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
Non-Confidential Submissions to Document 18/60, Document 14/65 and other relevant material

Reference: ComReg 19/59f

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An Coimisiún um Rialáil Cumarsáide
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1 Non-Confidential Submissions to Consultation 18/60

1.1 Dense Air

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Commission for Communications Regulations
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Ireland

30 July 2018

Dear Sir,

Submission to ComReg 18/60
Proposed Multi Band Spectrum Award Preliminary consultation on which spectrumbands to award

On behalf of Dense Air Ireland Limited, we thank you for the opportunity to comment on which spectrum bands to award as part of the preliminary consultation.

Dense Air Ireland Limited

Dense Air Ireland Limited (DAI) has been established by Airspan Networks to acquire spectrum assets globally as a "wholesale neutral-host" operator for small cell networks to support 5G evolution.

True 5G service concepts depend on massive "densification" of evolving mobile networks.

Airspan Spectrum Holding Limited is already spectrum license holder since August 2017 in Ireland and has established Dense Air Ireland Limited to build and operate a wholesale neutral-host shared network using small cell architecture to provide network densification as a service to mobile network operators (MNOs) in Ireland.

Our Dense Air business model is also being prepared for operation in Portugal and Belgium with plans to expand further internationally. The small cell products used by Dense Air are today being mass deployed by Sprint in the USA and Reliance Jio in India and are providing dramatic efficiency improvements.

Small Cells

Mobile telecommunications systems operate using the best modulation scheme that can be negotiated between tower and handset. This depends on signal quality which in turn is a function of range from the tower and accompanying propagation loss and multi-path degradation.

Close to the tower, sophisticated 256/64 QAM modulation are possible providing very high data rates. As distance increases from the tower and the signal is degraded, the system defaults to lower-order modulation schemes like QPSK at the cell edge. This reduces bit throughput for large parts of cell coverage.

All macro LTE networks have typically poor *average* spectral efficiency over their coverage area. This is exacerbated at higher frequencies.

Small cells operate over a limited area coverage at lower powers and enable high spectrum re-use. This allows local access using high-order modulation schemes that emulate being close to the tower. This raises the bit/Hz efficiency of the entire cell.

Small cells dramatically improve the spectral efficiency of mobile network macro cells using comparatively little extra bandwidth compared to the efficiency gain.

Small cells are critical to realising the data potential of 5G services because they allow the productivity of spectrum (in terms of bits/Hz) to be raised for large parts of the coverage area.

The evolution towards 5G service concepts is not possible without "massive densification" of mobile networks and small cell architecture provides the planned mechanism to provide this densification.

Wholesale Neutral-Host Networks

Small cell operation requires dedicated licensed spectrum, typically 20 MHz bandwidth, in closely similar bands to macro-cell operations.

Since small cells operate at low power facilitating aggressive spectrum re-use, only one channel is typically required to be available in an area for all networks in the mobile ecosystem to benefit.

It is this realisation that is the basis of the wholesale dedicated neutral-host model being deployed in other countries. It uses a single 20 MHz channel in an area to deploy small-cell operations for MNOs as a wholesale "carrier's carrier".

This is the model that Dense Air applies.

Specifc comments on Chapter 2: Information on spectrum bands potentially suitable for WBB

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.

Dense Air is not focused on "macro" bands like 700 MHz and 1.4 GHz. We believe that these spectrum assets are best utiulised by Ireland's existing Mobile Network Operators. However, bands like 2.3 GHz and 2.6 GHz TDD are better held in innovative operators like Dense Air, who using technologies like Neutral Host can bring to market, cost effective ways to extend and densify existing mobile and fixed wireless networks.

In addition to sub 6 GHz bands for mobile services, we believe ComReg should also review the rules and allocations in millimeter bands, both 26 GHz as already proposed, but also for bands like 57-71 GHz, which are needed for the mass deployment of 4G and 5G NR. In both cases we believe these bands should continue to be allocated on a licensed based, but the licensing scheme should be modified to the deployment context and location.

26 GHz is a key band for 5G NR and the proposed release should be aligned to other release in Europe and beyond, as noted by the consultation. However we see no benefit in including this spectrum in the same auction as the sub 6 GHz "Non-Line-of-Sight" bands. We believe that a separate spectrum award process should be proposed and that this award should also consider

modified rules for 57-71 GHz. Any investment by an operator would always consider the suitability of the use of both lower bands like 26 GHz and higher bands such as 57-71 GHz.

One of the key propositions of Dense Air in Ireland is Wireless Fibre Extension (WFE) which we describe as the "stretching out" of fixed and mobile broadband coverage beyond the reach of traditional mobile macro cells and FTTH using our small cell technology. We believe that bringing enhanced and extended services to areas where fixed technologies can not economically deliver has significant public policy benefits and should be incentivised by the regulatory regime where possible.

One of the enabling products in our portfolio for WFE is an economic and efficient mmWave radio that can operate in either point to point mode or mesh mode in rural areas using licenced spectrum above from 57-71 GHz.

The issue we have today is the disincentive the current licensing and spectrum pricing policy for links in this band. Dense Air would like to propose an amendment that would increase efficient use of the 57-71 GHz spectrum without lowering either the protection afforded to other licence holders or the administrative revenue generated from the band. This amendment would be universally applied, Dense Air is not requesting any kind of special treatment. This amendment should be proposed at the same time as the 26 GHz release.

The Use Case (for 57-71 GHz)
Dense Air, through its technology partner Airspan Networks, has available a very economic mmWave radio that can extend fibre networks and deliver fibre like services to end users through our retail partnerships. The links cost only a few hundred EUR, which is a step change in the industry for low cost, high capacity backhaul solutions. When meshed together, they can deliver significantly less expensive connectivity compared to running fibre overhead or in the ground.

The Current Problem
The pricing regime for spectrum at 60 GHz (and all spectrum above 39GHz) is EUR €150 pa per link which dominates the TCO of mmWave mesh solutions. This means that the operational expenses required to run multi-hop meshed links, virtually negates the potential reliability and customer price benefits it can deliver in a rural extension context. In urban areas where wireless links are used for short reach enterprise connectivity, the pricing reflects the economic value of the spectrum resource and service providers pass this on to their customers.

A Solution for higher frequencies (57-71 GHz).
Dense Air believes that a simple mechanism could allow the various service providers and use cases to match the economics of higher frequency spectrum cost with service delivery. It could also enable the public policy benefit of encouraging the use of the spectrum outside urban areas to provide high capacity data services not possible by other means. If the financial incentive is sufficiently attractive, many more links would be utilised and licence revenue would not likely decrease in aggregate. As the likely increase in link volume will be outside urban areas, interference is unlikely to be an issue and therefore link management rules would not need to be changed. Dense Air believes that chained/meshed multi-hop links should be priced as a single link at the published price. 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.

Please consider the above proposal. Such a change, allied with highly efficient radios, has the ability to incentivise building high capacity coverage further out from the traditional network edge than is

currently possible. Dense Air is willing to support this proposal with further discussions, use case diagrams, physical demonstrations and technical studies as required.

In conclusion, we believe that there should be two spectrum awards. The first should focus on Sub 6 GHz Bands and include 700 MHz, 1.4 GHz, 2.3 GHz and 2.6 GHz. The second and separate spectrum award should focus on 26 GHz and 57-71 GHz, and should propose a new spectrum licensing spectrum that is suitable for both urban and rural deployment economics.

Specific comments on Chapter 3: Band Specific Developments

Dense Air's main comments on the band specific developments relate to 2.3 GHz (TDD) and 2.6 GHz (TDD) allocations.

Firstly, 2.3 GHz has been released in the UK and is currently one of most deployed bands, with massive deployment in others countries including India, China and Indonesia. Airspan Networks has deployed over 200,000 small cells in India alone and is now mass deploying solutions in other Asian countries. The wide and extensive eco-system at 2.3 GHz enables low cost services in both Mobile and Fixed Wireless solutions. The release of the 90 MHz in this band (2300 MHz to 2390 MHz) will enables operators to economically add capacity and extended coverage to their network, especially using managed services like the offering Dense Air can provide.

The other band of interest to Dense Air is the 2.6 GHz Band, primiarily the TDD allocation, known as Band 38. TDD deployment at 2.6 GHz while not popular in Europe is happening at scale in other countries, especially in Japan and North Amercia. Airspan has deployment over 250,000 indoor small cells in the USA and over 20,000 outdoor small cells, on poles and/or cable strands. We believe the TDD eco-system can be used to enhance and extend service in Ireland on a very cost effective basis.

Because of the land border between the Republic of Ireland and the UK, we believe ComReg should adopt the same technical license conditions for 2.3 GHz and 2.6 GHz TDD that OFCOM use for this band. This will ensure easy coordination between Southern and Northern Ireland.

Specific comments on Chapter 4: Preliminary assessment of the Candidate Bands

Dense Air believe that a single spectrum award process for all Sub 6 GHz bands is the optimal arrangement, and that a second and separate award should be considered for mmWave bands, such as 26 GHz, with an associated update of the licensing conditions for 57-71 GHz.

We would urge ComReg to award all of the proposed sub 6 GHz bands at the same time, i.e. 700 MHz, 1.4 GHz, 2.3 GHz and 2.6 GHz as large spectrum award processes enable players like Dense Air to acquire spectrum alongside other MNOs and interested parties. When spectrum is auctions piece meal, in smaller allocations, prices increase, which utilimately eliminate new entrants and reduce competition and innovation.

We would like ComReg to note that Airspan Spectrum Holdings (ASH) entered the Ireland market primiarily because the 3.6 GHz spectrum award released 350 MHz simulateously, 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.

Public Policy Concerns

Radiofrequency spectrum is a valuable public resource. There is a compelling public interest in requiring spectrum to be used in the most productive and efficient way possible. It was thought for a long time that purely economic allocation systems would tend to allocate spectrum to the mostly highly value use. This works well when comparing "like-with-like".

However, the experience with mobile networks around the world shows that the "mostly highly value use" for individual carriers (as opposed to the mobile ecosystem) tends to be for homogenous macro- cellular networks.

On the other hand, the macro-cell architecture is not, in our view the most *technically* efficient deployment, especially for the evolution to 5G and the requirement to make the networks denser to maximise customer data bandwidth.

Improvements in productive efficiency are possible if traditional macro networks are overlaid with a small cell network. This raises the productivity at macro-cell edges and greatly improves bit throughput over the macro-coverage area.

The productivity improvement derives from a mix of macro-networks overlayed with massively dense infill to boost the productivity at cell edges. The productivity improvement more than offsets the additional spectrum allocated, especially if the spectrum is operated under a wholesale neutral host model.

While the technical efficiency gains are clear, the economic approach of traditional allocation methods do not allow the gains to be realised, because the architectures are not able to be compared "like- with-like".

This is the challenge in public policy.

In traditional spectrum allocations, the radiofrequency spectrum is treated as a "raw" resource to be allocated to its most highly valued use, irrespective of that use. Traditional allocation seeks technological neutrality. Perversely, it is this approach that reduces the incentives to apply small cell overlays. For an MNO the most highly valued use of the spectrum bandwidth is to deploy a macro-cell network, even if this does not provide the highest level of technical efficiency.

There is not enough spectrum available for every operator to apply a small-cell overlay and few would do it anyway.

It is not rational for every operator to maintain its own small-cell overlay.

Without separate provision for small cell architecture, we believe that the economics of major network carriers will block out the deployment of small cells, notwithstanding their technical benefit.

The small cell business case cannot compete with the business case of mobile network operators (MNOs). It is a *complementary* solution with entirely different economic structures to the MNO business and it is therefore not "like-for-like".

5G requires a more nuanced policy response. The two key proposed we have are;

1) **Dense Air (DAI) considers the best solution is to ensure that 2.3 GHz and 2.6 GHz TDD bands are released in a scenario that is designed to enable the massive deployment of lower power small cell architectures as a complement to the allocation of macro bands like 700 MHz and 1.4 GHz. This release compelments the allocations at 3.6 GHz for 5G NR.**

2) **One of the key mechanisms to enable spectrum to be obtained by complementary players like Dense Air (DAI) is to impose a spectrum cap on "Mid Band" sub 6 GHz spectrum like 2.3 GHz, 2.6 GHz and the existing allocations at 3.6 GHz. We believe that no single operator should obtain more than 150 MHz of this combined spectrum.**

Summary and Conclusions

Dense Air (DAI) strongly supports a spectrum award process that facilitates the release of additional spectrum for small-cell neutral host networks, not just for LTE deployment but also for migration to 5G-NR. A single sub 6 GHz spectrum award and separate award focused on 26 GHz and higher bands like 57-71 GHz is the best solution.

DAI's technical and market advisers are at your disposal at any time to assist with further understanding of the pathways to 5G and the place of small cells and how they work to raise spectral efficiency. Similarly, we can offer further detailed exposition of our experiences with allocation methods which inform the recommendations we have made.

Please let me know if I can provide any further advice or assistance at [redacted]

Yours sincerely,

Paul

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1.2 Eir

Eircom Group

Response to ComReg Consultation:

Proposed Multi Band Spectrum Award

Preliminary consultation on which spectrum bands to award

ComReg Document 18/60

30 July 2018

DOCUMENT CONTROL

Document name	Eircom Group response to ComReg Consultation Paper 18/60
Document Owner	Eircom Group
Status	Non Confidential

The comments submitted in response to this consultation document are those of Eircom Limited and Meteor Mobile Communications Limited (trading as 'eir' and 'open eir'), collectively referred to as 'eir Group' or 'eir'.

RESPONSE TO CONSULTATION

eir welcomes the opportunity to comment on ComReg's proposals on which bands to be included in the next multi-band spectrum award (MBSA2). ComReg previously consulted on potential bands and other aspects for a potential MBSA2 in 2014, ComReg 14/101. The material presented in the current consultation focuses solely on the preliminary consideration of candidate bands for a future award process. Whilst there are no consultation questions presented by ComReg it is "*envisage[d] that responses to this preliminary consultation will inform a draft regulatory impact assessment ("RIA") on which band(s) to award (and how best to assign rights of use in those band(s)) and facilitate the development of more informed and detailed award proposals, which will be set out in a subsequent consultation document*"[1] [emphasis added].

Given that ComReg has presented no material for consideration in this consultation other than potential candidate bands for a possible MBSA2, it is not clear to eir what ComReg considers to be the status of the other matters related to a potential MBSA2 presented by ComReg in the 2014 consultation. It is eir's firm view that all the matters considered in ComReg 14/101 in terms of potential award design parameters must be visited afresh. Four years have passed since that consultation and any proposed spectrum award must be considered on the basis of current circumstances and medium term perspectives, taking into account relevant national policy objectives and best practice approaches to addressing such objectives in a well-designed award process or processes.

We note for example the RSPG's view[2] that there is no one size fits all in terms of spectrum award designs and it is important to first establish the objectives for the award (see section 4 of the RSPG report). We note that BEREC has indicated it will publish two best practices reports on spectrum authorization/award procedures and coverage obligations with a view to considering their suitability for 5G during 2018 which will also be very relevant to the consideration and establishment of the objectives and design parameters for a potential MBSA2.

There are important issues to resolve, not least what the primary purpose or purposes of the award process or processes will be. In section 2 of the consultation there appear to be at least three primary purposes that ComReg is seeking to pursue with a potential MBSA2. These are

[1] Para. 1.6, ComReg 18/60
[2] RSPG Report on Efficient Awards and Efficient Use of Spectrum

the making available of additional spectrum for 4G, releasing new spectrum for 5G and separately, dealing with the liberalisation and/or expiry of the 3G licences. Additional spectrum for 4G could come from the 2600GHz band which has been lying fallow since 2016. The pursuit of 5G would benefit the release of new spectrum in bands such as 700MHz. The 3G licences are exclusively in the 2100MHz band.

We discuss the bands in detail below and we note there will be further detailed consultation on award designs later this year. We would however note that it may be time for Ireland to move away from CCA formats to another format reflective of the more mature market setting, relative to 2012 and recognising the need to channel scarce financial resources to achieve societally beneficial outcomes including investment in new technologies and services, and investment in improved coverage delivering quality of service and competitive benefits. A more nuanced approach to spectrum licensing is required. Every Euro paid in spectrum licence fees is a Euro less for network investment. We note for example the circumstances in France[3] whereby the regulator agreed to extend spectrum licences for the mobile operators in return for firm commitments to enhance 4G coverage. The French government announced an agreement with the mobile network operators to accelerate mobile coverage and enhance coverage quality. No State funding will be provided as part of the agreement. In return for the increased investment, the 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.

We request ComReg to confirm whether the objectives of the potential award process will be informed by the Government's Mobile Phone and Broadband Taskforce, for example in terms of encouraging more mobile coverage in rural areas, as this will be an important factor to take into account when considering the appropriate format for a proposed award.

[3] https://www.reuters.com/article/us-france-telecoms/french-telcos-to-spend-3-7-billion-to-plug-network-gaps-idUSKBN1F20XQ

3G Licence renewal (2100MHz)

eir considers it may be inappropriate for the 2100MHz band to be part of the same award process as the release of new spectrum particularly if the award process is based on an auction. The considerations for licence renewal are different. The licence expiry dates were set many years ago for administrative purposes and they bear no relationship to operator investment cycles. Operators have invested in and continue to invest in the development of their networks using the 2100MHz frequencies. Near term investment will be deterred if future use of this spectrum is to be determined by an auction and an existing operator's investments to date will be written off if the operator is driven out of the spectrum. As such a different approach is required for licence renewal.

We note that inclusion of the 2100MHz band in a potential MBSA2 may seem attractive to ComReg because this was the approach adopted in 2012 for the GSM licences. However the circumstances are different and any award process must be designed based on current and prospective market circumstances. It would be wrong for ComReg to make a decision based on the availability of an auction tool that has previously been used to with mechanisms for two timeslices and liberalisation options. ComReg must first establish the principles and objectives for an award process and then, if necessary, engage through a competitive tender, the support of an auction designer. The auction designer should not be involved in setting the principles and objectives otherwise regulatory decision making could be skewed by a bias towards a particular auction tool and its capabilities.

In addition, ComReg's rationale for a multi-band award appears to be based on consideration of substitutability and complementarity amongst the bands that would be included. In that regard, ComReg suggests that the 2100MHz band could be complementary to bands such as 700 MHz, 1.4 GHz, 2.3 GHz or 2.6 GHz.[4] However, this overlooks the practical matter that 2100MHz is already fully deployed using 3G technology. It is not because an operator acquires another band that the customers can be moved around. On the other hand, the other bands identified by ComReg are 4G/5G band and are not yet deployed. Operators will be able to participate in an award process for these bands with the intent of using them alone or in combination as appropriate.

[4] Para. 2.16, ComReg 18/60

The approach taken towards the 3G licences will have to appropriately address a number of considerations including the following:

- The inherent unfairness towards eir

This is the second time eir has been confronted with the prospect of effectively paying for licence renewal a number of years in advance of licence expiry. The first time was in 2012 in respect of eir's 2G licence. An auction was held in 2012 in advance of the expiry of eir's 2G licence some three and a half years later in July 2015. Notably the 2G licences for O2 and Vodafone had already expired and those operators where benefiting from interim licences giving them a number of years advantage over eir in terms of accruing returns on their licence and network investments.

The situation is more stark in respect of eir's 3G licence. If, for example, ComReg held an auction in 2019 to determine the renewal rights to the 3G spectrum this would be in the region of 8 years in advance of eir's license expiry date. In contrast this would be in the region of 2 years for Vodafone and Three. It would be reasonable to expect licence renewal to be addressed within a couple of years of the expiry date so in this regard Three and Vodafone are not being disadvantaged in terms of timing. eir on the other hand is 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. eir's 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 place it at a relatively weaker financial position relative to other bidders who have completed the phased payment of their 3G licence fee.

- The rebalancing of H3G's excessive spectrum holdings following its acquisition of O2

Following the acquisition of O2 by H3G and the European Commission's acceptance of a novel MVNO capacity voluntary commitment which included an option for spectrum divestment to an MVNO, there is a substantial spectrum imbalance between Three and the other MNOs. Three possesses 50% of the 2100MHz spectrum, 47% of the 1800MHz spectrum and 43% of the 900MHz band. If left unaddressed, this spectrum imbalance significantly distorts the competitive landscape. In the context of an auction this could be facilitated by maintaining spectrum caps that include existing spectrum holdings. In the case of administrative assignment, which is more appropriate for licence renewal, 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. Considering other potential policy objectives eir believes it is more important to ensure existing players are given the tools to effectively compete on more balanced terms.

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

Should eir 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. 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. As such liberalisation should not be addressed through an auction process. Indeed there may be broader benefits in approaching licence renewal from the perspective of administrative assignment ensuring that the limited funds for capex of operators can be better directed towards coverage and quality of service improvements, particularly in less economic rural areas. eir also notes that it paid the highest per MHz / pop price in the 2012 auction which suggests it was unreasonably penalised for early renewal / liberalisation in respect of GSM licence.

Developing the 5G ecosystem

At paragraph ComReg comments on spectrum requirements for 5g "*For example, for spectrum below 6 GHz, the RSPG's first (RSPG 16-032) and second (RSPG 18-005) opinions:*

- *identify the 3.6 GHz Band (which has already been awarded by ComReg) as the primary band for 5G; and*
- *identify that 5G will need to be deployed in bands already harmonised below 1GHz, including, in particular, the 700 MHz Band.*"

With regard to the 3.6GHz Band it is correct that ComReg completed an award process however eir is still waiting, one year from licence issue, for access to the spectrum to be commenced. It is a significant failing on the part of ComReg that access to the spectrum has not been forthcoming. This situation cannot persist and ComReg must ensure all transition activity is completed without any further delay.

eir notes that spectrum such as 700MHz will be of interest given its role as a pioneer band for 5G. In particular as a coverage layer it will be complementary to deployment in other bands, notably 3.6 GHz. We note ComReg's statement that the 700MHz spectrum will be available for use from 4th March 2020 but in light of the current situation in respect of the 3.6GHz band ComReg must clearly set out what actions it is taking to ensure that the milestone for 700MHz availability will not be missed. Ensuring availability of appropriate bands and capacity to support 5G is of particular importance to the Irish industry. Operators require certainty regarding the terms of access to spectrum including, not unreasonably, a confirmed date from when they will have access to such spectrum.

We note ComReg's view that additional spectrum for 5G capacity above 6GHz may not be required in the near term. Whilst we do not disagree with this view it is important that available complementary spectrum is included in this award. As such we agree that the 700MHz Duplex band be made available. However eir also believes that steps should be taken now, as part of the ongoing process, to make the 700MHz Duplex Gap and the 1.4GHz Centre Band available for Supplementary Down-Link. It makes perfect sense to address these bands now in a holistic manner with the 700MHz. ComReg offers no tangible reason to justify its proposal to park SDL spectrum despite its availability with references to them being addressed down the road in the spectrum strategy statement consultation.

eir agrees that the 2.6GHz band can be considered for release also, particularly as it has been available for use since April 2016. Indeed it is ironic that ComReg preferred to sequence award of the 3.6GHz band in advance of the 2.6GHz band despite the fact that the latter would actually be available to winning bidders and as ComReg acknowledges in the consultation, there is a mature and well developed equipment ecosystem for the 2.6GHz band. It is not clear why ComReg chose to delay release of the 2.6GHz band.

With regard to the 2.3GHz Band eir does not agree with ComReg's preliminary conclusion that it should be made available for release in the near future. Operators in small markets like Ireland benefit significantly from the synergies arising from international harmonisation and therefore consideration of this band should be put on hold until an implementing Decision on technical harmonisation has been adopted.

1.3 Ericsson

Ericsson Consultation Response to Comreg Proposed Multi Band Spectrum Award

Reference submission to Comreg: 18/60

Ericsson welcomes the COMREG proposal for a Multi Band Spectrum Award.

The proposed Multi Band Award will help realise the full potential of 5G network deployments and meet the growing demands on network performance enabling 5G use cases that will benefit service providers, industries and consumers. National licensing of the right spectrum, in sufficient amounts, to mobile broadband providers is fundamental to creating momentum for 5G service deployments.

It is essential that future spectrum awards ensure:
– Harmonised spectrum arrangements are applied across the EU and internationally.
– Harmonised frequency ranges, technical conditions and tuning ranges are agreed.
– Security of interoperability/roaming across boarders
– Appropriate conditions for spectrum use are applied
– Bandwidth availability to meet 5G and network performance demands
– Spectrum availability for high-throughput backhaul systems is assigned
– View Spectrum as part of the countries critical national infrastructure
– Incentivise network deployments

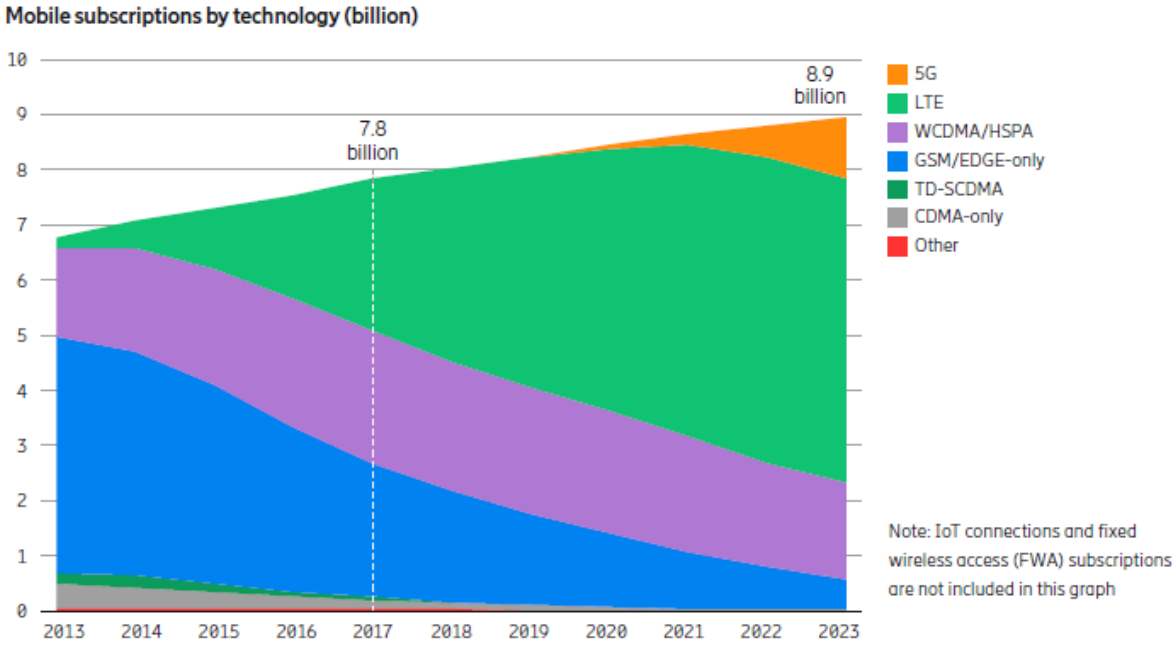
Background

4G:

Operators are evolving their existing LTE networks to LTE-Advanced (LTE-A), combining lower and higher frequency bands (both for FDD and TDD modes). This will lead to a wider coverage area, increased network capacity and faster data speeds. With Gigabit LTE, fiber-like mobile broadband speeds are achieved. This means people can enjoy their apps, music streaming and video content, for example, with less performance degradation, even during peak times or in crowded places. Gigabit LTE is enabled by LTE-A features, including 4x4 Multiple Input Multiple Output (MIMO) antenna technology, three-channel carrier aggregation and higher order modulation schemes.

The demands of numerous existing and new use cases can be fulfilled on evolved 4G (LTE) networks. As networks evolve, there will be even more opportunities to enhance the existing use cases, as well as to meet the demands of more new use cases when 5G is implemented.

Mobile operators need to start evolving their networks to support new 5G technology concepts, while also investing in their LTE networks. LTE is expected to reach 4.3 billion subscriptions by 2021 globally and it will play a strong role in tomorrow's 5G networks.
Non-Standalone 5G NR will utilize the existing LTE radio and Evolved Packet Core networks as an anchor for mobility management and coverage, while adding a new 5G radio access carrier to enable certain 5G use cases.



