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DotEcon Assessment of Consultation Responses

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1 Introduction

1. In June 2019, ComReg published a consultation on proposals for a multiband spectrum award of spectrum in the 700 MHz, 2.1 GHz, 2.3 GHz and 2.6 GHz bands. The proposals have been developed through a number of documents, with the most recent (ComReg 19/59R) both giving ComReg's response to an earlier preliminary consultation (ComReg 18/60) on which bands to include and setting out proposals for the design of the award process.
2. DotEcon has provided various expert economic advice on the proposed award process, with our most recent report on award design (ComReg 19/59a) being published as part of ComReg's June consultation. We have now been asked by ComReg to consider the responses to ComReg 19/59R and how they relate to our previous report. This report provides our views on award design issues raised by respondents.

2 Early liberalisation

2.1 ComReg's proposal

Options to liberalise

3. The proposal included options for licensees to liberalise use of their existing 2.1 GHz spectrum licences, which are currently restricted to UMTS/3G use. These licences expire in:
 - July 2022 (for 2x15 MHz held by Three);
 - October 2022 (for 2x15 MHz held by Three and 2x15 MHz held by Vodafone); and
 - March 2027 (for 2x15 MHz held by Meteor/Eir).
4. ComReg set out three options:
 - *Option 1*: Do not liberalise these licences;
 - *Option 2A*: Provide the option for all existing licensees to liberalise some or all of their existing 2.1 GHz rights of use, from the time of the substantive decisions concerning the present Proposed Award; and
 - *Option 2B*: Provide the option for all existing licensees to liberalise some or all of their existing 2.1 GHz rights of use following the assignment of new licences in the Proposed Award.
5. Option 2A and 2B give operators options to liberalise from some date *onwards*. Exercising the option to liberalise is not limited to one particular date. There appears to have been some confusion about this point amongst consultees, as we discuss below.
6. ComReg favoured adopting Option 2A. This approach would yield benefits by permitting use for 4G (or other technologies) from the earliest reasonable opportunity and be consistent with EC Decision 2012/688/EU.

Additional fees for liberalisation

7. With respect to potential liberalisation fees, ComReg proposed not to apply any additional fees for liberalisation in the short period until October 2022. However, additional fees might be payable for liberalised use from October 2022 until March 2027, which would potentially apply to Eir if it chooses to liberalise its licence expiring in March 2027 and if the market price of liberalised spectrum licences from 2022 until 2027, as indicated by the auction, exceeds the current licence fees being paid by Eir. Even though such a case was considered unlikely, this provision was considered necessary to avoid the possibility that Eir might gain access to liberalised 2.1 GHz period during this period at a significantly cheaper price than winners of comparable spectrum in the auction, potentially leading to a competitive distortion and/or potential dispute.

8. A mechanism for inferring market prices for 2.1 GHz spectrum in the period October 2022 to March 2027 from auction prices for winning bidders was set out in detail in our report.¹ We also showed that the price that Eir is already paying for its existing 2.1 GHz licence was likely to be higher than reasonable estimates of the current market price of corresponding liberalised spectrum, making it unlikely that any such additional fee for liberalisation would be needed.
9. Therefore, under option 2A, it would be open to Eir to liberalise prior to the auction, with a small risk of a subsequent additional payment, or to wait and liberalise after the auction once the market price of liberalised 2.1 GHz was known. Under option 2B, the option to liberalise could only be exercised after the auction.

2.2 Views of respondents

10. The three MNOs all commented on the potential effect of early liberalisation in their responses.

Eir's view on timing of liberalisation

11. Eir agrees that there should be early liberalisation, but argues that existing licensees may not have sufficient information to make a decision as to liberalise their spectrum in advance of the outcome of MBSA₂, which determines their access to future rights of use of spectrum in this and other bands, especially if there is a fee to pay for early liberalisation. Therefore, Eir suggests that ComReg should allow licensees to make a decision with regard to early liberalisation at any point before the licence expiration date and that any liberalisation fees should only apply for the actual duration for which spectrum use is liberalised.
12. Alternatively, if existing licensees are required to make a decision to liberalise their licences before the conclusion of the proposed MBSA₂ process, then ComReg should decide in advance that there will be no charges for early liberalisation (on the basis that ComReg considers it highly unlikely that any fees would apply). In Eir's view, this would avoid licensees being subject to uncertainty in relation to future fees.

Eir's views on additional fees on liberalisation

13. Eir disagrees with the possibility of levying additional fees for early liberalisation. Notwithstanding this general opposition to additional fees, Eir also raises two objections to the proposed methodology for calculating any such additional fees:
 - First, any difference between the auction price for 2.1 GHz licences and the fees paid by Meteor for the current un-liberalised licence may not only reflect the additional value of liberalising the spectrum, but also

¹ See ComReg 19/59a, Section 3.3.5.

include other factors unrelated to liberalisation, such as a general increase in the underlying value of (un-liberalised) 2.1 GHz spectrum and the value to Three and Vodafone of continuity of service. In Eir's view, it would be inappropriate to levy liberalisation fees in respect of any increase in value that does not relate specifically to liberalisation rather than other causes; and

- Second, it would not be appropriate to use auction prices for licences in time slice 2 within the calculation, as early liberalisation only affects time slice 1.

Reduction of Eir's current licence fees

14. Eir also argues that, if ComReg considers that allowing Eir to liberalise its spectrum without paying additional fees for early liberalisation could distort competition, then it should also consider the potential distortions that might arise from allowing Eir's competitors to acquire liberalised 2.1 GHz spectrum at a price that is lower than the price paid by Eir for its un-liberalised spectrum. Thus, if ComReg considers the possibility of levying additional fees for liberalisation, then it should counter-balance this with the possibility of offering a rebate to Eir for its existing licence if 2.1 GHz spectrum sells at a lower price in the auction. Thus, Eir suggests that ComReg should either:
 - liberalise existing licences at no cost; or
 - if an additional liberalisation fee might be levied in the event that liberalised 2.1 GHz spectrum in time slice 1 sells at a higher price than that paid by Eir for its un-liberalised licence, then also offer a rebate in the event that the auction price is below the price paid by Eir.
15. Finally, Eir requests clarification around how the adjusted price per MHz per population for its 2.1 GHz spectrum has been calculated, as it considers this to be inexplicably much lower than the adjusted price per MHz per population calculated for Three and Vodafone, given that the payment terms for all licences are the same and the only difference is the date of issue, which is within a five-year difference.

Three's views on liberalisation fees for Eir

16. Three's view is that Eir should not be allowed to liberalise without paying a fee, because Eir's choosing to liberalise indicates that there is benefit over and above what it had already paid for. Therefore, allowing liberalisation without a fee would represent a windfall gain for Eir alone.
17. As an alternative to providing the option for Eir to liberalise its existing licence, Three proposes that Eir should be given the option to return its licence to ComReg early, so that the spectrum would be available for re-award on a liberalised basis. In this case Three proposes that any remaining SUFs on the returned licence would be waived, but any remaining payments relating to the licence SAF should still apply. Three highlights that this option could be extended to itself and Vodafone, and if taken up this would mean that all of the 2.1 GHz spectrum would be available for new liberalised licences from the date of award, removing the need for time slicing and extending Three's licences.

Vodafone suggestion to hand back licences

18. Vodafone agrees on balance with allowing early liberalisation once an auction date is fixed to support the earliest delivery of greater capacity to customers. However, it expresses concern that Three's "double holding" of 2.1 GHz spectrum would give it a significant cost advantage by reducing the need to build extra sites to cope with network capacity requirements, which could have an impact on market share over time. Vodafone's suggested change to remove the need for time slicing by allowing MNOs to hand back their licenses in 2021 would also limit the effect of early liberalisation.

2.3 Assessment and recommendations

Underlying principles

19. The recommendations on potential fees to be charged for early liberalisation are based on balancing a number of potentially conflicting principles, namely:
 - as far as possible, not distorting Eir's incentives to liberalise;
 - ensuring that access to liberalised spectrum for Eir is not at unduly favourable terms that could distort downstream competition; and
 - as far as possible preserving, and not undermining, the rights and obligations established by the previous award of 2.1 GHz spectrum.
20. On the back of the third principle, the proposals amount to offering Eir an option to remove the technological constraint in its current licence at some price (likely zero), rather than starting entirely afresh with a new licence on new terms. Therefore, changes to the existing licence are kept to the minimum necessary.

Additional payments for liberalisation

21. The proposed approach to liberalisation needs to be robust to all reasonable contingencies with regard to the outcome of this award. This includes the possibility that allowing Eir to liberalise its current licences free of charge might give rise to a competitive distortion by allowing Eir access to spectrum on unduly favourable terms. In such a case it would be appropriate to set a liberalisation fee to ensure that the total fees applicable to Eir are aligned with the going market rate (i.e. the opportunity cost, which is likely similar to what

other users would likely be paying for the first five years of any 2.1 GHz licenses they are awarded).²

22. We note that the step of liberalising an existing licence is by itself unlikely to alter the *current* opportunity cost caused by the licensee. Other users – themselves able to make liberalised use of that spectrum - are likely to be precluded from using that spectrum to a similar degree whether or not the licence is liberalised. However, when the licence was originally awarded, fees were determined administratively and under different usage conditions and valuation assumptions. Therefore, there is the potential that the current opportunity cost is higher than the fees determined at the time of the award. Even if administratively set charges did reflect opportunity cost at that time, this would have been the opportunity cost set by alternative *un-liberalised* use. This may well be below the current opportunity cost as it was determined by *others'* potential use, which was technologically constrained. For this reason, opportunity cost in a liberalised regime will be at least as great as that in an un-liberalised regime. Any such change in opportunity cost due to liberalisation is distinct from any gain in value that the current licensee might enjoy from relaxing restrictions on how that spectrum might be used.
23. This said, based on our benchmarking analysis, it appears unlikely that the market price of the 2.1 GHz spectrum determined in this award will be above the fees currently being paid by Eir for its existing un-liberalised licence. The evidence and reasoning is set out in our previous report and the conclusion that such an additional payment for liberalisation is unlikely does not appear to have been contested by any respondent.
24. The proposed approach is not the same as requiring that Eir make a payment equal to the entire increase in the value of spectrum to it from liberalisation, in effect leaving Eir with no net benefit from liberalisation. In competitive markets, where firms compete for inputs they pay what they need to secure these in the face of competition from rivals, that is a market price, which will typically be less than full benefit to them (measured by the difference in the enterprise value with and without the input).
25. Therefore, the proposed approach gives Eir credit for what it is already paying under its existing licence for un-liberalised 2.1 GHz spectrum. An additional liberalisation payment is only triggered if the auction reveals a market price

² For the avoidance of any doubt, we are not making a broader argument here that all operators must always pay identical prices, for example on a per MHz basis. Indeed, we note that one of the reasons that Three objects to the CCA on the basis that winners may pay different amounts for similar packages of spectrum. We discuss this issue in detail below when considering auction design issues. We note for now that bidders may pay dissimilar amounts for similar packages if they face different amount of competition and so impose different opportunity costs on other bidders. This may be a necessary feature of pricing for winning bidders in a competitive auction process if efficient outcomes are to be supported, yet winners pay as little as possible subject to this requirement.

The question of whether an additional price is necessary as part of an administrative decision to liberalise spectrum is different in nature. Here the concern is whether the licensee might have pay significantly less than its opportunity cost and so be unfairly advantaged by the fact that it had not needed to compete for that right to liberalised spectrum access, but rather received that right in part through the administrative decision to liberalise, whereas other operators may have competed directly to acquire already liberalised rights.

exceeding this. This approach respects the rights and obligations of Eir under its existing licence and does not seek to reset the price currently paid for un-liberalised spectrum access. Rather, the approach ensures that Eir pays the minimum amount necessary for the option to liberalise its licence while ensuring that there are no resulting distortions. Therefore, Eir is being given the strongest possible incentive to liberalise, subject to the requirement that it does not pay less than opportunity cost within a liberalised regime.

26. We strongly disagree with the proposal from Three that Eir should pay for the full value it receives from liberalisation. This is incompatible with ComReg's objectives for the process, as we set out below, and might discourage Eir from liberalising.
27. In spectrum awards bidders typically pay what they need to in order for competitors to not be prepared to pay more. This means winning prices are based on opportunity cost, rather than value of the spectrum to the winner, with the winner often enjoying some surplus. Therefore, as a matter of general principle, there is no presumption that licensees should pay the full amount of the value of spectrum to them.³ Efficiency considerations require that payments reflect opportunity costs of other potential users, not the value to the licensee itself. The issue we face is that this opportunity cost may have increased due to moving from an un-liberalised to a liberalised regime.
28. Given Eir's current payments for its un-liberalised licence, if, as Three suggests, Eir were to pay the entire benefit of liberalisation, then there is a good chance that this would result in Eir paying in excess of a reasonable estimate of the current market price of 2.1 GHz spectrum. This is incompatible with the principle that spectrum fees should reflect the need to ensure the optimal use of spectrum, which is a key objective for ComReg in the design of this process. If Eir liberalised on such terms it might be paying in excess of the likely opportunity cost of the spectrum (the value to others of using the spectrum instead). This would discourage Eir from liberalising and potentially even give an inappropriate incentive to vacate the spectrum.

Rebates on Eir's existing fees

29. On the other hand, for the reasons highlighted in our award design report (ComReg Document 18/59a), it would not be appropriate to give Eir a rebate on the fees for its current licence, even if prices for new 2.1 GHz licences awarded are lower. Doing so would undermine the outcome of the previous award and set a poor precedent for future awards. Eir committed to paying the fees for the un-liberalised licence in the full knowledge that the market value could go up or down. If these payments are not binding, bidding incentives for future awards could be distorted through expectations that the State would similarly underwrite the risk of the spectrum falling in value at some later date.
30. Furthermore, we know as a matter of principle that, if the only relevant change affecting the valuation of a spectrum licence were removal of a constraint on the technology that could be used, this must increase the value of that licence.

³ For example, if a single unit is sold in a second price auction, the winner pays the valuation of the strongest loser and so can expect to enjoy some surplus.

For the same reason, if other factors affecting valuation remain the same, the opportunity cost of a licence cannot fall moving from an un-liberalised regime to a liberalised one. Turning this around, if the opportunity cost associated with Eir's licence has indeed arisen since its original award (when other potential users would, at that time, also have been subject to the same constraints on the technology that could be used), then this must be due to other factors causing the valuation to change (such as increases in the general supply of spectrum). It would be inappropriate to now change Eir's licence fees to reflect such other changes affecting spectrum valuations more generally.

31. Therefore, the proposed approach can be interpreted as granting Eir the option to relax the technological constraint within its current licence, rather than cancelling the current licence and awarding a new one on entirely new terms. Any potential additional payment for liberalisation would be made in consideration of its exercise of the option to liberalise its licence, not as a correction for any change in the asset value of the original un-liberalised licence.
32. For this reason, we do not see any reason to consider a situation in which new 2.1 GHz licences are awarded at a price below Eir's current fees as inappropriate. New licensees would have simply acquired the new licenses in different circumstances to those prevailing when Eir acquired its current licence.

