



Commission for
Communications Regulation

Multi Band Spectrum Award

DotEcon Report – Assessment of Responses to Draft IM

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Assessment of responses to Draft IM

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Executive Summary

1. In December 2019, ComReg published its 'Draft Decision' (document 19/124) for the forthcoming award of spectrum in the 700 MHz, 2.1 GHz, 2.3 GHz and 2.6 GHz bands (the second multi-band spectrum award (the 'MBSA2'), and in May 2020 ComReg published the Draft Information Memorandum (the 'Draft IM') Stakeholders were invited to provide comments on both documents.
2. In December 2020, ComReg published its final decision for the award (the 'Decision')¹ along with, among other things, a supporting report prepared by DotEcon.
3. Having carefully analysed responses to the consultation on the Draft IM, we do not believe that any substantive issues have been identified, but some respondents have provided helpful technical suggestions that we recommend be adopted for the final auction rules. In addition to these, certain modifications are required to give effect to the Decision.
4. In summary, we recommend that ComReg make the following modifications relative to the Draft IM:
 - the calculation of the early liberalisation fee (if any) to be paid by Eir be adjusted in line with the Decision (Document 20/122) to base the estimated market price of 2.1 GHz liberalised spectrum only on the award price of the band in the first time slice;
 - in line with the Decision, the 2300 – 2330 MHz frequency range be made available as six 5 MHz frequency-generic lots alongside the 2330 – 2390 MHz frequency-generic lots rather than a single 30 MHz fixed frequency lot, with these changes to the 2.3 GHz band lot structure meaning that:
 1. the methodology for dealing with winners of fixed frequency lots when generating assignment options can be somewhat simplified; but
 2. additional provisions need to be put in place in the assignment option generation process to ensure that if Eir wins 2.3 GHz spectrum in the award, the frequencies it is assigned are those at the bottom of the band to overlap with those currently being used by RurTel (2307 – 2327 MHz);
 - in light of a suggestion from Eir, we recommend adjusting the methodology for generating assignment options by removing the random tie-break criteria when selecting candidate frequency plans for a given bidder ordering (which means a

¹ Document 20/122 and Decision 11/20

bidder ordering may not generate multiple candidate frequency plans, rather than just one as under the rules in the draft IM);

- we recommend adopting measures to streamline the assignment option generation process by implementing a rule-based approach to the treatment of unsold time slice 1 lots within the recursive algorithm for generation of bidder orderings in a band;
- the assignment stage winner determination process can be improved by removing the need for the winning assignment bids to conform to one of the candidate frequency plans identified for constructing assignment options;
- in line with the Decision, the minimum prices for the 2.6 GHz TDD and 2.3 GHz fixed frequency lots be reduced, relative to the minimum prices for other lots in the respective band, to reflect the power limits applied to those frequencies and the corresponding uncertainty over the value of same;
- the minimum prices in general be updated to take into account revisions to the mobile WACC² since the draft IM was published and final expected licence terms at the time of publishing the final IM;
- in light of the Decision to provide bidders with 'exposure pricing' information during the primary bid rounds (which was included in the draft IM but not formalised at that point), a technical annex be added to the final IM setting out the mechanics of how the bidder "discounts" are calculated;
- in light of concerns raised by Eir, that the rules relating to possible action from ComReg following a bidder's failure to meet a deposit call at the end of the main stage be redrafted to clarify that:
 1. ComReg will retain discretion over whether or not to exclude the bidder;
 2. in the event that the bidder was not excluded, ComReg will have discretion over which, if any, of the bidder's bids would remain valid; but
 3. if the bidder is excluded, all of its bids will be excluded from the winner determination and pricing process.
- that the process for resolving any issues regarding common insiders following submission of applications for the award be reviewed by ComReg and potentially modified to ensure that, for consistency with the award rule of not publishing the number or identities of applicants/participating bidders, the information about other applicants that is revealed to the parties with the common insider is minimised; and
- in light of a suggestion from Three, the process for calculating refunds of fees already paid by winning bidders in the event of delayed access to spectrum applies similar principles, as

² <https://www.comreg.ie/publication/the-cost-of-capital-for-the-irish-communications-sector-final-report>

appropriate, for calculating the minimum/reserve prices, i.e. to assume a flat cash flow benefit from a licence and amortise the licence price using an appropriate discount rate to calculate a daily deprival value for the licence.