Ericsson Mobility report June 2018

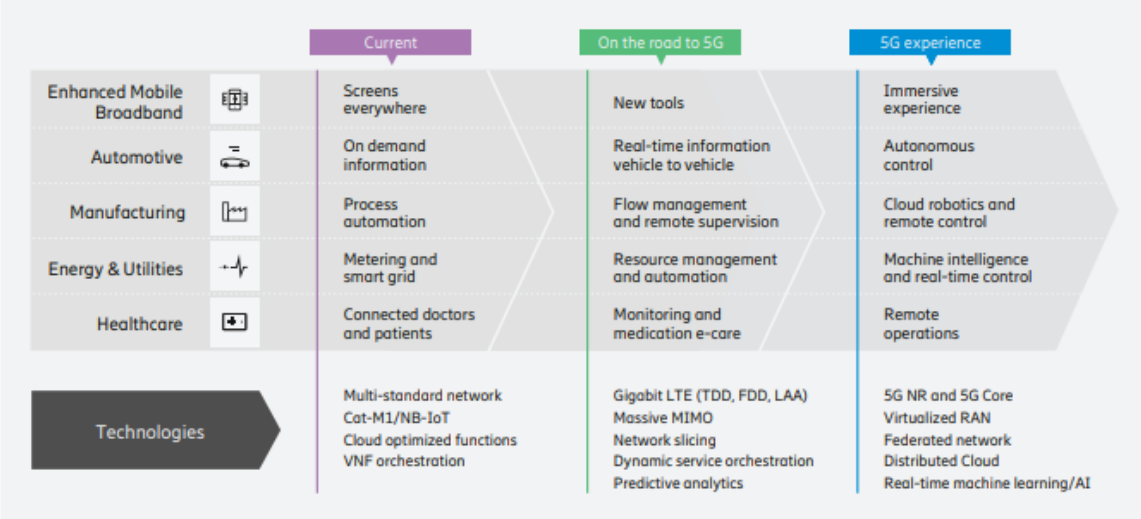
5G:

With global mobile data traffic expected to grow eight times by the end of 2023, there is a need for a more efficient technology, higher data rates and spectrum utilization. New applications such as 4K/8K video streaming, virtual and augmented reality and emerging industrial use cases will require higher bandwidth, greater capacity, security, and lower latency. Equipped with these capabilities, 5G will bring new opportunities for people, society, and businesses.

First commercial 5G networks and devices based on the 3GPP standards are expected in 2018. The first very few 5G devices will likely be introduced towards the end of 2018. Ericsson estimates the number of subscriptions reaching one billion by the end of 2023.

5G will enable enhanced mobile broadband (eMBB) services and create huge potential for new value-added wireless services through a wide range of new use cases. These new use cases include fiber-equivalent Fixed Wireless Access (FWA) services, massive Internet of Things (IoT) services, and critical IoT – enabling new applications in the automotive, manufacturing, energy & utilities and healthcare sectors, among others. To ensure the smooth introduction of 5G, operators need to look ahead and identify the deployment approach, best supports their own business strategies, makes best use of existing investments including existing and future access to spectrum. The time to start developing and market-testing new business models is now, as operators prepare their current networks for 5G deployment.
Ericsson has identified five important areas of use case development, enabled through the evolution of current 4G networks to full 5G-enabled experience, as shown in Figure 1.

Figure 1: Use case evolution and supporting technologies.



Device availability:

Figure 2 shows the approximate timing of 5G device availability. Early FWA devices have been developed to meet market needs in the USA and Australia for example. The first 3GPP-compliant 5G smartphones and tablets are likely to be launched in 2019. To date, the IoT business has primarily been driven by the affordability of devices. Costs of 3GPP-compliant devices have come down significantly recently, and as they approach 5–10 euros, we are starting to see the cellular-delivered IoT market becoming better established. The market for industrial IoT, or critical M2M, services is at an earlier stage, but will likely be a significant market in the longer term. We foresee 3GPP systems becoming the IoT technologies of choice for operators and industry in the longer term

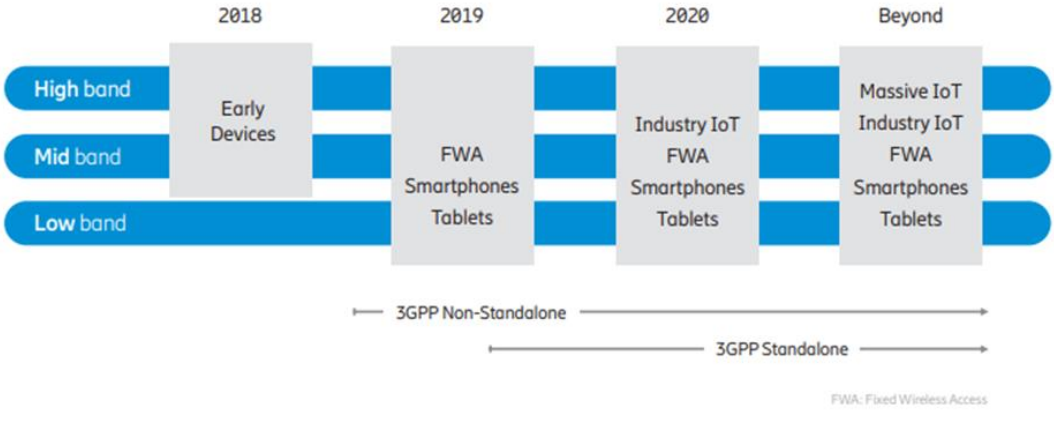


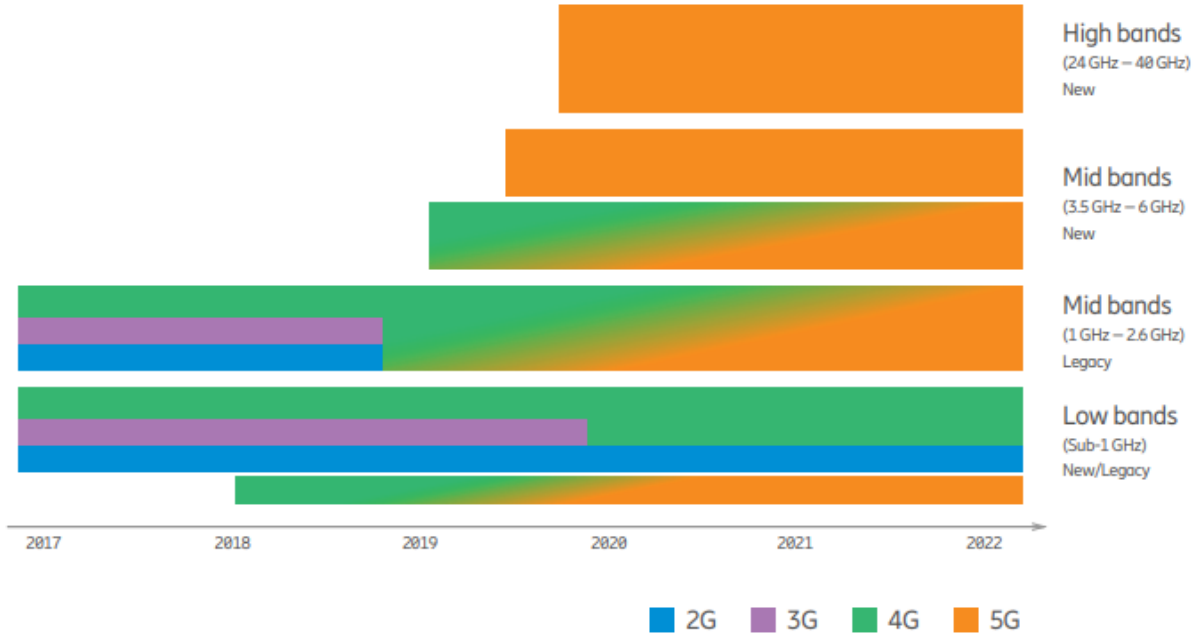
Figure 2: 5G device availability.

Spectrum:

Decisions on where, when and how operators deploy 5G are not only driven by commercial considerations but also on the availability of spectrum, network equipment and devices. It is worth noting that many new use cases can use 4G today and move to LTE Advanced and NR in the future. It makes sense to start developing new use cases as soon as possible, using the best technology available. We expect to see 5G start being deployed by leading operators during 2019.

Operators will need to develop their spectrum strategies based on their own particular business focus, and the frequencies available to them, today and in the future. Utilizing legacy spectrum in combination with new bands enables operators to serve a wider variety of use cases more efficiently and, in many cases, more quickly; the whole can be greater than the sum of the parts. Figure 3 gives a general indication of spectrum availability across all RAN generations over time. The spectrum available to 5G will vary from market to market, according to whether it is already in use and the timing of auctions and licensing processes.

Figure 3: Spectrum allocation over time.



About Ericsson:

Ericsson is one of the leading providers of Information and Communication Technology (ICT) to service providers, with about 40% of the world's mobile traffic carried through our networks. We enable the full value of connectivity by creating game-changing technology and services that are easy to use, adopt and scale, making our customers successful in a fully connected world. For more than 140 years, our ideas, technology and people have changed the world: real turning points that have transformed lives, industries and society as a whole.

About Ericsson Ireland:

Ericsson Ireland operates in two locations, Dublin and Athlone, and has responsibility for three distinct business segments:

- Sales and Support for our Local Customers
- Research and Development (R&D)
- Professional Services delivered globally.

Our local customer base is the focus of our business. Since 1957 we have been a supplier and partner to the Posts and Telegraphs (P&T), subsequently eir, with whom we continue to work today. Over the years, our list of customers has grown substantially and now includes Vodafone, Three, Telefonica/giffgaff, Virgin Media, ESB, Irish Rail and many more. We continue to work in a progressive way with our customers; where once we sold telephony switches, we now deliver software to leverage digital services that will eventually lead us to 5G and beyond.

Our R&D center based in Athlone was established in 1979 and continues today to be one of the leading R&D sites for Ericsson globally. It is recognized across Ericsson for its world-class development systems that are optimized for high speed deliveries and superior quality products. It houses a full spectrum of network and IT competences needed to systemize, build and support next generation network management systems for Ericsson.

Ericsson Ireland also hosts the global hub for the delivery of high value professional services including Network Transformation, Network Design & Optimization, System Integration, Managed Services, Business Consulting, Operational Consulting, Technology Consulting and Learning Services.

Through collaboration and support of local schools and universities, educational and technology organisations and support of several charities, Ericsson Ireland has a strong connection with the local community.

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1.4 ESBN

Energy for generations

Telecom Services, ESB Networks

ESB Networks' response to ComReg's Consultation on Proposed Multi Band Spectrum Award (18/60)

30/07/2018

Contents

1. INTRODUCTION

ESB Networks (ESBN) welcomes the opportunity to respond to the Commission for Communications Regulation (ComReg) consultation in relation to its proposed Multi Band Spectrum Award.

Radio spectrum is a hugely important natural resource, enabling both critical and non-critical services to be deployed and made available to the benefit of all citizens and Ireland Inc. It is a key enabler for the provision of wireless services which in turn generates significant economic, technological, social, environmental and safety benefits. In that regard, it is vital that appropriate radio spectrum is made available in a timely manner which brings the maximum benefit for the people of Ireland. ESBN approves of ComReg's proposals to release the proposed spectrum bands.

1.1 Introduction to ESBN

ESB Networks Ltd. (ESB Networks), a regulated subsidiary within ESB Group, is the licensed operator of the electricity distribution system in the Republic of Ireland. ESB Networks is responsible for building, operating, maintaining and developing the electricity network and serving all electricity customers in the Republic of Ireland.

The electricity distribution network includes all distribution stations, overhead electricity lines, poles and underground cables used to bring power to more than 2 million domestic, commercial and industrial customers connected to the electricity network nationwide. ESB Networks also maintains the high voltage transmission network in Ireland on behalf of the Transmission System Operator (TSO) EirGrid.

Secure telecommunications is vital to the safe and efficient operation of the grid. The electricity network depends heavily on having high quality and high availability communications infrastructure (meeting specifications for back up; redundancy; resilience; low delay and jitter). ESBN deploys and operates extensive fixed and wireless telecommunications infrastructure to provide ESB and EirGrid with necessary real time information for operational purposes (i.e. to monitor and control the distribution and transmission networks). Such critical communication cannot always be provided by public communications networks, as these networks do not satisfy the operational network requirements.

ESBN telecommunications network requires connectivity in a significant number of locations throughout the country, often in remote areas where propagation of high frequency signals is limited (e.g. within High Voltage substations). A significant proportion of ESBN's telecommunications network relies solely on wireless for several reasons, e.g. cost, efficiency, resilience, reliability, flexibility etc.. In addition, wireless offers a solution where it is technically difficult to use cables to connect devices to the network. Radio spectrum is a fundamental component of ESBN's existing safe and resilient operational telecommunications network.

2. COMMENTARY

ESBN has responded with comments on the spectrum bands included in the consultation below. ESBN in principle approve the release of spectrum in a timely manner to industry. This principled approval is caveated such that other spectrum users are not adversely

ESBN's comments are outlined below:

700 MHz

ESBN agrees with ComReg's assessment that the 700 MHz Duplex should be included in the Proposed Award.

ESBN agrees that the Duplex Gap and Guard Bands should not be included in the Proposed Award.

As ComReg discuss, the Duplex Gap and Guard Band has the potential to be utilised for PPDR. ESBN previously outlined its support for PPDR in its response to ComReg's Consultation 14/101.

ComReg has released a large quantum of spectrum to industry over the recent years, with effectively all of this licensed to large commercial operators. It is refreshing to see the potential for some spectrum being designated for specific purposes. This would of course require national policy direction from the DCCAE and/or Minister. ESBN encourages DCAAE and/or the Minister to make policy decisions setting aside this spectrum for PPDR usage. Failing to do so would inevitably result in yet more spectrum being assigned to large commercial operators to the detriment of the PPDR industry and society as a whole. Access to this spectrum for PPDR could facilitate the deployment of cost effective voice and data services for emergency purposes.

1.4 GHz

ESBN agrees with ComReg that neither the 1.4 GHz spectrum band nor extension bands should be included in the Proposed Award. ESBN agrees with ComReg that the 1.4 GHz Centre Band has the potential to provide additional capacity for mobile networks, with ESBN contesting that this will not be a reality in the near future. ESBN therefore encourages ComReg to consider the release of 1.4 GHz Centre Band in the medium term, and for the 1.4 GHz Extension Bands not to be changed from current usage in the long term.

ESBN notes that although there are 41 devices that can operate in Band 32 according to the GSA, this in itself is too small a number for the ecosystem. The real benefit of a spectrum band for commercial networks is derived when CPE developers incorporate spectrum bands into its multiband end user devices. ESBN cannot access the section of GSA website as denoted with footnote 72 in ComReg's consultation as this section is privileged to certain users. Without access to this website, ESBN can only comment from its existing knowledge that it is not aware of any major equipment manufacturer who plans to include 1.4 GHz Centre Band in CPE devices in the near future (although notes that Huawei and Qualcomm expressed view that 1.4 GHz should be included in the spectrum release). ESBN believes there may be issues regarding manufacturing suitable antennas for CPE to include 1.4 GHz as well as other spectrum bands used by MNOs.

ESBN notes that 1.4 GHz spectrum has been licensed in the UK, Germany and Italy for up to a decade. ESBN also notes that an ECC Decision on the 1.4 GHz centre band was made in 2013 (subsequently amended). With all of this movement on the 1.4 GHz centre band, ESBN is not aware of any meaningful existing deployment or planned deployments in the

ComReg's 14/101 noted it was premature to be considering release of 1.4 GHz spectrum band.

Given all this, ESBN considers that ComReg are correct not to include these bands in the Proposed Award.

ESBN believes that ComReg should only consider the release of the 1.4 GHz Centre Band in the future, and should leave the extension bands for usage for fixed point to point links. The Centre Band allows for 55 MHz of TDD spectrum be released, which has great potential to deliver supplementary downlink capabilities for mobile networks. There are only 3 MNO's in Ireland who can effectively make use of this spectrum in the future, where 55 MHz of spectrum should be sufficient to meet such demand. Indeed, ComReg proposes to release 2.3 GHz and 2.6 GHz TDD spectrum in this Proposed Award and this should provide more than enough to industry.

ESBN encourages ComReg to preserve the vital fixed link services in the 1.4 GHz Extension Bands in the long term. **CONFIDENTIAL**. Losing access to this spectrum band for its existing links would cause ESBN significant concern as there is no proposal from ComReg to accommodate users of this band in another suitable spectrum band.

ComReg should make clear its long term plans for the 1.4 GHz Extension Bands in its upcoming Spectrum Strategy. Should ComReg decide that the 1.4 GHz Extension Bands will be released in the future, ESBN encourages ComReg to give as much visibility as possible to users as well as providing suitable low frequency alternative(s) which users can utilise. ESBN also believes that in the instance where users of 1.4 GHz fixed links cannot reuse their equipment in alternative bands being made available, a reimbursement fund should be made available to recompense those fixed link users that are displaced as a result.

1.4 GHz Centre Band and 26 GHz spectrum demand is a function of the outcome of the Proposed Award. Licensees of spectrum arising from the Proposed Award are only then in a position to understand their demand for 1.4 GHz Centre band and 26 GHz spectrum. Therefore ComReg are correct not to include these bands in the Proposed Award.

2.1 GHz

ESBN agrees with ComReg that the paired 2.1 GHz Band should be included in the Proposed award.

2.3 GHz

ESBN agrees with ComReg that the 2.3 GHz Band should be included in the Proposed award.

2.6 GHz

ESBN agrees with ComReg that the 2.6 GHz Band should be included in the Proposed award.

ESBN agrees with ComReg that the 26 GHz Band should not be included in the Proposed award.

3. SUMMARY

Radio spectrum is a vital natural resource which must be managed efficiently to facilitate economic, social, technological and environmental advances within Ireland. ESB Networks welcomes the opportunity to respond to this consultation

ESBN commends ComReg on its ambition to release available spectrum in a timely manner.

ENDS

1.5 Imagine

Imagine

Imagine's response to the Proposed Multi Band Spectrum Award – Preliminary consultation on which spectrum bands to award consultation

(ComReg 18/60)

Non- Confidential:

Contents

1 Introduction

Imagine welcomes the opportunity to respond to the recent consultation ComReg 18/60 “Proposed Multi Band Spectrum Award, Preliminary consultation on which spectrum bands to award”.

2 Imagine Response

Imagine believes that there is unprecedented demand for both MBB and FWA capacity in Ireland. This increase in demand is apparent both in urban areas and in regional rural/Ireland as was demonstrated in the high level of competition for spectrum in the recent 3.5GHz auction. The Irish requirement for spectrum reflects demand globally and is well documented in all demand forecasts published (e.g. Cisco, Ericsson) in recent years. In fact, the demand curve is only getting more acute.

Imagine believes that the evolution of LTE-A to 5G is the single biggest technical step change in any access technology since the introduction of GSM, and the deployment of this technology is key to meeting increased demand. This is particularly the case in Rural Ireland, where significant access network challenges remain, which are disproportionately impacting citizens in those areas that depend most heavily on regulated spectrum as their primary means of accessing and using the Internet both in their home and in support of their businesses.

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.

It also allows for a truly connected society with IOT and for the development and deployment of all key 5G use cases such as inter alia autonomous cars, smart factories and cities.

Figure 1 [redacted] *band C-Band (3.5GHz) 5G Roadmap available 2018*

In addition to the RAN and Core vendors, Imagine notes that device chipset manufacturers are already deploying early-stage 5G prototypes with initial commercial offerings expected to be available as early as Q4 2018. Imagine fully expects stable commercial offerings as early as Q2 2019. It should be noted that RAN and Core vendors already have offerings in 5G - particularly in the pioneer 5G bands of 3.5GHz (Huawei) and 26Ghz (Samsung).

Figure 2 [redacted] *(Chip manufacturer Roadmap)*

With 5G trials being announced almost daily it is clear that the first reports of commercial services already being deployed demonstrates that the road-map for the evolution of LTE-A to 5G is accelerating faster than all previous estimates and is unprecedented in the industry.

Imagine note that it is ComReg's preliminary view to include some but not all the spectrum bands under discussion in this consultation.

In particular Imagine note that it is ComReg's preliminary view for various reasons that the following bands be included in the Multi Band Auction (MBA):

- 700Mhz Duplex
- Paired 2.1GHz
- 2.3GHz
- 2.6GHz

It is Imagine's view for the reasons discussed in the consultation document that these should be included in the MBA.

Imagine also notes that it is ComReg's preliminary view, for various reasons that are detailed in the consultation, that the following bands not be included in the MBA:

- 26GHz
- 1.4GHz
- unpaired 2.1GHz

It is Imagines view that we concur with ComReg's preliminary view and for the reasons outlined in the consultation that all of these bands should not be included in the MBA.

2.1 Auction Process

Given the recent experience of the CCA auction process of 3.5GHz Imagine believes that CCA is a suitable mechanism for the auction and allocation of this spectrum. However, Imagine believes that the process as constructed and operated for 3.5GHz spectrum does significantly disadvantage smaller operators. In particular, the approach whereby a portion of the licence fee is paid up-front and a larger portion is paid annually over the licence period is welcome. However, as this was implemented in the 3.5GHz auction, as the auction price increased 100% of all such increases were added to the up-front cost instead of being distributed across the licence period by increasing the annual licence fees. This creates a very significant issue for smaller operators who must therefore secure access to large cash resources up-front to allow them to compete in the auction process. The need to secure such up-front cash resources is disproportionately disadvantageous to smaller operators in such an auction format and we urge ComReg to level this part of the playing field in future auctions.

2.2 Band Categories

In the context of 5G, spectrum bands are widely discussed within the industry in three different categories, all of which are required to provide a complete solution for 5G. These include:

Low-Band (<1GHz) is needed for coverage and deep in-building penetration . These are known as the coverage bands and are expected to be in high demand for the coverage layers of MBB, IOT and FWA. They will have to form part of any operator's spectrum portfolio.

Mid-Band (1GHz – 6 GHz) these bands form part of the spectrum that is optimal for general deployment of 5G. These bands support use-cases requiring wide area coverage and/or significant capacity. They are also the bands that are best suited for regional/rural FWA (as proven locally by Imagines FWA LTE-A network). 3.5GHz is designated as one of the pioneer bands for 5G and already has a burgeoning ecosystem and a clearly defined migration path from LTE-A to 5G. For FWA in regional/rural Ireland it is particularly important that the TDD allocations of mid-band spectrum are ring-fenced for FWA deployment as this is where the FWA ecosystem is targeted. In addition, TDD's asymmetric nature best maps on to the usage patterns of FWA customers. It is important to ensure that no digital divide develops in 5G deployments and that non-mobile operators have sufficient spectrum in this band to deliver on all 5G use cases and deployment scenarios. Failure 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.

High Band > 6GHz This is the real heavy-lifting band that is targeted at densification of 5G networks and, although coverage is relatively limited, it has large amounts of spectrum available to support large channel bandwidths. 26GHz is also designated as a pioneer band for 5G and already has a burgeoning ecosystem. It is expected that this band could be deployed in combination with low and mid bands as the capacity layer for small cell deployments in urban areas and in certain regional locations.

It is our clear and strongly held view that where possible all spectrum should be allocated contiguously to individual operators as fracturing of the spectrum block only leads to inefficient use and sub-optimal deployments.

2.3 Spectrum Cap

To ensure competition across MBB, FWA and IOT it is Imagine's view that there should be two levels of caps introduced. This will also ensure that spectrum is not hoarded by any operator and that the spectrum is used efficiently. In this context we should point out that there has been just one commercial service launched since the 2017 3.5GHz auction (Imagine). It is likely that currently unused 3.5GHz spectrum allocated in the recent auction is being held for deployment in 5G and so it is appropriate that this spectrum, where it is being retained for 5G use, is included in the overall caps that must apply to any multi-band auction being considered by ComReg. These proposed caps fall broadly under the following categories.

2.4 Overall Cap

There should be an overall cap on the amount of spectrum held by any one operator after this new multi-band spectrum is allocated. This cap should be enough to allow for a gigabit 5G service offering at scale in both Urban and regional/rural Ireland for MBB, IOT and FWA.

All existing 2G, 3G and 4G spectrum that is also designated for 5G deployment should be included in the overall cap.

It is Imagine's view that any one operator should not hold more than 25% of spectrum that is expected to be available in 2020. In a recent MBA in the UK, where there were effectively only three bidders, 37% was deemed an appropriate overall cap. In the Irish market, where there are already five spectrum holders in the low and mid bands, a lower figure is appropriate specially to make best use of existing spectrum and attract new entrants.

2.5 Low/Mid/High band caps

In addition to an overall cap, there should be a cap on the amount of spectrum any operator can hold in each of the three categories of spectrum. This is essential to ensure adequate competition in all areas of 5G deployment with equitable capabilities across the industry. This is also important to ensure the efficient use of spectrum and to avoid any further exacerbation of the digital divide.

All existing 2G, 3G and 4G spectrum also designated for 5G deployment must be included in the overall spectrum cap and also in the appropriate band cap(s).

With inter band CA a cornerstone for 5G technologies and allowing for gigabit service to be deployed across bands, Imagine believes there should be caps in all band types commensurate to the amount of spectrum

available. Particularly in the low and mid bands where there is limited spectrum, caps should be introduced to foster competition but be sufficient to allow for gigabit services.

In the low-band we believe there should be a 100MHz cap for any one operator which allows for gigabit services in this coverage layer.

In the mid-band where slightly more spectrum is available there should be a 200MHz cap for any one operator. This would ensure all existing spectrum holders could run existing systems until transitioned to 5G and the capability of gigabit services in 5G with some flexibility in the radio configurations that could be deployed. With the amount of spectrum available this would allow for new entrants.

In the high-band where there is significantly more spectrum available there should be a cap equal to 25% of the available spectrum in the high-band for any one operator to ensure effective competition and use of spectrum across multiple operators.

1.6 JRC

ComReg Consultation – Ref 18/60

Proposed Multi Band Spectrum Award

Preliminary consultation on which spectrum bands to award

Executive Summary

The Joint Radio Company (JRC) welcomes the opportunity to respond to this consultation. JRC supports the actions of the Commission for Communications Regulation (ComReg) for the proposed release of the radio spectrum noted and the establishment of a combined award of the bands identified to ensure that complementary bands are made available at the same time.

JRC supports ComReg's proposal to exclude the following frequencies from the multi-band award process;

- 700 MHz Duplex Gap & Guard Band;
- 1.4 GHz Band, both Centre and Extension Bands; and
- 26 GHz Band.

The potential characteristics of use of these bands are different to those considered relevant to the multi-band award and therefore should be treated separately.

Background

Joint Radio Company Ltd is a wholly owned joint venture between the UK electricity and gas industries specifically created to manage the radio spectrum allocations for these industries used to support operational, safety and emergency communications.

JRC manages blocks of VHF and UHF spectrum for Private Business Radio applications, telemetry & telecontrol services and network operations. JRC created and manages a national cellular plan for co-ordinating frequency assignments for several large radio networks in the UK.

The VHF and UHF frequency allocations managed by JRC support telecommunications networks to keep the electricity and gas industries in touch with their field engineers. These networks provide comprehensive geographical coverage to support installation, maintenance and repair of plant in all weather conditions on 24 hour/365 days per year basis.

JRC's Scanning Telemetry Service is used by radio based Supervisory Control And Data Acquisition (SCADA) networks which control and monitor safety critical gas and electricity industry plant and equipment throughout the country. These networks provide resilient and reliable communications at all times to unmanned sites and plant in remote locations to maintain the integrity of the UK's energy generation, transmission and distribution.

JRC supports the European Utility Telecommunications Council's Radio Spectrum Group, and participates in other global utility telecom organisations. JRC participates in European Telecommunications Standards Institute (ETSI) working groups developing new radio standards, and European telecommunications regulatory groups and workshops.

JRC also manages microwave fixed link and satellite licences on behalf of the utility sector.

JRC works with the Energy Networks Association's Future Energy Networks Groups assessing ICT implications of Smart Networks, Smart Grids & Smart Meters and is an acknowledged knowledge source for cyber-security in respect of radio networks.

JRC's detailed response

JRC observes the following with regard to the bands that ComReg are proposing to exclude from the multiband award;

700 MHz Duplex Gap and Guard Band

The diversity of uses that both the Duplex Gap and Guard Band may be put to, in particular the deployment of SDL services in the Duplex Gap, warrant further detailed analysis to establish the appropriate combination of services to be accommodated. In the event that it were deemed appropriate that PPDR services were to be accommodated then this would likely involve some form of policy intervention and as such this further justifies ComReg's decision to reserve its position on this band.

1.4GHz Centre and Extension Bands

Whilst the 1.4 GHz Centre Band has been given over to SDL based services in some Member States services within the band have not been forthcoming and as ComReg has noted 1.4 GHz SDL capable devices are low in number. We support ComReg's perspective that based on a lack of compelling demand for SDL capability in the 1.4GHz Centre Band they have chosen to reserve their position in terms of releasing this band at this time particularly as this band is not complementary to the multi-band award. ComReg also acknowledges that there are incumbent users in the Extension Band, which include fixed links that are critical to the operational performance of the National Electricity Grid in Ireland. JRC therefore encourages ComReg to seek to protect the incumbent use within the Extension Band. To this end, any future consideration of the displacement of services from the extension band should be subject demonstrable evidence that the 1.4 GHz Centre Band (+ other SDL bands) are insufficient to service market demand.

26 GHz Band

JRC endorse the guidance for the deployment of high bandwidth mobile services in the 26 GHz band as very much a targeted hot spot model as outlined by ComReg. We therefore endorse the position being adopted by ComReg that until there is greater clarity on the potential uses / users of the band, development of equipment for the band, and its role relative to other mmWave bands to delay its release.