Methodology for determining amount of any liberalisation fee

33. In setting out a methodology for calculating liberalisation fees that would apply for Eir, we recognise that this would ideally be based on a comparison of the award price for 2.1 GHz spectrum in time slice 1 and Eir's current fees. However, as noted in our award design report, with an auction format that allows for package bidding (in this case the CCA) there is no explicit final price for an individual lot category, and it is necessary to use an approximation based on final clock prices and auction revenues.
34. In this case, using only the time slice 1 clock price could lead to distorted bidding incentives and risk exposing Eir to gaming by other bidders. If the liberalisation fee is not based on an average of prices across both time slices, other bidders could have an incentive to bid up the price of 2.1 GHz lots in time slice 1 simply to manipulate the liberalisation fee and impose a cost on Eir.

Other factors affecting spectrum valuation since initial award

35. We also acknowledge that the prices achieved in the upcoming award will reflect any general change in value to the 2.1 GHz spectrum relative to when Eir acquired its current licence, as well as other factors (which *might* include continuity of service, as Eir has suggested). However, we are not trying to answer the hypothetical question of what Eir's licence might have cost if we could wind the clock back to when it was originally awarded and suppose instead that it was awarded with no technological restriction.
36. The argument for charging Eir a liberalisation fee is not that it should pay according to its benefit of liberalisation, but that it should be expected to pay an amount that is broadly in line with what other licensees are paying for their

liberalised 2.1 GHz licences over the first time slice, reflecting the fact that the opportunity cost caused by its usage rights may have increased due to potential alternative users now being able to use that spectrum on a liberalised basis, whereas when it was originally awarded alternative users would have been subject to a technological restriction. As set out above, we are not seeking to set a new price for Eir's existing licence at this point, but only to set a reasonable additional charge for the liberalisation option. Therefore, we do not agree that it is inappropriate to use the difference between the award prices and Eir's current fees to establish the liberalisation fee.

Price of Eir's current licence

37. Eir has also asked for an explanation of how the price of its current licence (that would be compared against the award prices for determining the liberalisation fee) was calculated. To be clear, the reported prices for the previous 2.1 GHz awards in Ireland were subjected to the same adjustments as prices from other awards for the benchmarking exercise (to ensure a comparison with the benchmarking output was meaningful, for example standardising differences in licence durations). As explained in our benchmarking report, these reported prices included the fees for the TDD spectrum awarded at the same time. This standardisation procedure was used to compare the estimated price of the spectrum at the time of the award with the overall benchmarking output for the 2.1 GHz band. These standardised prices for previous 2.1 GHz awards were not intended to be interpreted as the price level for input to the calculation of a liberalisation fee; this was a purely hypothetical exercise to demonstrate that an additional fee for liberalisation was unlikely. Any actual fee would be determined only on the basis of Eir's current fees for its 2.1 GHz FDD spectrum and the auction outcome. We set out the steps that would be taken to determine any liberalisation that Eir would be required to pay (including a provisional calculation of the current price that would be used for comparing against the award price) in Annex B.

Interim licence vs. grant of liberalisation option

38. Three argues that Eir's licence must not, in any eventuality, be liberalised without payment of an additional fee over and above its existing 3G licence fee. Three justifies this on the basis that "*if Eir takes up that option, then there must be some additional value to having the licence liberalised*". However, Three does not propose what that additional fee might be or how it might be calculated.
39. ComReg's proposals around the calculation of Eir's fee for early liberalisation are consistent with its statutory obligations and stated objectives. In particular, if the auction determines that the market value of Eir's 2.1 GHz spectrum, when liberalised, is higher than its current licence fee, it will be required to pay that market value. On the other hand, if the auction determines that the market value of its spectrum when liberalised is lower than its current licence fee, it will still be required to pay the current licence fee (the reasons for same are set out above). Importantly, in no case will Eir end up paying a fee that is lower than the fee paid by other MNOs for comparable liberalised spectrum. Accordingly, we are of the view that there is no basis to the concerns raised by Three.

40. Three objected that there was a difference in approach between determining fees for granting a short-term interim licence and the methodology for determining liberalisation fees for Eir. However, it is important to recognise that there is a distinction between changing the conditions on a licence already held by an operator through an administrative decision to allow liberalisation, which would not represent giving something of self-standing value, and giving the operator something new, such as access to spectrum over a period in which it would not otherwise hold a license. Therefore, the liberalisation of Eir's licence is not a comparable situation to Three paying for an interim licence to align its licence with Vodafone. On this basis we do not see any particular reason why there should be any link between the liberalisation fees paid by Eir and the interim licence fees to be paid by Three.

Timing of liberalisation

41. The current proposal is for existing licensees to have the option to liberalise existing 2.1 GHz at the earliest opportunity once substantive decisions about the auction process have been made, but before running the auction. This ensures consistency with EC Decision 2012/688/EU. We recognise that this approach gives rise to the possibility of Eir having to make a payment for liberalisation after the auction, and this not being known at the point that Eir decides to liberalise. However, our assessment is that it is appropriate that Eir should pay an additional fee for liberalisation, should the auction determine that one should be paid.
42. Furthermore, we highlight that the distinction between option 2A and option 2B refers only to the point at which ComReg makes the liberalisation option available. Licensees have discretion as to when, if at all, they exercise this option. It is appropriate for ComReg to go ahead with option 2A, as it avoids forcing licensees to wait longer than necessary to migrate away from legacy UMTS/3G use. The risk to Eir of doing so ahead of the award is small due to an additional payment being unlikely, but it is free to avoid this uncertainty entirely by choosing to liberalise the licence after the award, in order to do so in full knowledge of the fee, if any, it would face.
43. It would be inappropriate to force existing licensees to wait longer than necessary to liberalise existing licence, as this frustrates potential migration away from legacy UMTS/3G use. However, Eir's concerns about any risk it faces is mitigated by giving it the option to either liberalise early, before the auction but once ComReg has set in place the award process, or after the auction in full knowledge of any additional liberalisation payment that would be needed. Our understanding is that this is indeed what ComReg is proposing.

3 Time slices

3.1 ComReg's Proposal

Proposed time slices

44. Three, Vodafone and Eir all currently have access to spectrum in the 2.1 GHz band, but while both Three and Vodafone's licenses expire in 2022; Eir's runs until 2027. Therefore, ComReg proposed to make 2.1 GHz spectrum available in two time slices:
- the first, consisting of 2x45 MHz and running from 2022 until 2027 (ComReg will offer Three short interim licences, both of which currently end before Vodafone's, to allow for a common start date for all 2.1 GHz time slice 1 licenses); and
 - the second, consisting of 2x60 MHz (i.e. including the spectrum Eir currently has access to), running from 2027 until the common expiry date for all licenses in this award.

Time slicing the capacity bands

45. With regards to the other bands available in the award, ComReg proposed to also use time slices for the 2.3 GHz and 2.6 GHz bands, but not the 700 MHz band. This is on the grounds that allowing switching between the supra-1 GHz bands, which are likely to be substitutes for the purposes of delivering capacity in the long run, may help bring about an efficient outcome. The start date for licenses in these bands will be earlier than for the 2.1 GHz spectrum, but the end date of the first time slice and the start date of the second will be aligned.
46. ComReg sees no need to award the 700 MHz spectrum in two time slices, because it is more likely to be a complement to the supra – 1 GHz bands.
47. The use of time slices creates synergies between lots for the same spectrum in different time slices, which are best addressed by the use of a combinatorial auction format. However, this is not the sole basis for ComReg's proposed use of a CCA (See Chapter 6 below).

3.2 Views of respondents

48. Various respondents have objected to the use of time slices (for some or all of the higher frequency bands) on the grounds of:
- constraints it puts on the choice of auction format;
 - complexity for bidders when valuing licences and submitting bids; and
 - opportunities for strategic bidding.
49. Some respondents have proposed alternatives to the use of time slicing.

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50. Eir agrees with the time slicing of the 2.1 GHz band, if it is to be included in the award, but argues that the flexibility provided by time slicing the other bands is unnecessary and creates undesirable opportunities for strategic bidding. It suggests that not applying time slices for these bands would reduce aggregation risk and remove the need for a fully combinatorial auction format.
51. Three also believes that time slicing creates a risk of strategic bidding, arguing in particular that bidders might bid in a way that is designed to break up the bands over time. They would do so expecting not to win these packages but would nevertheless obscure price discovery and could make mistakes that would lead to inefficient outcomes in the event that one of these gaming bids wins.
52. Both Three and Vodafone argue that the timescales attached to each of the time slices are inappropriate:
- Three highlights that the proposed periods for each of the time slices create lots with durations that do not correspond to bidders' demands. Bidders require long term certainty of ownership to encourage investment, as the 2.1 GHz transitions to be used to support 4G and 5G, while operators also have flexibility over the loss of this spectrum, as 3G approaches its end date; and
 - Vodafone believes that the proposed time slices for this award create significantly more difficulty than those used for the 2012 auction, and is concerned that operators would need sufficient spectrum and equipment to serve customers in each time slice but neither of the time slice periods (independently) allows for sufficient return on investment. Vodafone also believes that having to value spectrum licences that begin in 2027 is problematic as it is difficult for operators to anticipate any changes in demand that might occur so far into the future.
53. The MNOs have suggested some alternatives to time slicing:
- Eir proposes an administrative assignment of 2x15 MHz in the 2.1 GHz band to each of the incumbent MNOs, with a price based on the auction price for the remaining lots;
 - Three suggests having two licence categories with different licence start dates and a common long-term end date, which could be given the same eligibility points as each other to facilitate switching; and
 - Vodafone's preferred solution is to have a common start date for high frequency band spectrum (1 June 2021), and to offer 2.1 GHz spectrum holders the opportunity to hand back their licenses early – Vodafone argues that the operators would gain by no longer having to pay spectrum usage fees and that it would allow for all of the 2.1 GHz spectrum to be included in the award with a common start date and no need for time slices.
54. The option for MNOs to hand back their licences early instead of using time slices was also mentioned by Three. This would reduce concerns over early liberalisation and licence alignment as well.
55. A number of respondents also suggest that, even if time slicing is used for the 2.1 GHz band, it is not necessary to time slice the 2.3 GHz and 2.6 GHz bands.

They argue that the substitutability of these bands for 2.1 GHz spectrum has been overstated (for example, Three claims that legacy issues with the 2.1 GHz band prevent it being comparable to the higher frequency bands). Removing time slicing for these bands would help to simplify the auction (both Eir and Three contends that time slicing these bands significantly increases the number of options bidders have to consider) and remove the need for a combinatorial auction format.

56. Similarly, Imagine suggests that the 2.3 GHz band and the TDD section of the 2.6 GHz band should not be time sliced, on the basis that ComReg has not demonstrated that these bands are substitutable for the FDD spectrum.

3.3 Assessment and recommendations

Necessity of time slicing for the 2.1 GHz band

57. It is important to highlight upfront that the inclusion of the 2.1 GHz band necessitates time slicing (at least in that band) if Eir continues to hold its existing licence for the remainder of the term (i.e. up to 2027). If we were to instead apply Three's proposal to have two lot categories in the 2.1 GHz band with different start dates (2022 and 2027) and a common expiry date, this has the adverse effect of creating a lot category that only one bidder would be interested in. It is likely that only Eir would be primarily interested in the shorter licences and that Eir would not have such a strong interest in the longer licences. Because this situation would be common knowledge amongst bidders, it becomes simple for bidders to segment their demand (i.e. Eir for the three shorter licences and Vodafone and Three across the nine longer licences) and avoid competition by tacit collusion. Measures to limit transparency in the auction by reporting only aggregate demand do not mitigate this, as it is evident to all who is likely to be bidding on each lot category.
58. In addition, Three's proposal would present Eir with a risk of strategic bidding by other bidders. Although there could be genuine demand for the shorter licences (that would begin in 2027) from other bidders, it would seem reasonable to expect Eir would have a significantly greater interest in those licences to maintain its spectrum holdings in the 2.1 GHz bands beyond the expiry of its current licence. In particular, Eir would need to bid for the shorter licences if it wished to bid for the maximum amount of spectrum allowed by the cap across the full licence period. Other bidders may therefore attempt to artificially bid up the price of the shorter licences, with the aim of either maximising the amount Eir would need to pay or restricting Eir's spectrum holdings over the longer term.
59. Neither of these possibilities created by Three's proposal – facilitation of tacit collusion or strategic bidding - are desirable. The fact that Three's lot category proposal identifies a lot category that is particularly relevant for one bidder separates it from the time slicing proposal where multiple bidders are likely to have similar interest a variety of lot categories. Time slicing means that all bidders interested in 2.1 GHz would need to bid for lots in both categories (time slices) to obtain a longer licence and the opportunities to manipulate the prices

to be paid by others would be much more limited as all bidders are as likely as each other to have demand for specific lots (i.e. there is no particular lot that would be more suitable for some bidders over others).

60. Given the above, we therefore consider that time slicing in the 2.1 GHz band is by far the superior approach.

Administrative assignment of 2.1 GHz

61. We do not agree that Eir's proposal for an administrative assignment of some of the 2.1 GHz spectrum is appropriate. This is not a licence renewal process, as Eir has claimed, but rather an award for new rights of use in the 2.1 GHz band. Existing licensees should not be given any preferential treatment or have a claim to the spectrum simply by virtue of their incumbency.
62. Furthermore, Eir has access to 2x15 MHz of the 2.1 GHz spectrum until 2027 (i.e. 6/7 years beyond the expected timing for the award of new licences), which should offer sufficient time to address any business continuity concerns that might arise if its 2.1 GHz holdings were to change beyond that period. ComReg's statutory objectives dictate that it needs to support the efficient use of spectrum, and (as discussed in previous ComReg consultation documents) assigning frequencies via an auction process is typically considered more effective in this regard than administrative assignment. Other potential users should be given equal opportunity to compete for (and potentially win) the spectrum, to ensure that it is allocated efficiently (which may not involve all current licensees winning spectrum).

Option to return 2.1 GHz licences early

63. Allowing the MNO's to hand back their 2.1 GHz spectrum licences early, as suggested by Vodafone and Three, might be a viable option and could help to simplify the award. In particular, if Eir⁴ were willing to relinquish its 2.1 GHz licence so that the spectrum could be reassigned with (at least roughly) the same start date as the rest of the band there would be no need to use time slicing at all. Such a process would be supported further if all three of the MNOs were to hand back their licences on a common date, allowing for the new 2.1 GHz licences to be completely aligned across the whole band and avoiding the need to consider offering interim rights of use to Three. For this to work (in terms of removing time slicing) it would of course require Eir to give up the guarantee of holding at least its current amount of 2.1 GHz spectrum for the duration of the first time slice, which may not be an attractive option.
64. We consider that it may be prudent to at least explore the possibility with the current licensees to determine whether or not there would be sufficient interest in the above option. If this is an option considered worth pursuing, there would be a need for any commitments to give up existing licences to be made sufficiently early, to allow for bidders to take account of the implications for the

⁴ Three and Vodafone surrendering their licenses could simplify the award by removing the need for alignment and potentially allowing new rights to start earlier, regardless of Eir's decision.

award and prepare accordingly. We remain concerned that it appears unlikely that all licensees (in particular Eir) would agree to give up existing licences.