1 Introduction

1. In December 2019, ComReg published document 19/124 (the 'Draft Decision') setting out provisional policy decisions for the forthcoming award of spectrum in the 700 MHz, 2.1 GHz, 2.3 GHz and 2.6 GHz bands (the second multi-band spectrum award, or 'MBSA2')³.
2. In May 2020, ComReg published the Draft Information Memorandum (the 'Draft IM'), which set out the detailed rules and processes which ComReg proposed to employ to implement the award as described in the Draft Decision.⁴ Stakeholders were invited to provide comments on both documents.
3. In December 2020, ComReg published its substantive Decision (the 'Decision') for the award, along with, among other things, a supporting report prepared by DotEcon.⁵ These documents included an assessment of comments received in relation to the Draft Decision, as well as an assessment of some, but not all⁶, of the comments submitted by stakeholders on the Draft IM.
4. In this document, we first set out the implications of the Decision for the award rules and the recommended changes required in the final Information Memorandum ('final IM') to reflect the Decision.
5. Second, we consider comments from stakeholders on the Draft IM that have not been already considered in the Decision and supporting documents already published by ComReg. These comments primarily concern matters of clarification and suggestions from stakeholders for various modifications of the rules as proposed in the Draft IM.

³ Document 19/124, "Proposed Multi Band Spectrum Award - Response to Consultation and Draft Decision on the 700 MHz Duplex, 2.1 GHz, 2.3 GHz and 2.6 GHz Bands", published 20 December 2019.

⁴ Document 20/32, "Proposed Multi Band Spectrum Award - Draft Information Memorandum and Draft Regulations", published 13 May 2020.

⁵ Document 20/122, "Multi Band Spectrum Award – Response to Consultation and Decision", published 18 December 2020.

⁶ Insofar as these related to broader policy choices, rather than details of implementation.

2 Changes due to the Decision

6. A number of changes to the Draft IM are required to give effect to the Decision. These have come about both where ComReg has reached a decision having consulted with stakeholders and also due to progressive changes in circumstances regarding the available spectrum (in particular, regarding the 2.3 GHz band spectrum currently used by RurTel).
7. These changes relate to four specific areas (set out in the subsequent subsections):
 - the methodology for calculating a liberalisation fee for Eir;
 - the amended lot structure for the 2.3 GHz band and the decision to assign any lots allocated to Eir in that band at the bottom of the band to overlap with the frequencies currently used by RurTel;
 - adjustments to the reserve prices for the upper 2.3 GHz lot and the 2.6 GHz TDD edge lots; and
 - the implementation of exposure pricing in the CCA to be used for running the award.
8. In this section, we deal only with the consequences of the Decision for the detailed award rules that will be set out in the final IM. The Decision itself explains why ComReg has reached certain conclusions and we take these as a given for the purposes of this report.

2.1 Liberalisation fee for Eir

9. The three mobile network operators (MNOs) in Ireland, Three, Vodafone and Eir, each have current rights of use for spectrum in the 2.1 GHz band. Vodafone and Three's licences expire in 2022, while Eir's licence runs until 2027.
10. Under the current licence terms, the licensees are required to use the spectrum for UMTS (commonly known as '3G' mobile). However, ComReg has decided to provide the MNOs with the option to "liberalise" their current 2.1 GHz licences, allowing them to use the spectrum with other technologies and services in advance of the commencement of new licences issued under the planned award. This brings the 2.1 GHz band into line with current licensing policies, which are typically service and technology neutral, and will permit licensees to migrate to more modern technologies. The liberalisation option can be taken up by an MNO at any time from the making of the relevant regulations until the expiry of their licence.

11. For the relatively short period up to 15 October 2022 (the latest expiry date of any of Vodafone and Three's licences⁷) there will be no applicable liberalisation fee for any of the three existing 2.1 GHz licensees. However, and as set out in the Decision, if Eir was to take up the liberalisation option, it would potentially be required to pay a fee for the period from 16 October 2022 up to the expiry of its licence on 11 March 2027 (or whichever part of that period the licence was liberalised for).⁸ In particular, Eir would need to pay a fee for liberalising its 2.1 GHz licence early in the event that the market value of new liberalised 2.1 GHz rights of use implied by the outcome of the MBSA2 exceeds the fees for Eir's existing licence (with the level of the liberalisation fee set by the difference). The reasons for applying a fee under these conditions are discussed in detail in earlier reports published by ComReg and are not repeated here.⁹
12. ComReg has also set out in previous documents a proposed methodology for calculating Eir's liberalisation fee, where the fee (if any) would be based on the estimated auction price¹⁰ of the 2.1 GHz lots combining both time slices.¹¹ In its response to the Draft Decision, Eir argued that using the second time slice in the calculation would be inappropriate as the value of the spectrum in the two time slices would be different (due to the timing of when the spectrum would be useful for 5G), and that only the value of the spectrum in the first time slice (the period over which Eir's liberalised licence would run) should be taken into account.
13. After careful consideration, ComReg agreed that there was merit in Eir's contention, and determined that it would be appropriate to use only the estimated price of the 2.1 GHz spectrum in the first time slice for the liberalisation fee calculations. In its Decision (Paragraph 4.86), ComReg set out that the broad methodology would be the same as that described in paragraph 5.58 of Document 19/59R, save for changes to take account of using only the price of the 2.1 GHz spectrum for the first time slice, rather than averaging across both time slices. ComReg noted that it would provide the detailed methodology in its response to the Draft IM.
14. In that regard, we understand that the methodology for determining the early liberalisation fee to be paid by Eir, amended to only use the first time slice