Recognising that there are significant incumbent uses in the band and that there is a considerable amount of spectrum within the band that is available and can be made available to the Mobile Service without impacting incumbent uses the RSPG Second Opinion[1] advises that;

> *"Member States should make a sufficiently large portion of the 26 GHz Band (e.g. 1 GHz) available for 5G by 2020, in response to market demand, taking into account that 5G deployment in this frequency range is expected to be used for local coverage"*; and
>
> *"The 26 GHz Band is likely to be deployed in areas with very high demand, for example transport hubs, entertainment venues, industrial or retail sites and similar…"*

[1] RSPG Second Opinion on 5G networks (Strategic Spectrum Road Map Towards 5G for Europe), Document RSPF 18-005, 30 January 2018.

"Regulatory flexibility for the progressive release of the 26 GHz band will facilitate an efficient introduction of 5G without having an unnecessary negative impact on the current users of the band."

When ComReg does seek to make the 26 GHz band available for 5G services we encourage them to take account of the RSPG position and seek to accommodate incumbent uses in the design of the award.

1.7 Three

Multi Band Spectrum Award

Response to Document 18/60 from Three

30th July 2018

Introduction

Three is pleased to respond to this preliminary consultation regarding the bands that should be included by ComReg in the next multiband spectrum award. We are of the view that ComReg is taking the right approach here to consult on issues like the scope of the award before getting into the detailed consideration of the award itself.

For the most part, Three is of the view that ComReg has considered the right criteria when forming a view on whether each band should be included in the next Multi-Band award. We also agree with ComReg's conclusions in most cases with the exceptions highlighted below.

Response

Three's view in relation to each of ComReg's proposals is listed below.

Proposal	**Comment**
ComReg is of the preliminary view that 700 MHz FDD Duplex should be included in the Proposed Award.	Three agrees with this proposal.
ComReg is of the preliminary view that the 700 MHz Duplex Gap (TDD) and 700 MHz Guard Bands should not be included in the Proposed Award.	Three agrees with the proposal.
ComReg's preliminary view is that the 1.4 GHz Band (both the 1.4 GHz Centre Band and the 1.4 GHz Extension Bands) should not be included in the Proposed Award.	Three agrees that it is preferable to wait until more clarity is available regarding take-up and standardisation of the expanded band.
ComReg is of the preliminary view that the 2.3 GHz Band should be included in the Proposed Award.	Three agrees with this proposal, but the industry needs to better understand how and when the Rurtel licences are going to be discontinued.
ComReg is, of the preliminary view that the 2.6 GHz FDD Duplex Band should be included in the Proposed Award.	Three agrees with this proposal. We would welcome however more information on the guard band requirements between the FDD and TDD bands at 2.6GHz.

ComReg is of the preliminary view that the 2.6 GHz TDD Duplex gap Band should be included in the Proposed Award.	Three agrees with this proposal. We would however welcome more information on the guard band requirements between the FDD and TDD bands at 2.6GHz
ComReg is of the preliminary view that the Paired 2.1 GHz Band should be included in the Proposed Award.	Three does not agree with this proposal. See further comments below.
ComReg is of the preliminary view that the 26 GHz Band should not be considered for inclusion in this award process	Three agrees with this proposal.

The 2.1GHz Band

Three does not agree with ComReg's proposal to include the 2100MHz spectrum band (B 1) in the Multi Band Spectrum Award. This would make the award unnecessarily complex, and would also introduce an unfair advantage for Eir that would distort competition. Three is of the view that matters relating to the liberalisation of existing 2100MHz licences and renewal of those that expire should be addressed separately from the award of the new spectrum bands listed above.

While Three is generally in favour of liberalisation, we note that the EC decision for liberalisation of this band dates from 2012, and specifies 30th of June 2014 as the date for this liberalisation. ComReg first consulted on the matter in 2014, and generally received support for the liberalisation of licences at that time, however no further action was taken to progress liberalisation since then. Cleary ComReg is of the view that there is no particular urgency in dealing with liberalisation. The staggered times for expiry do not coincide with the availability of new spectrum, and since there is no time-related factor that means this needs to be resolved at the same time as the award of new spectrum then it should not be included.

The existing 2100MHz licences expire on four different dates, none of which coincides with the availability of the 700MHz band or the earliest availability of 2.6GHz or 2.3GHz spectrum. This could lead to multiple time-slices in the award process (5 or 6) which would be unworkable.

The different expiry dates for existing licences would also distort the attractiveness of some of the lots across the range of possible bidders in the long term, i.e. 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. This is particularly the case for the three lots of 2x5MHz held by Eir which do not expire until 2027. This is about 7 years after the date for the award and about 5 years after the other three licences in the band expire. This gives Eir a particular advantage in bidding in the 2100MHz band over other bidders – 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.

The presence of these lots could also reduce the transparency of the auction in an uneven way, e.g. if eligibility points could be "hidden" in bidder specific lots.

ComReg has made the point on a number of occasions that, any condition or action that distorts competition in the award process ultimately distorts market competition leads to inefficiencies, and disadvantages consumers. For this reason, ComReg should not include the 2100MHz band in the next multi-band award, but should treat the liberalisation and re-award of that spectrum as a separate stand-alone matter.

/..

1.8 Vodafone

Vodafone Response to ComReg documents:

Proposed Multi Band Spectrum Award
Preliminary consultation on which spectrum bands to award

Reference: ComReg 18/60

Date: 29/06/2018

Introduction

Vodafone welcome the opportunity to respond to ComReg consultation 18/65: **Proposed Multi Band Spectrum Award, Preliminary consultation on which spectrum bands to award**

.

The main points we make in this document aligns with our previous response to ComReg's **Draft Spectrum Management strategy 2106 to 2018. (15/131)**

As discussed in that document Vodafone believe that spectrum play a vital role in the communications value chain and the efficient allocation and assignment of spectrum, and efficient processes for the awards of mobile spectrum are a key support to the Irish economy and should be a key policy priority for ComReg.

In an open and competitive market, it is vital that Ireland has available the best and most efficient telecommunications services.

A major input to the effectiveness and efficiency of mobile communications services is the quantity of spectrum allocated and assigned to these services. In this regard we believe that Ireland is continuing to lag behind our European neighbours. As there are some cost drivers that drive higher cost in Ireland, such as our smaller scale, that we cannot control it is extra important that we fix the parts that we can control. In our view we can should at least match the quantities of spectrum assigned in Ireland to European best practice.

In January 2015 we illustrated this lag by showing a bar chart of spectrum assignments. That chart showed that in mobile spectrum assigned we lagged every other European country except Malta. At the time we had about 50%of the quantity of mobile spectrum then assigned in Germany.

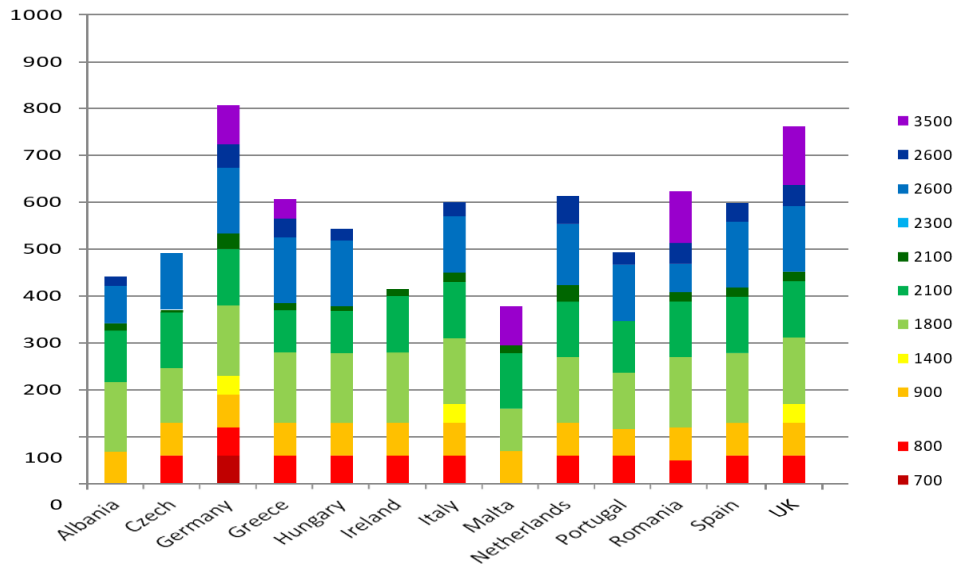


Fig 1 2015 Spectrum Assignments in EU markets where Vodafone operate

A refreshed copy of that graph, showing the bands from 700MHz to 2.6GHz shows that Ireland still lags significantly. (Not including the 3600MHz band out as not yet available for service)

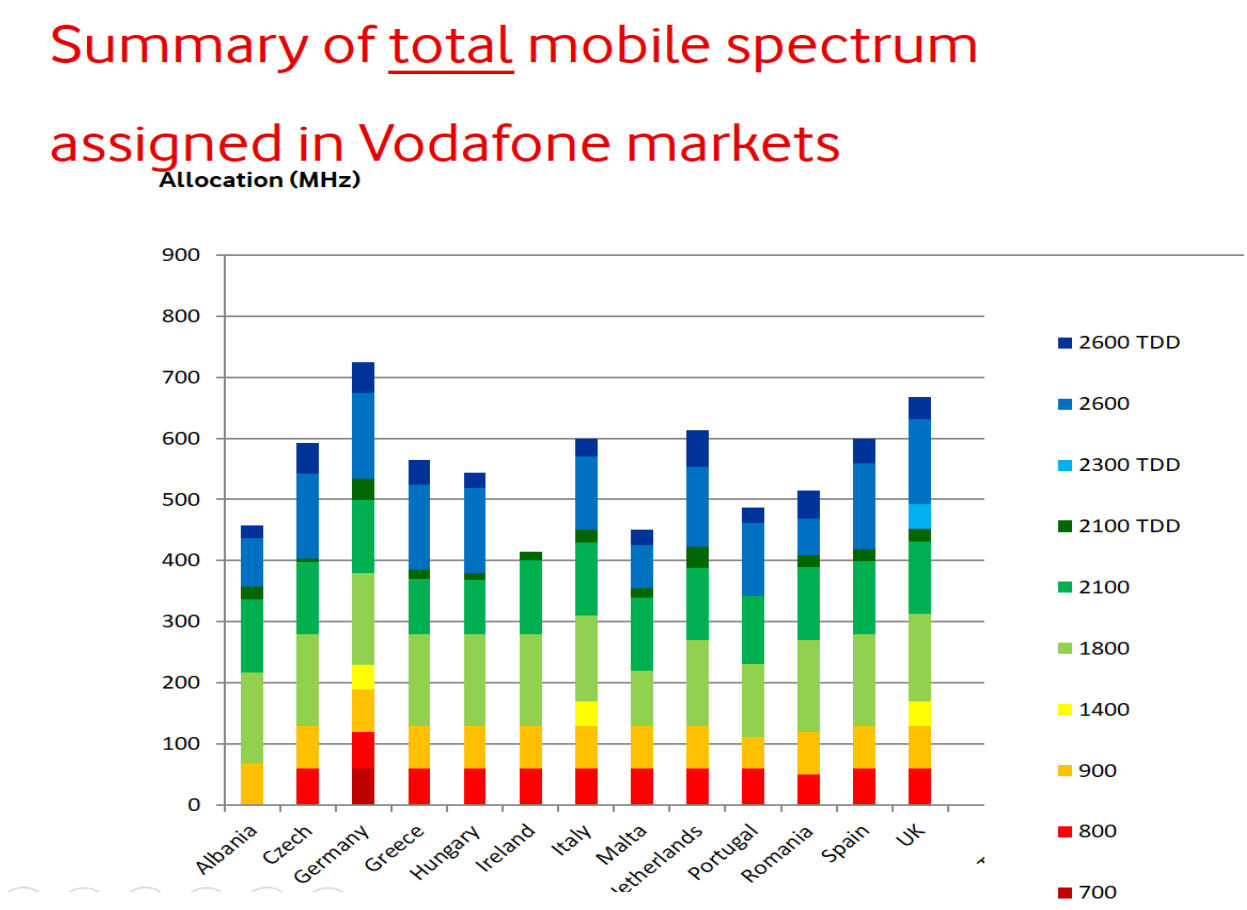


Fig 2 2018 Spectrum Assignments in EU markets where Vodafone operate

Having a smaller available spectrum pool has real negative effects for customers in Ireland leading to poorer quality of service as well as higher costs. Because of the rapid growth in usage of data, customers are now experiencing reducing data rates because of constraints caused by this lower quantity of spectrum available.

Constructing additional sites as an alternative to using more spectrum would drive significant added long-term costs.

For these reasons we believe that moving quickly to align the quantity of spectrum assigned must be a key consideration in the design of the next Spectrum Award.

In the text below we comment on the individual bands that can be included. As was the position in our 2014 responses to "SPECTRUM AWARD - 2.6 GHZ BAND WITH POSSIBLE INCLUSION OF 700 MHZ, 1.4, 2.3 AND 3.6 GHZ BANDS "we believe that the early assignment of the 2.6 GHz band should be a priority. In considering the other bands Comreg should take into account whether the inclusion of these other bands will bring significant delays to the process.

We note the following from the Vodafone submission to ComReg's Draft Spectrum Management strategy 2106 to 2018.

Vodafone:

- *Believes that Ireland must ensure we have spectrum assignments in line with other European countries.*
- *Believes that a digital single market for European customers will bring benefits for Irish customers - this requires moving towards a consistent policy environment for spectrum across EC countries.*
- *insists that greater alignment on timing of licences across the EU is necessary to facilitate the Digital Single Market and achieve economies of scale*
- *agrees auction objectives should include efficient use of spectrum and increasing access to mobile broadband services, but believes that positive discrimination towards possible new entrants should be avoided*

Action for ComReg to support the development of Mobile services in Ireland:

- *accelerate the auctioning of 2.6GHz spectrum - It would be feasible and efficient to run this auction this year, in parallel with 3.6GHz as independent lots.*

- *continue to work to reallocate the 700MHz band but do not wait for completion of this band to release other bands.*

These point remain valid. In the section below we respond to ComReg's position on each of the bands proposed. We expect that all of these bands will eventually be allocated to mobile services. The key objective for Comreg should be to pick a sub-set that will allow for the an early and efficient award process.

Our favoured approach is for ComReg to plan for and schedule more than one spectrum award. The first award should include at least the 2600MHz spectrum, with 700MHz and as many of the other bands as are sufficiently aligned at the European level and sufficiently straightforward at the Irish level to avoid significant delays to the award.

In choosing band plans for each part of the spectrum we agree with ComReg's approach of aligning with European standard band plans. This is key to having effective networks in Ireland: the scale of our customer base cannot drive technology development of base-station or terminal equipment so we must make maximum use of international standards to benefit from the rapid developments that are being made in new technologies.

Many of the principles issues surrounding auction have been consulted on a number of times and suitable formats are now well established. This should facilitate the production of a reasonably accurate timetable of forthcoming awards.

Comments on Individual Bands:

The 700 MHz Band

We agree with ComReg's segregation of the 700 MHz Band into the following:

1. "700 MHz Duplex": consisting of the paired frequency range 703–733 MHz and 758–788 MHz;
2. "700 MHz Duplex Gap": in the frequency range 733–758 MHz; and
3. "700 MHz Guard Bands"

700 Duplex.

We agree that the 700 MHz Duplex has been harmonised for providing WBB ECS (Section 3.1.1);

We welcome ComReg's statement that it has now been established that **4 March 2020** is the date on which the 700 MHz Duplex will be available in Ireland (see Section 3.1.2); and

We ask that the award for this spectrum is significantly in advance of this date. (to allow for planning and site preparation)

We agree with ComReg 's preliminary view that 700 MHz Duplex should be included in the Proposed Award.

We note also ComReg's comments in paragraph 4.8

> 4.8 These characteristics also mean that rights of use in the 700 MHz Duplex are likely to be a good complement to rights of use in the 2.6 GHz Band and, by awarding these bands together, would provide potential users the opportunity to acquire a desired mix of coverage and capacity spectrum rights, which may promote competition by providing greater opportunities for new entry.

Referring back to our inputs to Comreg Spectrum Strategy we agree that the combination of 700MHz and 2600MHz may be attractive, but reiterate our point that any reservation of spectrum for a new entrant is likely to lead to inefficiency.

In addition, while we agree that 700 MHz may be a good complement for the 2600 MHz band we do no believe that it is necessary to delay the award of 2600MHz until the 700MHz availability. In particular, if the 700MHz should be delayed from current timescale then the existing demand for 2600MHz would justify proceeding with an award for 2600MHz in advance.

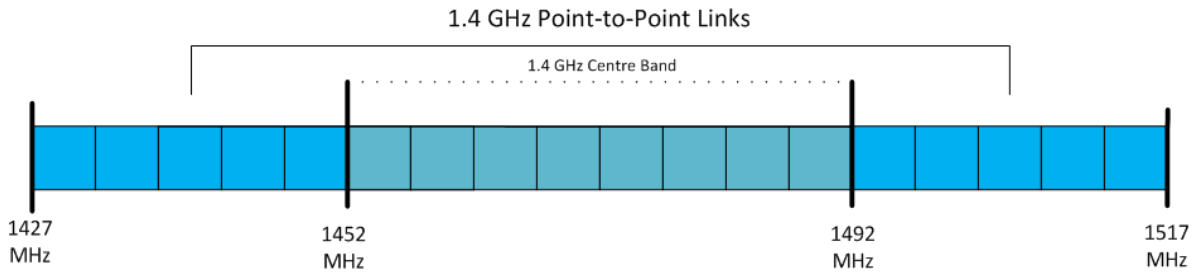
700 MHz Duplex Gap and 700 MHz Guard Bands

Our view is that SDL for WBB communications is the most likely long-term efficient use of the 700 MHz Duplex Gap and 700 MHz Guard Bands. However, given the current positon on standardization of these band we agree with ComReg position that these bands should not be included in the current Proposed Award.

1.4 GHz Band (including extension bands)

We agree with ComReg's analysis, dividing the 1.4 GHz Band into the 1.4 GHz Centre Band and 1.4 GHz Extension Bands as illustrated below.

Figure 3: The 1.4 GHz Band, including the 1.4 GHz Extension Bands



We note that the 1.4 GHz Centre Band is presently unused and believe there is sufficient standardization of this band to make it useful for adding network capacity.

As the 1.4 GHz Extension Band is assigned to a wide variety of users, including the Fire Services etc. it is likely that it would take a very considerable time to clear these bands for reassignment to Mobile Services.

While we recognised that assigning the band in two stages carries the risk of inefficient assignment due to possible fragmentation we believe there is a larger rick of inefficiency in leaving the center portion unassigned for an extended period.

For this reason, we favour including the 1.4 GHz Centre Band in the Proposed Award and putting the 1.4 GHz Extension Bands into a future award process.

As discussed in paragraph 4.20 "The Third, option", a potential joint award of SDL-type spectrum rights in the 1.4 GHz Band and the 700 MHz Duplex Gap would be an attractive option in a later award process.

Taking these factors into account we favour having the center band as part of the auction.

The extension band can be part of a later auction, with potentially other part of the 700MHz band and the 26GHz band.

This band is not a high priority. We note that the value of this spectrum is less than other bands and suggest that 1.4GHz spectrum should not be treated as equal in the design of competition caps.

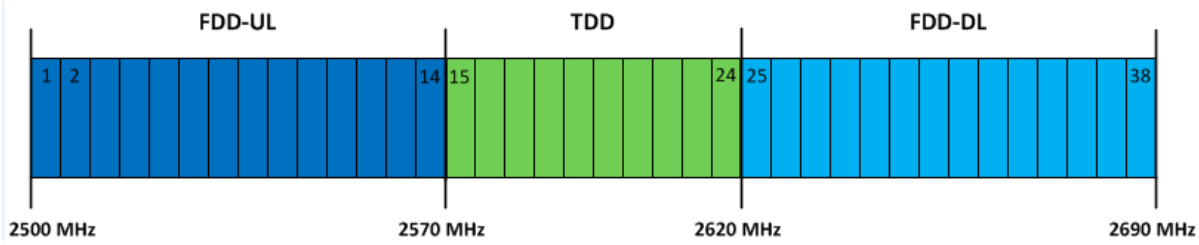
2.6 GHz Band

In Document 14/101, the 2.6 GHz Band was identified as a key band for the proposed award process. The reasons discussed included the then imminent availability of the 2.6 GHz Band in April 2016 following the expiry of the existing MMDS licences.

We strongly agree with ComReg 's preliminary view that the 2.6 GHz Band should be included in the Proposed Award.

The 2.6 GHz Band is a very well-established band in Europe for MFCN/ECS and has been awarded for MFCN/ECS in the majority of Member States and urge Comreg to move quickly to award this band in Ireland.

Figure 7: The 2.6 GHz Band showing the primary band plan



If there are delays to the award of the 700MHz, or delays caused by other issues arising then we ask that Comreg consider awarding their band on its own. This band has been unused in Ireland for a number of years and the customer demand for additional network capacity will ensure that this band is efficiently used. Leaving a band unused is the least efficient usage of the band.

3.65 The 2.6 GHz EC Decision alternatively allows the use of the 2.6 GHz FDD Duplex sub-bands (i.e. 2500-2570 MHz and 2620-2690 MHz), in part or in full for TDD[89] where any such use (which is to be decided at a national level)

We note that while alternative band plans for 2.6GHz are possible we believe that because of the pent-up demand and the fact that handset already available in the Irish market we favour following the primary band plan.

2.1 GHz Band

Paired 2.1 GHz Band

We note that Paired 2.1 GHz Band is harmonised for MFCN including IMT systems, and in addition the device ecosystem for the Paired 2.1 GHz Band is extensive.

However, the current spectrum rights, with four end dates ranging from June 2022 to march 2027 add considerable complexity of the award process for these bands.

We believe it will be possible to construct 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;

An early librelisation option to should aim to have a common start point of all operators with a new assignment in 2022.

Our main concerns are that the time-slice element of the auction process may contribute to complexity in the design of the next award. This in turn could cause delays to the auction of 2600MHz and 700MHz bands. Recalling the 2012 MBSA our understanding is that the accommodating the 'time-slices' added considerable to the complexity of the award and delayed its implementation. We would like ComReg to set an early target date for the next auction and decide on including 2100MHz only if all issues can be resolved sufficiently to allow it to be awarded without causing overall delay.

If this can be achieved, we would favour including the paired 2.1 GHz Band in the Proposed Award.

If this cannot be done, we suggest dropping 2100MHz to a later award date.

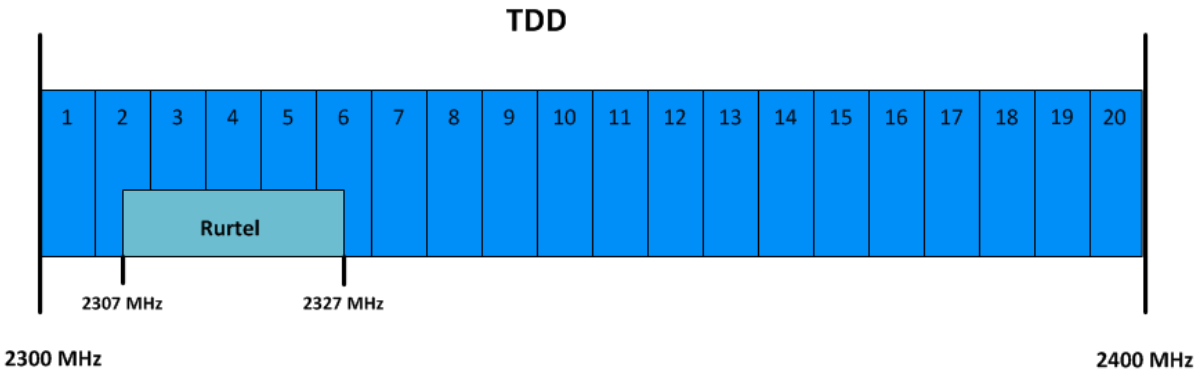
Unpaired 2.1 GHz Band

Because of the lack of standardization, we agree with the ComReg preliminary view that the Unpaired 2.1 GHz Band should not be considered for inclusion in the Proposed Award.

2.3 GHz Band

We agree with ComReg's proposed bandplan for the 2.3 GHz Band.

Figure 6: The 2.3 GHz Band



We see Spectrum rights in the 2.3 GHz Band as 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 to support its inclusion in the Proposed Award on that basis.

We agree therefore with ComReg's preliminary view that the 2.3 GHz Band should be included in the Proposed Award.

We note however that the value of this spectrum is less than the 2.6GHz band. This is due to the much smaller ecosystem of mobile phones available in this band. This difference in value should be a consideration in the design of competition caps if this band is auction at the same time as 2.6GHz band.

26 GHz Band

As discussed in Vodafone's response to ComReg Consultation 17/85 (Spectrum Award in the 26GHz band) we believe that this band will be an important band in the medium term to support new 5G services.

However, given the current status of standardization we agree with **ComReg's preliminary view that the 26 GHz Band should not be considered for inclusion in this award process**, and instead be assigned under a separate, subsequent award process,

Summary of Vodafone position

We believe that all of these bands discussed in ComReg's document 18/60 will be used for mobile Communications albeit in different timescales.

In order to support efficient long term planning and equipment installation we would ask ComReg to produce an indicative long-term program of planned spectrum awards.

In a first award we would like to prioritise the assignment of the 2.6GHz band as there is a real and immediate advantage to customers available if this band is awarded quickly.

The timescale for the 700MHz Duplex channels should be planned to happen at least in in line with a timeframe to match their March 2020 availability.

We also favour also the inclusion of other bands in the next award : the 2.3MHz band, the centre portion of the 1.4MHz band, and the as the paired 2.1GHz bands, as they are substitutes - albeit of lower value.

Later timescales could be indicated for awards for the 700MHz centre and guard band, the 1400 MHz extension, and the 26Ghz bands

2 Non-Confidential Submissions to Consultation 14/65

2.1 Eircom

eircom Group

Response to ComReg Preliminary Consultation Paper:

Liberalisation of the paired terrestrial 2GHz spectrum band

Implementation of European Commission Decision 2012/688/EU

ComReg Document 14/65

08 August 2014

DOCUMENT CONTROL

Document name	eircom Group response to ComReg Consultation Paper 14/65
Document Owner	eircom Group
Last updated	08 August 2014
Status	Non Confidential

Response to Consultation

eircom welcomes the opportunity to comment on the extension of liberalisation to the existing 3G licences in the 2GHz band (also referred to as the 2100MHz band). These licences are currently restricted for 3G mobile technology. As ComReg will be aware eircom fully supports the European led policy for liberalisation of rights to use radio frequencies. This policy has already been applied in Ireland to the 800MHz, 900MHz and 1800MHz spectrum bands in accordance with Decision 2009/766/EC as amended by Decision 2011/251/EU, and Decision 2010/267/EU. It is appropriate that ComReg takes appropriate steps to advance liberalisation of the 2100MHz band as required in Decision 2012/688/EU.

From a licensing perspective, eircom offers the following in response to ComReg's request for views on the suitability (or otherwise) of the existing provisions in the 3G and GSM Regulations and the 3G Licences to facilitate the deployment of the full suite of liberalised technologies as provided for under Decision 2012/688/EC. The IMT family now consists of IMT-2000 and IMT-Advanced however the current legislation specifically references IMT-2000 and not IMT-Advanced. The 3G licence references ERC Decision ERC/DEC/(99)25, which has since been superceded by ECC Decision (06)01. One of the reasons for the 2006 Decision was to update the reference to IMT systems (i.e. covering both IMT-2000 and IMT-Advanced). It would therefore be appropriate to modify the 3G Licences to reference ECC Decision (06)01 rather than ERC Decision ERC/DEC/(99)25.

In broad terms there can be economic and competition enhancing benefits accruing from the liberalisation of spectrum licensing. The ability to deploy a range of different technologies increases the potential for competitive differentiation. The over-riding benefits of technology neutral licensing have been debated and recognised at European and national level. We believe the same principles apply in respect of the 2100MHz band and do not consider it necessary to reprise the principled debate. Indeed the Framework Directive, as we discuss later, provides a clear steer for the introduction of liberalisation. The key focus of the current consultation therefore should not be on whether liberalisation of the 2100MHz band is appropriate but on how liberalisation should be implemented in the Irish 3G licences taking into account the specific circumstances.

The implementation of liberalisation was effected in the 800MHz band when the licences were first issued in 2013. In the case of the 900MHz and 1800MHz bands ComReg linked the implementation of liberalisation principles to the issuance of new licences in light of the expiry of the original terms of two of the three operational 900MHz licences.It is not possible to follow either of these approaches in respect of the 3G licences. The band is fully licensed as set out in Table 1 of the consultation document. The earliest expiry date of the 3G licences is June 2022, almost 8 years hence, and March 2027, almost 15 years hence, in respect of the last of the current licences to expire. It would not be an efficient use of spectrum to delay the benefits of liberalisation until the current 3G licences expire. As such there is a clear case that 3G licences should be amended to implement technology neutral spectrum rights taking into account the specific circumstances.

Regulation 18 of the Framework Regulations 2011[1] establishes that ComReg must by 30th June 2016 "*take all appropriate measures to ensure that Regulation 17(2) to (7)* [measures to ensure that licences are issued with minimum restrictions] *applies to all remaining general authorisations or individual rights of use and spectrum allocations used for electronic communications services which existed on the commencement of these Regulations*." Regulation 17(2) requires ComReg to promote technology neutrality and "*ensure that all types of technology used for electronic communications services may be used in the radio frequency bands that are declared available for*

[1]SI 333 of 2011

electronic communications services in the Radio Frequency Plan published under section 35 of the Act of 2002 in accordance with European Union law."