Need to time slice the other capacity bands

65. If time slicing is to be used for the 2.1 GHz band (i.e. if Eir's licence is not returned early), we continue to consider that it is necessary to time slice all of the higher frequency bands. The reasons for this are predominantly based on minimising gaming opportunities and maximising switching options, and are (as some respondents have recognised) built on the premise that the 2.1 GHz, 2.3 GHz and 2.6 GHz bands can be considered substitutes.
66. Various respondents have argued that the 2.3 GHz and 2.6 GHz bands are not direct substitutes for 2.1 GHz spectrum, and therefore they do not need to be time sliced even if the 2.1 GHz band is. However, the respondents do not seem to have taken into account the timeframe over which the licences will be valid when expressing their views on the substitutability of the bands. Currently, due to legacy issues for existing MNOs, they may not be close substitutes in terms of immediate use (noting that this may not be the case for a new entrant). However, all of the bands have similar propagation characteristics and in the long run will likely be used for providing capacity for hybrid 4G/5G networks (this includes both the available TDD and FDD spectrum). Existing uses and legacy issues are not particularly relevant for determining whether the bands are substitutable over the duration of the licence, especially in light of ComReg's proposals to increase the (overall) licence period to 20 years.
67. It is important for efficiency that the award format chosen allows bidders to switch relatively easily between the three higher frequency bands as relative prices evolve. In turn, this also leads to the conclusion that time slicing the 2.3 GHz and 2.6 GHz bands is also desirable, predominantly from the perspective of protecting Eir from gaming and maximising its switching opportunities. In particular, if Eir wishes to bid for an amount of spectrum that is within 30 MHz of the overall cap, without time slicing all three higher frequency bands it would be forced to include 2.1 GHz spectrum in time slice 2 in its bids. This would not only limit Eir's ability to switch between substitutable bands as relative prices evolve, but (since other bidders will be aware that Eir cannot switch to different bands without reducing its demand or violating the cap) could also leave it open to strategic bidding aimed at artificially increasing the price of 2.1 GHz lots in time slice 2. We therefore consider it important that the 2.3 GHz and 2.6 GHz bands are also time sliced.
68. We appreciate that these specific issues set out above were contained in a confidential annex to our previous report, which may have limited informed responses on this issue. We recommended this information be kept confidential as we were concerned that elaborating on the potential for gaming behaviour might be unfair to Eir. However, given that Eir does not appear to have recognised the issues itself, we consider it is now better if the rationale for time slicing all the supra-1GHz bands is set out transparently. We elaborate on this in Annex 1.
69. We do not claim that the bands are perfect substitutes for existing MNO's, but since they are likely to be used for the same thing in the long run it is

appropriate to err on the side of caution and apply time slices to them all (see above and below in that regard). Furthermore, insofar as there are differences between the bands (for example, Three also points out that the start date of the 2.1 GHz spectrum will be later than the other bands) bidders are able to reflect this in the amount they bid for each band relative to the others.

Complexity for bidders from time slicing

70. The proposed relatively cautious approach to time slicing does not impose any substantial costs on bidders, as the increase in complexity for bidders in reality is likely to be small in an auction format that allows for package bidding. In particular, bidders are free to effectively ignore the time slicing and only bid for packages that include the same combination of lots over the full period up to 20 years.
71. The concerns of Vodafone (that the time slices are not long enough to allow a sufficient return on investment) and Three (that the time slices do not match up with bidders' demands) effectively go away if a bidder never bids for (and therefore can never win) combinations of lots that are not wanted by that bidder. As package bidding affords bidders the opportunity to bid only for packages that contain licenses spanning the full period, they have no need even to value lots in each time slice separately if they do not wish to do so. Bidders can only be awarded a licence that they view as too short if they have explicitly submitted a bid for it. Using a CCA, where package bidding deals with aggregation risk, resolves these issues. Bidders need only value spectrum for individual time slices if they have an intention of bidding for time slices separately.
72. In practice, time slicing may turn out to be irrelevant to the outcome of the auction. However, we cannot assume that this will be the case. Even if only one bidder makes use of the time slices in its bids, this could of course have knock on effects for everyone in terms of the winning bids and prices to be paid. Given that there is little downside to using time slices (as bidders have an option, not a requirement, to use the flexibility this affords) and there are some concerns about efficiency and fairness if we do not, we recommend taking the safer approach to implement time slicing for all of the higher frequency bands.

Auction format if time slices removed

73. Some respondents commented that if time slicing were removed then that would allow for an alternative auction format to be used. It is certainly true that the likely synergies across time slicing necessitate a combinatorial auction format with package bidding, in order to mitigate the significant aggregation risk that would otherwise occur. However, we would like to highlight that it is not the only consideration driving our suggestion to use the CCA, and this recommendation would be the same regardless of whether time slicing is ultimately required. Stakeholders should therefore not view the option to return 2.1 GHz licences early in order to remove time slicing as a means of influencing the choice of auction format used. Section 6 describes our reasons for recommending the CCA in further detail.

4 Competition caps

4.1 ComReg's proposal

74. ComReg proposed to set two spectrum caps for this auction, based on the total spectrum holdings of bidders, rather than just the spectrum that is available in this award. The first of these is a sub 1 GHz cap of 70 MHz. ComReg noted that:
- a cap below 70 MHz risks unduly restricting demand and increases the probability of spectrum going inefficiently unsold; whereas
 - a cap above 70 MHz risks there being only two winners for 700 MHz spectrum in this award.
75. ComReg also proposed to set an overall spectrum cap for this award, recalling that the purpose of a competition cap is to allow competition among bidders to determine the distribution of spectrum, subject to preventing an extreme asymmetric outcome that could risk adverse effects on downstream competition in mobile services.
76. In our report on the award format, we laid out the worst-case scenarios in terms of asymmetry between the MNOs under different levels of the cap. We measured this as the difference between the amount of spectrum held by the MNO with the most and the MNO with the least spectrum, as a proportion of the total amount of spectrum held by the three MNOs. We calculated the worst case scenarios under the assumption that entrants did not win any of the lots on offer.
77. Using this information and noting that it sees no justification for either effectively reserving spectrum for entrants or non-mobile operators, or for seeking to reduce asymmetry between MNOs, ComReg proposed to set an overall cap between 375 MHz and 420 MHz. It did not express a view over the exact level of the cap.

4.2 Views of respondents

78. A number of respondents commented on the proposals for competition caps, with a variety of opposing views expressed on the level and structure of the caps. Vodafone has a preference for an overall competition cap at the upper end of the proposed range, while Eir and Imagine both suggest it should be at the lower end (or below). Three would prefer the caps to be structured differently and to not take account of existing holdings at all.
79. Imagine believes that the proposed overall competition cap is too high, and that ComReg needs to consider potential users other than the MNOs when determining the appropriate level. In summary, Imagine argues that:
- opportunities for the MNOs to consolidate significant spectrum holdings creates incentives to acquire spectrum as a barrier to entry, which then allows them to concentrate their services on the more

- profitable urban areas, leading to a disparity in services across Ireland and poorly served rural areas;
- the problem with service disparity is exacerbated by the nature of Irish demographics and population density, but this means that (with all spectrum auctions) ComReg needs to encourage service availability in regional Ireland. However, it notes that it appears that ComReg has only taken into account the asymmetry of MNO spectrum holdings and the need to avoid unsold lots when determining the proposed competition caps;
 - unsold lots should not be a concern as there is likely to be demand from new and existing operators, as in the 3.6 GHz award;
 - when setting competition caps, ComReg should ensure that there is sufficient spectrum available for operators other than the three MNOs to compete for and acquire, rather than concentrating on MNO asymmetry (which appears more about ensuring the MNOs get roughly equal amounts of spectrum rather than what is best for the country);
 - the extent of service disparity across the country means that competition caps need to play a larger role than just allowing the MNOs to divide the spectrum between them, and more focus should be put on allocating scarce spectrum to the operators and geographic areas that are most in need of it.
80. In light of these arguments, Imagine suggests a more suitable overall cap (including existing holdings) would be in the region of 290 MHz, to ensure that no operator could acquire more than 25% of the total available spectrum. We note, however, that Imagine does not provide any justification or evidence for why 25% is the appropriate level at which to set such a cap. In terms of the range proposed by ComReg (375 MHz – 420 MHz), Imagine believes that a cap of 375 MHz would be the least-worst option to ensure sufficient flexibility for all interested operators but without promoting an undesirable concentration of spectrum holdings.
81. Eir agrees with the proposals to apply a sub-1 GHz cap and an overall cap (taking into account existing holdings), but believes that the level of the overall cap should be at the lower end of the range proposed. Eir argues that:
- the cap needs to prevent larger operators from strengthening their market positions through the accumulation of large spectrum holdings, and the level of the overall cap should not exceed 375 MHz (if an additional 2.1 GHz cap were also applied);
 - the proposed range for the competition cap (in particular the upper end) is based on a superficial analysis and there has not been a proper assessment of competition – the justification for proposing a cap that maintains the current level of asymmetry (in particular that the post-merger spectrum asymmetry has not led to a deterioration in competition between MNOs) is questionable;
 - the proposed approach considers the difference between Three and Eir, but ignores the position of Vodafone and the proposed caps would allow Vodafone to increase its spectrum holdings relative to Eir (which would not benefit competition within the market); and

- even without a thorough assessment of competition, a more appropriate metric for measuring the asymmetry in spectrum holdings would be the difference between the largest and smallest holdings as a percentage of the largest, because what matters is the ability to replicate the capacity of the largest operator.
82. Eir also suggests that there should be an additional 2.1 GHz specific cap of 50 MHz. This would prevent any subset of the MNOs from acquiring all of the 2.1 GHz spectrum, helping to ensure that the existing users can maintain their services without disruption to consumers.
83. Vodafone agrees that competition caps are necessary to guard against extremely asymmetric results and supports the proposals to have a separate competition cap for the sub-1 GHz spectrum and an overall cap. Vodafone agrees with the level of (and reasoning behind) the sub-1 GHz cap. It believes that the range proposed for the overall cap is reasonable and has a preference for the cap to be set at the higher end of that range.
84. Three disagrees with the proposals for the competition caps and believes that an alternative (symmetric) structure that does not take into account existing holdings would be more appropriate. Three argues that the proposed cap structure disproportionately discriminates against and disadvantages Three without any legal or objective basis, and that ComReg has not identified any extreme asymmetry in the market or provided justification for why the proposed competition caps are necessary to prevent against this happening as an outcome of the award. Moreover, Three objects to the proposed competition caps in combination with the CCA, which it argues exacerbates the problems.
85. Three also asks for clarity on ComReg's proposals regarding which bands would be included in the caps and how variations in spectrum holdings over time would be taken into account.
86. In relation to the proposed sub-1GHz cap, Three argues that:
- the sub-1 GHz spectrum is already distributed optimally (in that holdings are as close to parity as possible) without any of the MNOs being at a particular disadvantage;
 - the 700 MHz band is important as a greenfield band for initial 5G services in Europe, and the 800 MHz and 900 MHz bands will not be as easily available for 5G due to existing uses;
 - the 900 MHz band is not a substitute for the 700 MHz band due to differences in the availability of the spectrum/compatible devices for 5G and the expiry dates of the licences;
 - the proposed sub-1 GHz cap unfairly disadvantages Three as it would only be able to acquire a maximum of two of the 700 MHz lots when Eir and Vodafone could each get up to three;
 - furthermore, the proposed cap could lead to a situation where Three wins none of the 700 MHz spectrum and each of Eir and Vodafone win three lots (leading to a significant sub-1 GHz disparity) – no such outcome is possible for the other MNOs as (absent new entry) they would always be guaranteed at least one lot;

- the asymmetry in the caps may lead to differences in the prices paid by the MNOs for equivalent lots, due to Three's inability to express a valuation for a third lot in its bids – this discriminates against Three (as it faces paying an opportunity cost it cannot reciprocate) and the problem is more significant if a CCA is used;
 - the proposed cap may increase Vodafone's incentives to reduce Eir to one 700 MHz block (as it would not have to pay the opportunity cost of denying a third block to Three), and in response Eir may overstate its demand in the higher frequency bands in an attempt to increase the cost for Vodafone – this could risk an inefficient outcome as bids would be based on strategic considerations rather than valuations.
87. Regarding the overall cap, Three submits that:
- the cap is arbitrary and lacks justification, without any competition case as to why a cap is required;
 - there is an argument for guarding against one or two MNOs from acquiring an excessive amount of spectrum in the award, but this can be achieved with a symmetric cap;
 - as with the 700 MHz cap, an overall cap that includes existing holdings creates asymmetries between bidders that would unfairly enable one bidder (Eir) to bid for more spectrum than its two rivals and gives Vodafone more flexibility than Three;
 - the problems arising from the asymmetries are more significant with the use of a CCA as there would be a large asymmetry in MNOs abilities to impose prices on each other.
88. Three believes that the proposed caps would undermine the results of previous auctions, as they negatively affect bidders that were more successful bidders in previous awards. Three argues that if previous auctions (in particular the 3.6 GHz award) are viewed as efficient then it would be wrong to allow the resulting differences in spectrum holdings to count against bidders in the proposed MBSA. Furthermore, bidders might have bid differently in the 3.6 GHz award if they had known it would count towards caps in future awards.
89. Three believes that, overall, the caps as proposed are contrary to ComReg's statutory objectives for the award process to be non-discriminatory and proportionate. Three proposes an alternative solution whereby all competition caps are symmetric and only take into account the bands included in the auction. Three suggests:
- a cap of 2x10 MHz per operator in the 700 MHz band (to ensure that at least three operators acquire sufficient sub-1 GHz spectrum to support both 5G and legacy services); and
 - a cap of 150 MHz across the 2.1 GHz, 2.3 GHz and 2.6 GHz bands, allowing sufficient flexibility for bidders to pursue realistic targets.