⁷ Vodafone's licence (for 2x15 MHz of 2.1 GHz spectrum) expires on 15 October 2022. Three has two licences (each for 2x15 MHz), one of which expires on 24 July 2022 and the other expires on 1 October 2022. In line with the Decision, Three has been given the option to apply for and be granted interim licences that will run to 15 October 2022 for some or all of the 2.1 GHz spectrum it is currently assigned, subject to a fee.

⁸ If Eir liberalised its licence after 16 October 2022, the liberalisation fee would only be due (if necessary) in relation to the period from the point of liberalisation up to the licence expiry.

⁹ See ComReg documents 19/59R, 19/59a, 19/124, 19/124a, 20/122 and 20/122a.

¹⁰ The CCA uses package bidding and generates final prices for the packages of lots won, rather than for individual lots or lot categories. The auction would therefore not give an explicit price for the 2.1 GHz spectrum, so it is necessary to form an estimate based on the information available.

¹¹ See ComReg documents 19/59R, 19/59a, and 19/124a.

price, will be set out in detail in an annex within the final IM which further particularises that proposed in paragraph 4.56 of Document 20/122.

2.2 Amended 2.3 GHz band lot structure

15. In the Draft IM, the proposed lot structure split the 2.3 GHz band into three types of lot (lot categories) for each time slice:
 - the 2300 – 2330 MHz frequency range made up a single 30 MHz fixed-frequency lot, required because of the reduced value of this spectrum relative to the rest of the band due to the extent of the geographical usage restrictions needed (at least for part of the licence term) to avoid interference with the Eir’s RurTel services currently operating within this range;
 - the 2330 – 2390 MHz frequency range was split into 12 frequency-generic 5 MHz lots; and
 - the 2390 – 2400 MHz block formed a single fixed-frequency 10 MHz lot, required because of power restrictions in this range.
16. Since the publication of the Draft IM, Eir has transitioned more of its RurTel services out of the band (although RurTel is still operating in County Donegal). However, progress has been sufficient that ComReg now considers that the 2300 – 2330 MHz spectrum can be included as frequency-generic lots along with the 2330 – 2390 MHz (giving a total of 18 frequency-generic 5 MHz lots in each time slice). This provides a useful simplification.
17. In Section 5.5.5 of Document 20/122, ComReg’s final decision was to make the 2.3 GHz band available in the form of:
 - eighteen 5 MHz unpaired frequency-generic lots (between 2300 – 2390 MHz); and
 - one fixed frequency lot (between 2390 – 2400 MHz).
18. The top 10 MHz of the 2.3 GHz band will remain a fixed frequency lot due to the lower applicable power limit.
19. Further, on the basis that Eir would be best placed to manage any potential interference issues arising from the remaining RurTel services in the Donegal area, ComReg has set out its intention that the assignment stage would maximise the extent to which any 2.3 GHz lots awarded to Eir overlap with the frequencies used by RurTel (2307 – 2327 MHz)¹², such that Eir’s assignment relating to any frequency-generic 2.3 GHz lots it wins would form a contiguous block beginning at 2300 MHz. Assignments to all other winning bidders would be positioned immediately above Eir’s spectrum rights of use.
20. Both the change in lot structure and the decision to align Eir’s winnings with the frequencies used by RurTel have implications for the generation of

¹² See Section 5.5.4 of ComReg Document 20/122

assignment options in the auction that will need to be reflected in the final IM. In particular, this affects:

- the methodology for generating assignment options in bands with fixed-frequency lots maximising alignment of frequencies allocated to a bidder across the two time slices in bands with fixed-frequency 'edge lots'; and
- the methodology for generating assignment options in the 2.3 GHz band in order to prioritise alignment between Eir and RurTel.

We deal with these two points in the subsections below.