It is permissible under the Regulations to impose restrictions if there is an objective justification and an exhaustive list of relevant matters for consideration is set out in Regulation 17(3).

(a) avoid harmful interference,
(b) protect public health against electromagnetic fields,
(c) ensure technical quality of service,
(d) ensuremaximisation of radio frequency sharing,
(e) safeguard the efficient use of spectrum, or
(f) ensure the fulfillment of a general interest objective as defined by or on behalf of the Government or a Minister of the Government in accordance with paragraph (6).

Items (a) to (d) are technical matters that have already been addressed through harmonisation studies at international level and are therefore not a material consideration for the current review as it has been demonstrated there are no technical reasons to restrict the licences in the 2GHz band to 3G technology only.

Items (e) and (f) are relevant matters for this national review as they both relate to efficient use of the spectrum. Under item (f) restrictions may be imposed in the public interest for the avoidance of inefficient use of radio frequencies. Regulation 18(4) is also very pertinent to a national review, "*In applying this Regulation, the Regulator shall take measures to promote fair competition.*"

The key issue that this review will need to consider is whether the concentration of spectrum in the 2100MHz band arising from the acquisition of Telefonica O2 by Hutchison 3G, combined with the application of liberalization, is an efficient use of spectrum and / or promotes fair competition.

As can be seen from the following diagram the merged entity will have a dominant holding of higher frequency spectrum in the 1800MHz and 2100MHz bands.

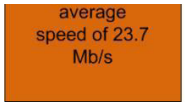
eircom	
3 / O2	
% of FDD spectrum held by 3 / O2	33

The combined holding would exceed the caps set for the 2012 auction in both the 900 and 1800 MHz bands (and the maximum overall spectrum which ComReg envisaged any MNO would hold) and have double the 2100 MHz spectrum holdings of the other MNOs (which was not part of the auction). The merged entity will hold approx. 50% of the higher frequency spectrum. This spectrum is very useful to provide capacity for high speed mobile broadband services.

This outcome would lead to a significant imbalance in spectrum holdings. Access to spectrum is vital to the competitiveness and commercial success of MNOs. The spectrum available to an MNO is a key determinant of the capacity and capability of its network, and the costs of building and maintaining that network. Significantly more spectrum allows an operator to deliver higher speeds to a larger number of customers and in the Irish market this provides an enduring advantage.

As part of this review ComReg must consider whether it should liberalise some or all of the merged entity's 2100MHz spectrum holding. Liberalising more than 3 blocks could give the merged entity a material advantage in the market which could not be replicated by competitors thereby potentially promoting unfair competition.Liberalisation of the entire six blocks held by the merged entity would worsen the asymmetry already established in respect of the 1800MHz band.

For illustration we consider the relative capability of eircom and the merged entity in the 2100MHz in the scenario of LTE deployment. From a marketing perspective, with 6x2x5MHz blocks at its disposal, the merged entity could advertise mobile broadband speeds 'up to 225 Mb/s' whereas eircom would be capped at 'up to 110 Mb/s'. These speeds are based on 3GPP Release 8 2x2MIMO configuration. System improvements such as 4x4MIMO will double these. Further enhancements such as 8x8MIMO and LTE Advanced will further increase these effectively widening the gap between the merged entity and eircom capabilities. This is a material disadvantage to eircom, who as the third player in the market, must compete aggressively against the near duopoly of the merged entity and Vodafone with a combined market share in the region of 80%. With the asymmetry of spectrum between the merged entity and eircom, simulations show that the merged entity will be able to offer more than double the average user speed to more than twice as many customers



A decision to liberalise all the 2100MHz blocks held by the merged entity will severely compromise eircom's ability to maintain a sustainable position on the market. A reduced market share for eircom would result in a cycle of decline of reduced scope and incentive for investment and reduced ability to deliver speed, with further negative impacts for consumers. Consumers will have a narrower choice of provider and products nationally, leading to a drop in quality and higher prices for high speed products in what would become effectively a two player market. For these reasons eircom strongly believes that ComReg should undertake a thorough competition assessment.

As part of its assessment ComReg must also consider the efficient use of spectrum. If the significant competition concerns raised in this response are ignored it may also be the case that the quantity of spectrum retained by the merged entity is simply more than it needs and

consequently ComReg should consider whether it is an efficient use of the spectrum for so much liberalised capacity band spectrum to be held by one operator.

On either turn of the coin, from a competition or efficient use perspective, we believe there is a strong case that no more than three blocks of the merged entity's 2100MHz spectrum should be liberalised.

2.2 O2 & Three

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Ms Sinead Devey
Commission for Communications Regulation
Abbey Court
Irish Life Centre
Lower Abbey Street
Dublin 1
BY EMAIL: [redacted]

1 August 2014

Dear Sinead

Liberalisation of the 2GHz Band (Doc 14/65)

I refer to ComReg Doc. No. 14/65, which is a preliminary consultation by ComReg regarding liberalisation of the 2GHz mobile band. Both Hutchison 3G Ireland Ltd (Three) and Telefonica Ireland Ltd (O2) hold 2GHz licences to operate 3G services. As you will know, O2 has recently been acquired by the Three Group. I am now providing a brief response to ComReg's preliminary consultation on behalf of both licensees.

Three and O2 welcome ComReg's preliminary consultation and believe ComReg should liberalise the existing 2GHz (3G) licences without delay. We believe ComReg should review the terms in the 2GHz (3G) licences and make modifications as appropriate to bring them in keeping with the current market and technological conditions. In addition, ComReg should consider how it can liberalise both the paired (FDD) and unpaired (TDD) spectrum in the band through this process.

The European Commission Decision (2012/688/EU) requires Member States to make the 2GHz band available on a technology neutral basis; subject to compliance with Block Edge Masks. This decision is intended to allow operators to roll-out new technologies, including 4G and other services in the band, so long as minimum technical conditions are met. It gives operators freedom to innovate and introduce newer, faster, and more efficient technologies, which will benefit consumers. Four licences have been issued to operators to provide services in this band, however they all contain a technology restriction, specifying 3G service only, and terms and conditions appropriate to a technology specific licence. The EC decision requires ComReg to modify these licences to remove this restriction and amend these terms and conditions, provided this does not cause a distortion of competition.

It is important that ComReg removes the technology restriction as it causes uncertainty for operators. Even if no operator wishes to roll-out a different technology in this band immediately, it is difficult to plan for this while the uncertainty remains. Three and O2 do not believe that the liberalisation of existing licences would in any way distort competition, but instead would facilitate innovation and investment. This is to the benefit of consumers and would enhance competition in the market. It is also consistent with ComReg's overall spectrum policy of technology neutrality. We note that when GSM licences expire in July 2015, all other mobile licences will be in the "Liberalised Use" or technology neutral form. As

[redacted]

all existing operators hold licences for spectrum in several bands (800, 900, 1800, 2100), and as there are other bands to come available in the future (700, 2600), no distortion of competition would be brought about by the liberalisation of existing 3G licences.

As ComReg itself has highlighted, the current 3G licences were awarded following competitions in 2002 and 2007. The market structure has changed significantly since then, as has the technology. The majority of licences operational in Ireland are currently Liberalised Use Licences which aim to give licensees freedom to innovate and compete. The original 3G licences contain several conditions that would have been pertinent at the time, but which are now essentially legacy terms. No customer subscribes to a service that operates only on one band, or one that is delivered under one licence only. In practice, operators use all of their licensed spectrum and networks to deliver the best service to their customer as is appropriate according to their location, handset, and requirement. Operators do not treat a customer differently if their handset switches band, or technology. For this reason, ComReg should also review the general terms in the 3G licences and remove any unnecessary conditions so as to provide consistency between the new Multi-band Liberalised Use Licences and the 2GHz licences.

Finally, some of the current 3G licences provide for an assignment of a single frequency or TDD block in addition to the dual frequency or FDD blocks. We believe ComReg should include liberalisation of all spectrum in the current licences as part of this process, with appropriate technical restrictions so as to avoid interference.

We can provide clarification on any of these points as required, and look forward to the next stage in the process.

Yours Sincerely

Tom Hickey

2.3 Vodafone

Vodafone response to Comreg Consultation: Liberalisation of the paired terrestrial 2 GHz spectrum band

Preliminary Consultation. Reference: ComReg 14/65

Ref. 14/65

Response Date: 07 Aug 2014

Introduction

Vodafone welcome the opportunity to comment on the implementation of Decision 2012/688/EU in Ireland (i.e. the "liberalisation" of the existing rights of use in the paired terrestrial 2 GHz band to enable the deployment of technologies compatible with the technical conditions set out in Decision 2012/688/EC).

Comments on Specific Consultation Issues

Comreg Question 1

In present circumstances, ComReg would welcome views on the potential impact of such liberalisation particularly in terms of 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;

Vodafone agrees that in absence of other factors, the flexibility that comes with liberalisation of spectrum would bring gains to consumers.

In a market with competitive infrastructure suppliers liberalised spectrum will enable Network Operators to make best use of spectrum resources to provide a choice of services to customers.

A number of studies have evaluated the gains to consumers from mobile infrastructure competition. In Annex 1 we have provided brief summaries of a study completed and analysis carried out for a second study.

These studies agree that infrastructure competition brings consumer benefit in terms of Price, Choice, Innovation, and Quality of Service,

In the medium term, the gains from liberalisation arise from re-farming to LTE. The timing of the use of this spectrum for LTE will depend on a number of technology developments.

Having reviewed the likely technology roadmap position with Vodafone Group technology and our suppliers, our view of the expected timings are as follows:

- Internationally, 2100 tends to be the lowest priority band for refarming to LTE (typically after refarming 1800, deploying new 800 and 2600 and sometimes even introducing LTE into 900).

- This is due to
    a) the need to continue to support existing 3G devices and traffic, and
    b) generally the 2100 band is not seen as a priority band among vendors for carrier aggregation

- We believe that 2016 is the earliest date for technical trials. This means that it will be post 2018 before carrier aggregation with LTE in other bands becomes available.

The consumer gains available are then available in this medium term rather than the short term of the next two years.

Comreg Question 2

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.

Vodafone has made clear to ComReg its view that the merger of Hutchison and O2 has given rise to a significant imbalance in spectrum assignment among mobile operators in Ireland. We have also communicated to ComReg the impact of such imbalance to Network Infrastructure competition in Ireland.

This imbalance is particularly acute in the 2.1GHz band. The merged entity will have double the duplex spectrum of both Vodafone and Meteor, (6 duplex blocks of 5MHz versus 3 duplex blocks available to Vodafone and Meteor). An imbalance of this scale does not appear in any other market in Europe.

The original UMTS licences at in the 2.1GHz band were deliberately designed to have symmetrical allocation – creating a competitive infrastructure market.

The effect of allowing one operator to provide LTE services using twice the 2.1GHz spectrum of other operators will be to severely damage Infrastructure competition.

Given the imbalance in other bands, liberalisation of this band combined with carrier aggregation will exacerbate the imbalance between LTE services provided by Hutchison and the LTE services provided by other operators.

An imbalance of spectrum allocation of this scale will bifurcate the market. The products that Vodafone and the merged H/O2 will offer will not directly compete. As communicated through the H3/O2 Merger approval process to ComReg and the Commission, we believe this will be to the detriment to the level of investment and product innovation in Ireland and will lead to the absence of infrastructure competition. Consequently consumer welfare and benefit will be damaged.

Vodafone also notes that there is an asymmetry in the conditions attached to the rights of use in the 2.1GHz band and the liberalised spectrum allocated under the MBSA process. This gives rise to a situation whereby the obligations imposed on operators using the 2.1GHz band to provide UMTS services are different should they provide these services using the liberalised bands. As many of these additional obligations relate to aspects of the retail UMTS service offered rather than spectrum related matters, it would appear to be appropriate that ComReg examines the alignment of the conditions of the rights of use of the 2.1GHz band with those of the liberalised spectrum under the MBSA even in advance of any decision or more detailed consideration of whether to liberalise the 2.1GHz band.

Given both the apparent delay before consumer gain can practically be achieved and the real risk of consumer detriment, Vodafone believes that:

- ComReg should proceed cautiously with moves towards liberalisation of this band,
- Before liberalisation is implemented a comprehensive review of the prospective negative effects of spectrum imbalance should be carried out.

Summary

In summary Vodafone are strongly in favour of Network Infrastructure Competition and believe that there is strong evidence of the considerable consumer benefits that can be derived from this competition

Spectrum Liberalisation should support Network infrastructure competition. However where there is excessive imbalance in spectrum allocations this liberalisation can exacerbate the damage caused to infrastructure competition by this imbalance.

A comprehensive analysis of the efficiently of post-merger spectrum allocations and their effect on the market should be completed by ComReg before proceeding with the implementation of this directive.

ANNEX 1

The impact of intra-platform competition

Studies have demonstrated the benefits of infrastructure-based ("inter-platform") competition over service-based ("intra-platform")

- Competition between communications operators on the basis of their network infrastructure rather than simply services provides superior outcomes for consumers in terms of:
  - Price
  - Choice
  - Innovation
  - Quality of Service

"While both inter- and intra-platform competition seem to exert a similar effect on prices, inter-platform competition has a significantly higher impact on broadband speed than intra-platform competition.
This seems plausible given that alternative infrastructure operators have a high degree of flexibility to differentiate their products and, hence, to compete on quality."

The impact of intra-platform competition on broadband prices and speeds' R. Smith et al.

Competition and market structure
Proven incentives of mobile infrastructure competition

Resource: 'Assessing the case for Single Wholesale Networks in Mobile Communications' Frontier Economics, to be published 2014

Proven incentives of mobile infrastructure competition:
First mover advantage
Operators will try to be the first to cover areas which are only economically viable with one operator

Network sharing
Competing operators co-operate to share network costs to extend coverage into areas where duplication is uneconomic

Cost reduction
strong incentives to reduce costs making more areas economically viable to cover

Outcome
Population coverage up to 21% higher in countries with network competition compared to countries served by a single network; coverage increased 3x faster.

Market share

Operators want to increase through differentiation and first mover advantage which can be done by introducing innovations as quickly as possible.

Higher likelihood of success
Multiple operators searching for innovations results in a stronger likelihood of successful

Capitalising on innovation
Vertically-integrated mobile operators have ability to capitalise on innovation of their own businesses and will have information needed to make realisation successful.

Outcome
Evidence suggests higher take up and quicker technology introduction under competition.
Lower unit costs

Large dynamic efficiency benefits
Literature suggests dynamic efficiency gains are much larger than static gains.

Reduce costs
Competitive environments imply less cost is passed through, incentivising cost reduction

3 Three Submissions

3.1 Three Email 18th January 2019

From: Tom Hickey [redacted]
Sent: 18 January 2019 10:46
To: George Merrigan [redacted]
Subject: NERA Report - Irish Multiband spectrum Auction

Dear George

One of the most important items on ComReg's Action Plan for 2019 is preparation for the next multi-band spectrum award (MBSA2 –Future Mobile Connectivity). This award will have a significant impact on investment in mobile networks and the development of connectivity in Ireland. With this in mind, Three asked NERA Economic Consulting, to draw on its well-recognised international experience in this area to identify the key issues to be addressed and to provide recommendations on the process that will deliver the best outcomes for Irish consumers and the wider economy.

I have attached a short briefing note prepared by Three, which is a summary of NERA's analysis and recommendations. I have also attached a copy of NERA's full report.

We look forward to engaging with ComReg on this matter, and if any clarification is required in relation to NERA's report, then we will be happy to facilitate this.

Best Regards
Tom Hickey

Three.ie

Tom Hickey

[redacted]

Make it count.

3.2 Three Nera Report Briefing Note

Briefing Note - NERA Report on the Irish Spectrum Auction

ComReg is currently planning the process to award over 350 MHz of prime mobile spectrum. Accounting for about 42% of total mobile spectrum available, this award process will have a critical impact on how Ireland's mobile infrastructure and connectivity will develop over the next decade.

Three asked NERA Economic Consulting, to draw on its well-recognised international experience in this area, to identify the key issues to be addressed by ComReg and to provide recommendations on the process that will deliver the best outcomes for Irish consumers and the wider economy.

NERA make the following key recommendations:

1. While operators can expect to pay a market price for access to spectrum, a process that risks inflated prices would be detrimental to Ireland's digital future:
    - International academic studies and empirical evidence from around the world show that inflated spectrum prices have a negative effect on investment and on consumer welfare;
    - Excessive spectrum pricing risks could delay 5G roll-out and cause Ireland to fall behind its peers for connectivity;
    - Avoiding high spectrum prices is particularly important in Ireland, given the relatively large rural population and challenges of attracting investment capital in a small market;
    - Spectrum prices can be expected to fall considerably when compared to previous awards, particularly the 2012 auction.

2. Rules on packaging and caps should be as simple as possible subject to achieving the goal of an efficient, pro-competitive and fairly priced award outcome:
    - While trade-offs may need to be made when choosing the appropriate caps and packaging, this should be kept as simple as possible in order to facilitate an efficient outcome;
    - Bidders need to be able to obtain a critical mass of spectrum, and to switch demand in response to changing price.

3. Getting the most efficient outcome for the 2100 MHz band right is much more challenging than the other bands due to legacy issues. This spectrum may be more efficiently allocated outside the auction:
    - The 2100MHz band is already in use by mobile operators and was the original 3G band;
    - If "liberalised", this band could be immediately upgraded to 4G use, which would deliver an immediate increase in its efficiency of use and consumer welfare;
    - Legacy licence issues mean it would likely be better to liberalise the 2100MHz band separately from the main award.

4. The auction format and rules should be simple and efficient:
    - ComReg should follow the trend amongst European regulators that previously used the Combinatorial Clock Auction (CCA) format of switching to a simpler, better adapted format;
    - If additional coverage obligations are to be determined in the auction, then this should be a separate stage distinct from the determination of the spectrum allocation.

15/01/2019

3.3 Nera Report

NERA
ECONOMIC CONSULTING

Preparing for the 2019 Irish multi-band spectrum award

Prepared by NERA Economic Consulting with the support of Three Ireland (Hutchison) Limited

December 2018

NERA
ECONOMIC CONSULTING

NERA Economic Consulting is a global firm of experts dedicated to applying economic, finance, and quantitative principles to complex business and legal challenges. For over half a century, NERA's economists have been creating strategies, studies, reports, expert testimony, and policy recommendations for government authorities and the world's leading law firms and corporations. We bring academic rigor, objectivity, and real-world industry experience to bear on issues arising from competition, regulation, public policy, strategy, finance, and litigation.

Our communications, spectrum and auction practices work around the world advising regulators and spectrum users on auction design, bid strategy, spectrum policy, and pricing and valuation. Our previous projects include design and implementation of 4G auctions in Belgium, Mexico, Saudi Arabia, Singapore, and reports for the GSMA on best practice in the pricing of radio spectrum. In Ireland, we advised a bidder in both the 4G multi-band auction in 2012 and 3600 MHz 5G auction in 2017.

For more information, please visit the NERA website at **www.nera.com**.

Authors:

Richard Marsden is a Managing Director and leader of NERA's Radio Spectrum and Auctions Practice, which focuses on the design of allocation mechanisms, bidding strategy, and related competition, pricing, regulatory, and public policy issues. Based in NERA's New York City and London offices, Mr. Marsden has 20 years of experience in microeconomics, political economy, and business consulting. He has worked for regulators and private companies in more than 40 countries across the Americas, Africa, Asia Pacific, and Europe.

Dr Soren Sorensen is an Associate Director in NERA's Auction Group with more than 15 years' consulting experience. His work spans spectrum auctions in more than 25 countries, for both regulator and mobile operators. Dr. Sorensen has extensive experience all widely used auction formats, including the SMRA, clock auction, CCA and CMRA. He has also developed software tools for analysing bidding behaviour, including efficient algorithms for determining winners and prices in combinatorial clock auctions.

Peter Traber is an Analyst in NERA's Radio Spectrum Practice, based in New York City. He is responsible for managing NERA's database of spectrum awards, including information on global price benchmarks, spectrum allocations and award mechanisms.

Contents

1. Introduction

Within the next 6 months, ComReg is expected to announce an award design for over 350 MHz of prime mobile spectrum, about 42% of total spectrum available for mobile in Ireland. This will likely involve a multi-band award for three newly available bands at 700, 2300 and 2600 MHz, and the liberalisation and re-award of expiring licences in the 2100 MHz band. The award outcome could be pivotal in determining whether Ireland builds on its recent success in climbing the European Digital Economy and Society rankings or slips back.

NERA Economic Consulting ('NERA') has been asked by Three Ireland to provide an analysis of some of the key issues that ComReg must grapple with when determining how the award should be designed. Specifically, we focus on: the pricing of the available spectrum; the packaging of the spectrum; and the choice of auction format.

We make three main observations:

1. **When designing the award, ComReg should have particular regard to the impact of its decisions on the price of spectrum, and the risk that inflated prices could be detrimental to Ireland's digital future.**

   The spectrum being awarded will bring great benefits to the economy and society but the ability of operators to monetise that value is limited. Given the significant increase in supply, ComReg should expect lower prices for this award than in the 2012 4G auction. Any other outcome may imply distortions in the bidding process.

   We present evidence that excessive spectrum pricing in this award could delay 5G and would be detrimental to mobile operators, their customers and the wider economy. Avoiding high spectrum prices is particularly important in Ireland, given the challenges of attracting investment capital in a small market with a relatively large rural population. 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.

2. **Simple packaging structures are preferable for the multi-band award.**

   Rules on packaging and caps should be as simple as possible subject to achieving the goal of an efficient, pro-competitive and fairly priced award outcome. Given the limited availability of new coverage spectrum at 700 MHz, ComReg should avoid structures that could artificially inflate demand. Meanwhile, the design of 2300 and 2600 MHz should facilitate easy switching in the auction between these closely substitutable bands. Packaging the 2100 MHz is much more challenging owing to legacy issues; this spectrum may be more efficiently allocated outside the auction.

3. **ComReg should consider following the trend amongst European regulators that previously used the CCA format of switching to a simpler format**.

   It is now widely understood that the CCA design can introduce incentives for unduly aggressive bidding. There are simpler formats, including new variants of the SMRA and clock auction, that may be better choices for Ireland's multi-band award.

2. Spectrum pricing

In early 2019, ComReg is expected to announce plans for a major auction of mobile spectrum, one that could shape the landscape for competition and investment in provision of high speed mobile data services in Ireland. The award will include:

- the 700 MHz band – at least 60 MHz of spectrum suitable for extending 5G to rural Ireland; and
- the 2300 and 2600 MHz bands – up to 290 MHz of capacity spectrum to service rapidly growing demand for mobile data on Ireland's 4G and 5G networks.

In addition, ComReg must also decide whether to renew or re-award of 2x60 MHz of spectrum in the 2100 MHz band, where existing 3G licences are set to expire between 2022 and 2027. This spectrum will need to be liberalised, so it can also be deployed for 4G and 5G capacity.

In combination, these four bands will contribute about 42% of mobile spectrum in the preferred frequency range below 4 GHz.[1] With such a large amount of spectrum coming available in a single award, the associated spectrum fees will have a significant financial impact on mobile operator balance sheets. This will happen at the same time that the industry is investing heavily in network upgrades to increase 4G capacity and speeds, and is preparing to launch 5G services.

Mobile operators should expect to pay a fair price for this valuable resource, but it is important that this price is not inflated. This is particularly important in Ireland because the scope for subscriber growth is limited and operators are experiencing a decline in average revenues per user (ARPU), notwithstanding rapid growth in data traffic.[2] This means that operators cannot expect to fund new investment from future growth but must do so from the expected stream of profits from serving existing customers. Thus, if spectrum fees were unduly high, this would likely detract from the capital available to operators to invest in 4G and 5G rollout. Consistent with its obligations to maximise long-term benefits to the Irish economy and consumers, ComReg should therefore make concerns about high fees a central consideration in its auction design, alongside efficiency and competition.

In this section, we build on NERA's prior work for the GSMA on spectrum pricing to show why ComReg should be concerned about high spectrum pricing. We explain why this issue is particularly relevant to the Irish market, especially in the context of the multiband award. We then propose some concrete actions that ComReg can take to ensure that spectrum sold in the auction is not priced above its fair market value, i.e. the price that would emerge from a well-functioning market in which bidders submit bids based solely on the intrinsic value of spectrum to them. Our view is that ComReg's independent regulatory status and statutory

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1 We assume that 2x30 MHz of 700 MHz, 100 MHz of 2300 MHz, 2x70 MHz of 2600 FDD, and 40 MHz of 2600 MHz TDD will be available in the expected 2019 Multi-band award in Ireland.

2 For example, from Q2 2008 to Q2 2018, ComReg reported a more than 20% drop in Total Mobile Retail Revenues from €492m to €387m. See ComReg, Quarterly Key Data Reports, available at www.comreg.ie.

objective to promote the interests of consumers means it is well positioned to make the right decisions on allocation and pricing of spectrum for mobile.

This section is structured around four key messages:

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 4G auction.

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.

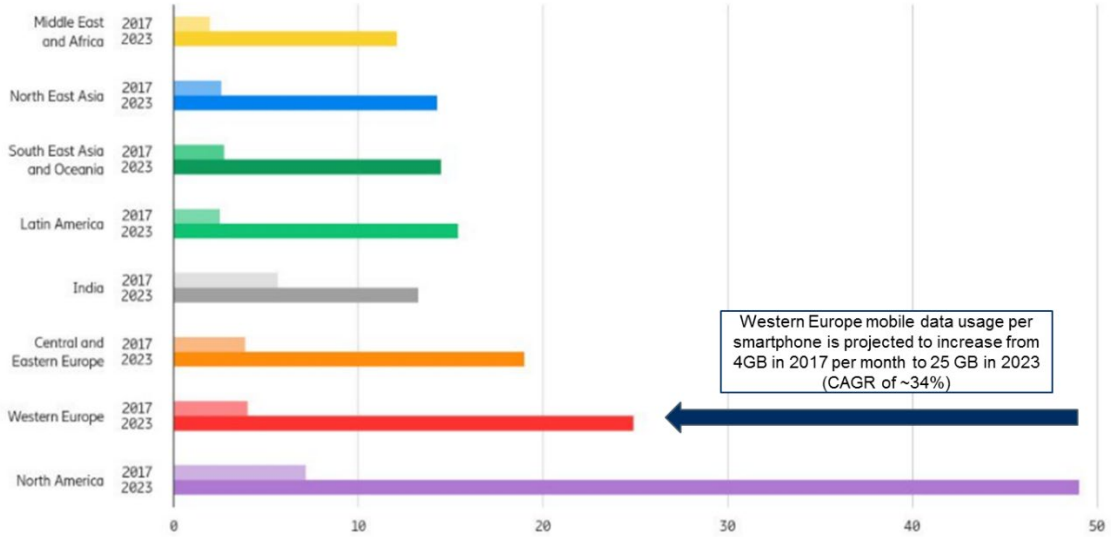
2.1. Why spectrum prices for mobile should fall

In a competitive market, the price of spectrum is determined by the intersection of demand and supply. Around the world, demand for and supply of spectrum are both increasing. In most countries – including Ireland – demand is not underpinned by any corresponding increase in mobile operator revenues. Accordingly, although absolute spend on spectrum may continue to rise, the fair market price (per MHz) of mobile spectrum should fall. However, as we explain here, because spectrum is a critical input that can affect the quality of a network, its value is sensitive to any constraints on supply, especially if these could lead to one or more operators gaining a sustained advantage over their rivals.

Demand for spectrum from mobile operators is rising rapidly, driven by the need for more network capacity to support rapid growth in mobile data usage. Figure 1 illustrates Ericsson's projected growth in demand for mobile data. This growth is driven by the adoption of data-intensive applications, such as high-quality video streaming. More spectrum can also support higher data speeds, but – once an operator has a critical mass of spectrum – this is less important than adding capacity, as there are (as yet) few applications that require speeds higher than can be provided with a good 4G connection. According to a report commissioned by ComReg, demand for mobile data will increase four-fold between 2017 and 2022.[3]

[3] Frontier Economics, 27 April 2018, *Mobile Data Traffic Forecast in Ireland* (ComReg 18/35).

Figure 1: Ericsson projected mobile data usage per active smartphone (GB per month)



Source: Ericsson Mobility Report, June 2018
Notes: Arrow and text added by NERA Economic Consulting

Radio spectrum is the first and best option for mobile operators seeking to expand network capacity. If operators fail to deploy this additional capacity, their networks will become increasingly congested, which will be reflected in a declining quality of services, for example lack of connectivity, longer latency and dropped connections. To avoid such problems, especially in urban centres, operators will need to steadily increase deployment of spectrum throughout the next decade. They will also need to refarm all or most of their 2G and 3G spectrum for 4G and 5G use.

There are other ways that mobile operators can increase their network capacity:

- The main alternative to spectrum is **network densification** – for example infilling new macrocells or deploying small cells.