4.3 Assessment and recommendations

The relevant market and preventing excessive asymmetric outcomes

90. The competition caps as proposed are designed to prevent highly asymmetric spectrum holdings after the award that might negatively affect competition in the relevant downstream market(s). We have discussed in detail (in our award format report) why we believe that, although the spectrum may be of interest to a variety of users, the relevant market in relation to assessing the potential competitive impact of the spectrum available for award is that for mobile services. There is a significant amount of available spectrum that has been identified as suitable for WBB ECS and has the potential to have an impact on the relative spectrum holdings (and ability to compete in the downstream market) of the three MNOs. We therefore need to take into account the potential post-award asymmetry in spectrum holdings across the MNOs when determining the relevant caps to apply.
91. Imagine has suggested that ComReg should consider the need to ensure sufficient spectrum is available to other users and that the MNOs should be considered as part of a wider market. In this respect, we recognise that there is potential for some of the spectrum (in particular the higher frequency bands) to be used for services other than mobile, with fixed wireless access (FWA) and small-cell networks for offering wholesale capacity being the most likely. However, we do not believe that these markets are relevant from the point of view of determining measures to safeguard competition. FWA services are distinct from and not a good substitute for mobile services, and FWA operators are therefore unlikely to be in competition with MNOs. Furthermore, wholesale capacity via a dense-cell network is a business model that sits upstream from the MNOs. Although it might provide some benefit to competition in the mobile market (through increased capacity and less reliance on holding spectrum licences), it is unlikely to fundamentally change the competitive conditions between the MNOs, as small-cell networks provide inputs to MNOs and cannot offer full mobile services themselves. In any case, it is an undeveloped business model and the impact it will have is highly uncertain.
92. We do not agree with Imagine that the MNOs have strong incentives to acquire spectrum as a barrier to entry to other parties such as Imagine, not directly competing. For example, a mobile operator would not be concerned about spectrum being allocated to an FWA provider that would provide services in rural areas that the mobile operator does not serve. MNOs who also provide FWA may find some benefit in doing so, but these concerns have been raised before in relation to the 3.6 GHz award, and we do not believe this situation is likely to arise. At the same time, to the extent that MNOs might achieve anticompetitive benefits from precluding spectrum to other MNOs, this is guarded against by the spectrum caps.
93. The question is, therefore, is there a valid argument for active intervention in the downstream market structure by effectively reserving spectrum for smaller (non-mobile) specialist providers. This appears to be what Imagine is suggesting with its proposal for a cap of 290 MHz (which would mean at least 170 MHz

would be guaranteed to non-incumbent MNO users). However, as mentioned in our award format report, we do not see any particular justification for doing this; there is significant uncertainty over the benefits that might be gained from non-traditional and untested business models, and restricting the amount of spectrum available to the MNOs for well-established mass-market services could be to the detriment of consumers. Intervening in this manner to reduce the spectrum available for mobile could have a significant cost, so there is a significant evidential burden to overcome in terms of justifying the reservation of spectrum for other applications. In our view, this burden has not been met.

94. Furthermore, the recommended auction format (i.e. the CCA) is an 'entrant friendly' award format, providing scope for a smaller bidder to fit in with the demands of the incumbents but also ensuring (through package bidding) that any spectrum portfolio acquired would be sufficient for its needs. Indeed, this is one of the reasons that we believe the CCA is suitable for this particular award. The Irish 3.6 GHz award (completed in 2017 using a CCA) has already demonstrated that bidders other than the MNOs (in that instance Imagine and Airspan) can be successful in spectrum awards in Ireland without any need for preferential treatment.
95. For these reasons we are still of the opinion that competition in the mobile market is the most relevant consideration when establishing any competition safeguards, and we have not seen evidence which would justify the application of additional measures to guarantee spectrum for specialist providers of non-traditional services.

Considerations for the level of the caps

96. In terms of setting the level of the proposed competition caps, we acknowledge that this was not based on a comprehensive competition assessment, as Eir has pointed out. However, we do not believe that such an assessment was or is necessary. The caps are in place to prevent extremely asymmetric outcomes that might be harmful to downstream competition. They are not designed to micromanage the spectrum holdings of operators or establish a particular market structure, and as such the proposed range for the overall cap is designed to allow reasonable flexibility for the market to establish the distribution of spectrum. We highlight that the post-merger scenario was used simply as guidance as to what could be considered a reasonable and non-problematic degree of asymmetry from a competition perspective.
97. We do recognise, however, that our assessment of asymmetry assumed that the MNOs would acquire as much of the available spectrum between themselves as allowed by the caps and did not take account of the possibility that other bidders might win some of the spectrum. It is, therefore, possible that the 'worst-case' asymmetry under a given overall cap could be greater than reported in our analysis if the spectrum won by a non-MNO came out of the assumed winnings of the weakest MNO. On this basis, we believe that there might be an argument for setting the overall cap at the lower end of the range proposed, to allow for the possibility that other users might have an impact on the relative post-award spectrum holdings of the MNOs. For example, under a cap of 375 MHz, the worst-case absolute asymmetry if non-MNO bidders won

nothing would be 85 MHz. If instead, other bidders won 30 MHz, then the worst-case asymmetry would be 115 MHz. A cap at the lower end of the range should not be overly restrictive, and all MNOs would have the ability to significantly increase their spectrum holdings (Three would be able to win an additional 155 MHz in this award, Vodafone could get 180 MHz, and Eir would be able to win up to 190 MHz in time slice 1 and 220 MHz in time slice 2).

Metric for measuring asymmetry

98. Eir has suggested an alternative metric for measuring asymmetry, which it believes to be more appropriate. In particular, Eir believes that rather than measuring asymmetry based on the difference between the largest and smallest MNO holdings as a proportion of the total available spectrum, it would be more appropriate to measure the difference relative to the holdings of the largest player. However, Eir does not provide any indication of what then would be considered a suitable level of asymmetry with this alternative measure for setting the caps.
99. Eir's reasoning behind its choice of metric is that the spectrum holdings of the smallest operator, relative to the largest, is what determines the ability of the smaller operator to provide a comparable quality of service and so compete effectively with the larger operator. We recognise this concern and note that our metric is also based on the difference in spectrum holdings between the smallest and largest operators; the greater the difference, the greater the measure of asymmetry. However, we do not believe it is appropriate to ignore intermediate-sized operators, as they clearly affect competition in the downstream market. Consider the case where the intermediate operator was not in the market, and its spectrum was not in use (i.e. the total amount of available spectrum was lower). Our measure of asymmetry would be higher, but Eir's would remain the same. Since this would be likely to represent a lessening of competition, it seems appropriate that the metric should consider the total amount of spectrum available when measuring asymmetry.
100. We are unclear about Eir's concerns regarding the idea that the caps do not account for the possibility that Vodafone could increase its asymmetry relative to Eir. The caps would prevent the asymmetry between Eir and Vodafone from exceeding the maximum possible level of asymmetry between Eir and Three, and we do not see any particular reason why Vodafone should not be able to increase its own spectrum holdings within these bounds. Furthermore, if a cap is set to restrict the difference in spectrum holdings between the largest and smallest operators (in terms of spectrum) to an acceptable level, then it is inevitable that intermediate operators would be able to increase their own spectrum holdings relative to the smallest operator.

Additional 2.1 GHz cap

101. We disagree with Eir that an additional cap for the 2.1 GHz band is necessary. As discussed in the award format report and above, we do not believe there is any particular reason why there should be any special measures in place to ensure existing users can win back spectrum associated with expiring licences. Operators do not have any special right to spectrum beyond licence expiry

simply because they are a current licence holder, and there is a significant amount of (long-run) substitutable spectrum being made available in this award. Furthermore, we highlight that Eir is currently guaranteed use of 2x15 MHz in the 2.1 GHz band until at least 2027, meaning it should have time to prepare for any changes in its holdings beyond that point without any disruption to consumers.

Need to take account of existing holdings

102. With regard to Three's suggestion that existing holdings should not be taken into account, we disagree. Competition in the downstream market is affected by relative *total* holdings of substitutable or complementary spectrum, not just the amount won in a particular award. If bidders participate in an award with very different starting positions, it is necessary to impose competition caps that account for existing holdings in order to protect against the potential for highly asymmetric post-award asymmetry in total holdings.
103. If pre-award spectrum holdings across bidders were sufficiently symmetric it may be sufficient to set a competition cap that does not include existing holdings, as was the case with MBSA in 2012 where all MNOs held the same 2.1 GHz rights of use. This may provide a useful simplification for auction rules in some cases, as it is then not necessary to define rules linked to existing holdings, which can be ignored for the purposes of the auction. However, this is clearly not the situation that we are facing here. Ignoring previously assigned spectrum when determining appropriate competition caps would fail to take into account relevant factors affecting downstream competition and potentially be contrary to ComReg's statutory objective to promote competition.
104. The fact that some bidders are more restricted than others in terms of the amount of spectrum they can win in a given award is not a justification for a symmetric cap disregarding existing holdings; those bidders who can win less are starting the award from a position of already having access to more spectrum in the first place. Three argues that the 900 MHz and 700 MHz bands are not substitutable (and hence the 900 MHz band should not count against the limit on 700 MHz spectrum) due to different device availability and the different expiry dates of the licences. However, what is more relevant for assessing substitutability is the long-term use of the spectrum, rather than differences in the current situation. This was discussed in ComReg document 14/102 which identified the 700 MHz, 800 MHz and 900 MHz as likely to be long-run substitutes for providing coverage and in-building penetration and we have no reason to change this view. Furthermore, 10 years (the overlapping period during which both new 700 MHz licences and 900 MHz licences awarded in 2012 will both be held) is a significant length of time, during which relative spectrum holdings (in particular in the important sub-1 GHz bands) are likely to have an impact on competition. We therefore believe that 700 MHz and 900 MHz spectrum can be considered substitutable for these purposes and that it is appropriate to consider them together as part of a sub-1 GHz cap.

Asymmetric prices are not discriminatory

105. Three and NERA (on behalf of Three) are also incorrect to suggest that the asymmetric prices arising from the combination of the caps and the CCA are discriminatory. Three's argument for equal prices is in effect a claim that other bidders with smaller existing spectrum holdings should pay more - above their respective opportunity costs - simply because Three's greater existing holdings of spectrum limit the extent to which Three can compete for additional spectrum. If two bidders within a CCA are in the same situation, winning the same packages and facing the same competition from rival bidders, they will pay the same winning prices. However, if bidders win different packages, or face different levels of competition from rivals, they may have different winning prices. This is not discriminatory as they are in objectively different situations.
106. ComReg's primary concern is efficient allocation of spectrum, subject to ensuring downstream competition is effective. This means that each winner (and group of winners) needs to pay at least its opportunity cost, otherwise there would be alternative higher value users and efficient allocation would not have been achieved. If bidders are then to pay the least possible subject to this requirement of paying at least opportunity cost (which is what the second pricing rule for a CCA does), then by direct implication if bidders winning similar packages impose different opportunity costs, they will pay different amounts. Equalising winning prices would require that the bidder with the lower opportunity cost pays more than its opportunity cost, as the other bidder paying less than its opportunity cost is not compatible with efficient allocation. However, full price equalisation might not be possible if this led to the bidder with the lower opportunity cost paying more than its bid.
107. Also, we face a fundamental problem that if bidders expect to pay more than their opportunity cost, then they have incentives to reduce their bids in order to reduce their prices; therefore, bidding incentives are polluted by this approach. The minimum revenue core pricing used in the CCA has the specific property that aggregate incentives to deviate from bidding at valuation are minimised subject to winners paying at least (individual and collective) opportunity cost; this property of minimum revenue core pricing promotes efficient allocation. Therefore, if we sought to impose (through whatever mechanism) similar prices for bidders winning similar packages, but facing different amounts of competition, this would distort bidding incentives and be incompatible with the objective of efficient allocation.
108. In this regard, we reiterate that Three is not starting from the same position as the other bidders. Before the award Three already has access to more spectrum than the other operators; in effect, Three is not bidding for the same thing as the other MNOs (when viewed in the context of overall post-award spectrum holdings) and may also face a different level of competition from its rivals due to differing requirements for incremental spectrum across bidders. Therefore valuations (and prices) are likely to vary across bidders, and there is no particular reason to expect or require that any award process should lead to uniform pricing.
109. Regarding the sub-1 GHz cap, if we take the total sub-1 GHz holdings of the MNOs into account (using Three's terminology where one block is 2x5 MHz),

Three would start the award with 5 blocks, and Vodafone and Eir would have 4 blocks each. In effect, Three bidding for two 700 MHz lots in the award is equivalent in result to one of the other MNOs bidding for three lots (as in both cases it would take the bidder to seven sub-1 GHz blocks in total). Three winning a second 700 MHz lot (and a seventh sub-1 GHz block) can be essentially viewed as similar in effect to Vodafone/Eir winning a third 700 MHz lot; given this, it is not unreasonable that Three should pay the opportunity cost associated with denying another MNO a seventh sub-1 GHz block. Conversely, if Vodafone were to win a third 700 MHz lot, the opportunity cost it would be required to pay (absent other bidders) would be set by the implied value of a seventh sub-1 GHz block to Three or Eir (i.e. based on Three's bid for two 700 MHz lots or Eir's bid for three 700 MHz lots). When taken in the context of overall sub-1 GHz holdings, any asymmetry in pricing which results is not a result of discriminatory treatment of Three. Because Three is clearly not in a comparable position with other MNOs in terms of sub-1 GHz holdings, other MNOs with less spectrum than Three to start with might have a greater appetite for spectrum in order to catch up with Three and/or to simply meet a growing need for spectrum; in this case Three will naturally face more competitive pressure and higher prices if it wants to increase its own holdings.

110. Similarly, Three's claim that it is unfair that it is the only MNO that faces winning nothing in the 700 MHz band also falls down if viewed in the context of total sub-1 GHz holdings. If there is no interest for the 700 MHz lots other than from the MNOs, then all three MNOs would be faced with the prospect of ending the auction with five, six or seven sub-1 GHz lots. If there is interest from at least one additional bidder, then Three is arguably in a more favourable position than Vodafone and Eir due to its greater existing holdings; in that case it would be guaranteed five sub-1 GHz lots at the end of the auction, while the other two would only be guaranteed four.

Three's alternative proposal

111. Three's proposal for a 2x10 MHz cap on 700 MHz in the award would seem to disadvantage the other two MNOs (relative to ComReg's proposed sub-1 GHz cap), in terms of the total sub-1 GHz spectrum they could hold after the award. Three on the other hand would be able to get the same under either option, but would face less competition if its own suggestion were applied. With a 70 MHz cap on sub-1 GHz spectrum, any (and potentially two) of the three MNOs could end the award with seven sub-1 GHz blocks. Under Three's proposal, only Three would have the option of acquiring a seventh sub-1 GHz block, with Vodafone and Eir able to end the auction with at most six.
112. Similarly, the supra 1-GHz cap (combined with the 700 MHz cap) proposed by Three would place tighter restrictions on the total spectrum that Vodafone and Eir could acquire in the award than any level of overall cap within the range proposed by ComReg, while Three is likely to be less restricted by its own proposal than by ComReg's. Three suggests a cap of 170 MHz for the spectrum available in this award, which corresponds to the amount it would be allowed to win under an overall cap (on total spectrum holdings) of 390 MHz. Therefore, at any cap ComReg sets below this level, Three is effectively proposing to loosen the cap on itself while restricting other MNOs further.

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113. Three, however, would only be more restricted by its own suggestion than by ComReg's proposal if the overall cap were to be set at 390 MHz or above. With a lower overall cap, Three would be able to acquire more spectrum under its own suggestion, while Vodafone and Eir would be more restricted.
114. Three's proposals, therefore, seem in general to be rather self-serving and to the detriment of other bidders who would be more constrained in their bidding options than under ComReg's proposals. Since, as discussed above, we do not agree with Three that there is any particular degree of unfairness or discrimination in applying caps that take account of existing holdings, we do not see any convincing argument for why Three's approach would be more appropriate.
115. Three's argument that the 700 MHz cap would provide greater incentives for Vodafone to reduce Eir to one 700 MHz block as it would not have to pay the opportunity cost of denying a third block to Three does not seem to make sense. In the hypothetical situation that a bidder placed a value on denying a competitor access to a second lot, there would always be an incentive to place a bid accordingly. The prospect of paying the opportunity cost of denying a third block to a third player should not make any difference to that. For example, if the bidder places a value of €100 on restricting a rival to only one block rather than two, then if rational, it would still choose to do so regardless of whether that would cost €1 or €99. If the cost were to be greater than €100 then it would not be worth the investment and presumably the bidder would not have submitted a bid that might result in a price that it considered too high. This argument by Three seems at best speculative and is not a convincing reason to relax the cap on 700 MHz spectrum.

