 as guidance in coming to any synchronisation arrangements.

Default Frame Structure

A 12.58 Compatible frame structures between operators are required to achieve synchronisation. Frame structures define the timeslots for uplink and downlink. To achieve synchronisation these uplink and downlink slots need to be aligned. Technologies such as TD-LTE and WiMax have technology specific suites of predefined frame structures that provide a range of downlink to uplink ratios. The choosing of an appropriate frame structure for an operator would depend on the traffic profile (i.e. downlink to uplink traffic) it intends to carry over the network.

A 12.59 Setting a default frame structure would allow for regulatory certainty for the first operator to roll out in an area (i.e. where there is no other network to synchronise with) as to the BEM which would apply to it. This would promote speed to market and negate the need for potentially lengthy inter-operator negotiations on the appropriate frame structure.

A 12.60 There are currently seven TD-LTE frame structures defined by 3GPP. The table below sets out the configuration of each option and the associated UL:DL ratio.

Table 41: TD-LTE frame structure options

UL-DL Configuration	Subframe number										DL:UL Ratio
	0	1	2	3	4	5	6	7	8	9	
0	D	S	U	U	U	D	S	U	U	U	1:3
1	D	S	U	U	D	D	S	U	U	D	1:1
2	D	S	U	D	D	D	S	U	D	D	3:1
3	D	S	U	U	U	D	D	D	D	D	2:1
4	D	S	U	U	D	D	D	D	D	D	7:2
5	D	S	U	D	D	D	D	D	D	D	8:1
6	D	S	U	U	U	D	S	U	U	D	3:5

**where U is for uplink transmission, D is for downlink transmission and S is a "special" subframe used for a guard time*

A 12.61 ECC Report 216 considers the compatibility between LTE-TDD subframe options and existing WiMAX frame configurations and indicates that the greatest probability of compatibility is with the use of TD-LTE configuration 2 (i.e. a ratio of 3:1).

A 12.62 In Document 15/70[993] ComReg applied similar technical conditions for the 3.6 GHz Award including a TDD inter-network synchronisation procedure.

A 12.63 In the UK, Ofcom published its decision on the planned release of the 2.3 GHz and 3.4 GHz bands[994], in which it states that it will set configuration 2 as the default frame structure for synchronisation. Those operators utilising configuration 2 would be required to operate under a permissive BEM and those choosing alternative frame structures would be required to operate under a restrictive BEM.

[993] ComReg Document 15/70, available at www.comreg.ie

[994] Ofcom - Public Sector Spectrum Release: Award of the 2.3 and 3.4 GHz spectrum bands

ComReg is of the preliminary view that the setting of a default frame structure would encourage synchronisation between networks and quicker rollout of services. Additionally the market seems to be converging on the use of configuration 2 for synchronisation. Therefore, ComReg proposes TD-LTE configuration 2 (i.e. 3:1 downlink to uplink ratio) or equivalent frame structure as the default frame structure for TDD networks. This approach was also proposed in Document 15/70 for the 3.6 GHz Award.

Permissive and Restrictive BEMs

A 12.64 In respect of BEMs, ComReg proposes that:

- Operators utilising frame structure configuration 2 on their network (and having a common reference phase clock with adjacent channel operators[995]) would be subject to a permissive BEM with the parameters set out in the table below.

Table 42: Permissive BEM for 2.3 GHz Band

BEM Element	Frequency Range	Power Limit
In-block	Block assigned to the operator	68 dBm/5 MHz
Transitional Region	-5 to 0 MHz offset from lower block edge 0 to 5 MHz offset from upper block edge	Min(PMax - 40,21) dBm/5 MHz EIRP per antenna
Transitional Region	-10 to -5 MHz offset from lower block edge 5 to 10 MHz offset from upper block edge	Min(PMax - 43,15) dBm/5 MHz EIRP per antenna
Baseline	2 300-2 390 MHz (except for in-block and transitional regions)	Min(PMax - 43,13) dBm/5 MHz

[995] Operators need to ensure the start of frame is aligned with adjacent channel operators above and below its assignment

Table 43: Permissive BEM for 2.6 GHz Band

BEM Element	Frequency Range	Power Limit
In-block	block assigned to the operator 2575-2615 MHz	61 dBm/5 MHz
	Block assigned to the operator (2570-2575 MHz and 2615-2620 MHz)	25 dBm/5 MHz
Transitional Region	-5 to 0 MHz offset from lower block edge 0 to 5 MHz offset from upper block edge	Baseline requirement level is applied
Transitional Region	-1 to -5 MHz offset from lower block edge 1 to 5 MHz offset from upper block edge	+4 dBm/MHz
Transitional Region	-1 to -0.2 MHz offset from lower block edge	3+15(ΔF+0.2) dBm/30 kHz
Transitional Region	0.2 to 1 MHz offset from upper block edge	+3-15(ΔF-0.2) dBm/30 kHz
Transitional Region	-0.2 to 0 MHz offset from lower block edge 0 to 0.2 MHz offset from upper block edge	+3dBm/30 kHz
Baseline	2 615-2 620 MHz (except for in-block and transitional regions)	+4 dBm/ MHz

- Operators utilising alternative frame structures (or failing to synchronise with adjacent channel networks for any other reason) would be subject to the restrictive BEM with the parameters set in the table below. It is important to note that in order to meet the restrictive mask operators would likely have to adopt guard bands within its assignment.

Table 44: Restrictive BEM 2.3 GHz Band

BEM Element	Frequency Range	Power Limit
In-block	Block assigned to the operator in the range 2 300-2 390 MHz; and	68 dBm/5 MHz e.i.r.p. per antenna
	Block assigned to the operator in the range 2 390-2 400 MHz	shall not exceed 45 dBm/5 MHz to ensure coexistence with systems above 2 400 MHz
Baseline	2 300-2 400 MHz (except for in-block frequencies)	-36 dBm/5 MHz EIRP per cell[996]

Table 45: Restrictive BEM 2.6 GHz Band

BEM Element	Frequency Range	Power Limit
In-block	Block assigned to the operator (2 570-2 575 MHz and 2 615-2 620 MHz)	25 dBm/5 MHz
	Block assigned to the operator 2 575-2 615 MHz	61 dBm/5 MHz
Baseline	2 570-2 575 MHz (except in UL mode operation in that block) and any 5 MHz block between unsynchronized TDD networks (2 575-2 620 MHz)	-45 dBm/MHz EIRP (integrated over 1 MHz bandwidth) (-38 dBm/5MHz)

A 12.65 ComReg proposes to exempt small cells (with an EIRP not exceeding 24 dBm) for in indoor domestic and other indoor locations from synchronisation restrictions. This approach was also proposed in ComReg Document 15/70[997] for 3.6 GHz Award.

[996] This value is based on a scenario including all base station classes (Macro, Micro, Pico and Femto). A more restrictive scenario may allow a more relaxed value for some BS classes

[997] ComReg Document 15/70, available at www.comreg.ie