- MNOs can also **deploy more spectrally efficient technologies** such as beamforming and massive MIMO. These increase the capacity and propagation of some bands, especially higher frequencies.

In practice, mobile operators can be expected to deploy such techniques in combination with more spectrum. The higher the price of spectrum, the less they will consume and the more they might rely on cell densification and new technology. However, it is implausible that an operator would invest in these alternatives to the extent that they replicate the capacity and speed benefits associated with using more spectrum. Other than acquisition, the costs of deploying additional spectrum (in existing bands) is relatively small. In contrast, deploying new sites and new technologies is expensive and may not be practical in some locations. For example, planning or space restrictions may limit scope to deploy new sites or add more antennas to masts. There are also limits on the gains from capacity enhancing techniques such as cell-splitting.

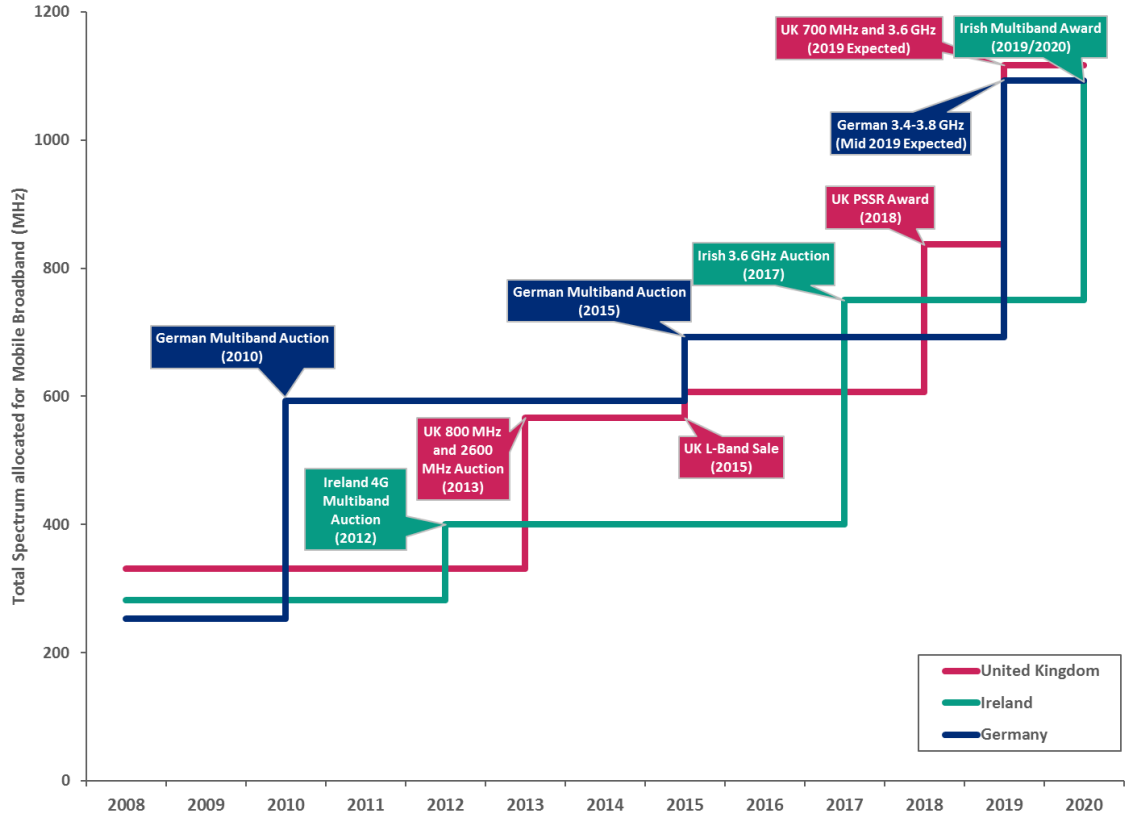
Historically, high valuations for spectrum have been based on expectations that this would enable operators to gain a greater share in an expanding market. However, throughout the 4G

era, mobile operators have experienced flat or declining ARPUs, despite huge growth in data use. Although the 5G era is expected to bring new market opportunities associated with the Internet of Things (IoT), the ability of MNOs to turn these into viable revenue streams is uncertain. This implies that, looking forward, MNOs will invest in spectrum primarily to maintain quality of services relative to their peers, and thus stay competitive and maintain market share.

In a market with high fixed costs and low revenue growth, MNO profitability is dependent on maintaining large customer bases. Operators with congested networks risk losing customers to rivals, owing to perceived poor quality of service. In such an environment, the value of spectrum is very sensitive to whether or not individual operators face capacity constraints that could reduce their competitiveness. If regulators can release supply ahead of critical demand, then prices should be modest and harmful congestion can be avoided. However, if operators anticipate that there may be insufficient spectrum for all operators to avoid congestion, then they can be expected to spend heavily on spectrum to defend their customer base and minimize the loss of enterprise value. In this case, auction prices are driven primarily by strategic factors affecting MNOs rather than the value derived from consumer's willingness to pay for 5G services, and therefore may be a poor proxy for social value generation.

The good news is that there is plenty of spectrum coming available in Ireland. Figure 2 compares the timeline for release of spectrum in Ireland to Germany and the UK. As can be seen, with the 2017 release of 3.5 GHz and the 2019 multi-band award, Ireland is moving from a position of relative shortage in the supply of mobile spectrum to relative abundance. Crucially, there is sufficient spectrum being made available that all three Irish MNOs can each acquire the critical mass of spectrum that they need to avoid network congestion through the medium term. This should allow the focus of competition to move towards products and services, rather than who has the least congested network.

Figure 2: Spectrum allocation timeline in Ireland, United Kingdom, and Germany (2008-2020)



Sources: NERA Economic Consulting
Notes: Spectrum available following completion of a primary award or secondary market acquisition of liberalised spectrum. We include 700 MHz, 800 MHz, 900 MHz, 1500 MHz (L-Band), 1800 MHz, 2100 MHz (FDD), 2300 MHz, 2500 MHz (FDD/TDD), and 3.4-3.8 GHz (liberalized use).

While the social value of the mobile data services that spectrum awarded in the next Irish auction will deliver is high, the share of this value that will be realised by mobile operators is modest. If we assume that no operator expects to gain a significant competitive advantage over the others, because all will acquire substantial new resources, then the market price of the spectrum should be modest. Certainly, one would expect prices per MHz to be significantly lower than in Ireland's 4G auction in 2012, when there was a relative shortage of spectrum suitable for both geographic coverage and network capacity.[4] In this context, a modest market price should be considered a good thing, i.e. an indication that ComReg is doing its job in bringing spectrum to market in a timely manner. In contrast, a high market price may be an indication of market failure, for example auction rules that create artificial scarcity or distort the competitive landscape.

[4] In 2012, there were four operators but only enough 800 MHz spectrum to allow three operators to win the 2x10 MHz desired for 4G coverage. For legacy reasons, ComReg – unlike other EU countries – was unable to release the 2600 MHz band, meaning that only the 1800 MHz band was immediately available for 4G capacity.

2.2. Excessive spectrum pricing could delay 5G

Over the last three years, NERA has undertaken extensive research for the GSMA into the linkages between high spectrum prices and market outcomes.[5] Our reports identify both theoretical and empirical evidence that policy decisions that artificially inflate spectrum prices cause damage to consumers. Put simply, higher prices are associated with more expensive, lower quality mobile broadband and irrecoverable losses in consumer welfare.

The reports presented the following findings:

- New theoretical and empirical work by academics shows that high sunk costs associated with essential inputs – such as spectrum licences – can depress investment and dampen price competition.

- Worldwide, spectrum prices have trended upwards throughout the 4G era; however, in Europe, this is only true for a minority of countries, where high price results can be linked to questionable decisions on award rules.

- Empirical analysis reveals a link between higher spectrum prices and lower investment in next generation mobile, as well as higher prices for consumers. From this, it can be inferred that policy decisions that artificially inflate spectrum prices can set back a country's mobile broadband aspirations and destroy substantial consumer welfare.

We briefly explain each of these findings below. The key point is that extracting revenues for spectrum is not a "free lunch". Placing constraints on the supply of spectrum can boost government revenues but this may come at the expense of leadership in 5G. Over the long-term, countries that work to create an environment that supports modest, market-based pricing of spectrum are more likely to have successful mobile sectors.

Why sunk costs matter

The main rationale for charging a price for spectrum is to promote its efficient use. The price is an objective means of distinguishing between different applications for spectrum licences. In this way, a well-designed auction will allocate spectrum to those who value it most thus incentivising them to use it efficiently. Charging for spectrum also provides money for the state and, where demand is high, this can be significant.

Nevertheless, it is important that prices do not exceed a fair market level. There is broad agreement that if spectrum is priced so high that it fails to sell, this does serious harm. Spectrum is a renewable resource, so when it is left unassigned for any prolonged period, welfare benefits that would have accrued to consumers, and society more widely, are lost

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[5] NERA report for GSMA, February 2017, *Effective Spectrum Pricing: Supporting better quality and more affordable mobile services* (the "global report"); and NERA report for GSMA, September 2017, *Effective Spectrum Pricing in Europe: Policies to support better quality and more affordable mobile services* (the "Europe Report"). The full reports as well as summaries can be downloaded from the GSMA website at: https://www.gsma.com/spectrum/effective-spectrum-pricing/

forever. According to Frontier Economics, in a report prepared for ComReg, radio spectrum contributed a total of €6.2bn (3.5%) to Ireland's Gross National Income (GNI)[6] and supported approximately 17,000 full time equivalent jobs in 2016.[7]

But what if spectrum is priced highly but still sells? Historically, many mobile industry observers argued that because spectrum costs were 'sunk', no matter how high a price is paid, there should be no impact on network investment or higher mobile tariffs. The classic comparison is with investing in a piece of factory machinery which cannot be sold again. The upfront cost of the machine is sunk. Therefore, as it cannot be recovered, it should not influence future decisions regarding the price of the products created using the machine. In our GSMA report, we highlighted recent academic work that contradicts this notion that firms ignore sunk costs when making decisions on investment and pricing.[8] Far from being a distortion-free tax, the literature shows how high upfront input costs can depress investment and reduce price competition, especially in settings – as in the Irish mobile sector – when there are only a few network operators.

Rising prices in the 4G era

Our global study examined 325 awards of spectrum bands across 60 countries from 2000-2016. We found that, over the 4G era from 2008-2016, the average final price paid for spectrum increased 3.5-fold, while average reserve prices increased over 5-fold. Although the prices paid for many awards worldwide remain moderate, we observed that the upward trend was being driven by a growth in the number of very high price auctions.

Our European study drew on a subset of these awards, covering 139 spectrum band releases across 30 European countries. We found the same upward trend in prices in Europe as worldwide. Although there are fewer examples of extreme high price auctions, these again are more common towards the end of the time period. With regards to reserve price setting, there was no clear trend in the European sample, but we did identify wide variation in reserve pricing for both coverage and capacity spectrum between countries. This implies that local regulators are taking very different approaches to setting reserve prices, notwithstanding their common obligations with respect to spectrum management under the European directives. While many countries in Europe price conservatively – for example, Finland and Sweden –

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6 Frontier uses GNI rather than GDP, as this is the measure of national income preferred by the Central Bank of Ireland. Frontier writes: "Gross national income is the sum of a nation's gross domestic product and the net income it receives from overseas." (ComReg 18/118a, pg 5).

7 Frontier Economics, December 2018, *The Economic Contribution of Radio Spectrum to Ireland* (ComReg 18/60).

8 Specifically, we highlighted three economic principles that highlight why firms do not treat upfront spectrum fees as sunk costs: (1) The "hold-up problem" that arises when the return on one parties' sunk investments can ex post be expropriated by another party (see for example Rogerson, 1992, *Contractual Solutions to the Hold-up Problem*, Review of Economic Studies, Vol 59, pp. 777-794); (2) "Internal financing constraints" that arise from large expenditures from acquiring spectrum licences may exhaust access to capital from multinational parents or external sources and thus be rationed in response to low profitability (see for example Stein, 1997, *Internal Capital Markets and the Competition for Corporate Resources*, The Journal of Finance, Vol. 52, pp. 11-114). (3) We also highlight simulated experiments. In one experiment, economists found that high fees for licences to enter the market produced high short-term prices for consumers in markets with a small number of competitors (see Offerman and Potters, 2006, *Does Auctioning of Entry Licences Induce Collusion? An Experimental Study*. Review of Economic Studies (2006), Vol. 73, pp. 769-791.).

others have apparently attempted to set prices at or close to their market value – for example, Croatia and Hungary.

This upward trend in prices would not be so concerning if all instances of very high prices were being set by the market, i.e. attributable to strong competition between bidders with robust business cases. However, our research shows that many of these outcomes were due to policy decisions, not market forces. For example, in Europe, exceptionally high prices for spectrum in auctions in Austria (2013), Netherlands (2012) and Poland (2015) can be linked to distorted bidding incentives that stemmed from issues with the auction design and local policy decisions.

For a more recent example of auction outcome being distorted by peculiar regulatory decisions, consider the case of Italy's 5G auction in October 2018. The 200 MHz of spectrum available at 3600 MHz sold for €3.58bn or € 0.29 per MHz/pop.[9] This very high price can be attributed to artificial scarcity resulting from two decisions made by telecoms regulator Agcom. First, in early 2018, the regulator decided to extend by six years the concessions of FWA (fixed wireless) operators in the band, which meant that only 200 MHz of a possible 400 MHz spectrum was available for mobile operators. Second, the regulator selected a peculiar lot structure of two 80 MHz lots and two 20 MHz lots, with a 100 MHz cap per operator, which meant that no more than two Italian operators could secure a meaningful 5G portfolio. This unhappy outcome may be compared with the successful award of the same band in Ireland, where ComReg made available 350 MHz, most of it in 5 MHz lots, and required FWA operators to compete against mobile operators. The auction was competitive, resulting in a fair market price of € 0.04 per MHz/pop.[10]

The link between high spectrum prices and lower investment

Over the last 18 months, many governments worldwide have launched new digital strategies, which emphasise the importance of investing in 5G mobile. Governments can help realise their ambitions by adopting policies that incentivise network investment by mobile operators. In our research for the GSMA, we looked for evidence that high spectrum prices depress investment and, vice versa, that embracing policies that discourage high spectrum prices can help boost investment.[11] To test these links, we explored the relationship between a country's "wireless score" (a measurement of service quality and 4G uptake that serves as a proxy for investment) and total spend on spectrum.

Both worldwide and in Europe, we found a correlation between lower total spend on spectrum and higher wireless scores. We also found a correlation between lower spectrum costs and lower consumer prices for data services. Taken together, we calculated that high

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[9] We adjust the final upfront price of €4.35bn for the payment structure of the licences and discount using a rate of 8.63% (payments are spread between 2018 and 2022). We also adjust for licence duration and PPP differences using IMF PPP rates.

[10] To calculate this benchmark, we apply an 8.63% discount rate to Ireland's annual spectrum usage fee (SUF).

[11] See Section 2.2 of the global report (NERA report for GSMA, *Effective Spectrum Pricing: Supporting better quality and more affordable mobile services*) and the "Spectrum prices and network investment" starting on pg. 11 of the Europe report (NERA report for GSMA, *Effective Spectrum Pricing in Europe: Policies to support better quality and more affordable mobile services*).

spectrum prices were associated with net welfare losses[12] of €24 billion (€48 per person) across 12 European countries. Our results support the hypotheses in the academic literature that high input costs suppress investment and discourage price competition. They contradict the more simplistic hypothesis that licence costs do not affect investment because they are sunk costs.

These empirical findings reinforce the point that regulators should take great care to avoid actions that could distort auction outcomes and lead to prices that exceed a fair market level. The financial upside, if any, for governments from revenues is offset by the risk of award failure and downstream inefficiencies leading to lower quality, more expensive services. In some countries, where spectrum auctions have taken place against a background of fiscal crisis, it can be hard to accept this trade off. Fortunately, the next Irish auction is scheduled at a time when the economy has been performing well, which should provide the political freedom needed for ComReg to prioritise the long-term interests of the nation.

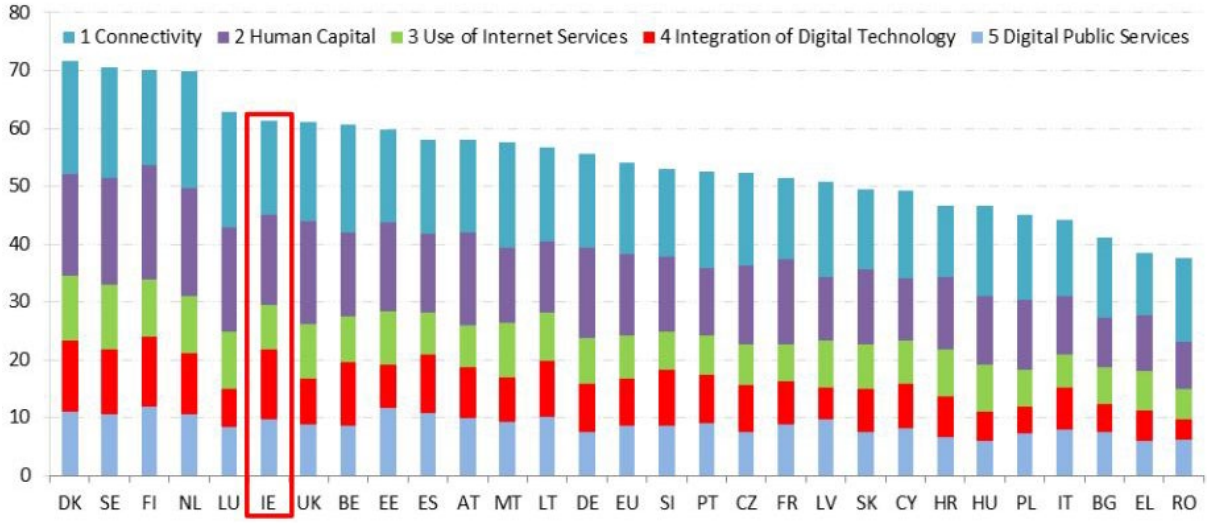
2.3. Why spectrum pricing is a relevant concern in Ireland

In recent years, Ireland has outperformed many European countries in developing its digital economy and society (DES). In 2018, Ireland ranked 6th amongst 29 EU member states in the European commission DESI rankings, up from 9th in 2017, as illustrated in Figure 3. However, within this index, it underperformed in connectivity (11th place) and, in particular in key components of connectivity, including fixed broadband (19th), ultrafast broadband (22rd) and 4G coverage (17th).[13] Connectivity has long been recognised as a particular challenge in Ireland owing to disproportionately high roll-out costs relative to many other European countries (for reasons we discuss below). This makes it particularly important that ComReg and the Irish government promote an environment that incentivises operators to invest in their networks. Getting spectrum pricing right is a key part of this environment.

[12] Total welfare losses for consumers were €34 billion, against gains in auction revenues for government treasuries of €9.8 billion.

[13] European Commission, *DESI 2018 Country Report Ireland*. Available at: https://ec.europa.eu/digital-single-market/en/scoreboard/ireland

Figure 3: EU Digital Economy and Society Index (DESI) 2018 Rankings



Source: European Commission, DESI 2018 Country Report Ireland.

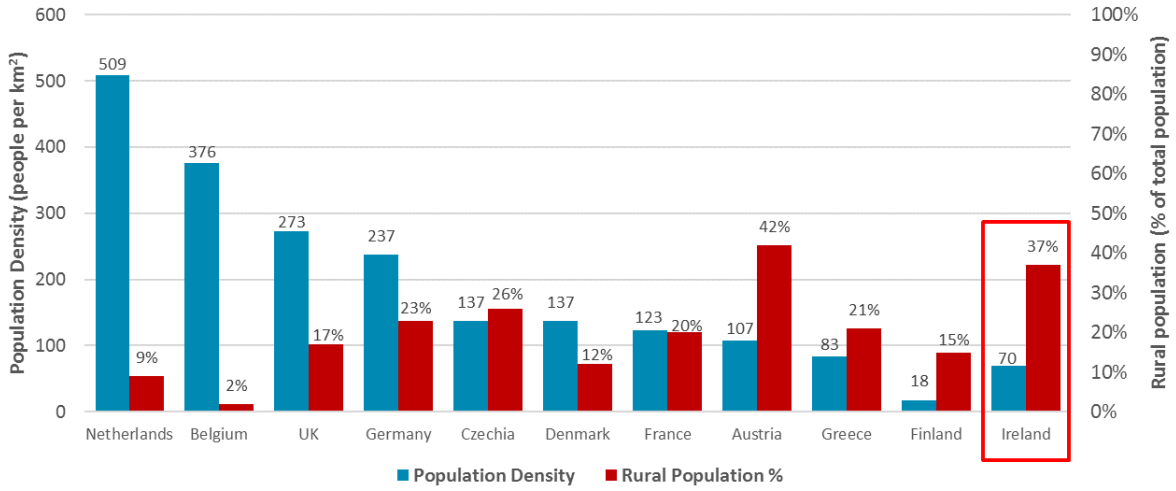
For broadband coverage, Irish consumers are very dependent on DSL connections. We are advised by Three that, in many locations, DSL speeds have already reached their maximum, which implies that Ireland risks falling back down the connectivity rankings as other countries invest in fibre to the home. Ireland's National Broadband Plan should reverse any decline eventually if delivered, but implementation of the plan is delayed.[14]

The root cause of Ireland's connectivity challenge is its high population dispersal. As illustrated in Figure 4, Ireland has a low population density and high rural population when compared to other European countries. However, these simple statistics do not tell the whole story. First, there are no dense high-rise cities: compared to, say, equivalently sized UK cities, Dublin has a modest sized city centre and a large low-rise suburban area. Outside of the five main cities, buildings are scattered almost everywhere. Whereas in many European countries, the rural population is clustered into small towns and villages, in Ireland that is mostly not the case. For various historic reasons, rural area houses are often built in 'ribbon developments' consisting of a whole series of one-off houses all the way along the roads between villages. Ireland also has an unusually large road network for its population size.[15] This makes for a very challenging environment for both fixed and mobile rollout because it means that to reach almost all the population, nearly all small roadways must be covered.

[14] On 27 November 2018, the government accepted a review of an Independent Process Auditor of the procurement process for the NBN. The Department of Communications, Climate Action & Environment is currently reviewing the Final Tender from Granahan McCourt. (https://www.dccae.gov.ie/en-ie/news-and-media/press-releases/Pages/-Minister-Bruton-Publishes-Smyth-Review.aspx)

[15] In a report for ComReg, Frontier Economics reports that Ireland has 5,306 km of primary and secondary roads and a further 91,000 km of regional and local roads. This amounts to 21km per 1000 inhabitants, or twice the EU average. (Frontier Economics, 30 November 2018, pg 8, *Meeting Consumers' Connectivity Needs a report from Frontier Economics* [ComReg 18/103b]).

Figure 4: Population density and rural population %, Ireland and other countries



Source: World Bank Data for 2017. Accessed 20 November, 2019.

Given the challenges with availability and cost of fixed broadband in Ireland, wireless services, especially mobile, play an important role in providing broadband in Ireland. According to the DESI, take-up of mobile broadband is 104%, well above the EU average of 90%.[16] Nevertheless, even though mobile may be the best solution for providing broadband in some areas, it also faces high costs in providing more ubiquitous coverage.

Three Ireland tell us that about 60% of all their sites are in rural areas, while only 37% of the population live in those areas.

Three also advised us of other factors that add to the expense of building and maintaining a wireless network in Ireland compared to other European economies:

- Irish operators do not have big enough networks to secure the technical and operational benefits available to operators in larger countries. This compounds the problem of the disproportionate rollout burden created by population dispersal.
- Ireland has the 3rd highest electricity prices for non-household consumers in Europe, according to Eurostat,[17] and electricity is a key component of the costs of running base stations.
- Access to fibre outside the main cities is difficult to obtain and expensive.
- Planning processes are long and cumbersome and localised at the local authority level. Perhaps reflecting this, rents for radio sites are higher than in many European countries.

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16 European Commission, *DESI 2018 Country Report Ireland*. Available at: https://ec.europa.eu/digital-single-market/en/scoreboard/ireland

17 Electricity prices in Ireland are only lower than Malta and Cyprus. If taxes are included, then Ireland ranks 6th in the European Union. Eurosat, accessed 20 November 2018, *Electricity prices for non-household consumers, second half 2017 (EUR per kWh)*. We exclude "Taxes without VAT" and only include the value before taxes. Source: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Electricity_prices_for_non-household_consumers,_second_half_2017_(EUR_per_kWh).png

Given that Irish operators already face a disproportionately high cost base for network rollout, it follows that they are likely to be particularly sensitive to high spectrum costs. Enacting policies that support modest market prices for spectrum may therefore matter even more in Ireland than in many other European countries.

The rewards for Ireland if it puts the right policies in place to drive investment in mobile broadband connectivity may also be disproportionately high. The same population dispersal profile that makes the Irish population particularly expensive to cover at this stage in the development in mobile connectivity may not be such a barrier in the future. For example, consider the case of connected cars and the possibility that this will ultimately require a mobile grid covering all roads. This is an enormously expensive undertaking in countries with large empty areas and long roads connecting disparate towns but may, in the very long term, be less so in Ireland where almost all roads will already need to be covered to service most of the population. Put differently, if Ireland can get its policy mix – including spectrum pricing – right, it could ultimately be positioned to lead EU digital economy and society rankings.

2.4. How ComReg can mitigate the risk of high spectrum prices in the multiband auction

In our GSMA work, we identified four policy recommendations for regulators, as summarised in Figure 5. In this section, we consider what actions ComReg could take, consistent with these recommendations, to promote fair pricing of spectrum in the forthcoming multiband award. Such actions include setting modest reserve prices and avoiding licence conditions and auction rules that may distort bidding.

Figure 5: NERA policy recommendations on spectrum pricing

#1 **Prioritise spectrum allocation**	#2 **Set modest reserve prices**
• Release usable spectrum in anticipation of need • Provide a roadmap for future spectrum availability, so operators understand their options	• Do not set reserve prices above a conservative estimate of true market value • Treat annual fees as an integral part of the reserve price
#4 **Help operators manage risk**	#3 **Adopt a long-term perspective**
• Avoid options for bidders to foreclose the market and be mindful of threats to enterprise value • Adopt an integrated approach to spectrum pricing and licence conditions, such as coverage obligations	• Prioritise consumer welfare benefits from investment and competition over short-term revenue benefits • Adopt longer licence durations

Source: NERA report for the GSMA, September 2017, *Effective Spectrum Pricing in Europe: Policies to support better quality and more affordable mobile services*.

Prioritising spectrum allocation

During the 4G era, ComReg lagged behind most other European countries in mobile spectrum allocation, owing to legacy delays in the release of the 2600 MHz band (the band was used for microwave terrestrial TV distribution systems which could not easily be moved). As a result, Irish operators have had to build their 4G networks with less capacity available than European counterparts. Arguably, this was less of an issue in Ireland than it would have been in, say, Germany or the United Kingdom, as Ireland has fewer dense urban locations, and thus fewer cell sites subject to early congestion as data use expanded. Looking forward, however, as heavy data use broadens beyond urban centres, this spectrum capacity will become essential.

The good news is that legacy issues at 2600 MHz have been resolved and ComReg has identified a series of additional spectrum bands to be released. In 2017, Ireland became the first country in Europe to release spectrum across the entire 3.4-3.8 GHz band for 5G mobile use. As illustrated in Figure 2, following the multiband auction in 2019/2020, Ireland is set to catch up with Germany and the UK to become a European leader in spectrum allocation.

ComReg has also adopted best practice in terms of flagging potential future releases of spectrum. In the same policy document in which it outlined its plan for a simultaneous release of new spectrum at 700, 2300 and 2600 MHz, ComReg also flagged the potential future release of spectrum at 1.4 GHz and 26 GHz.[18] It decided that it would be prudent to delay these awards until the ecosystems for these bands are more developed and the industry has digested the multi-band release.

In summary, ComReg has a well-developed roadmap for release of spectrum over the next five years. There is plenty of spectrum available and operators should have a clear understanding of their purchase options. Going forward, Ireland is well positioned to avoid artificial scarcity in spectrum supply, which should set the stage for all operators to build adequate spectrum portfolios at modest prices.

Setting modest reserve prices

Best practice is to set reserve prices that are below a conservative estimate of true market value, to facilitate competitive auctions with room for price discovery and to minimize the risk of spectrum going unsold.

A central challenge for regulators is that estimating market value is not easy. For past awards, including both the 2012 multiband and 2017 award of 3600 MHz, ComReg relied on benchmarks of prices from awards in other countries to inform how it sets the reserve prices. Key advantages of this approach include simplicity and low cost. However, there are also risks. In particular, if the sample size is small, the benchmark could be distorted by high price outliers (including low price outliers are less of a problem, as they will not lead to unsold spectrum) and there may be local factors not reflected in international benchmarks.