Overall recommendations

116. Overall, we continue to be of the view that a separate sub-1 GHz cap and overall cap that take account of existing holdings remains to be the most appropriate approach for setting measures for safeguarding competition. We are confident that the 70 MHz cap on sub-1 GHz spectrum has been set at the correct level. Regarding the overall cap, we recognise that respondents have submitted different views on the appropriate level, and it is not clear that any particular point in the proposed range is obviously preferable. However, as discussed above, our analysis regarding the worst-case scenario (in terms of asymmetry between MNOs) did not take into account the possibility that other bidders might win some of the spectrum. The worst-case asymmetry between MNOs under a given cap could therefore be greater than implied if the spectrum won by the non-MNO bidder came out of the spectrum that would otherwise have been awarded to the smallest MNO. For this reason, it may be sensible to position the level of the overall cap at the lower end of the proposed range.

5 Fees

5.1 ComReg's proposal

117. ComReg proposed to set minimum prices in the award with the aim of balancing three factors, namely that:
- minimum prices should not be so high as to choke off demand;
 - minimum prices should not be so low as to encourage participation by speculative bidders; and
 - minimum prices should not be so low as to facilitate collusive behaviour.
118. With regards to the methodology used to balance these objectives, ComReg considers benchmarking to be appropriate, as it overcomes information asymmetries in other approaches by using bidders' actual willingness to pay in other jurisdictions. It also notes that benchmarking has been used in the 2012 MBSA and the 3.6 GHz award, and final prices were many multiples of reserve prices in both of these cases.
119. ComReg proposed to split the minimum fees 40/60 between spectrum access fees (SAFs) and spectrum usage fees (SUFs). Regarding the level of the minimum fees, ComReg proposes to set fees for each band in the award based on their respective benchmarks, which are the geometric means for competitive, European awards in the last ten years. The minimum prices suggested in our benchmarking report were:
- €0.38 per MHz per capita for the 700 MHz frequencies;
 - €0.20 per MHz per capita for the 2.1 GHz frequencies; and
 - €0.04 per MHz per capita for the 2.3 GHz and 2.6 GHz frequencies.

5.2 Views of respondents

120. ComReg received three responses (from the three MNOs) that provided comments on the proposed minimum prices and structure of fees.
121. While the MNOs agreed with the split between SAFs and SUFs, they all argue that the proposed minimum fees are too high. This was because the benchmarking included awards that they did not believe were comparable, and they suggest there is a risk of choking off demand.
122. Eir points to a number of previous awards having prices below the proposed minimum as a reason to believe the proposed minimum fees are too high. In particular, it claims that the minimum prices cannot be described as conservative, because they lie between the lower quartile and median of the observed prices. Eir has asked for minimum prices to be no higher than the lower quartile of the distribution, rather than at the geometric mean. However, eir would be content for minimum fees to be set at the proposed levels if a pay-as-bid auction format were to be used, to reduce the scope for strategic demand reduction.

123. Vodafone suggests that there is a downward trend in prices in some bands, such as the 2.1 GHz band, which has been mentioned in relation to early liberalisation, but is not reflected in the benchmarking. It agrees with NERA's argument that the amount of spectrum available along with the limited ability of operators to monetise 5G services means that prices are likely to be lower relative to the 2012 multiband award prices. Vodafone is also concerned that uncertainty regarding RurTel in the 2.3 GHz band could reduce the value of the band for this award, and claims that non-European awards should be excluded from the analysis, because the markets in these countries are very different. In addition, Vodafone makes reference to a number of arguments set out in the GSMA report "GSMA Response to the RSPG Report on Efficient Awards and Efficient Use of Spectrum", which expresses the views that:
- there is no consistent approach to setting reserve prices in auctions across European national authorities;
 - the only purpose of reserve prices is to establish the opportunity cost of the next best use, so that it sells at a price that is higher than the opportunity cost, or that if unsold it can be assigned to the next alternative user that would have a marginal value for it;
 - there are multiple examples of mobile auctions around the world where spectrum has remained unsold due to reserve prices being too high;
 - the market value of the spectrum would be revealed by a well-designed auction and attempts to second-guess the market value shows a lack of confidence in the ability to design and run an efficient auction; and
 - use of benchmarking to set reserve prices leads to a ratcheting up of spectrum prices over time".
124. For these reasons, Vodafone requests ComReg to re-evaluate and reduce the minimum prices.
125. Three believes that there is a risk arising from the current proposals of setting the minimum prices too high, such that they could choke off demand at the application stage. Three argues that conditions around the early 5G era spectrum awards are different to previous awards in that:
- operators are adding to existing spectrum portfolios rather than renewing licences or bidding to enter the market (so valuations are for incremental spectrum rather than for initial spectrum)
 - total revenues derived from harmonised spectrum bands have fallen in recent years while the volume of spectrum has increased
126. For these reasons, spectrum valuations now can be expected to be lower than in previous awards. Three therefore argues that a number of the awards that have been included in the benchmarking analysis are not relevant for assessing minimum prices for the upcoming award, in particular Three believes that:
- it is not appropriate to include 800 MHz and 900 MHz awards in the analysis for 700 MHz minimum prices as 700 MHz would likely be used for 5G with a different business model to those for the other bands that were used to provide 2G/3G/4G services;
 - the market value for 700 MHz can be expected to be less than that which applied to the 800 MHz and 900 MHz bands in 2012;

- similarly, the business cases and valuations that applied to the 2.1 GHz band in the 3G era will be very different to those that apply now; and
 - using samples from the previous 10 years is inappropriate and the benchmarking should be adjusted to use only recent samples.
127. Three suggests that it is necessary to leave a margin (presumably between minimum prices and the benchmarks) to avoid choking off demand, ensure that the outcome is determined by the market, and allow for a degree of price discovery during the award. It does not agree that the use of the geometric mean (rather than the arithmetic mean) by itself is enough to provide a sufficient margin to give enough certainty that the benchmark prices will not choke off demand.
128. Three argues that there is little to be lost by reducing the benchmarks relative to the current proposals. It highlights that the risk with setting minimum prices slightly too low is small, but setting them too high could choke off demand, reduce competition in the award, and increase the chance of lots going unsold. Three proposes that lowering the minimum prices by one standard deviation would achieve a suitable margin without compromising the effectiveness of the minimum prices.

5.3 Assessment and recommendations

Purpose of minimum prices

129. We agree that minimum prices should be set at a level that avoids choking off demand, which could have negative consequences for participation in the award and efficient assignment of the spectrum. Contrary to the arguments put forward by Vodafone and the GSMA that minimum prices are set solely for the purpose of establishing the opportunity cost of the next best use (to ensure that it can be sold at a price above the opportunity cost, or assigned to the next best user), minimum prices also help to minimise scope for strategic bidding aimed at keeping prices low and/or speculative participation. Setting minimum prices at an appropriate level requires a balancing of these considerations, and with the recommendations set out in our report on benchmarking and minimum prices (ComReg document 19/59b) we believe we have achieved this.

Improvements to the benchmarking methodology

130. When conducting the benchmarking analysis and determining our recommendations on minimum prices, we used the geometric mean of prices achieved in previous awards, rather than the arithmetic mean as we have done in previous benchmarking exercises. This is because the price data from other awards is typically skewed with a long upper tail; the geometric mean is less affected by extreme values and provides a better central estimate of licence prices. We do not make any claim that use of the geometric mean as the reference point is *guaranteed* to not choke off demand, but it is more robust than the arithmetic mean to upper tail outliers, closer to (and in our sample, below) the median and therefore an improvement on the previous approach.

Some degree of judgement cannot be avoided and this improvement to the statistical methodology does not obviate the need for care to ensure reserve prices have not been set too high.

131. Naturally, there is a degree of uncertainty over the minimum prices that best balance the objectives of minimising strategic/speculative bidding and supporting competition within the award. However, the presence of uncertainty does not prevent the benchmarking estimates from being informative, and the analysis is careful to assess a range of prices in which a conservative estimate can be set. Taking a reasonably conservative approach to setting minimum prices relative to the geometric mean (noting that in all of our samples, the arithmetic mean, which would previously have been the starting point, is above the geometric mean) provides us with a reasonable confidence that the proposed minimum prices are below the likely clearing prices in the award.
132. In this regard, we also highlight that:
- the proposed minimum price for the 700 MHz band is in line with the minimum prices for the 800 MHz and 900 MHz bands in the 2012 multiband award in Ireland; and
 - the proposed minimum price for the 2.1 GHz band is in line with the minimum price for the 1800 MHz band in the 2012 multiband award in Ireland, and the minimum prices proposed for the 2.3 GHz and 2.1 GHz bands are significantly lower still.

Final prices in Ireland have been well above minimum prices

133. It is important to recognise that the comparison above is between the proposed minimum prices and the *minimum prices* used for the 2012 award. The *prices achieved* in the 2012 multiband award were significantly higher than the minimum prices i.e. the minimum prices were well below the market value. Furthermore, as we have noted, the prices paid previously for 2.1 GHz licences are significantly higher than the value suggested by the benchmarking and the proposed minimum price for the band. Even if the value of spectrum has fallen since those previous awards, we believe that the proposed minimum prices are still likely to be below the market clearing prices and are appropriate for the Irish market and this award.

Constructing a sufficiently large sample

134. In terms of the data points used, the benchmarking analysis already recognises that some awards are more relevant than others, and summary statistics for the whole sample as well as nested subsets including competitive, recent and European only awards are provided and considered for this reason. In that regard, Vodafone's suggestion that non-European awards should be excluded from the analysis has already been accommodated since we consider this as a separate (and important) case.
135. For the 700 MHz minimum price we have included the 800 MHz and 900 MHz data points as part of the analysis, as there are not many 700 MHz auction data points (in particular in European countries within the last 10 years). Even if the business cases are somewhat different (as argued by Three), we still believe that

the bands are substitutable and that this provides us with some additional evidence that can be used as input to the determination of minimum prices. We note that non-parametric tests suggest the samples across the three bands could reasonably be considered to come from the same statistical distribution. In any case, the observed means are similar with and without the additional data points, suggesting that the value of the bands is comparable and meaning the inclusion of the 800 MHz and 900 MHz bands has made very little difference to our recommendations. There is no statistically significant evidence to suggesting that the bands cannot be pooled for these purposes.

136. Similarly, it is necessary to look at previous awards from over an appropriately long timeframe, in order to provide a reasonable (and meaningful) number of data points. As discussed in the benchmarking report, we believe that looking at the last 10 years is appropriate. Previous benchmarking analysis has narrowed the timeframe to the last five years, but this in part was to remove the effect of excessively high or low prices resulting from the dot-com bubble at the start of the millennium (and its subsequent burst). Given the amount of time that has elapsed since then, we believe that awards in the last 10 years are unlikely to be affected and the time period considered can be extended.
137. We understand the arguments that business cases may have changed over the years, but the spectrum on offer in the upcoming award is still important and valuable spectrum for WBB services and previous awards for similar spectrum are useful as an indicator of the potential value. Provided a reasonably cautious approach is taken to setting the level of minimum prices, we still believe that using past awards as guidance is appropriate.

Downward trend in 2.1 GHz prices

138. We also believe that the concerns around a downward trend in 2.1 GHz prices are overstated, as the substantially higher prices in this band were outliers at the start of the century. The fees for the previous 2.1 GHz licences were set at a time when they may have been affected by the inflated prices that came out of the dot-com bubble (as evidenced by the difference between the fees for current 2.1 GHz licences and the benchmarking output for competitive awards in the last ten years) and we took this into account for the proposals on liberalisation fees. However, this 'trend' does not appear to affect the later part of our sample and, therefore, is largely an artefact of high prices achieved around the time of the 2000/2001 TMT bubble.
139. We have taken into account the strong likelihood that prices in the early 2000s might be overinflated by looking at subsets of awards only in the last 10 years (and highlight that once outliers have been removed, the geometric mean for competitive awards of 2.1GHz spectrum in the last ten years is slightly higher than that for competitive awards in the whole sample). Furthermore, we have set the proposed minimum price for new 2.1 GHz licences significantly below the geometric mean for competitive awards (worldwide) in the last 10 years. To this end, we believe that we have adequately accounted for any reduction in value relative to the high prices seen early in the millennium, and do not see any particular downward trend that would suggest the value is still dropping to the extent that the proposed minimum prices would be inappropriate.

Relation to auction format

140. We strongly disagree with Eir's suggestion that the minimum prices proposed would be appropriate under one auction format but not under another. It is true that higher minimum prices can help to guard against strategic bidding aimed at keeping prices low, but this is not the only consideration. We also want to remove incentives for speculative bidding. Furthermore, whether a pay-as-bid auction or a CCA (or any other auction format is used) is entirely irrelevant when it comes to the question of whether minimum prices are too high; if the minimum prices set are high enough to choke off demand and risk an inefficient outcome, this would be the case under any auction format, as the auction format does not affect bidders' valuations. Therefore, we cannot see any justification for linking the level of fees to the proposed auction format, and it is difficult to accept Eir's argument that the minimum prices are too high on the basis that it would consider them appropriate under a different auction format.
141. It is also incorrect to suggest, as Vodafone does, that the need for reserve prices demonstrates a lack of confidence in the auction model. We agree that a well-designed auction would reveal the true market value of the spectrum, but reserve prices (or minimum prices) are commonly set in the context of being a part of the auction design that adds to the overall model for achieving an efficient outcome. In particular, regardless of the details of the auction format, reserve prices reduce incentives for collusion of all forms (both tacit and explicit) and also consolidation by bidders before an auction intended to limit competition by reducing the pay-off to bidders from engaging in such behaviours. Reserve prices also deter speculative or frivolous participation in auctions that might compromise their orderly running. It is not the case that they are used as a separate tool for propping up deficiencies in the auction format.

Suitability of benchmarking

142. Vodafone has also suggested that the use of benchmarking leads to a ratcheting up of prices over time. We disagree with this. If an award is competitive then the minimum prices have no bearing on the final prices achieved (other than to the extent that they have prevented bidders from artificially keeping prices low). For prices to be ratcheted up over time, minimum prices need both to be set at the benchmark, and significantly increase the prices that bidders pay. We believe that prices are determined by competition, particularly for European awards, which are the most important reference for setting minimum prices in Ireland.
143. Vodafone has also failed to provide any real examples or evidence that a benchmarking approach is inappropriate. In particular, noting that spectrum has gone unsold in other auctions, whether or not it is assigned later, is not sufficient evidence of this. For example, in many of these auctions there may have been excess demand at reserve prices, but bidder's behaviour during the auction led to unsold lots. For example, in auctions that impose uniform prices for each lot type (unlike the CCA, which does not), there may be no facility to award lots at a price lower than the final price per lot, but above the reserve price. If bidders drop demand for multiple lots in one step, this can result in

unsold lots under such auction rules. However, it is incorrect to infer from such an occurrence that the reserve price was the cause of the unsold lots, as setting a lower reserve price would make no difference to the auction outcome.

144. We disagree that benchmarking in general is inappropriate for determining minimum prices. Provided due care is taken over the interpretation and use of the output, we do not see any reason why information that can be taken from previous awards should not be used as a reference point for minimum prices in future awards.

Recommendations

145. For the reasons discussed above, we believe that the proposed minimum fees remain appropriate and do not see any particular reason to reduce them at this point. Doing so would not necessarily come at little or no cost, but would affect the balance between the two objectives of minimising the risk of strategic or speculative bidding whilst ensuring that participation is not discouraged. We have not seen any convincing evidence in the responses to suggest that the proposed minimum fees are inappropriate or that the suggested alternatives would be better.
146. However, we expect to update the benchmarking report and review minimum price proposals closer to the auction, to take into account awards that have happened in the meantime and the adjusted licence duration. While there will be no methodological changes, we may adjust our recommendations on the minimum price levels in the light of new data, if any.

6 Auction format

6.1 ComReg's proposal

147. ComReg proposes to use a combinatorial auction format for this award. ComReg justifies this on the basis that lots in different categories are likely to be complementary, both across different bands (e.g. 700 MHz and the supra 1 GHz spectrum) and across the two time slices.
148. Of the available combinatorial formats, a sealed bid combinatorial auction and a CMRA were both deemed to be inappropriate. The former provides no opportunity for bidders to gather information and focus on packages they might win, while the latter is relatively untested. Both formats create difficulties for bidders in situations where there are a large number of lots, such as this one.
149. ComReg was of the view that a CCA is the most suitable format for this award, because it:
- allows bidders to submit multiple, mutually exclusive bids for packages of lots, which avoids aggregation risk and mitigates substitution risk;
 - provides opportunities for bidders to pool information as the auction progresses;
 - reduces the risk of bidding behaviour that does not reflect bidders' valuations, such as strategic demand reduction or tacit collusion; and
 - supports an efficient outcome, with a relatively low chance of inefficiently unsold lots. Allowing for asymmetric prices may be important in achieving efficiency.

6.2 Views of respondents

150. All respondents are generally supportive of the use of an auction.
151. The proposed use of a Combinatorial Clock Auction (CCA) was criticised by the MNOs for introducing unnecessary complexity. This was closely linked to the use of time slices. Vodafone suggested that a CCA was only problematic because of the time slices and resulting large number of packages that bidders need to value. Eir and Three are of the view that removing time slices would remove the need for a combinatorial auction format.
152. Some respondents highlighted that DotEcon has recently advised against the use of a CCA in an auction in the Netherlands. Both Eir and Three believe that the same arguments should apply to this award. Eir's argument is based on the simplicity and certainty pay-as-bid rules afford bidders, and the availability of alternative ways of deterring strategic demand reduction. Three notes the interaction of opportunity cost pricing and asymmetric caps, and refers to a statement from DotEcon's recommendation on the Dutch auction, that "*under such asymmetric constraints the ability of bidders to set each other's prices is*

uneven and attempts to exploit this asymmetry through strategic bidding may result in inefficient outcomes”.

153. Eir suggests that a CCA lacks transparency, brings potential for gaming, and that DotEcon has in this instance underestimated many of the format’s downsides. It says that a CCA creates incentives for strategic bidding and favours stronger bidders, because:
- the need to submit knockout bids that are likely well in excess of what will have to be paid in order to guarantee winning spectrum is more difficult for smaller bidders;
 - budget constrained bidders may then have to choose between bidding for smaller packages, or submitting bids for their full value of larger packages, but risking winning nothing (this may happen unexpectedly, with no chance to bid again);
 - the uncertainty over what will be paid is itself enough to create serious governance issues for some bidders; and
 - asymmetries arising from opportunity cost pricing, favouring larger bidders even if there is no strategic bidding aimed at exploiting this.
154. Instead, Eir favours a pay-as-bid format on the grounds that it removes uncertainty over what winning bidders will have to pay, allows budget constrained bidders to better represent their valuation structure in their bids, reduces incentives for gaming, and there is no risk of a bidder coming out of the auction with nothing unless it has submitted a bid for nothing. However, Eir is opposed to certain pay-as-bid formats such as the CMRA (on the grounds that it is complex and likely to favour stronger bidders) as well as formats like the SMRA or clock auction with retained demand, which constrain a bidder’s ability to switch. It recommends a simple clock auction, with a relaxed activity rule whereby a bidder could submit bids exceeding its eligibility provided they were consistent with the preferences it had already expressed. Eir argues that this would allow bidders to express their preferences throughout the auction, but would not have the same risks as the CCA or CMRA due to its relative simplicity and transparency.
155. Eir believes that it is unnecessary to time slice the 2.3 GHz and 2.6 GHz bands and suggests that time slicing only the 2.1 GHz band would reduce aggregation risk in the award. In that case, there would be less need for a combinatorial auction format, and a simpler format (such as the SCA with a relaxed activity rule) would be sufficient.
156. Three is concerned with use of the CCA in general and sees specific problems with the format as proposed, whilst also suggesting the potential for gaming in other formats has been overstated. Its main concern relates to the perceived unfairness of asymmetric prices. In particular, Three notes:
- combinatorial auctions have a mixed track record of achieving efficient outcomes;
 - there is potential for strategic behaviour and highly asymmetric pricing if CCA’s are used in situations with predictable asymmetries between bidders;
 - there are examples of “CCAs producing peculiar results”, which it attributes to strategic exploitation of asymmetric prices;

- now that more spectrum is generally available, the need to avoid aggregation risk only arises because of the inclusion of the 2.1 GHz band; and
 - strategic demand reduction (which the minimum prices also hope to address) is unlikely to be an issue because revenue is not an objective of the award and the MNOs will not want to risk compromising their position in the downstream market. The CCA could instead deter value-based demand reduction.
157. Three submits that bidders with predictably low marginal valuations may be tempted to exaggerate their demand in order to prevent an outcome where they pay more than stronger bidders, who may in turn retaliate by overstating their own demand, or bid spitefully, knowing that they have a relatively large amount of price setting power. At the same time, bidders have contradicting incentives to end the auction as quickly as possible. As a result, the CCA creates a high risk of strategic bidding, which may result in an inefficient outcome.
158. The main objection to the use of a CCA by Three is based around the claim that they are discriminatory because of the likelihood of asymmetric prices, particularly in the presence of asymmetric caps. Three's inability to set prices due to the cap on sub-1 GHz spectrum could unfairly give its rivals a windfall gain. It stresses that an efficient outcome is the main objective of this award, and while uniform pricing is not an objective, neither is achieving any minimum revenue. In light of this, it suggests that prices that are close to uniform should be expected, based on it being a competitive award where bidders can be expected to have similar values for incremental spectrum.
159. Therefore, if it is not the case that bidders pay similar prices, Three is of the view that the auction process must be treating bidders unfairly. This is expanded on by providing legal references on discrimination and an example, produced by NERA, demonstrating how such prices would come about. NERA mentions decreased ability to invest downstream and the potential for bidders to overstate their values in order to put price pressure on rivals as mechanisms through which asymmetric pricing could result in an inefficient outcome. However, the focus remains on the claim that these prices would be discriminatory. It suggests that a clock-SMRA hybrid would be preferable.
160. Three also suggests that asymmetric prices undermine the method for setting liberalisation fees (pointing to difficulties Ofcom had in using a CCA to set prices for licence renewal in the UK). It also questions the relevance of a CCA having been used in the past, stating that bidders would prepare appropriately for the auction regardless of format.

6.3 Assessment and recommendations

Time slicing and package bidding

161. It is important to highlight upfront our view (discussed above) that if Eir does not return its current 2.1 GHz licence early so that it can be included in the award with the same licence term as the rest of the band, time slicing of at least

the 2.1 GHz band is necessary. Furthermore, for the reasons set out above we believe that in this scenario it will also be important to time slice the 2.3 GHz and 2.6 GHz bands. With time slicing, there is a strong case for the use of a combinatorial auction format that supports package bidding to mitigate the aggregation and substitution risk stemming from the likely strong complementarities between lots across time slices. Indeed, concerns over the problems that could arise through only winning spectrum in one time slice were raised by various respondents.

162. Of the candidate combinatorial auction formats, the CCA is the most appropriate:
- The large number of lots available and the importance of the spectrum available in this award for the Irish telecoms market means that an auction with an open phase is desirable. This open phase provides bidders with information about the demand of their competitors, allowing them to identify the packages they are likely to win. Conversely, sealed bid combinatorial auctions provide no opportunities for feeding back information about the demand of competitors, making it difficult for bidders to determine which packages they can realistically expect to win.
 - The CMRA is also an open, multi-round format. However, given the large number of lots available, there is a risk of excessive complexity for bidders that may want to manage and update a potentially large number of bids on a round by round basis.
 - The CCA is a format tried and tested in Ireland, which has been proven to be suitable for awards with many, potentially complementary, lots.

Auction format if time slicing were unnecessary

163. Even if Eir were to return its licence early and time slicing became unnecessary, we would still recommend the use of a CCA. This is because we believe there would still be a significant degree of aggregation risk and substitution risk in the absence of time slices:
- bidders may require a minimum amount of spectrum in excess of the lot size within any given band, so there are likely complementarities across lots within bands;
 - bidders may desire a combination of lots across multiple bands (e.g. a mix of sub-1 GHz band higher frequency spectrum, as would typically be the case for a mobile operator), in which case there would be complementarities across spectrum bands; and
 - the various higher frequency bands are likely to be substitutable at least in the long run, so bidders are likely to have valuations for a range of alternative packages with different combinations of spectrum and want to switch multiple blocks across those bands in response to price changes.
164. Given this, we are of the view that, on the grounds of efficiency, the auction format should support package bidding and provide opportunities for bidders to express their demand for a range of packages.

165. Furthermore, the CCA helps to support entry and/or participation by smaller bidders. This can have positive consequences for the auction and/or the downstream market. Allowing bidders to submit bids for a wide variety of spectrum combinations means there is greater scope that a smaller participant's package will be able to fit within a winning outcome and acquire some spectrum. Package bidding is also helpful for entrants for whom it might be important to acquire a particular portfolio of spectrum (e.g. a mix of high and low frequency spectrum).
166. The CCA has the added benefit of being familiar to a number of potential participants in the award, having been successfully used in Ireland for the 2012 MBSA and the more recent 3.6 GHz award (in which two non-MNO bidders won spectrum alongside MNOs).
167. We believe that a number of the concerns of the respondents are misplaced. For example, concerns about excessive complexity arising from the combination of the CCA and time slicing fails to recognise that, as discussed above, package bidding means that time slices can effectively be ignored (i.e. bidders can choose to focus their bids solely on packages that would lead to licences spanning both time slices). Therefore, the auctioneer faces some complexity in implementing this auction, but this should not be relevant to bidders. The proposals provide flexibility to bidders and it is up to them whether to avail of the possibilities this provides.
168. The concerns from incumbent MNOs needs to be balanced against the benefits that package bidding is likely to have entrants, whether or not ultimately successful in winning spectrum rights of use. As a result, using a format that does not support package bidding would particularly disadvantage entrants, and potentially discourage participation. The 3.6 GHz auction demonstrated that the potential for entry should not be dismissed out of hand and that auction design should be fair for potential entrants too.

Uncertainty about prices, governance and budget-constraints

169. It is true that under certain conditions, namely when there would be many lots in excess supply at final clock prices, bidders might face uncertainty about the final outcome and prices. In particular, the so-called *knock-out bid* that would guarantee that the bidder would win its final clock package could be well above their final clock bid, as Eir points out.
170. However, in relation to Eir's concerns that the 'knockout bids' might be beyond the reach of certain bidders, we note that the main consequence of the existence of knockout bids (which are a mathematical consequence of the activity rules of the CCA) is that they permit bidders to bid *less* than the full amount of their valuation for their final clock package, yet still have a guarantee that they will win this package (subject to not raising bids for other packages too much). In the event that the knockout bid level for the final clock package were above a bidder's valuation for that package, it would be irrational for that bidder to bid in excess of its valuation, as that would expose the bidder to a risk of winning the package and paying more than the package was worth to it (in which case the bidder would have been better off it had lost entirely). Therefore, if a bidder wants to bid at its knockout bid level and is unable to do

so because of a budget constraint, then that bidder would also be unable to bid at its valuation. Contrary to Eir's assertion, the existence of knockout bids aids bidders with budget constraints, as there may be a means for that bidder to lock in its final clock package without having to bid at its full valuation

171. We accept that there may be challenges for budget constrained bidders in auctions. However, these issues are not unique to CCAs. Regardless of the specific format, there will typically be some need for bidders to assess what they can realistically win within their budget constraint, and possibly to update such an assessment in the course of the auction. For example, in an SMRA or clock auction, a budget constrained bidder has a complex decision about competing for a larger number of lots, because it may need to contract to a smaller number of lots later due to reaching its budget constraint, but could by then have already raised prices to the extent that it can no longer afford fewer lots. Within a CCA, budget-constrained bidders may face trade-offs between being able to express differential valuations between larger and smaller packages, and ensuring that smaller packages are bid for at valuation (as this may push bids for larger packages above the budget constraint). Therefore, if bidders are budget constrained they will face some difficulties whatever the format. Auction mechanisms need to test bids through competition; no efficient mechanism could involve bidders making untested claims that their actual valuations are much higher than their bids.
172. In summary, we see the issues facing budget-constrained bidders in a CCA as being broadly analogous to those they face in other formats, as in all cases some assessment of what bidders might be able to reasonably win within their budgets will be needed. However, we accept that winning prices being typically below bids may add an additional consideration for budget-constrained bidders. This may also make governance arrangements more difficult for some bidders. We do not accept that these are major concerns, as Irish experiences with CCAs have been positive, with bidders other than the traditional MNOs winning spectrum in the 3.6 GHz auction; these entrants do not appear to have been inhibited by such problems.
173. Nevertheless, we are currently undertaking a separate study for ComReg looking at whether ancillary information could be given to bidders during the clock rounds that would allow them to anticipate if they might need to pay the full amount of a bid if it won. The findings are expected to be made public in January 2020. If this approach proves feasible and fruitful, it could be implemented through a minor revision in the information policy of the proposed award process.

Eir's proposed alternative

174. Eir has suggested that a simple clock auction (SCA) would be appropriate if relaxed activity rules were used. However, we disagree that the SCA (whether with relaxed activity rules or not) would be suitable due to the following reasons:
- The SCA allows bidder to submit just a single bid in each round at given prices, and only the bids submitted in a particular round are assessed to determine whether the auction can end and the winning outcome. This

significantly restricts the number of potential allocations across bidders that can be considered and limits the extent to which bidders' preferences over alternative packages can be accounted for when determining the auction outcome. This is particularly problematic in scenarios where there is a large number of lots available over a variety of substitutable categories. Conversely both the CCA and CMRA allow bidders to submit a range of bids expressing preferences over different packages. This provides greater possibilities for 'packing' the demands of different bidders to establish an efficient outcome.