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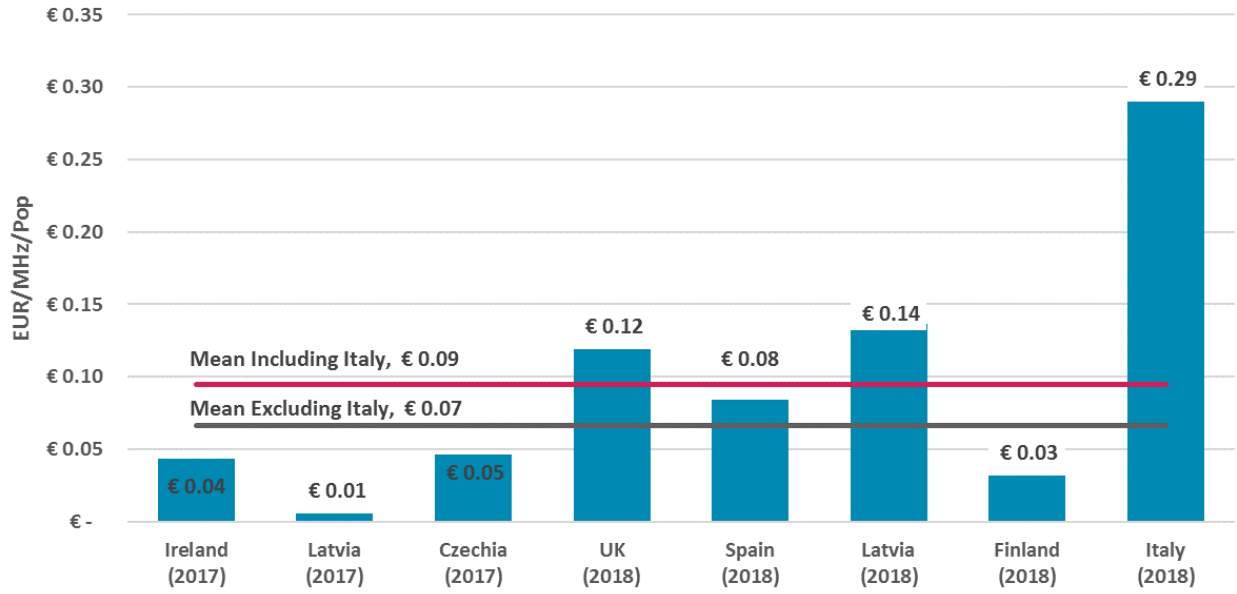
[18] ComReg, 29 June 2018, Sections 4.3 and 4.6*, Proposed Multi Band Spectrum Award: Preliminary consultation on which spectrum bands to award* (ComReg 18/60).

In hindsight, ComReg appears to have got its approach to the 3600 MHz auction about right. In 2015, based on an analysis of benchmarks, ComReg's advisor, DotEcon, found that "*minimum prices [in the 3600 MHz Auction] should be set in the range €0.015 to €0.025 per MHz per capita*."[19] The report also recognized that there is less risk of choking off demand for spectrum at the lower end of the given range. ComReg ultimately adopted the lowest point of the range (€0.015) for metro regions and a discounted price for rural areas. This facilitated a competitive auction process, with final nationwide prices averaging €0.04.

Nevertheless, it is not hard to imagine how the same exercise could have gone very wrong if performed in November 2018. Such an analysis would likely have focused on 5G-era auctions, as shown in Figure 6, including the record price in Italy. Note that a simple average including Italy is €0.09, more than twice the market price in Ireland. Had a reserve price based on that benchmark been applied in Ireland, a large chunk of spectrum would likely have gone unallocated. This simple example shows the importance of making conservative assumptions when using benchmarks, including eliminating high price outliers (especially if local factors, as in Italy, distorted prices) and setting reserve prices significantly below the final benchmark.

Figure 6: European 3.4-3.8 GHz Awards from Ireland's 2017 3600 MHz Auction onwards



Source: NERA Economic Consulting
Notes: Inclusive of annual fees, adjusted for inflation and licence duration (15 years). Converted to EUR using IMF PPP rates. A standard 8.63% discount rate is used.

Two other ways that regulators can help operators plan and manage their costs are 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, ComReg has been a leader within Europe.

[19] DotEcon, 9 July 2015, pg. 22, *Report from DotEcon on 3.6 GHz band reserve prices* (ComReg 15/72).

Unlike most other regulators, it 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%). ComReg should continue this approach.

Helping operators manage risk

Prices in spectrum auctions reflect the conditions under which bidders are competing for the scarce resource. If those conditions are distorted, then the price may deviate from the fair market level. In both our European and global reports for GSMA, we highlighted a range of policies, award rules and licence conditions that create risk for bidders and distort award outcomes. The Irish multiband auction and 2100 MHz refarming will be a high-risk event for Irish operators. With 42% of total Irish mobile spectrum at stake, an operator that fails to secure a critical mass might cease to be a competitive entity. With three strong operators, such an outcome seems unlikely, but it is not impossible. ComReg has the tools to preclude such undesirable outcomes, including prudential use of spectrum caps and good auction design.

In our report on spectrum pricing in Europe for GSMA, we specifically highlighted the risks inherent in running large multiband awards:

> "*A much bigger problem in Europe has been poor choices in award rules which lead to excessive spectrum pricing, through promotion of insincere bidding, exposure of bidders to loss of enterprise value or encouraging anti-competitive bidding. In recent years, many European countries have held large multi-band awards. Such large auctions offer both advantages and disadvantages. At their best, such events make it easier for bidders to manage substitutability and complementarity across bands, and thus identify the optimal spectrum portfolio for their needs. At their worst, they open up the possibility that an incumbent could suffer serious network disruption or even be knocked out of the market, especially where they face losing access to legacy spectrum*."[20]

In the report, we highlighted the cases of 4G awards in Austria, the Netherlands and Poland where prices for incumbent operators were, almost certainly, inflated beyond true market value, owing to award designs that created artificial scarcity in spectrum. For incumbent bidders in these auctions, their future enterprise value was on the line, and the award formats encouraged aggressive rather than conciliatory bidding.

To avoid such problems in Ireland, ComReg should be particularly careful with respect to the following areas of award design:

1. **Coverage spectrum.** Although a large quantity of spectrum is available, there is only 2x30 MHz of additional coverage spectrum at 700 MHz for 5G. This spectrum is particularly important for Ireland, given the large rural population. An obvious and highly likely outcome is that the three MNOs will win 2x10 MHz each. Any other

[20] NERA report for the GSMA, September 2017, pg. 20, *Effective Spectrum Pricing in Europe: Policies to support better quality and more affordable mobile services*.

outcome could leave one operator with an inferior 5G play. ComReg could address this by setting a 2x10 MHz cap per operator, relying on the reserve price and/or competition from entrants to ensure a fair price outcome. If instead it sets a higher cap that allows for competition between the MNOs in this band, then it should ideally avoid any auction format that uses opportunity cost pricing, as such formats are known to encourage over-bidding for incremental spectrum in situations where winning bidders are setting each other's prices.[21]

2. **Common cap across 2300 and 2600 MHz.** Above 2 GHz, there is plenty of spectrum available and the likelihood of any bidder or bidders foreclosing the Irish market seems remote. Nevertheless, there is merit in adopting a prudential cap set at a level that ensures at least bidders secure a critical mass of spectrum. As the 2300 and 2600 MHz bands are close substitutes for 4G and 5G capacity, and operators may decide not to buy in all bands, it makes sense that any cap extends 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.

3. **Auction format.** For the last two awards, ComReg has used a combinatorial clock auction (CCA) format. This format may not be the right one for this award. The main upside of using the CCA (or related package bid formats) is that it eliminates aggregation risk, but this is unlikely to be a major concern for MNOs in this auction. 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. 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. Such a scenario is highly plausible in Ireland, where the prospects for non-MNO participation are uncertain. (To reduce this risk, ComReg could set tighter spectrum caps, but – as we explain in Section 3 – that would mean reducing the range of possible award outcomes.)

4. **Coverage obligations**. Spectrum auctions, especially ones for sub-1 GHz spectrum, provide a tempting opportunity for regulators to attach coverage obligations to licences. If these obligations are symmetric across all licences and set at "precautionary" levels that can be achieved on a commercial basis, then they should not distort bidding.[22] However, some countries have gone further, attaching onerous obligations to a subset of licences, which then sell at a discount to unencumbered spectrum. ComReg should be wary of going down such a route, as this creates artificial scarcity of "clean" spectrum and may distort bidding across the whole auction. There are better solutions, for example having a second auction stage in which operators compete in a reverse auction to reduce their payments for spectrum in

[21] For further discussion of this point, including the academic literature, see Section 4 of this report.

[22] DotEcon make the same point in their recent report for ComReg: DotEcon, Coverage obligations and spectrum awards, 30/11/2018, ComReg 18/103d.

return for committing to non-commercial coverage targets in specified geographic areas.[23]

Adopting a long-term perspective

Our final recommendation was that governments and regulators adopt a long-term perspective on allocation of spectrum for mobile, and thus prioritise the benefits to consumers and society that are associated with modest market-based prices over short-term revenue gains from high-price auctions. Ireland already scores well with respect to setting up a regulatory framework that encourages long term planning. Decisions on spectrum are largely delegated to ComReg, which is an independent regulator. EU objectives to promote the efficient use of spectrum and support downstream competition are incorporated into ComReg's statutory objectives.

An area where ComReg should review its approach is with respect to licence duration. To date, ComReg has typically issued fixed-term licences, which expire after 15 years. By international standards, 15 years is a relatively short licence term. ComReg should consider adopting longer licence terms that allow more time for investment amortisation. ComReg should also consider policies that provide greater certainty for operators over licence renewal, so that they have incentives to continue to invest in spectrum in the final years of a licence term.

There is an emerging industry consensus that mobile licences should be at least 20 years given the long investment cycles in mobile technology:

- In 2016, the European Commission proposed a minimum spectrum licence duration within Member States of 25 years.[24] Although the proposal was not adopted owing to concern from member state regulators that this might unduly constrain achievement of future policy goals, the general principle that operators need more certainty to invest was established.

- The Australian Communications and Media Authority (ACMA) recently proposed to increase licence durations from 15 to 20 years to contribute "*significantly to the degree of predictability has about its future use of the licensed spectrum, encouraging long-term investment in the use of spectrum*."[25]

- In a paper titled "*Best practice in Mobile spectrum licencing*", the GSMA argues for minimum 20-year licence terms to provide operators with the certainty they need to

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[23] In ComReg 18/103d, DotEcon also observe that attaching onerous coverage obligations to lots can lead to distorted auction outcomes. However, we disagree with their conclusion that such distortions can be avoided by having separate coverage obligations within the same stage of an auction. As we discuss in Section 4, if such obligations are deemed necessary, they should ideally be included in a separate bidding stage.

[24] European Commission, 12 October 2016, *Proposal for a Directive of the European Parliament and the Council: establishing the European Electronic Communications Code (Recast)*, 2016/0288 (COD).

[25] ACMA, May 2017, Annex A, pg. 12, *The licensing system: Supporting material for the Exposure Draft of the Radiocommunications Bill 2017*. Available at: https://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/Spectrum-review/exposure-draft-radiocommunications-bill-acma-supporting-material

undertake long-term investments in network roll out and deployment of new services.[26] The GSMA further argues that investors are "reluctant" to invest in spectrum licences if the expected payback period is too short to fully realise the business case required for investment.

- A 2016 report by LS Telecom, Valdani Vicari & Associati and PolicyTracker found evidence of a relationship between longer licence durations and higher CapEx investment in mobile networks within EU Member States.[27] Specifically, the report argues that 10-15-year licence durations are too short and lead to negative business outcomes, such as lower investment in mobile networks and subsequent decrease in quality of service for consumers.[28]

A downside of fixed terms, regardless of duration, is that incentives to invest further in the spectrum will always diminish towards the end of the licence, unless bidders have reasonable certainty over renewal. Some, more market-orientated regulators, such as the FCC (USA) and Ofcom (UK) have systems for default renewal of licenses, so as to address this problem. In the UK, licences are subject to automatic extension after a 20-year initial licence term, unless revoked with at least 5 years notice. In the likely event that licences continue beyond their initial term, licensees must pay fees that reflect a conservative estimate of market value. This approach provides UK operators with greater certainty over their long-term spectrum holdings and future expenditure on spectrum, as well as creating stronger incentives for secondary trading. ComReg may wish to consult with the industry on whether a similar system could work in Ireland.

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[26] GSMA, September 2016, pg. 38, *Best practice in mobile spectrum licensing*. Available at: https://www.gsma.com/spectrum/best-practice-mobile-spectrum-licensing/

[27] LS Telecom, Valdani Vicari & Associati, PolicyTracker, 4 October 2017, pg. 97, *Study on Spectrum Assignment in EU*. Available at: https://publications.europa.eu/en/publication-detail/-/publication/2388b227-a978-11e7-837e-01aa75ed71a1/language-en

[28] *Ibid. pg. 113.*

3. Spectrum packaging and caps

Spectrum packaging is the term used to define how the available spectrum is structured into lots and how these lots can be aggregated into licences. Spectrum caps describe the limits placed on how much spectrum or how many lots a bidder can acquire in the auction.

There are advantages and disadvantages to more restrictive versus less restrictive packaging and caps. Restrictive measures set bounds on the range of allocation outcomes that are possible and may increase or decrease the likelihood of particular outcomes. A downside is that this necessarily constrains the scope for the market to test alternative outcomes and could, in principle, prevent an efficient outcome. The upside of restrictions is that they may reduce risk both for bidders and for the regulator, for example by eliminating outcomes that may have a negative impact on downstream competition. Risk reduction may help ensure that bids more accurately reflect the intrinsic value of the spectrum to bidders.

The extent to which packaging and caps address risk for bidders may also influence the choice of auction format, as some formats are better than others for addressing specific concerns. For example, a regulator may decide that a less restrictive approach to packaging (such as having many small lots) may require a more complex format, such as multi-round package bidding (to ease aggregation risks associated with buying many lots).

In this section, we discuss the options available to ComReg for packaging spectrum and setting caps for the following groups of spectrum that could be included in the next multi-band auction:

- the 700 MHz FDD band, where there are several plausible options for packaging and caps;
- the 2100 MHz band, where packaging is not straightforward, and there is a strong case for direct award instead of auction; and
- the 2300 and 2600 MHz bands, where we think there is an obvious best solution of packaging all available spectrum into 20 MHz blocks.

Our recommendations are designed to (a) facilitate easy **switching** between substitutable spectrum; (b) managing risk for bidders by eliminating outcomes in which operators fail to win a **critical mass of spectrum** in any particular band; and (c) **avoiding unnecessary complexity** in the choice of auction format.

We assume that, wherever possible, spectrum within each band will be sold in two stages, with a first stage to allocate generic lots and a second stage to assign specific frequencies on a contiguous basis. This approach, which has long been used by ComReg, works well and has become the norm across European spectrum awards.

3.1. 700 MHz

The 700 MHz band consists of 2x30 MHz of low-band spectrum, ideal for wide-area coverage. It can be used for 4G but has also been identified as a pioneer band for 5G. These characteristics are very different from the other three bands which are all above 2 GHz,

suitable for capacity for coverage, and have more established 4G ecosystems but less established paths to 5G. For these reasons, 700 MHz is not a close substitute for these other bands.

As all three Irish operators already have a critical mass of other low-band spectrum for 4G, it is quite likely that they will target this spectrum for 5G. The minimum unit of demand is 2x5 MHz, but operators may have a strong preference for a block of at least 2x10 MHz to provide sufficient capacity to justify investment in a third sub-1 GHz band.

With three operators in Ireland, this suggests an obvious likely outcome in which each operator wins 2x10 MHz. This may also be the best outcome for downstream competition as it will position all three operators for early provision of 5G in rural Ireland.

This creates a dilemma for ComReg, with two broad approaches it could take on packaging and caps:

1. *Accept the equilibrium*. ComReg could define three lots of 2x10 MHz and cap each bidder at 2x10 MHz. There are two main upsides of this approach: it would eliminate the risk that a bidder won only 2x5 MHz, which may be too little, and would ensure a minimum of three winners, which may be desirable for promoting early availability of 5G in rural Ireland. In this case, competition in the auction would only occur if there is a fourth bidder that is interested in acquiring 700 MHz spectrum. For example, this was the approach taken by the Belgium regulator for their award of 800 MHz, which has the same 2x30 MHz structure as the 700 MHz band (FDD).[29]

2. *Let the market explore more options*. ComReg could alternatively define spectrum in either 2x5 MHz or 2x10 MHz lots and set a higher cap, e.g. at 2x15 MHz or 2x20 MHz. This would allow the market to explore whether there are higher value auction outcomes than the equilibrium one. This could facilitate a more competitive auction; however, it also opens up the possibility of highly asymmetric outcomes. In this case, for the reasons we set out in Section 4, it may be preferable to use a non-package bid format, so as to avoid any incentives for over-bidding. An example of this approach is Germany which sold the spectrum in 2x5 MHz blocks with no caps using an SMRA format (the three incumbent operators each won 2x10 MHz each).

If ComReg decides to adopt lots of only 2x5 MHz, it could consider allowing operators to specify a "minimum spectrum requirement" (MSR) of 2 lots in the 700 MHz band. With this rule, a bidder that has specified an MSR is released from their obligation to purchase a single lot if they are outbid on a second lot. This approach eliminates the specific risk that a bidder could win 2x5 MHz when it wants at least 2x10 MHz, and can be implemented in a clock or SMRA format, so nullifying the need for package bidding to address aggregation risk. This

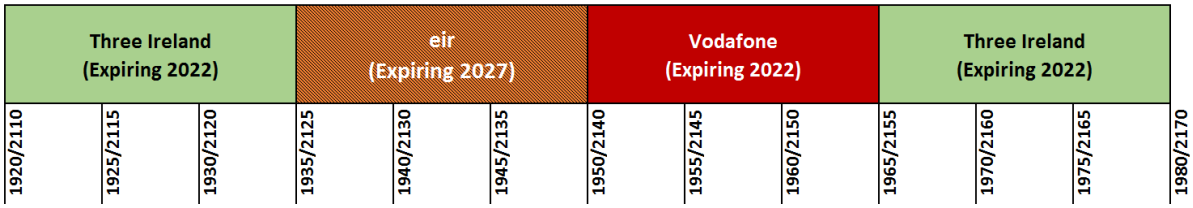
[29] Belgian Institute for Postal Services and Telecommunications, 12 November 2013, *BIPT makes the results of the 800 MHz auction public* (English Translation). Available at: https://www.bipt.be/public/pressrelease/en/72/Persbericht_+resultaat_veiling_ENG.pdf

approach has been widely used in spectrum auctions worldwide, including the *Award of 2.3 and 3.4 GHz spectrum by auction* in the UK in 2018.[30]

3.2. 2100 MHz

The 2100 MHz band consists of 2x60 MHz of prime mid-band spectrum, ideal for providing network capacity. The entire band has historically been used for 3G, but this technology is approaching the end of its life and is likely to be discontinued in Ireland before 2025. For legacy reasons, Three holds two licences covering 2x30MHz and Vodafone holds a licence covering 2x15 MHz, all scheduled to expire between June and October 2022, whereas eir holds a licence for 2x15 MHz that expires in March 2027, as illustrated in Figure 7. Once liberalised, operators are expected to transition the band to either 4G or 5G use.

Figure 7: Ireland current 2100 MHz band plan



Source: NERA Economic Consulting with data from ECO Report 03. Available at: https://www.efis.dk/views2/report03.jsp

The re-award of 2100 MHz presents an exceptional spectrum packaging challenge with no obvious best solution in the context of an auction. The main problems are that the expiry dates of existing licences are not aligned with the commercial timetable for turn-off of 3G networks and are not aligned with each other. Given that Three and Vodafone could fall back on their 900 MHz 3G networks, it is possible that both operators may wish to refarm the spectrum before 2022. Meanwhile, eir may prefer to turn off its entire 3G network well before 2027. Thus, without early liberalisation, 2100 MHz spectrum may not be well used in the final years of the licence. This inconsistency also means that the spectrum could not be sold as a single category, as different availability dates affect the value. In turn, selling the spectrum in multiple categories may introduce aggregation and substitution risk for bidders seeking to form larger contiguous blocks for 4G or 5G use.

If the spectrum is sold in auction, it could be packaged in one of two ways:

1. *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.

[30] In the 3.4 GHz band, auction participants could specify a minimum requirement of up to 4 blocks (20 MHz) in the 3.4 GHz band. Specifying 4 blocks at application meant that a participant's standing high bids in the 3.4 GHz band would not become winning bids if the total number of that bidder's standing high bids was less than 4 at the end of the principal stage. Regulation 38, *2018 No. 86 of The Wireless Telegraphy (Licence Award) Regulations 2018.* Available at: http://www.legislation.gov.uk/uksi/2018/86

2. *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.

The first approach has been used before in Ireland for 1800 MHz in the 2012 4G award, where licences in the band were expiring at different times. It created significant complexity in the auction design and necessitated the use of package bidding, given the obvious need of some bidders to align their purchases in the two time periods. Having operators buy spectrum for a 5-year period from 2022-27 is also peculiar if they plan to use it to support 20-year investments in 5G.

The second approach may be a better choice this time if ComReg includes this spectrum in the auction. It is the one also proposed for Germany's 2019 auction, where BNetzA has the same challenge with 2100 MHz licences expiring at different times.[31] An advantage of having two long-term licence categories is that (unlike short and long term licence which cover entirely separate time periods) they are substitutable, so bidders could switch between them in response to price changes in an ascending bid auction. This could be done, as in Germany, with a SMRA-type design, so package bidding is not essential.

There are, however, two major problems with both approaches:

i. *Scope for strategic bidding*. Under either approach, each bidder has predictable minimum demands for spectrum blocks of spectrum, owing to their need to ensure continuity of their 3G networks. This may create undesirable options for bidders to engage in strategic bidding, for example driving up the price of spectrum in categories where their opponents need to buy more spectrum in the hope of securing concessions in other bands.

ii. *Timing of the award*. Unlike the new bands, newly awarded spectrum licences at 2100 MHz will not start until either 2022 or 2027. This makes the spectrum harder to value and raises concern about operators being obliged to pay for spectrum many years before they can actually use it. The operators may also need access to liberalised spectrum before these dates if they are to use it efficiently. (We note that, in Germany, the 2100 MHz is already liberalised and is already partially used for providing 4G services.)

It is also not obvious how ComReg should package the spectrum. Operators currently own 2x15 MHz of spectrum, but this is not obviously a sensible unit for the future, where operators may prefer blocks of 2x20 MHz or more. Moving to blocks of 2x10 MHz might support more future-proof outcomes but would mean operators with 2x15 MHz would be obliged to either expand or contract their holdings. Blocks of 2x5 MHz would allow the

[31] Bundesnetzagentur, 2018, *President's Chamber decision of 14 May 2018 on the order for and choice of proceedings for the award of spectrum in the 2 GHz and 3.6 GHz bands for mobile/fixed communication networks (BK1-17/001).* English Translation. Available at: https://www.bundesnetzagentur.de/EN/Areas/Telecommunications/Companies/FrequencyManagement/ElectronicCommunicationsServices/ElectronicCommunicationServices_node.html

market to explore all options, but this may be too small a unit to justify deployment of 4G or 5G technology once 3G networks are turned off.

It will be similarly 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 2x25 MHz cap, ensuring a minimum of 2x10 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.

Given these complications, it may be better if ComReg can find a solution for liberalising and reallocating this spectrum outside an auction. The simplest option may be to award the spectrum directly to operators in three 2x20 MHz blocks, with operators transitioning to their new holdings as existing licences expire. If this plan was adopted, all spectrum in the band could be immediately liberalised (including eir's residual licence term to 2027), and licences would have a common expiry date in 20-25 years. There would need to be a reconfiguration of the band, which could potentially happen sooner than 2022. These changes would give each operator the freedom they need to manage their own transition of customers from 3G to 4G/5G. In return, operators should pay fees that reflect the market value of the spectrum. Such an approach is similar to what has already happened in the UK, where 3G licences were liberalised[32] and, upon expiry of the initial term in 2022, the licensees will be expected to pay annual fees that reflect their market value.[33]

In this case, a direct award has multiple upsides. Firstly, it removes 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. Secondly, it removes undesirable complexity from the multi-band award, potentially facilitating a simpler design for the residual spectrum. Finally, it is 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 2100 MHz spectrum through the medium term. Operators would still be able to compete for incremental capacity spectrum in the auction for 2300 MHz and 2600 MHz spectrum.

3.3. 2300 MHz TDD, 2600 MHz FDD and 2600 MHz TDD

The 2300 MHz band consists of 100 MHz of unpaired TDD spectrum. Although not widely deployed (as yet) in Europe, it is a core 4G band elsewhere, notably in Asia Pacific, and has a well-developed handset ecosystem. 2600 MHz, under the European plan, consists of two sub-bands: 2x70 MHz of paired FDD spectrum, located either side of a 50 MHz block[34] of TDD spectrum. This spectrum is already widely in use across Europe for 4G capacity. Both 2300 MHz and 2600 MHz will, in due course, be transitioned to 5G use.

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32 Ofcom, 2013, *Statement on the Requests for Variation of 900 MHz, 1800 MHz, and 2100 MHz Mobile Licences.* Available at: https://www.ofcom.org.uk/consultations-and-statements/category-2/variation-900-1800-2100

33 Article 6 of *The Wireless Telegraphy Act 2006 (Directions to OFCOM) Order 2010*. Available at: https://www.legislation.gov.uk/uksi/2010/3024/article/6/made

34 50 MHz is available before guard blocks needed to avoid harmful interference between adjacent TDD and FDD systems.

These three bands have similar characteristics. They are located at similar frequencies that are ideal for augmenting network capacity and all have well-developed 4G ecosystems, albeit with some differences in legacy handset use. Historically, TDD spectrum has sold at a discount to FDD spectrum. However, in recent years, the price gap between them has closed, as TDD systems have matured. For example, 2.5 GHz FDD spectrum sold at reserve price in Singapore in 2013, whereas there was intense competition for the 45 MHz of 2.5 GHz TDD in the 2016 auction, and this ultimately sold for a 92% premium on a per MHz/pop basis over the FDD spectrum in 2013. Looking forward, TDD spectrum may even be preferred, as a greater proportion (typically 75%) can be used for scarce downlink capacity, whereas FDD capacity is always split 50:50 between uplink and downlink. TDD spectrum also supports beamforming with Massive MIMO, which appears set to become an important technology tool for increasing the efficiency in which mobile spectrum above 2 GHz is used in urban areas.

For these reasons, spectrum available in these two bands should be considered substitutable. It is important, therefore, that spectrum packaging allows bidders to switch demand between the bands easily in response to shifts in relative prices in an auction. This could ideally be achieved by having same-size blocks across all the bands. Operators can also 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. It is, however, ambiguous how much spectrum operators may target in any particular band. Therefore, blocks should not be so large as to close off allocation outcomes that could be efficient.

There is only one approach that clearly meets all these requirements, and that is to sell all the available spectrum in 20 MHz blocks:

- 2300 MHz: 5 lots of 20 MHz;
- 2600 MHz FDD: 7 lots of 2x10 MHz; and
- 2600 MHz TDD: 2 lots of 20 MHz (the remaining 10 MHz would be needed to create two 5 MHz guard blocks between TDD and FDD use, but these blocks could be assigned on a low power basis with the adjacent TDD lots).

Given the sizes of the three bands, there is no larger common lot size that could be used. Although a smaller block size (such as 10 MHz) is possible, and would allow a greater range of allocation outcomes, the benefit of more flexibility is almost certainly less than the benefit to bidders of certainty that they can secure at least 20 MHz in any band, which is a better size for 4G/5G use. As in previous ComReg awards, the spectrum would need to be sold initially on a generic lot basis, such that winning bidders can be guaranteed contiguity within a band, however many lots they win. Within TDD bands, it may be advantageous to specify a default downlink/uplink ratio (e.g. 3:1) to ensure adjacent users are synchronised or otherwise must buy enough spectrum to create their own guard bands.

Given the substitutable nature of this spectrum, any spectrum cap adopted should be across the 2300 and 2600 MHz bands, rather than band-specific. With three fairly strong MNOs and plenty of spectrum available, a global spectrum cap would only be needed either (a) as a precautionary measure to eliminate obviously undesirable outcomes; or (b) to constrain

strategic incentives for price driving behaviour if a CCA format is used (see next section). For example, a cap of 6 lots per bidder (120 MHz) would prevent two operators from buying more than 240 MHz between them, ensuring that at least 40 MHz was available for other bidders. Tighter caps would be advisable if a CCA format was used, so as to eliminate strategic incentives for bidders to exaggerate their willingness to pay for larger quantities of spectrum.

4. Auction format and rules

Over the last decade, there has been significant experimentation in the choice of auction formats for spectrum awards. Notably, many countries – including Ireland – embraced package bidding, primarily as a way of mitigating aggregation risk for bidders trying to assemble portfolios of spectrum suitable for launching 4G while continuing legacy 2G and 3G services. This has led to development of relatively complex formats, such as the Combinatorial Clock Auction (CCA) and the Combinatorial Multi-Round Auction (CMRA), which use package bidding.