- The SCA is also particularly susceptible to unsold lots, especially where there are complementarities across lots and aggregate demand can suddenly drop from being greater than supply to being below supply, even with small price increments. As discussed in our award design report, there are additional features that can be bolted on the SCA to mitigate this risk (such as exit bids and combinatorial closing rules). However, these do not fully resolve the issues that arise when there are complementarities between lots, and thus in our view these are not sufficient to mitigate the risks or support an efficient outcome in such an important award. Conversely, combinatorial formats such as the CCA and CMRA deal with the risks of unsold lots far more effectively and are more likely to result in an efficient allocation.
175. Furthermore, it is not possible to adopt a relaxed activity rule in the SCA without introducing potential for gaming. In the SCA, only the clock bids in the most recent round are relevant for the determination of the winning outcome. However, the relaxed activity rule hinges on establishing constraints on bidders to ensure that bidders who reduce demand must uphold their offer to reduce demand and accept a possibility of winning smaller packages, which requires considering a wider range of bids (including clock bids and bids for smaller packages) when determining the winning outcome. Simply allowing bidders to increase their demand if some conditions on relative prices are met would create a wide range of gaming possibilities, allowing bidders to hide their demand and/or distort prices. At the same time, trying to mitigate this problem by adopting a more complex approach to evaluating bids to include consideration of bids relevant to setting relative caps under a relaxed activity rule simply turns the auction into something resembling a CMRA; each bidder would have a number of bids in play at each round and the resulting auction would be nothing like a SCA. Therefore, we consider that the suggestion of an SCA with relaxed activity rules is fundamentally incoherent.

DotEcon recommendation in the Netherlands

176. As Eir and Three note, DotEcon recently recommended using an SMRA-clock hybrid for a multi-band auction in the Netherlands. However, this recommendation was based on the premise that there were no significant synergies between the lots on offer and without any explicit concern about possible complementarities for new entrants. Also, the Dutch government had an explicit objective of simplicity for the process itself.
177. ComReg's objectives are somewhat different. First, ComReg has a more nuanced view of complexity. Excessive complexity for bidders that might

compromise the efficiency of the award is to be avoided. Second, ensuring a level playing field for parties other than the traditional MNOs is important. However, ComReg's primary objective is the promotion of competition and ensuring an efficient outcome, and it is not especially concerned about what demands are made on ComReg itself in order to implement the process if there are potential efficiency benefits.

178. Without complementarities, a simpler approach will typically be suitable, so the choice of a combinatorial format may not be justified – in such cases we agree that simplification may be beneficial. However, in our report for the Dutch government we were extremely clear that, where complementarities arise, there are benefits to the use of combinatorial formats.
179. For the MBSA2, we expect that there is scope for material complementarity across lots (as discussed above). As a result, a combinatorial format is necessary to promote efficiency, and thus an SMRA-clock hybrid is not appropriate for this award. The differences in circumstances and objectives lead to different conclusions in the two cases.

Asymmetric pricing

180. Three's main objection to the use of a CCA is that it is likely to result in asymmetric prices in a way that unfairly discriminates against Three. In this regard, we first highlight that symmetric pricing is not an objective of the award, and we do not see any particular reason why it should be. As explained in Section 4.3 above, there is no reason to suggest that asymmetric prices are discriminatory if they arise because bidders start from different positions and face different levels of competition from each other. The competition faced by Three is derived from the demand for spectrum from Eir, Vodafone, non-MNO bidders and entrants. These bidders may wish to catch up with Three, in which case it might face relatively strong competition for spectrum. However, in this case asymmetric prices might be expected in an efficient award and are not unfair, as bidders are generally bidding for different things in terms of overall holdings and might be winning different holdings in terms of what they represent as an addition to any portfolio they already hold.
181. In terms of the impact of caps, we have already discussed that Three is in a different starting position by virtue of its current holdings of spectrum. Therefore, although caps are symmetric in terms of what they allow in terms of post-auction spectrum holdings, bidders differ in what they can acquire. In our view this approach is appropriate, as it ensures that bids are not made that reflect any expectation of acquiring market power by cornering the available spectrum; even if such bids were not successful, they could affect winning prices, leading to others paying more as a result of uncompetitive outcomes being allowed. However, these possibilities are excluded by the proposed caps and competition for spectrum occurs with limitations on the outcomes of the auction that are compatible with effective downstream competition.

Price driving

182. Alongside the claim that the prices are discriminatory, Three also suggests that the scope for asymmetric prices could incentivise strategic bidding and thus lead to inefficient outcomes. However, price driving strategies in a CCA where there is limited information available about competitors' demand and valuations would be risky. Under ComReg's proposal, bidders would find it difficult to isolate any part of another bidders demand to target, and since all bids are binding and are taken into account as potential winning bids, attempts to place bids beyond valuation with the aim of increasing the price paid by other bidders risks a bidder winning a package it does not want or at a higher price than it would be willing to pay. This should act as a significant disincentive for such behaviour, especially given that the direct commercial benefits to a bidder from making others pay more for spectrum are not obvious. Since spectrum access fees are a sunk cost as far as pricing decisions in downstream markets are concerned, and spectrum usage fees do not depend on the auction outcome, forcing rivals to pay more for spectrum is unlikely to allow a bidder to eventually charge more for its own services. Therefore, it is far from clear that there are long-run commercial benefits for bidders in engaging in such behaviour.

Strategic demand reduction

183. Three argues that strategic demand reduction is unlikely to be an issue as the MNOs are unlikely to want to compromise their position in the downstream market. However, this fails to recognise that there is a range of potential participants in the award in addition to the MNOs, such as FWA providers and/or small cell network operators.
184. Incentives for strategic demand reduction can be greater for weaker bidders who might anticipate needing to reduce demand later in the auction (as prices increase and they can no longer compete with stronger bidders). In particular, with a multi-round pay-as-bid auction format (such as the SMRA or SCA), these bidders may have strong incentives to reduce demand early (before prices exceed valuation) in an attempt to end the auction at lower prices, as continuing to compete for lots they do not expect to win would only serve to increase the price they would pay for the lots they do end up being assigned. However, this strategy risks an inefficient outcome if some bidders refrain from bidding for additional spectrum that they otherwise would have won in the efficient allocation.
185. The CCA provides for much better protection against strategic demand reduction than pay-as-bid formats, as the price a winning bidder will ultimately pay is largely unaffected by its own bids (i.e. opportunity cost pricing means prices are determined by the bids placed by rival bidders). Weaker bidders are, therefore, able to submit bids for larger packages up to valuation and test their ability to win the larger packages without fear that it will increase the price they would pay for winning a smaller amount of spectrum.
186. An example of how the CCA can be more effective than pay-as-bid-formats in mitigating the risk of strategic demand reduction is provided by the Danish

2.6 GHz auction, completed in 2010. In that award, there were fourteen 2.5 GHz FDD lots and four bidders. No bidder could win more than four of the FDD lots. Three was likely to have been the marginal bidder in that award and could reasonably have expected that it would have to settle for a number of lots below the maximum allowed. In the end, Three won two of the FDD lots, but clearly bid for more during the auction⁵.

187. Under a pay-as-bid format, Three could have expected that competing for larger packages would only increase the price it would have to pay for any spectrum it was ultimately able to win. In particular, Three would have known that it could have bid for only two lots from the beginning without facing any competition from other bidders (due to the cap), and it is likely that (given the final outcome) this would have been a good strategy for Three in order to achieve a favourable outcome. The auction was, however, run using a CCA, which provided the opportunity for Three to bid for additional spectrum and test its position as the marginal bidder without fear of affecting the price it might have to pay for a lower number of lots. As noted above, Three ultimately won two lots, but these were assigned at the reserve price (i.e. bidding for more lots had no bearing on the price it paid) and the fact that Three was able to bid for larger packages meant that other bidders would have been required to pay the opportunity cost of denying Three any additional spectrum.
188. In light of the above, we consider that due to the potential for a range of participants in the award with differing spectrum requirements and financial backing, the risk of an inefficient outcome due to strategic demand reduction is not immaterial. Use of the CCA provides much better protection against this than alternative pay-as-bid formats.

⁵ All other bidders won the maximum of 4 lots, and since prices for winners other than Three were above reserve there must have been competition within the auction so Three must have bid for more than two lots (otherwise there would have been no excess demand).

Annex A Need for time slices

189. In this annex we set out the reasons why it is appropriate to apply time slicing to all supra-1 GHz bands rather than just the 2.1 GHz band.
190. To recap, we are recommending that there be two time slices for the 2.1 GHz band:
- Time slice 1: 16 October 2022 – 11 March 2027; and
 - Time slice 2: 12 March 2027 – 30 June 2040 (working assumption)
191. In the first time slice there would be 2x45 MHz available in the 2.1 GHz band – this is the spectrum associated with Three and Vodafone’s current licences, which will expire in 2022.
192. In the second time slice the full 2x60 MHz in the 2.1 GHz band would be available.
193. All of the 2.3 GHz and 2.6 GHz spectrum available for the award would also be included in each of the time slices (although the first time slice for these bands would start in 2020). We are not recommending that ComReg apply time slicing for the 700 MHz spectrum.
194. We are also recommending that two spectrum caps be applied, which include current holdings of all WBB compatible spectrum:
- A sub-1 GHz cap of 70 MHz; and
 - An overall cap of 375 MHz.
195. Because it is only in the 2.1 GHz band that we have the issue of different expiry dates, it might be feasible to apply time slicing only to that band (i.e. to have just a single lot category for all of the other bands). However, doing so could create some problems, in that:
- Eir’s switching opportunities would be limited if it wishes to bid for close to (or at) the maximum amount of spectrum allowed by the caps; and
 - the constraints on Eir’s switching could offer gaming opportunities for other bidders aimed at driving up the prices to be paid by Eir.
196. The remainder of this Annex assumes that Eir has chosen to participate in the proposed award process.

A.1 Limitations on switching

197. The proposed competition caps are inclusive of current spectrum holdings available during each of the time slices. Since Eir’s current holdings will differ between the two time slices, the amount of spectrum it can bid for in each of the time slices will differ accordingly. More specifically:
- Eir has current spectrum holdings of 185 MHz in total across the 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz and 3.6 GHz bands. 30 MHz (2x15 MHz) of this is for spectrum in the 2.1 GHz band, the licence for which expires in 2027 (at the end of the first time slice).

- With an overall competition cap of 375 MHz (noting that the same general arguments apply for other caps within the originally recommended range), Eir could then bid for up to 190 MHz (375 MHz less 185 MHz) of additional spectrum with licence terms that cover the period of time slice 1.
 - For time slice 2, Eir's current holdings would be lower (due to the expiry of its 2.1 GHz licence) and it would be able to bid for up to 220 MHz (375 MHz less 155 MHz) of additional spectrum covering the second time period.
198. If we only apply time slicing to the 2.1 GHz band (and all other bands are awarded for a single licence term covering the total duration of time slice 1 and time slice 2) then, in order to have total holdings at the end of the award of 375 MHz (i.e. at the cap), Eir must bid for at least 30 MHz of the 2.1 GHz spectrum for time slice 2. This is because of the tighter restrictions on the amount of spectrum Eir could bid for in the award in time slice 1 than in time slice 2 (due to its different levels of existing holdings over the two periods).
199. As noted above, Eir would be able to bid in the auction for 190 MHz of spectrum covering time slice 1, and 220 MHz of spectrum covering time slice 2. If the other bands cannot be bid for separately across the two time slices then the only available option for making up the additional 30 MHz for time slice 2 would be to bid for 2.1 GHz spectrum in that time slice. Making up the difference using other bands would not be possible without violating the competition cap in time slice 1. Essentially, Eir would be "stuck" in the 2.1 GHz band if it wished to maximise its post auction holdings, subject to the competition caps.
200. The 2.1 GHz, 2.3 GHz and 2.6 GHz bands have similar propagation characteristics, are suitable for WBB services and all have an existing device ecosystem. They could likely therefore be viewed as (long-run) substitutes and it may be the case that bidders (including Eir) would wish to switch between them during the award, for example in response to price developments during the auction or (potentially for Eir) as part of a predetermined goal of switching out of the 2.1 GHz band and into other bands. Switching in this way would not be possible for Eir if it were to also bid for the maximum amount of spectrum allowed by the caps. For example, suppose Eir begins the auction by bidding for 30 MHz of 2.1 GHz spectrum in time slice 2 and 190 MHz of spectrum in the other bands (the maximum possible with a 375 MHz cap). Relative prices might make it desirable for Eir to switch demand away from the 2.1 GHz band and into the 2.6 GHz band. However, since the 2.6 GHz spectrum rights would span both time slices, this would not be possible as Eir could not switch its demand of 30 MHz away from the 2.1 GHz time slice 2 lots and instead bid for 30 MHz of 2.6 GHz spectrum without having to bid for a total of 250 MHz in time slice 1, which would violate the overall cap (once existing holdings are taken into account). The only options available to Eir would be to either continue bidding for the 2.1 GHz spectrum (to maintain demand at the cap) or reduce its overall demand.
201. This problem would not exist in the case that time slicing is applied to spectrum in the bands other than 2.1 GHz. In the example above, Eir could begin by bidding for 30 MHz of 2.1 GHz spectrum in time slice 2, plus 190 MHz of spectrum across the other bands. If it wished to switch away from 2.1 GHz, it could simply stop bidding for that spectrum in time slice 2 and bid instead for

additional spectrum in the other bands (e.g. 2.6 GHz), but only in time slice 2; this would allow for Eir to continue bidding for the maximum allowed whilst also ensuring that the competition caps were not violated.

202. Our proposals are to only apply time slicing for the spectrum above 1 GHz (i.e. 2.1 GHz, 2.3 GHz and 2.6 GHz) on the basis that 700 MHz is probably more of a complement than a substitute to these bands, and so the ability to switch between 2.1 GHz and 700 MHz spectrum is likely to be less relevant. There does not seem to be any particular need to apply time slicing for the 700 MHz band and we would recommend not doing so in order to avoid unnecessary complexity.
203. Note that, for simplicity, the discussion above considered only the case where Eir wished to bid for the maximum amount possible with an overall cap of 375 MHz. In fact, the same general arguments apply for any cap within the range proposed in our original award design report, and for total demand from Eir for an amount of spectrum within 30 MHz of the overall cap (e.g. with a 375 MHz cap, if Eir wished to bid for 355 MHz including existing holdings, 10 MHz of that would have to be 2.1 GHz time slice 2 spectrum).