More recently, however, the trend has been towards adoption of simpler formats for 5G awards. Notably, countries that previously used the CCA, namely Australia[35], Austria[36], Switzerland[37] and the UK[38], switched to formats inspired by the traditional simultaneous multiple round auction (SMRA) and simple clock auction for their most recent 5G awards. The Dutch Ministry of Economics has also been considering a shift away from the CCA and has held consultations on this subject.[39]

In this section, we discuss why regulators have recently tended to favour simpler auction formats over the CCA and other package bid formats. We then proceed to identify a number of variants of the SMRA and clock formats that have been used in other countries and deserve study as leading options for the design of the Irish multi-band award. We conclude this section with a brief discussion of the importance of providing aggregate demand data on a round-by-round basis, regardless of the choice of format.

4.1. Reasons why regulators are shifting away from the CCA

There are several reasons for this shift against the CCA, all of which are relevant to this auction in Ireland:

1. **Aggregation risk**. Combinatorial formats shield bidders from aggregation risk, which was often identified as a significant risk in 4G auctions, when bidders needed certain minimum quantities of spectrum in specific bands. Looking forward, aggregation risk is typically less important now, as operators typically have a critical mass of spectrum for

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35 Australian regulator, ACMA, used a CCA format for the 2014 award of 700 MHz and 2500 MHz in Australia. The upcoming 3600 MHz award beginning in November 2018 will use an "Enhanced SMRA" format, which is a hybrid between a traditional SMRA and a clock auction.

36 Austrian regulator, RTR, used a CCA format for the 2013 Award of 800 MHz, 900 MHz, and 1800 MHz. The upcoming 3410 to 3800 MHz award set to begin in early 2019 will use a simple clock auction.

37 Switzerland regulator, ComCom, used a CCA format for the 2012 award of 800, 900, 1800, 2100 and 2600 MHz. The upcoming award of 700, 1400, 2600, and 3600 MHz will use a clock auction format.

38 UK regulator, Ofcom, used a CCA format for the 2013 award of 800 and 2500 MHz. In 2018, Ofcom used a "Hybrid SMRA" format for the award of 2300 and 3500 MHz, which borrows rules from both the traditional SMRA and clock auction.

39 Ministerie van Economische Zaken, 14 March 2014, *Veilingseminar 14 maart 2017 bij het ministerie van Economische Zaken.* Available at: https://www.rijksoverheid nl/binaries/rijksoverheid/documenten/publicaties/2017/03/14/publicatie-veilingseminar-14-maart-2017/Publicatie_veilingseminar`+14+maart+2017.pdf

4G and are buying incremental spectrum for 4G/5G. The benefits of package bidding are thus diminished.

In a recent report for ComReg, DotEcon propose that ComReg consider including coverage obligation lots in the main stage of the next Irish auction, which bidders could acquire (at a negative price) alongside new spectrum.[40] They advocate this as an alternative to attaching such obligations to specific lots. We agree with DotEcon that it is good policy in this case to avoid attaching onerous coverage obligations to spectrum lots, but we disagree with their proposed solution. A huge downside of DotEcon's proposal is that it reintroduces aggregation risk into the auction, as the willingness of some bidders to acquire a coverage obligation may be tied to winning a certain quantity of 700 MHz spectrum. DotEcon's proposed solution to this is to use a combinatorial auction format, but this adds otherwise unnecessary complexity and risk (see discussion below) for bidders. In our opinion, a better solution for Ireland and a more logical conclusion to DotEcon's own reasoning would be to award any coverage obligations in a separate stage following the main auction.

2. **Asymmetric pricing**. Package bid auctions, such as the CCA, are typically implemented with a second price rule, under which winning bidders pay prices based on the opportunity cost of denying other bidders from winning the spectrum. This works best if there is plenty of competition, and all winning bidders have their price set by losing bidders. However, in practice, in a typical spectrum auction setting, winning bidders predictably end up setting each other's prices, based on the incremental demand that they drop in the auction. This can lead to grossly asymmetric price outcomes for bidders winning the same spectrum.

   Such price asymmetry can be grossly unfair. For example, consider the case in Box 1 where three operators are competing for spectrum in a band with three blocks of 2x10 MHz available; in this case, if all three bidders bid to valuation, the strongest bidder predictably gets the cheapest price! This is not a hypothetical case: larger and hard-to-explain price differences have been a feature of almost every CCA auction to date. One of the most egregious examples is the 2012 Swiss Multiband auction, where Sunrise paid 34% more than Swisscom but won a clearly inferior package of spectrum; and Orange won the same quantity of spectrum as Sunrise, but only paid less than one-third of its price.[41] 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. The SMRA format also typically produces outcomes in which substitutable spectrum is sold at similar prices, as bidders can switch demand between blocks in response to shifts in relative prices.

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[40] DotEcon, Coverage obligations and spectrum awards, 30/11/2018, ComReg 18/103d.

[41] Communications Commission (ComCom), 23 February 2012. *Auction of mobile phone frequencies in 2012*. Available at: https://www.bakom.admin.ch/bakom/en/homepage/frequencies-and-antennas/award-of-mobile-telephony-frequencies/new-mobile-telephony-frequencies-orange-sunrise-and-swisscom html

BOX 1: Example of perverse price outcomes in a CCA where winning bidders predictably set each other's prices

Suppose that the 700 MHz band is divided into three blocks of 2x10 MHz.[42] Further, suppose that there are only three bidders, all incumbent operators, with identical spectrum portfolios but different market shares. Suppose Bidder A (45% market share) is larger than Bidder B (30%) who in turn is larger than Bidder C (25%), and that valuations are loosely correlated with market share.

Suppose that the three bidders have the following valuations:

	2x10 MHz	2x20 MHz	Incremental value for 2nd block
Bidder A	€200m	€300m	€100m
Bidder B	€170m	€230m	€60m
Bidder C	€150m	€200m	€50m

The efficient outcome is for all three bidders to win one 2x10 MHz block each. This is also the outcome in a CCA if all three bidders submit bids for 1 and 2 blocks at their valuations. However, the price outcome is not symmetric. Bidder A, the largest bidder, pays only €60m, which is the opportunity cost of denying a second block to Bidder B. Meanwhile, the two smaller operators, Bidder B and Bidder C, must pay €100m each, the opportunity cost of denying a second block to Bidder A.

Now, suppose that Bidder C is confident that Bidder A and Bidder B will have higher values for their first blocks i.e. greater than €150m. Instead of dropping out of the bidding for a second lot according to valuation when the price reaches €50m, suppose it instead bids the price up to €150m, before dropping demand to 1 lot. It can now express a value of €300m for 2 blocks.

Bidder C's strategic decision to inflate its value for a second block does not change the allocation outcome but it does change the prices. Bidder C still has to pay €100m, the opportunity cost of denying a second block to Bidder A. However, Bidder A and Bidder B now have to pay €150m each, the opportunity cost of denying Bidder C's inflated value for a second block. This is obviously a much better relative outcome for Bidder C and is achieved with negligible risk.

3. **Incentives for spiteful bidding**. The CCA has been linked to incentives for spiteful bidding behaviour which may raise the price of spectrum above actual market-clearing levels. Based on information inferred from the clock rounds, bidders may submit spiteful bids in the supplementary round whose sole purpose is to drive up their rivals cost. Furthermore, the potential for spiteful bidding in the sealed bid round provides incentives for bidders to deviate from straightforward bidding in the clock rounds as well, either as

[42] The example works equally well with 2x5 MHz lots but is more complicated as there are more bid options. Assume that all three operators are capped at acquiring a total of 2 blocks each.

an offensive or defensive strategy. For example, returning to the example in Box 1, the two smaller bidders have incentives to exaggerate their value for a second block of spectrum, so as to reduce the risk they end up paying more than the large bidder.

There is a growing body of economic literature which highlights this concern with the CCA. Janssen and Karaymchev (2013)[43] show that if bidders have a primary preference for achieving a low price, and a secondary preference for raising their opponents' costs, they will bid aggressively in the clock rounds and submit spiteful bids in the sealed bid round. Janssen and Kasberger (2015)[44] demonstrate that this may lead to highly inefficient equilibrium outcomes in the CCA. Marsden and Sorensen (2017)[45] explain how such strategic incentives encourage bidders to deviate from straightforward value-based bidding, which may lead to inefficient award outcomes.

The 2013 Austrian multiband auction has been identified as a case study where spiteful bidding likely explains the exceptionally high price outcome in a situation where there was plenty of spectrum for three bidders. RTR attributed the high revenues to very aggressive bidding in the clock rounds coupled with bidders primarily submitting very high bids for very large "unwinnable" packages in the sealed bid round.[46] Levin and Skrzypacz (2016)[47] argue that this is evidence that the high prices in this auction were a result of spiteful rather than pure value-based bidding. The 2012 Dutch multiband auction also ended with exceptionally high prices and bidders challenged the use of the CCA on the grounds that it encourages price-driving behaviour.[48]

4. **Complexity**. The use of package bidding increases complexity for bidders. If there are only a few lots, this may not be a significant issue. However, in more complex settings, such as a multiband award, the number of possible packages that a bidder needs to evaluate may be very large. The efficiency of the final allocation crucially depends on bidders' ability to identify the right packages to bid for.

   There is a growing literature which shows that bidders struggle with this complexity. Bichler, Shabalin and Wolf (2013)[49], ran extensive lab experiments to compare the performance of both the SMRA and the standard CCA. They find that bidders do not bid for all relevant packages in the CCA and focused primarily on bids that are likely to win

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43 Janssen and Karamychev, 2016, *Spiteful Bidding and Gaming in Combinatorial Clock Auctions*, Games and Economic Behavior, Elsevier, vol 100(c), pages. 186-207.

44 Janssen and Kasberger, 2015, *On the Clock of the Combinatorial Clock Auction*, working paper. Available at: https://homepage.univie.ac.at/maarten.janssen/working%20papers/CCAclock0911.pdf

45 Marsden, R. and Sorensen, S. (2017), *Strategic Bidding in Combinatorial Clock Auctions – A Bidder Perspective*, chapter 35 in Bichler, M and Goeree, J, Handbook of Spectrum Auction Design (Cambridge University Press).

46 RTR, 2013, "Result of the 2013 multiband auction driven by consistently offensive bidding strategy on the part of all three contenders"

47 Levin and Skrzypacz, 2016, *Properties of the Combinatorial Clock Auction*, American Economic Review 2016, 106(9): 2528–2551

48 Rechtbank Rotterdam, ROT 12/3111, 2 October 2014. Available at: http://deeplink rechtspraak.nl/uitspraak?id=ECLI:NL:RBROT:2014:7917

49 Bichler, Shabalin and Wolf, 2013, *Do Core-Selecting Combinatorial Clock Auctions always lead to high Efficiency? An Experimental Analysis of Spectrum Auction Designs, Experimental Economics*, Vol. 16(4), pages 511-545

given the specific valuation structure and the prices in the clock rounds. This has a dramatic impact on the efficiency of the allocation. The CCA achieved much lower efficiency than the SMRA in their experiments. This is in line with Scheffel and Bichler (2012)[50] who find "*that the limited number of packages that bidders evaluate to be the greatest barrier to efficiency, much more so than differences in the auction formats*." This suggests that the efficiency of the CCA potentially worsens in more complex settings as bidders will find it even harder to identify the right packages to bid for.

4.2. Alterative formats

If ComReg decides to explore alternatives to the CCA format that it has used for the last two mobile spectrum awards, there are two alternative directions in which it could travel:

i. ***A different package bid format.*** There are currently no countries with public plans to implement an award using the CCA design previously used by ComReg. However, two countries are planning to use package bid formats for forthcoming awards:

- *Adapted CCA.* In Canada, ISED will award 600 MHz spectrum using the CCA format but with more restrictive "GARP" activity rules. According to ISED, the rule changes may promote more "truthful bidding" (based on valuation),[51] but in practice it is not obvious how they would address any of the concerns identified above.

- *CMRA.* Denmark's regulator, the DEA, plans to use a CMRA format for the award of 700 MHz, 900 MHz, and 2300 MHz.[52] This format, which has been used only once before for selling spectrum (also in Denmark) is effectively an iterative first-price combinatorial auction. However, it differs from previous versions of this format developed in academic literature in that it does not provide bidders with an opportunity to challenge the provisional allocation before it becomes final. As the auction is also run with very little transparency, bidders face great uncertainty over outcomes.

We doubt that either format would be a good choice for the next Irish multi-band auction. As described in Section 3, if the issues concerning 2100 MHz can be addressed outside the auction, then very little aggregation risk is left for bidders. Meanwhile, if it is decided to include coverage obligation lots in the award process, they could be sold in a separate bidding stage, so as to avoid distorting design choices for the main spectrum allocation stage. Without substantial aggregation risk, there is no strong rationale for package bidding, meaning that simpler formats can be used. In this case, the downsides of using the CCA clearly outweigh the upsides. It is harder to assess the CMRA given its novel nature. However, we are concerned that lack of

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50 Scheffel and Bichler, 2010, *On the Impact of Cognitive Limits in Combinatorial Auctions: An Experimental Study in the Context of Spectrum Auction Design*. http://dss.in.tum.de/files/bichler-research/2010_scheffel_cognitive_limits.pdf

51 Innovation, Science and Economic Development Canada (ISED), 2018, *Technical, Policy, and Licensing Framework for Spectrum in the 600 MHz Band.* Available at: http://www.ic.gc.ca/eic/site/smt-gst nsf/eng/sf11374 html

52 Danish Energy Agency, 19 September 2018, *Information Memorandum: 700 MHz, 900 MHz and 2300 MHz Auction* (English translation). Available at: https://ens.dk/sites/ens.dk/files/Tele/information_memorandum-700-900-2300-uk.pdf

transparency and outcome unpredictability could lead to inefficient allocation, create opportunities for strategic bidding and increase the risk of legal challenge to auction outcomes.

ii. ***A clock or SMRA format***. Countries that have moved away from the CCA have typically adopted variants of the clock and SMRA. Other countries, such as Germany and Sweden, continue to use these formats for all their mobile spectrum awards.

There are a number of variants of the SMRA and clock formats that ComReg might consider for the multi-band award:

- *SMRA with generic lots*. This standard format has been in use in Germany since the late 1990s. Bidders bid for individual lots within bands in an ascending price auction and can switch demand between lots in response to price movements. Provisional winning bids (standing high bids) are identified at the end of each round, with bidding continuing until there is no excess demand for any lot. The format is not designed to address aggregation risk. It can also proceed slowly.

- *Multi-unit clock auction*. Instead of bidding for individual lots, bidders bid for a number of lots by category, and can switch demand between categories in response to price movements. There is a common "clock" price for all lots in a category. Bidding continues until there is no excess demand in any category. The format is faster than the SMRA, promotes uniform pricing within categories, and – depending on the exact rules – may provide some mitigation of aggregation risk.

  A number of variants of this format have been implemented or proposed for spectrum awards, including:

  - **Simple Clock Auction.** In the simple clock auction, bids within (but not across) categories are de facto package bids. Bidders have flexibility to drop demand in response to price increases. This removes aggregation risk within categories for bidders but does introduce some risk of lots going unsold. For the Swiss 5G multiband auction[53] and Austrian multi-region 3.5 GHz auction[54], both scheduled for Q1 2019, DotEcon has developed a multi-category clock auction based on this format. There is a provision in this design for a second stage auction in case some lots go unsold.

  - **Enhanced Clock/SMRA.** This format is very similar to the simple clock, but there are provisions to retain demand so as to prevent lots

[53] Award documents can be found on the Federal Office of Communications website at: https://www.bakom.admin.ch/bakom/en/homepage/frequencies-and-antennas/award-of-mobile-telephony-frequencies/starting-signal-for-new-award-of-mobile-radio-frequencies.html

[54] RTR, 19 September 2018, *3,4 bis 3,8 GHz: Erste 5G-Ausschreibung veröffentlicht.* Available at: https://www.rtr.at/de/pr/PI19092018TK

going unsold. This approach removes the unsold lot risk for the seller but at the expense of increasing aggregation risk (where relevant) for bidders. NERA is a pioneer of this format, having used it for electricity-related auctions since the 1990s. We have recently implemented versions in Singapore (2013[55] and 2017[56]) and Mexico (2018)[57]. A similar format was also developed by Auctionomics and Power Auctions and the FCC for the US 600 MHz Forward auction as part of the 2017 Incentive Auction[58], and will be used for the Australian 3600 MHz auction.[59]

Any of these formats could potentially work in Ireland and deserve detailed study.

4.3. Information policy

A key feature of almost all auctions using the SMRA, clock and CCA designs highlighted here is that, at the end of each round, bidders are provided with information about the level of excess demand in each category or lot as applicable. This information facilitates price discovery, enabling bidders to refine their valuations and views on plausible spectrum outcomes. Without such information, bidders are bidding in the dark, and there is a high risk that they make mistakes, for example switching or dropping demand too quickly or slowly in response to price changes.

A good option for the Irish multi-band award, similar to the information policy adopted by ComReg for previous auctions and the way that most multi-round spectrum auctions in Europe are run, would be for the Auctioneer 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. Releasing aggregate demand has an established track record having been applied successfully in many past auctions in Europe and elsewhere. In contrast, our understanding is that the approach of not disclosing demand was a key factor that led to excessive prices in the much criticized Austrian 4G auction.

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55 Auction documents and auction results can be found at: https://www.imda.gov.sg/regulations-licensing-and-consultations/frameworks-and-policies/spectrum-management-and-coordination/spectrum-rights-auctions-and-assignment/1800-mhz-spectrum-right-and-2-5-ghz-spectrum-right-2013-auction

56 Auction documents and auction results can be found at: https://www.imda.gov.sg/regulations-licensing-and-consultations/frameworks-and-policies/spectrum-management-and-coordination/spectrum-rights-auctions-and-assignment/700-mhz-spectrum-rights-900-mhz-spectrum-rights-2-3-ghz-spectrum-rights

57 Auction documents and auction results can be found at: http://www.ift.org mx/industria/espectro-radioelectrico/telecomunicaciones/2018/licitacion-no-ift-7-servicio-de-acceso-inalambrico

58 FCC, 15 October 2015, Appendix G, *Application Procedures for Broadcast Incentive Auction Scheduled to begin on March 29, 2016: Technical Formulas for Competitive Bidding* (DA 15-1183). Available at: https://www.fcc.gov/document/application-procedures-broadcast-incentive-auction

59 ACMA, August 2018, *3.6 GHz band auction, November 2018: Auction Guide*. Available at: https://www.acma.gov.au/-/media/Spectrum-Licensing-Policy/Information/pdf/3-6-GHz-auction-2018-Auction-guide-pdf.pdf?la=en

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Friday, 25th January 2019

Dear Robert,

I would like to congratulate you on taking up your new role as Commissioner, and I hope you are settling in well. No doubt we will meet up in due course.

In the meantime, you will be aware of the upcoming multiband spectrum auction, which will have a significant impact on network investment and connectivity in Ireland in the short to medium term. With this in mind, we asked the economic consultants NERA to carry out an analysis of the main considerations for the upcoming award, and to provide some recommendations based on their considerable international experience on the process that will deliver the best outcomes for Irish consumers and the wider economy.

For information, I attach a copy of NERA's report, together with a short briefing note that was prepared by Three for stakeholders. The briefing note essentially acts as our summary of NERA's document. The report makes some interesting findings and recommendations, including:

- While operators can expect to pay reasonable spectrum fees, studies and evidence show that inflated spectrum prices have a negative effect on investment and consumer welfare. This is particularly important given current conditions in Ireland;
- ComReg should choose a simple auction design to deliver an efficient outcome. This extends to the packaging of lots, spectrum caps, and the award mechanism itself;
- Given the complications presented by the current use of the 2100MHz band, it would be best if this spectrum was liberalised (as required in Decision 2012/688/EU to be completed by June 2014) and re-licenced outside of the multi-band award.

We look forward to engaging with ComReg on this matter, and if any clarification is required in relation to NERA's report, we will be happy to facilitate this.

Sincerely,

Robert Finnegan, CEO.

Three Ireland (Hutchison) Limited
Registered Office:
28/29 Sir John Rogerson's Quay,
Dublin 2, Ireland

ComReg is currently planning the process to award over 350 MHz of prime mobile spectrum. Accounting for about 42% of total mobile spectrum available, this award process will have a critical impact on how Ireland's mobile infrastructure and connectivity will develop over the next decade.

Three asked NERA Economic Consulting to draw on its well-recognised international experience in this area and identify the key issues to be addressed by ComReg. We also requested that they provide recommendations on the process that will deliver the best outcomes for Irish consumers and the wider economy.

NERA make the following key recommendations:

1. While operators can expect to pay a market price for access to spectrum, a process that risks inflated prices would be detrimental to Ireland's digital future:
    - International academic studies and empirical evidence from around the world show that inflated spectrum prices have a negative effect on investment and on consumer welfare;
    - Excessive spectrum pricing risks could delay 5G roll-out and cause Ireland to fall behind its peers for connectivity;
    - Avoiding high spectrum prices is particularly important in Ireland, given the relatively large rural population and challenges of attracting investment capital in a small market;
    - Spectrum prices can be expected to fall considerably when compared to previous awards, particularly the 2012 auction.

2. Rules on packaging and caps should be as simple as possible, subject to achieving the goal of an efficient, pro-competitive and fairly priced award outcome:
    - While trade-offs may need to be made when choosing the appropriate caps and packaging, this should be kept as simple as possible in order to facilitate an efficient outcome;
    - Bidders need to be able to obtain a critical mass of spectrum, and to switch demand in response to changing price.

3. Getting the most efficient outcome for the 2100 MHz band is much more challenging than the other bands due to legacy issues. This spectrum may be more efficiently allocated outside the auction:
    - The 2100MHz band is already in use by mobile operators and was the original 3G band;
    - If "liberalised", this band could be immediately upgraded to 4G use, which would deliver an immediate increase in its efficiency of use and consumer welfare;

Three Ireland (Hutchison) Limited
Registered Office:
28/29 Sir John Rogerson's Quay,
Dublin 2, Ireland

- Legacy licence issues mean it would likely be better to liberalise the 2100MHz band separately from the main award.

4. The auction format and rules should be simple and efficient:
   - ComReg should follow the trend amongst European regulators that previously used the Combinatorial Clock Auction (CCA) format and switched to a simpler, better adapted format;
   - If additional coverage obligations are to be determined in the auction, then this should be a separate stage distinct from the determination of the spectrum allocation.

ENDS

4 Rurtel System Requests for Information

4.1 Comreg Information Request of Eir 28.11.2017

An Coimisiún um
Rialáil Cumarsáide
Commission for
Communications Regulation

28 November 2017

Mr William McCoubrey
Head of Regulatory Strategy
1 Hueston South Quarter
St. Johns Road
Dublin 8.

By registered post

Information request regarding Eir's licences in the 2.3 GHz Band used for its Rurtel network

Dear William

As discussed in our meeting on 20 November 2017 in relation to the above, ComReg is in the process of considering the future use and the potential award of the 2.3 GHz Band. ComReg is now gathering information on the existing use of the band and in this regard Eir currently holds licences in the frequency ranges 2308 – 2326 MHz and 2402 – 2420 MHz.

In this context, I would be grateful if you could provide the following information relating to the use of these licences which I understand to be used for Eir's Rurtel network:

- A background and chronology of the work completed by Eir to date in reducing the extent of the Rurtel network;
- Eir's view as to what further steps could be taken to reduce the extent of the Rurtel network;
- Noting that you have sent on the soft dial tone figures based on your preliminary investigations, please provide an update on the actual number of customers using the Rurtel network;
- Detail on the current Rurtel network deployment, including:
    - the number and locations of the point to multipoint base stations used to serve customers;
    - the number of customers served from each base station and their locations;
    - the number and locations of the 2.3 GHz point to point links used to back haul traffic to the exchange;
    - technical parameters for the point to multipoint links, point to point links and consumer premises equipment (CPE) / subscribers, in this regard Annex 1 to this letter includes a table of the information required for each; and
- Noting that Rurtel is a legacy system, Eir's plans for providing service to the customers identified above into the future and the envisaged timeframes of this.

As discussed at our meeting, using the above information ComReg intends to amongst other things, consider the compatibility and coexistence between Rurtel network and potential future services in the 2.3 GHz Band. You identified that Eir had carried out some work in this area previously and ComReg would be grateful if Eir can share its work on its coexistence studies.

An Coimisiún um
Rialáil Cumarsáide
Commission for
Communications Regulation

At our meeting on 20 November you identified that you would require 6 weeks to obtain some of the above information. Considering this and the holiday period ComReg would be grateful if the requested information could be provided by 8 January 2018.

ComReg may rely on and/or publish some of the above information if required, in this regard Eir is invited to clearly identify in its response what information it considers to be genuinely confidential[1].

If you wish to discuss any of the above, please feel free to contact me.

Yours sincerely

Joseph Coughlan
Radio Spectrum Engineer
Spectrum Policy and Development

[1] ComReg Document 05/24 - Response to Consultation - Guidelines on the treatment of confidential information - March 2005.