A.2 Strategic bidding by others

204. The limitations on Eir's switching ability if only the 2.1 GHz spectrum were to be time sliced potentially also exposes Eir to vexatious strategic bidding by other bidders. Since the other bidders would know that Eir would be stuck in the 2.1 GHz band in order to bid at (or close to) the cap, there may be incentives (and the opportunity) to bid for the 2.1 GHz time slice 2 lots with the sole aim of artificially driving up prices in order to either:
- make Eir pay as much as possible for the spectrum; or
 - force Eir to reduce its demand to put it at a disadvantage (in terms of spectrum holdings) in the downstream market.
205. Time slicing the other supra-1 GHz bands reduces the scope for this sort of strategic bidding, since Eir would be better able to switch away from the 2.1 GHz spectrum and bid for other bands in the event that the 2.1 GHz spectrum became relatively too expensive.

Annex B Eir liberalisation fee

206. In this annex we set out the approach to calculating whether Eir would be required to pay a liberalisation fee, and in the event that it did, the amount to fall due (based on currently available information).
207. For the avoidance of doubt, note that a liberalisation fee (if any) would apply only for the period 16 October 2022 to 11 March 2027 (or for whatever portion of that period Eir was to liberalise its current licence). Liberalisation fees would not be charged to any licensee for the period up to 15 October 2022.
208. For clarity, all estimates outlined in this annex are expressed in 2019 terms unless explicitly stated otherwise. We would expect to update these calculations prior to the publication of ComReg's substantive decisions on the award, taking into account updated CPI data among other things. Furthermore, ComReg is currently in the process of reviewing the mobile WACC (which is used as the nominal discount rate) – should a new figure be adopted prior to the publication of the substantive decisions, ComReg would recalculate the price point relating to Eir's current licence using any new mobile WACC. For the avoidance of doubt, however, the estimates will be locked down from the point at which the liberalisation option is available to current licence holders (under current proposals this would be at the point of publication of ComReg's substantive decisions).

Comparison of existing licences with benchmarking

209. In our award design report, we discussed the likelihood that the fees paid by the MNOs for their existing 2.1 GHz licences are above the current market price of the spectrum. To do this, we compared the benchmarks for the 2.1 GHz band (as an estimate of market price) with the following price points for the 2002 and 2007 awards of 2.1 GHz spectrum in Ireland (all in 2018 terms):
- 0.417 €/MHz/pop for the 2x15 MHz A licence (which had restricted coverage) and 5 MHz TDD awarded to Hutchison in 2002;
 - 0.772 €/MHz/pop for the 2x15 MHz B licence and 5 MHz of TDD spectrum awarded to each of Vodafone and O2 in 2002; and
 - 0.559 €/MHz/pop for the 2x15 MHz licence and 5 MHz of TDD spectrum awarded to Eir in 2007.
210. These price points were determined by taking the prices achieved in the respective awards (including SUFs) and running them through the same standardisation method applied to all award prices during the benchmarking exercise, expressing prices as a present discounted value of all licence payments, adjusting to a notional 15 year licence duration and deflating to 2018 prices. This standardisation procedure then allowed us to compare these price points with the benchmark data, as it was expressed in comparable terms. This yielded the conclusion that the price point for Eir significantly exceeded the benchmarks and suggested that it is unlikely that Eir would need to pay an additional liberalisation fee, assuming that those benchmarks gave an indication of likely market pricing of 2.1 GHz spectrum in the award.

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211. For the avoidance of doubt, however, the price point corresponding to the licence awarded to Eir in 2007 was calculated in a manner to be comparable with our benchmark data and is not (and was never intended to be) the starting point for determining any liberalisation fees to be paid by Eir.
212. That calculation requires a more careful and specific approach, taking account only the fees for Eir's FDD licence.

Mechanism for determining liberalisation fees for Eir

213. As set out in our award design report, a suitable process for determining any additional charges to be paid by Eir for liberalising its current 2.1 GHz licence(es) in the period 2022-2027 involves a number of operations. First, it is necessary to extract a price specifically for 2.1 GHz spectrum from the award outcome. Second, the total price paid by Eir for its current un-liberalised licence needs to be adjusted for differences in licence duration and inflation to make it comparable with the award price. Third, to the extent that market price exceeds what Eir has paid, a surcharge needs to be calculated, taking into account the period for which the licence will be liberalised.
214. These operations involve a number of steps. First, to calculate an average award price for liberalised 2.1 GHz spectrum:
- Sum the prices paid by each winning bidder to obtain total revenue for the award.
 - Allocate the total revenue to each lot category in proportion to final clock prices; this gives an estimate for the auction revenue associated with each of the two 2.1 GHz lot categories.
 - For the 2.1 GHz spectrum in each of the two time slices, divide the allocated auction revenue by the number of lots in the category sold to give an average auction price per lot for that category. Add these together to give an average auction price for a 2x5 MHz lot running for the full duration of both time slices.
 - Add the discounted sum of SUFs for a 2x5 MHz licence (again for the maximum possible licence term) for spectrum in the 2.1 GHz band to the average auction price to give a total price for a 2x5 MHz lot in the award; this is the 'current market price' of 2.1 GHz licences.
 - Using this overall price point covering both time slices (rather than just considering one of the two time slices) helps to avoid creating distortions to bidding due to incentives to push the price of the 2.1 GHz in one time slice or the other to manipulate the liberalisation fees. For discounting the SUFs we propose to use a real discount rate of 7.13% per annum.
215. Second, to calculate a comparable price for Eir's unliberalised licence:
- Calculate an equivalent price for a 2x5 MHz block of 2.1 GHz spectrum using the discounted fees (SAFs and SUFs) for Eir's current 2.1 GHz licences, adjusting for inflation and differences in licence duration. This is the 'previous price'.

- Use the difference between the current market price and previous price to assess whether and the extent to which prices for new 2.1 GHz licences have exceeded Eir's fees for its current licence.
216. Third, in the event that a liberalisation surcharge is needed:
- Amortise the difference (using a real discount rate of 7.13% per annum over the life of the licence) to give a per year difference between the market price of a liberalised licence and the current fee level for an un-liberalised licence.
 - Multiply the per year price difference by the number of 2x5 MHz lots Eir will liberalise (i.e. three) and take the present discounted value (using a real discount rate of 7.13% per annum) over the years for which the early liberalisation is applicable. This is then the one-off premium payable for early liberalisation during the time period 2022-2027.

Price point for Eir's current licence

217. The fees paid by Eir for its current 2x15 MHz 2.1 GHz licence comprise:
- a spectrum access fee (paid over a number of instalments during the first 15 years of the licence term); plus
 - annual spectrum usage fees (SUFs).
218. The nominal payments made (and yet to be made) by Eir over the course of the licence are summarised in Table 1 below.

Table 1: Fees for Eir's current 2.1 GHz FDD licence

Year	Date of payment	SAF (€)	SUF (€)	Total (€)
0	30 June 2007	44,400,000	1,904,610	46,304,610
1	30 June 2008	0	1,904,610	1,904,610
2	30 June 2009	0	1,904,610	1,904,610
3	30 June 2010	0	1,904,610	1,904,610
4	30 June 2011	3,800,000	1,904,610	5,704,610
5	30 June 2012	3,800,000	1,904,610	5,704,610
6	30 June 2013	3,800,000	1,904,610	5,704,610
7	30 June 2014	3,800,000	1,904,610	5,704,610
8	30 June 2015	3,800,000	1,904,610	5,704,610
9	30 June 2016	3,800,000	1,904,610	5,704,610
10	30 June 2017	7,600,000	1,904,610	9,504,610

11	30 June 2018	7,600,000	1,904,610	9,504,610
12	30 June 2019	7,600,000	1,904,610	9,504,610
13	30 June 2020	7,600,000	1,904,610	9,504,610
14	30 June 2021	7,600,000	1,904,610	9,504,610
15	30 June 2022	9,100,000	1,904,610	11,004,610
16	30 June 2023	0	1,904,610	1,904,610
17	30 June 2024	0	1,904,610	1,904,610
18	30 June 2025	0	1,904,610	1,904,610
19	30 June 2026	0	1,904,610	1,904,610
Total	-	114,300,000	38,092,200	152,392,200

219. For determining the liberalisation fee (if any) to be paid by Eir, the provisional price for a 2x5 MHz block based on the fees paid by Eir for its current licence (in 2019 terms and adjusting for licence duration to match the two time slices taken together) is **€31,655,826**.
220. This has been calculated as follows:
- Adjust the payments set out in Table 1 for inflation to put them into 2019 terms.
 - Calculate the real discount rate based on a nominal rate of 8.63% (i.e. the mobile WACC in Ireland) and CPI data (for future payments we assume a real discount rate of 7.13% per annum).
 - Discount the payments using the real discount rate to give the net present value (NPV) in 2019 terms of the total payments for Eir's 2x15 MHz licence in the 2.1 GHz band. This gives a total of **€100,503,979** for the 20-year licence.
 - Divide the NPV for the 2x15 MHz licence fees by three, to give **€33,501,326** as the price of a 20-year 2x5 MHz licence.
 - Adjust the 2x5 MHz price to account for the fact that new licences will be awarded for a maximum duration of 17 years and 258 days (i.e. across both time slices, and based on the working assumption that Time Slice 2 will end on 30 June 2040) by multiplying the total fee by the ratio of the sum of real discount factors (assuming a real discount rate of 7.13% per annum) across the two different licence durations⁶ – this gives a price point of **€31,655,826**. This is the 'previous price' that will be

⁶ This is calculated as $\left(\sum_{i=0}^{16} \frac{1}{(1+r)^i} + \frac{1}{(1+r)^{(6098/365)}}\right) / \left(\sum_{i=0}^{19} \frac{1}{(1+r)^i}\right)$, where r is the real annual discount rate.

compared against the current market price for a 2x5 MHz licence based on the award results.

221. The table below illustrates the calculations for determining the NPV of the fees for Eir's current licence.

Table 2: Adjusted fees for Eir's current 2.1 GHz licence

Date of payment	Amount for 2x15 MHz (EUR, SAF+SUF)	CPI ⁷	Inflation adjusted payment for 2x15 MHz (EUR, 2019 terms)	Real discount rate	Discount factor	Discounted payment for 2x15 MHz (EUR, 2019 terms)
30 June 2007	46,304,610.00	95.19%	48,646,866.54	0.00%	1.000	48,646,866.54
30 June 2008	1,904,610.00	99.91%	1,906,375.16	3.50%	0.966	1,841,988.53
30 June 2009	1,904,610.00	94.54%	2,014,670.71	14.80%	0.759	1,528,667.77
30 June 2010	1,904,610.00	93.70%	2,032,587.75	9.60%	0.760	1,544,060.37
30 June 2011	5,704,610.00	96.20%	5,929,719.73	5.81%	0.798	4,731,242.29
30 June 2012	5,704,610.00	97.87%	5,828,740.59	6.78%	0.720	4,198,779.11
30 June 2013	5,704,610.00	98.52%	5,790,393.61	7.92%	0.633	3,666,141.75
30 June 2014	5,704,610.00	98.89%	5,768,706.74	8.22%	0.575	3,317,702.03
30 June 2015	5,704,610.00	98.70%	5,779,529.83	8.83%	0.508	2,936,174.68
30 June 2016	5,704,610.00	99.17%	5,752,547.90	8.12%	0.495	2,848,410.79
30 June 2017	9,504,610.00	98.80%	9,620,411.25	9.04%	0.421	4,049,909.59

⁷ Source: <https://statbank.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=CPM01&PLanguage=0> (CPI figures are rebased to November 2019 terms, and future CPI estimates assume an annual inflation rate of 1.5%)

30 June 2018	9,504,610.00	99.17%	9,584,480.67	8.22%	0.419	4,017,876.44
30 June 2019	9,504,610.00	100.28%	9,478,281.44	7.43%	0.423	4,012,361.69
30 June 2020	9,504,610.00	101.78%	9,338,208.32	7.13%	0.408	3,814,338.17
30 June 2021	9,504,610.00	103.31%	9,200,205.24	7.13%	0.381	3,507,858.34
30 June 2022	11,004,610.00	104.86%	10,494,743.49	7.13%	0.356	3,735,125.98
30 June 2023	1,904,610.00	106.43%	1,789,522.61	7.13%	0.332	594,510.48
30 June 2024	1,904,610.00	108.03%	1,763,076.46	7.13%	0.310	546,741.91
30 June 2025	1,904,610.00	109.65%	1,737,021.15	7.13%	0.289	502,811.52
30 June 2026	1,904,610.00	111.29%	1,711,350.88	7.13%	0.270	462,410.91
Total (2x15 MHz)	152,392,200.00	-	154,167,440.06	-	-	100,503,978.88
Total (2x5 MHz)	50,797,400.00	-	51,389,146.69	-	-	33,501,326.29

Required payment

222. Based on the outcome of the award, if the estimated price of a newly awarded 2x5 MHz 2.1 GHz licence were to exceed the duration adjusted price paid by Eir for a 2x5 MHz licence based on its current licence fees (i.e. €31,655,826), a liberalisation fee would be applicable should Eir choose to liberalise its licence at any point before expiry.
223. The amount to be paid is calculated as follows:
- amortise the difference across the full 17-year 258-day licence term (using a real discount rate of 7.13% per annum) to give a yearly price difference;
 - multiply the yearly price difference by the number of 2x5 MHz licences Eir will liberalise (or has already liberalised) to give a total per year difference for the spectrum to be liberalised;
 - Eir would then be required to pay the present value of the annual price difference over the period of liberalisation beyond 15 October 2022 (calculated using a real discount rate of 7.13% per annum).

Example:

224. The example below sets out how we propose the calculation of Eir's liberalisation fee to work in the event that the estimated market price exceeds the price point for Eir's current licence.
225. Suppose the difference is €1m (i.e. the estimated price of a newly awarded 2x5 MHz licence across both time slices is €31,655,826 + €1,000,000 = €32,655,826, and that Eir wishes to liberalise its licence from before 16 October 2022 (i.e. for the full period over which a liberalisation fee would apply).
226. We first multiply the difference by three, which gives a total price difference of €3m.
227. The yearly difference (i.e. the amount per year over the 17-year 258-day licence term that gives a NPV of €3m) is €283,419.55.

Table 3: Example - annual price difference for 2x15 MHz licence

Year	Annual price difference (EUR)	Discounted price difference (EUR)
0	283,419.55	283,419.55
1	283,419.55	264,556.66
2	283,419.55	246,949.19
3	283,419.55	230,513.57
4	283,419.55	215,171.82
5	283,419.55	200,851.13

6	283,419.55	187,483.56
7	283,419.55	175,005.65
8	283,419.55	163,358.21
9	283,419.55	152,485.96
10	283,419.55	142,337.31
11	283,419.55	132,864.10
12	283,419.55	124,021.38
13	283,419.55	115,767.18
14	283,419.55	108,062.33
15	283,419.55	100,870.28
16	283,419.55	94,156.90
17	200,334.92	62,125.21
Total	5,018,467.34	3,000,000.00

228. If Eir was to liberalise its licence for the full 4 years and 147 days from 16 October 2022 to licence expiry (11 March 2027) it would be required to pay a lump sum of €1,112,097.21, calculated as:

- the full discounted price difference for the first four years; plus
- 147/365 times the discounted price difference for the fifth year.