Commission for Communications Regulation
An Coimisiún um Rialáil Cumarsáide
1 Dockland Central, Guild St., Dublin 1, D01 E4X0.
1 Lárcheantar na nDugaí, Sráid na nGildeanna, BÁC 1, D01 E4X0.
Tel | Teil +353 1 804 9600 Fax | Facs +353 1 804 9665 www.comreg.ie

Annex 1 – Detailed information request for Eir's Rurtel network in the 2.3 GHz band

Requested parameters for the different network component types

	Point to Multipoint Base Station	CPE / Subscriber	Point to Point Base Stations	
			Site A	**Site B**
1	Site ID	Site ID	Site ID	Site ID
2	Site Address	Subscriber Address	Site Address	Site Address
3	**TYPE:** P-MP Base Station	**TYPE:** CPE / subscriber	**TYPE:** P-P Base Station	**TYPE**: P-P Base Station
4	*Site ID's of CPE/Subscribers*	*Relevant Base Station Site ID*		
5	Eastings / Longitude	Eastings / Longitude	Eastings / Longitude	Eastings / Longitude
6	Northings / Latitude	Northings / Latitude	Northings / Latitude	Northings / Latitude
7	Site Height (m)	Site Height (m)	Site Height (m)	Site Height (m)
8	Antenna height(m)	Antenna height(m)	Antenna height(m)	Antenna height(m)
9	Transmitter Power (dBm)	Transmitter Power (dBm)	Transmitter Power (dBm)	Transmitter Power (dBm)
10	Losses	Losses	Losses	Losses
11	Antenna Gain (dBi)	Antenna Gain (dBi)	Antenna Gain (dBi)	Antenna Gain (dBi)
12	Max EIRP(dBm)	Max EIRP(dBm)	Max EIRP(dBm)	Max EIRP(dBm)
13	Antenna Make & Model including azimuth and elevation Pattern	Antenna Make & Model including azimuth and elevation Pattern	Antenna Make & Model including azimuth and elevation Pattern	Antenna Make & Model including azimuth and elevation Pattern
14	Polarisation	Polarisation	Polarisation	Polarisation
15	Transmit Frequency	Transmit Frequency	Transmit Frequency	Transmit Frequency
16	Receive Frequency	Receive Frequency	Receive Frequency	Receive Frequency
17	Transmitter Bandwidth	Transmitter Bandwidth	Transmitter Bandwidth	Transmitter Bandwidth
18	Receiver Bandwidth	Receiver Bandwidth	Receiver Bandwidth	Receiver Bandwidth
19	*Multi directional?- if so please provide requested information for each direction*	*Bearing to base station (in degrees relative to grid north)*	*Bearing to Site B (in degrees relative to grid north)*	*Bearing to Site A (in degrees relative to grid north)*
20	Adjacent channel selectivity	Adjacent channel selectivity	Adjacent channel selectivity	Adjacent channel selectivity
21	Receiver Sensitivity (in dBm/X MHz)	Receiver Sensitivity (in dBm/X MHz)	Receiver Sensitivity (in dBm/X MHz)	Receiver Sensitivity (in dBm/X MHz)
22	Noise floor (dBm/XMHz)	Noise floor (dBm/XMHz)	Noise floor (dBm/XMHz)	Noise floor (dBm/XMHz)
23	Minimum C/(N+I)	Minimum C/(N+I)	Minimum C/(N+I)	Minimum C/(N+I)
24	Max Interference Threshold	Max Interference Threshold	Max Interference Threshold	Max Interference Threshold
25	Min field strength at the location of the receiving antenna (dBuV/m)	Min field strength at the location of the receiving antenna (dBuV/m)	Min field strength at the location of the receiving antenna (dBuV/m)	Min field strength at the location of the receiving antenna (dBuV/m)

Annex 1 – Detailed information request for Eir's Rurtel network in the 2.3 GHz band

	Requested parameters for the different network component types			
	Point to Multipoint Base Station	**CPE / Subscriber**	**Point to Point Base Stations**	
			Site A	**Site B**
1	Site ID	Site ID	Site ID	Site ID
2	Site Address	Subscriber Address	Site Address	Site Address
3	**TYPE:** P-MP Base Station	**TYPE:** CPE / subscriber	**TYPE:** P-P Base Station	**TYPE:** P-P Base Station
4	*Site ID's of CPE/Subscribers*	*Relevant Base Station Site ID*		
5	Eastings / Longitude	Eastings / Longitude	Eastings / Longitude	Eastings / Longitude
6	Northings / Latitude	Northings / Latitude	Northings / Latitude	Northings / Latitude
7	Site Height (m)	Site Height (m)	Site Height (m)	Site Height (m)
8	Antenna height(m)	Antenna height(m)	Antenna height(m)	Antenna height(m)
9	Transmitter Power (dBm)	Transmitter Power (dBm)	Transmitter Power (dBm)	Transmitter Power (dBm)
10	Losses	Losses	Losses	Losses
11	Antenna Gain (dBi)	Antenna Gain (dBi)	Antenna Gain (dBi)	Antenna Gain (dBi)
12	Max EIRP(dBm)	Max EIRP(dBm)	Max EIRP(dBm)	Max EIRP(dBm)
13	Antenna Make & Model including azimuth and elevation Pattern	Antenna Make & Model including azimuth and elevation Pattern	Antenna Make & Model including azimuth and elevation Pattern	Antenna Make & Model including azimuth and elevation Pattern
14	Polarisation	Polarisation	Polarisation	Polarisation
15	Transmit Frequency	Transmit Frequency	Transmit Frequency	Transmit Frequency
16	Receive Frequency	Receive Frequency	Receive Frequency	Receive Frequency
17	Transmitter Bandwidth	Transmitter Bandwidth	Transmitter Bandwidth	Transmitter Bandwidth
18	Receiver Bandwidth	Receiver Bandwidth	Receiver Bandwidth	Receiver Bandwidth
19	*Multi directional?- if so please provide requested information for each direction*	*Bearing to base station (in degrees relative to grid north)*	*Bearing to Site B (in degrees relative to grid north)*	*Bearing to Site A (in degrees relative to grid north)*
20	Adjacent channel selectivity	Adjacent channel selectivity	Adjacent channel selectivity	Adjacent channel selectivity
21	Receiver Sensitivity (in dBm/X MHz)	Receiver Sensitivity (in dBm/X MHz)	Receiver Sensitivity (in dBm/X MHz)	Receiver Sensitivity (in dBm/X MHz)
22	Noise floor (dBm/XMHz)	Noise floor (dBm/XMHz)	Noise floor (dBm/XMHz)	Noise floor (dBm/XMHz)
23	Minimum C/(N+I)	Minimum C/(N+I)	Minimum C/(N+I)	Minimum C/(N+I)
24	Max Interference Threshold	Max Interference Threshold	Max Interference Threshold	Max Interference Threshold
25	Min field strength at the location of the receiving antenna (dBuV/m)	Min field strength at the location of the receiving antenna (dBuV/m)	Min field strength at the location of the receiving antenna (dBuV/m)	Min field strength at the location of the receiving antenna (dBuV/m)

4.2 Eir Response to ComReg 15.01.2018

From: William.McCoubre[redacted]
To: Joseph Coughlan
Cc: Tara Kavanagh
Subject: RE: RurTel
Date: 15 January 2018 17:18:03
Attachments: image001.gif
image002.jpg
Rurtel answers Jan18.docx
ATT00001.txt
ATT00002.htm

Hi Joseph,
Please see attached response to the questions. It is more a work in progress as unfortunately the necessary analysis is taking longer than anticipated in part due to resource availability. More to follow in the coming weeks.
Regards,
William

From: Joseph Coughlan [mailto:[redacted]
Sent: 08 January 2018 14:18
To: McCoubrey, William
Cc: Tara Kavanagh
Subject: RE: RurTel
Hi William,
Ok, appreciate your response by close of business Monday 15 January.
Thanks
Joseph

From: William.McCoubrey@[redacted]
Sent: 08 January 2018 12:53
To: Joseph Coughlan <[redacted]
Cc: Tara Kavanagh [redacted]
Subject: RE: RurTel
Hi Joseph,
Unfortunately I am not yet in a position to respond to your requests. Grateful if we could move the deadline out a week.
Thanks,
William

From: Joseph Coughlan [mailt[redacted]
Sent: 28 November 2017 10:45
To: McCoubrey, William
Cc: Tara Kavanagh
Subject: RE: RurTel
Hi William,
Thanks for this. Following on from our meeting please see attached the information request set out more clearly. If you have any questions in relation to the above please give me a call.
The hardcopy of the letter will follow in the post.
Regards
Joseph

Joseph Coughlan
Beartas & Forbairt Speictrim | Spectrum Policy and Development
An Coimisiún um Rialáil Cumarsáide | Commission for Communications Regulation

1 Lárcheantar na nDugaí, Sráid na nGildeanna, BÁC 1, Éire, D01 E4X0. |One Dockland Central, Guild Street, Dublin 1, Ireland, D01

E4X0.
Teil | Tel +[redacted]
Rphost | Email [redacted]
Suíomh | Website www.comreg.ie

testandtrial.gif

From: William.McCoubrey[redacted]
Sent: 22 November 2017 16:59
To: Tara Kavanagh [redacted]; Joseph Coughlan [redacted]
Subject: RurTel

Tara / Joseph,

Good to meet with you on Monday. As discussed the soft dial-tone numbers are as follows:

AHS1	8	Achill Sound
BSH1	7	Killarney
CBR1	3	Castlebar
LKY1	100	Letterkenny
MVW1	41	Mervue
Total	**159**	

Regards,
William

William McCoubrey
Head of Regulatory Strategy
—

—
eircom Ltd.
1 Heuston South Quarter
St. John's Road, Dublin 8
—
[redacted]
—

Response to ComReg questions in respect of Rurtel – January 2018

[redacted]

- **A background and chronology of the work completed by Eir to date in reducing the extent of the Rurtel network;**

eir response: The Rurtel service is not made available to new customers. The base is in decline and where possible, i.e. when there are no active users, eir will decommission a transmission site. The most recent example of this is the decommissioning of the Castelbar Rurtel facilities. The Achill Rurtel system has been decommissioned. Galway Rurtel originally had 95 working Repeater/Customer stations. This has now been reduced to 11 stations Some elements of the Kerry & Donegal systems have also been decommissioned.

- **Eir's view as to what further steps could be taken to reduce the extent of the Rurtel network;**

eir response: Rurtel customers are in areas where it is not economic to serve them using conventional fixed line technology. These areas are generally not well served by mobile coverage either. It is a question of economics and the only viable alternative for service to the remaining customers would be the outcome of a State-led initiative such as the National Broadband Plan.

- **Noting that you have sent on the soft dial tone figures based on your preliminary investigations, please provide an update on the actual number of customers using the Rurtel network;**

eir response: There are 87 active customers on the Rurtel system in three geographic areas:

Status	Killarney BYS1	Letterkenny LKY1	Mervue MVW1	Total
Test Line	3	10	2	15
Retail	**3**	**57**	**4**	**64**
Wholesale	**1**	**20**	**2**	**23**
Grand Total	7	87	8	102

- **Detail on the current Rurtel network deployment, including:**
  - **the number and locations of the point to multipoint base stations used to serve customers;**

eir response: There is presently 42 working Multi-point repeater sites. The ComReg website lists them by site name but shows no location information for them. Also, the identity of some is unclear because of different names in use for the same locations and/or the same place names used in more than one location.

  - **the number of customers served from each base station and their locations;**

eir response: eir has limited records available in respect of the Rurtel network. As such we are not currently in a position to provide details of customers served including locations. Identifying locations is taking longer than anticipated. Given the declining nature of the Rurtel base it may be more efficient to undertake detailed analysis closer to the award of the 2300MHz band as it would be expected that Rurtel will be less extensive. Higher level analysis is ongoing but will take some further time to complete.

Response to ComReg questions in respect of Rurtel – January 2018

[redacted]

- **the number and locations of the 2.3 GHz point to point links used to back haul traffic to the exchange;**

eir response: Backhaul will utilize spectrum in the 2300MHz band however these are not discrete point to point licenses.

- **technical parameters for the point to multipoint links, point to point links and consumer premises equipment (CPE) /subscribers, in this regard Annex 1 to this letter includes a table of the information required for each;**

eir response: We have not undertaken a detailed assessment for each customer. Please find attached technical information in respect of two sites which was provided to ComReg in 2010. This information is representative of the technology deployed.

Rurtel specs.doc

- **Noting that Rurtel is a legacy system, Eir's plans for providing service to the customers identified above into the future and the envisaged timeframes of this.**

eir response: eir has no specific plans for the provision of alternative service to customers on the Rurtel system. As noted above, it is a question of economics and the only viable alternative for service to the remaining customers would be the outcome of a State-led initiative such as the National Broadband Plan.

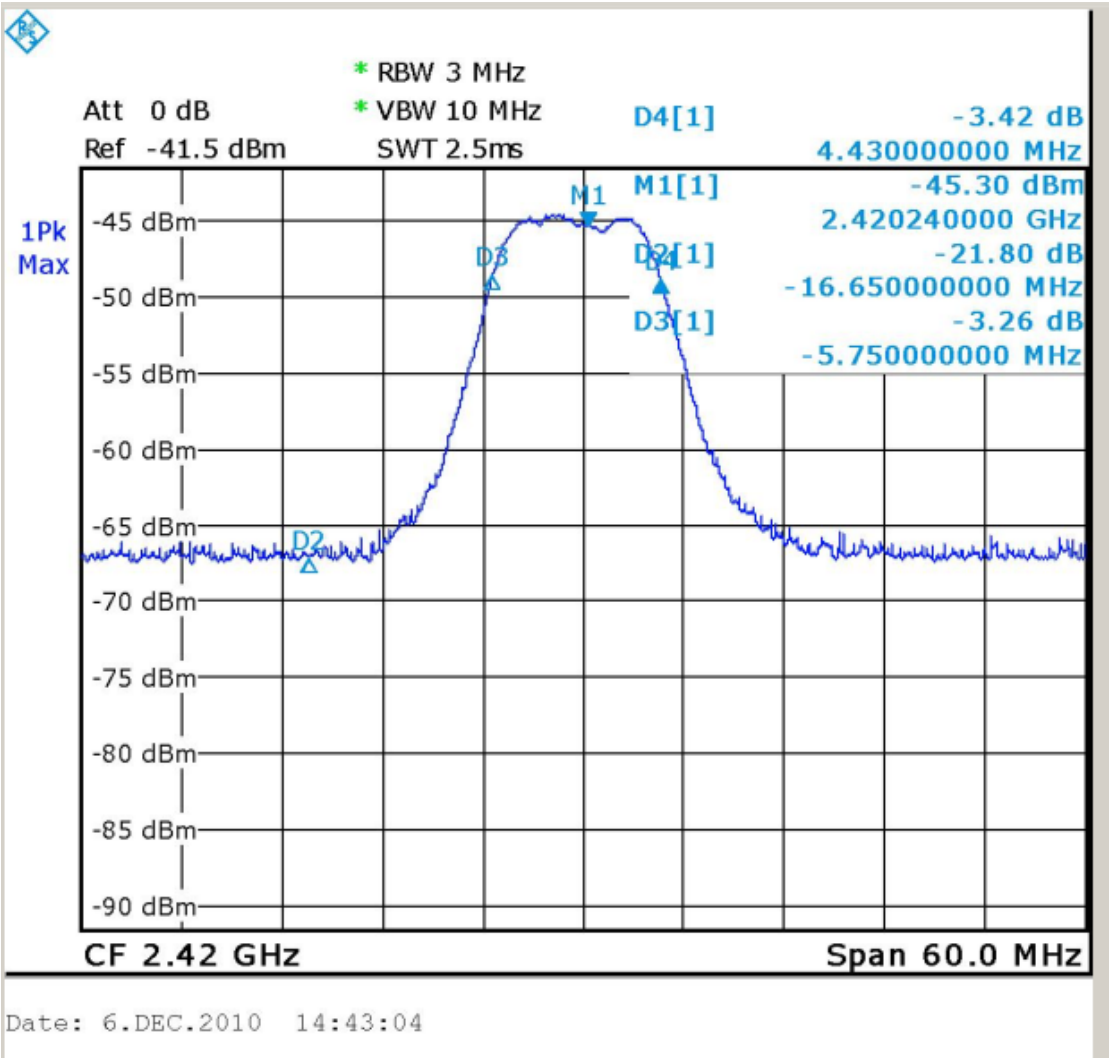
As discussed at our meeting, using the above information ComReg intends to amongst other things, consider the compatibility and coexistence between Rurtel network and potential future services in the 2.3 GHz Band. You identified that Eir had carried out some work in this area previously and ComReg would be grateful if Eir can share its work on its coexistence studies.

eir response: There may have been a misunderstanding at our meeting. eir has not undertaken coexistence studies. We do from time to time consider whether the availability of alternative technology such as mobile or FTTH may have improved in the Rurtel service area such that individual customers could be encouraged to migrate from the Rurtel system.

ComReg are currently carrying out analysis on how it can protect the existing usage of Rurtel in light of the proposed upcoming release of spectrum in the 2.3 GHz band. In order to carry out its technical analysis, ComReg requires information surrounding the technical configuration of Rurtel sites.
In this regard, ComReg requires Eircom to provide it with details of two Rurtel sites. The sites selected by Eircom should be a typical site, and also a worst case site i.e. the site with the highest elevation and covering the largest area. Details required are;

1. Particular site and coordinates:1
2. Bandwidth: 2 MHz1
3. Site Height: (agl/asl)1:
4. Antenna type: 1
5. Antenna pattern RPE:1
6. Antenna gain:1
7. Azimuth:1
8. Tilt:1 - none apart from LOS considerations from directional antenna - Omni transmitter
9. EIRP:1
10. Antenna polarisation:1
11. Spectrum Mask:0
12. Base Station Receiver sensitivity:1
13. CPE Receiver sensitivity:1

Rurtel Radio & Site Details	Site	Cregg Hill	Knockletterfore
	Co-ordinates	71370E 252370N	105668E 244362N
	Height ASL	300M	160M
	Height AGL	10M	48M
Directional Antenna Vertical Polarisation	Type	Shrouded Yagi	3.0M Grid
	Gain	17dBi	34dBi
	Azimuth	130 deg	122 deg
Omni Antenna	Type	Jaybeam Omni	Jaybeam Omni
	Gain	10dBi	10dBi
	Azimuth	Omni	Omni
Radio TX	TX Power	+30	+30
EIRP	Directional	+45dBm	+60dBm
	Omni	+38dBm	+38dBm
Radio RX level	Nominal	Rx level -62dBm nom	Rx level -62dBm nom
	Range	-94.5 to -45 dBm	-94.5 to -45 dBm



Rurtel Diplexer Freq Response

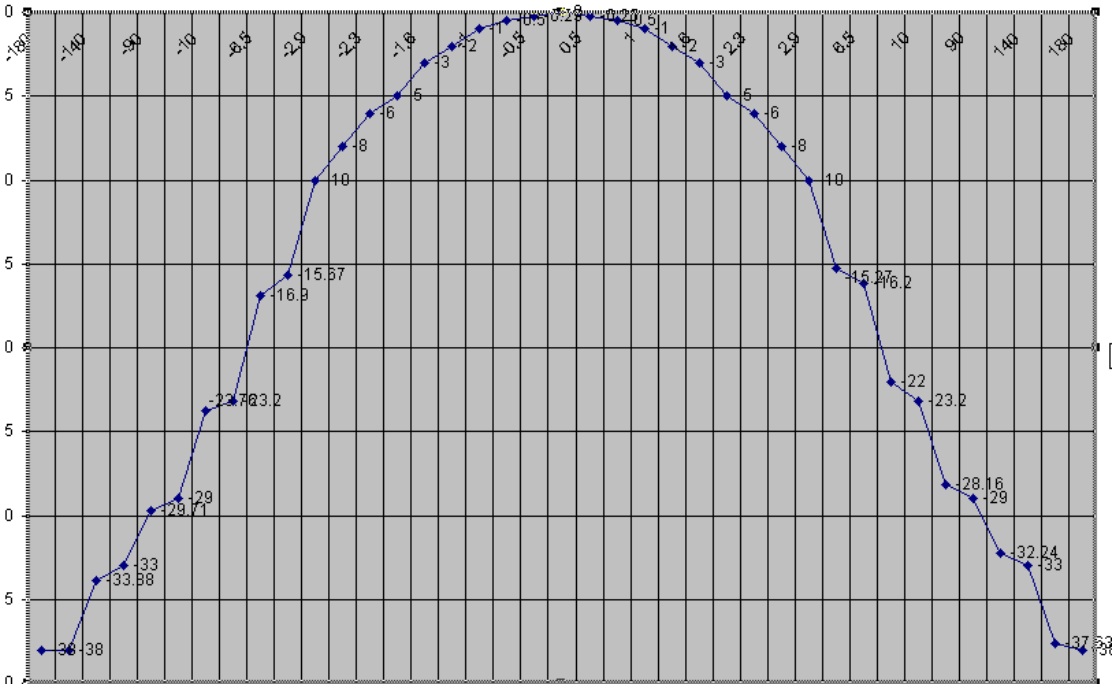
IF Filter 3dB @ 2 MHz
Adj Ch. Suppression 37dB

Antenna Pattern for 3 M grid antenna

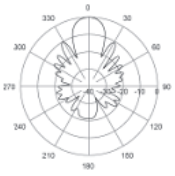
HH 39

-180	-38
-145	-38
-140	-33.88
-110	-33
-90	-29.71
-25	-29
-10	-23.76
-9	-23.2
-6.5	-16.9
-3.5	-15.67
-2.9	-10
-2.6	-8
-2.3	-6
-2.1	-5
-1.6	-3
-1.4	-2
-1	-1
-0.7	-0.5
-0.5	-0.25
0	0
0.5	-0.25
0.7	-0.5
1	-1
1.4	-2
1.6	-3
2.1	-5
2.3	-6
2.6	-8
2.9	-10
3.5	-15.27
6.5	-16.2
9	-22
10	-23.2
25	-28.16
90	-29
110	-32.24
140	-33
145	-37.63
180	-38

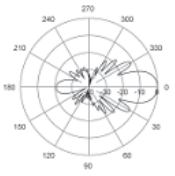
Antenna Pattern for 3 M grid antenna



Frequency:	2300 MHz to 2500 MHz
Gain:	17.0 dBi
VSWR:	<1.3:1
Maximum Power:	100 W
Polarisation:	Vertical or Horizontal
Horizontal Beamwidth:	26°
Vertical Beamwidth:	24°
Front to Back Ratio:	> 20 dB
Impedance:	50 ohms
Termination:	N Female
Lightning Protection:	DC Grounded



Horizontal Pattern



Vertical Pattern

Mechanical Specifications	
Materials:	Shroud, GRP Radiating Assembly, Brass Mounting Section 50 mm dia., Aluminium
Length:	1000 mm
Weight (excluding mount):	1.7 kg
Windloading @ 45 m/s:	91 N
Recommended Mounting Bracket:	3202078/68
Alternate Mounting Bracket:	0300064/00 + U-Bolts to match mounting pipe diameter.

4.3 ComReg Information Request of Eir 12.11.2018

An Coimisiún um Rialáil Cumarsáide
Commission for Communications Regulation

12 November 2018

Mr William McCoubrey
Head of Regulatory Strategy
Eir Group plc
1 Heuston South Quarter
St. Johns Road
Dublin 8

By registered post

Information request regarding Eir's licences in the 2.3 GHz band used for its Rurtel network

Dear William

I refer to the ongoing engagement between ComReg staff and Eir in relation to Eir's current Wireless Telegraphy Act licences in the frequency ranges 2308 – 2326 MHz and 2402 – 2420 MHz (i.e. Eir's Rurtel licences), including ComReg's information request of 28 November 2017 and Eir's response to same of 15 January 2018.

As you will be aware, ComReg is in the process of considering the future use and the potential award of spectrum rights in the 2.3 GHz band and reasonably requires such information to properly consider the compatibility and coexistence between Eir's Rurtel network and potential future services which may be deployed in this band.

Since the above-mentioned correspondence, ComReg staff have requested updates from Eir with regard to information provided on numerous occasions via email, phone and in meetings from a number of Eir staff relating to the technical parameters of these licences among other things. Based on the information provided by Eir to date, which included only two of the 36 Rurtel base stations in operation, it has not been not possible for ComReg to carry out detailed compatibility and coexistence studies in the 2.3 GHz band.

I would therefore be grateful if the technical information outlined in **Annex 1** to this letter (which has previously been requested) be provided in full and by no later than **Friday, 30 November 2018.**

ComReg reserves its right to seek such information using its formal statutory powers.

Finally, given that ComReg may rely upon and/or be obliged to publish some of the information received, Eir should clearly identify in its response what information it considers to be genuinely confidential and the reasons for same.[1]

Yours sincerely

George Merrigan
Director, Market Framework

[1] See, in this regard, ComReg Document 05/24 - Response to Consultation - Guidelines on the treatment of confidential information - March 2005.

ANNEX 1: INFORMATION REQUEST

1. RURTEL NETWORK TECHNICAL PARAMETERS REQUEST

Table 1 below outlines the technical parameters required to conduct detailed compatibility analysis for Eir's Rurtel Network. Please fill in all the blank fields **for each station**.

Table 1: Rurtel Network Technical Parameters

Parameter		Details	Comments
Rurtel System Details			
Rurtel Base Station Name			
Location (Eastings Northings)			
Height (a.s.l.) (m)**			
Height (a.g.l.) (m)**			
Number of customers supported on station			
Timeframe for decommissioning of site			
Frequency			
Transmit Frequency (MHz)			
Receive Frequency (MHz)			
Channel Bandwidth (MHz)			
Equipment Characteristics			
Transmitter Power (dBm)**			
Antenna	Make & Model**		
	Gain (dBi)**		
	Feeder Loss (dB)		
Antenna Radiation Pattern[2]**			
Receiver Selectivity**			

[2] Please provide files / details separately
** mandatory fields

Parameter	Details	Comments
Modulation scheme **		
Receiver Details		
Receiver location		
Receiver Height (a.s.l.) (m)		
Receiver Height (a.g.l.) (m)		
Timeframe for decommissioning of site		
Receiver Noise Figure (dB)		
Receiver Noise Floor, N (dBm)		
Interference Threshold C/(N+I) (dB) **		
Received Signal Strength, C (dBm)		
Propagation Environment		
Path Loss Model	ITU-R Rec. 452	
Link availability (% time) **		
Representative Link Budgets**		

2. UPDATED AND/OR FURTHER INFORMATION

ComReg also requires an update of the following information relating to the use of these licences which is used for Eir's Rurtel network:

1. In its response in January 2018, Eir indicated that the Rurtel service is in decline and will seek to decommission inactive users where possible. In that regard:
   i. Please provide details of any sites decommissioned since Eir's January response (e.g. location, alternative technology used etc);
   ii. Please provide details of any planned decommissioning of sites (e.g. location, timeframe, alternative technology); and
   iii. Please provide details of Eir's plans to decommission the entire Rurtel network (e.g. alternative technologies, timeframe, customers impacted).

2. In its response of 15 January 2018, Eir indicated that there are 87 active customers on the Rurtel system in three geographic areas (as identified below). In that regard:
   i. Please provide an update to this table;
   ii. Please also clarify what is meant by "Test Line".

Status	Killarney BYS1	Letterkenny LKY1	Mervue MVW1	Total
Test Line	3	10	2	15
Retail	**3**	**57**	**4**	**64**
Wholesale	**1**	**20**	**2**	**23**
Grand Total	7	87	8	102

3. In its response of 15 January 2018 date, Eir indicated that there was ongoing analysis in relation to the number of customers served from each base station and their locations. Please provide this analysis including locations of all CPE's.

4. Please identify which Rurtel sites are dedicated only to backhaul (i.e. have no customers directly connected to the site). Do these backhaul sites use different technical parameters to those sites serving customers? If so, please provide the technical parameters for these backhaul-only sites (having regard to the types of information identified in Table 1 above).

4.4 Eir Response to ComReg 03.12.2018

From:
To:
Subject:

Date:
Attachments:

From: William.McCoubrey@[redacted]
Sent: 03 December 2018 08:37
To: Suzanne Power [redacted]
Cc: Conor Berkeley [redacted]
Subject: RE: Information request regarding Eir's licences in the 2.3 GHz Band used for its Rurtel Network

Dear Suzanne,

Please see below for eir's responses to the questions raised.

Regards,
William

1. RURTEL NETWORK TECHNICAL PARAMETERS REQUEST

Table 1 below outlines the technical parameters required to conduct detailed compatibility analysis for Eir's Rurtel Network. Please fill in all the blank fields for each station.

eir response: We are not currently in a position to answer this question. The records on the network systems are insufficient to provide the details requested. Physical surveys are required as noted in response to part 2, question 2 below.

2. UPDATED AND/OR FURTHER INFORMATION

ComReg also requires an update of the following information relating to the use of these licences which is used for Eir's Rurtel network:

1. In its response in January 2018, Eir indicated that the Rurtel service is in decline and will seek to decommission inactive users where possible. In that regard:
    i. Please provide details of any sites decommissioned since Eir's January response (e.g. location, alternative technology used etc);

eir response: There has been some decommissioning carried out as evidenced by the reduction in the number of licences with ComReg.

PM9575/1 Achill Sound
PM9575/15 Castlebar

PM9575/18 Creggs
PM9575/19 Croaghmoyle
PM9575/20 Currabeg
PM9575/21 Dungloe
PM9575/28 Gearha
PM9575/29 Glassan
PM9575/43 Maghera
PM9575/46 Minaun Heights

ii. Please provide details of any planned decommissioning of sites (e.g. location, timeframe, alternative technology); and

eir response: There are currently no sites planned for decommissioning. 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.

iii. Please provide details of Eir's plans to decommission the entire Rurtel network (e.g. alternative technologies, timeframe, customers impacted).

eir response: eir has no current plan to decommission the entire RurTel network. See response to (ii) above.

2. In its response of 15 January 2018, Eir indicated that there are 87 active customers on the Rurtel system in three geographic areas (as identified below). In that regard:
   i. Please provide an update to this table;

eir response: Since January 2018 the number of customers has declined by 25. There are now 87 active customers on the three RurTel systems.

Status	Killarney BYS1	Letterkenny LKY1	Mervue MVW1	Total
Grand Total	**2**	**77**	**8**	**87**

ii. Please also clarify what is meant by "Test Line".

eir response: A Test Line is a PSTN line used by engineers to test the Rurtel system and to localise faults and check quality of service.

3. In its response of 15 January 2018 date, Eir indicated that there was ongoing analysis in relation to the number of customers served from each base station and their locations. Please provide this analysis including locations of all CPE's.

eir response: This analysis has not been completed. Physical surveys are required.

4. Please identify which Rurtel sites are dedicated only to backhaul (i.e. have no customers directly connected to the site). Do these backhaul sites use different technical parameters to those sites serving customers? If so, please provide the technical parameters for these backhaul-only sites (having regard to the types of information identified in Table 1 above).

eir response: The Kerry system comprises 8 repeater stations with 2 Customer stations supporting 2 working customers.

The Galway system comprises 5 repeaters and 6 Customer stations with 6 working customers.

The Donegal system is a more complex network.

From: Suzanne Power [redacted]
Sent: 13 November 2018 11:36
To: McCoubrey, William
Cc: Conor Berkeley
Subject: RE: Information request regarding Eir's licences in the 2.3 GHz Band used for its Rurtel Network

Dear William,

Please see attached,

Kind regards,

Suzanne
Suzanne Power
Comhordaitheoir Rannpháirtíochta Idirnáisiúnta
International Engagement Coordinator
An Coimisiún um Rialáil Cumarsáide
Commission for Communications Regulation
1 Lárcheantar na nDugaí, Sráid na nGildeanna, BÁC 1 D01 E4X0
One Dockland Central, Guild Street, Dublin 1, Ireland, D01 E4X0
[redacted]

From: [redacted] illiam.McCoubrey[redacted]
Sent: 13 November 2018 11:19
To: Suzanne Power [redacted]
Cc: Conor Berkeley <[redacted]
Subject: RE: Information request regarding Eir's licences in the 2.3 GHz Band used for its Rurtel

Network

Dear Suzanne,

Grateful if you could provide the information request in Word format.

Thanks,
William

From: Suzanne Power [mailt [redacted]
Sent: 12 November 2018 12:36
To: McCoubrey, William
Cc: Conor Berkeley
Subject: Information request regarding Eir's licences in the 2.3 GHz Band used for its Rurtel Network

Dear William,

Please see attached a letter for your urgent attention, on behalf of George Merrigan. A hardcopy will follow in the post today.

Should you have any queries relating to the information requested in Annex 1 of this letter please contact Conor Berkeley who will be happy to assist, at:

[redacted]

Yours Sincerely,

Suzanne Power

Suzanne Power
Comhordaitheoir Rannpháirtíochta Idirnáisiúnta
International Engagement Coordinator
An Coimisiún um Rialáil Cumarsáide
Commission for Communications Regulation
1 Lárcheantar na nDugaí, Sráid na nGildeanna, BÁC 1 D01 E4X0
One Dockland Central, Guild Street, Dublin 1, Ireland, D01 E4X0
[redacted]
Suíomh | Website www.comreg.ie