2.2.1 Provisions for edge lots

21. The methodology for generating assignment options set out in the Draft IM was developed to account for both the 2.3 GHz band and the 2.6 GHz band having fixed-frequency lots at each end of the band (the 'edge lots'), while assigning winning bidders contiguous frequencies wherever possible, and at the same time minimising the misalignment of bidders' frequency allocations across time slices.
22. This approach meant that five possible cases needed to be considered when generating assignment options for the 2.3 GHz and 2.6 GHz TDD bands (Case 2 and Cases 3a – 3d in the Draft IM):
 - **Case 2:** there are winners of edge lots, but no bidder wins edge lots at both ends of the band;
 - **Case 3a:** a bidder wins a lower (or upper) edge lot in one time slice and an upper (or lower) edge lot in the other time slice, but no other edge lots;
 - **Case 3b:** a bidder wins the lower and upper edge lots in the same time slice, but only in one time slice;
 - **Case 3c:** a bidder wins three different edge lots in the same band; and
 - **Case 3d:** a bidder wins all four edge lots in a band.
23. The auction rules impose restrictions on bidding for the 2.6 GHz TDD spectrum in the main stage of the auction that mean Cases 3b – 3d were predominantly relevant to the 2.3 GHz band. In particular, no bidder can submit a bid for a package including both 2.6 GHz TDD edge lots in a given time slice unless the package also includes *all* frequency-generic lots in the band in that time slice. Therefore, for the 2.6 GHz TDD band:
 - In Case 3b, a bidder that wins the edge-lots at both ends of the band in a given time slice would also have won all of the frequency-generic lots in that time slice, winning the entire band and having only one frequency option in that time slice. Therefore, there is no need to consider frequency assignment for this bidder in that time slice. If this bidder has also won some frequency-generic lots in the other time slice (but no edge lots), then the specific frequencies assigned in the other time slice

- makes no difference to that bidder's alignment across time slices (having won all lots in one time slice). Similarly, if that bidder has won some edge-lots as well in the other time slice, then any frequency-generic lots will be assigned frequencies next to the edge lots, but again this has no implications for that bidder for alignment across time slices.
- Case 3c is similar, except that the frequency assignment option specific for the winner of three edge lots would be fixed in both time slices. Any remaining winners could be given the full range of feasible assignment options within the remaining frequencies (and subject to any winner of the fourth edge lot getting frequency-generic lots adjacent to the edge lot).
 - Case 3d is even simpler in that a bidder that won all four edge lots must have won all of the lots in the 2.6 GHz TDD band across both time slices.
24. The procedures for dealing with cases 3b – 3d set out in the Draft IM were designed to cover the scenario in which a bidder won both edge lots in a given time slice and some, but not all, of the frequency-generic lots in between. It was then necessary to devise a methodology for generating assignment options that gave the bidder the opportunity to position its frequency-generic lots next to either the upper edge lot or the lower edge lot (potentially competing for its preferred option with other winners), whilst also trying to minimise misalignment across time slices.
25. However, the adjustments to the lot structure mean that the 2.3 GHz band will only have a single edge lot in each time slice, and Cases 3a – 3d therefore no longer apply to the band. Given this, and the implications of the 2.6 GHz TDD bidding restrictions discussed above, the assignment option generation methodology can be simplified.
26. Specifically, the process for Case 3c will no longer need to apply the edge contiguity requirements to each end of the band, and once the contiguity requirements have been applied in relation to the winner(s) of edge lots, any other winners can be given the full range of assignment options based on all feasible ways of arranging them within the remaining frequencies.
27. Case 3d can be removed from the process altogether as there could never be multiple winners in the band in that scenario.
28. The adjustments relating to Case 3b are a little less straightforward. If the winner of the upper and lower edge lots in a given time slice has also won all of the frequency-generic lots in the same time slice, the assignment option generation process is very simple (and essentially as if there was only one time slice for the band). As for Case 3c above, once all contiguity requirements have been applied for winners of edge lots, assignment options for all other bidders are simply based on the different ways of arranging those bidders within the remaining frequencies. Because of the bidding restrictions that apply in relation to the 2.6 GHz TDD band, this will be the relevant approach in most scenarios where the winner of the upper and lower edge lots in a given time slice is a real bidder in the auction.

29. However, a minor complication arises in relation to Case 3b because of the way unsold time slice 2 lots are associated with a notional winner (the 'TS2 Notional Winner'). The TS2 Notional Winner is then treated like other winning bidders for the purpose of generating assignment options, in order to keep unsold time slice 2 lots contiguous where possible. Because the 2.6 GHz TDD band bidding restrictions do not apply to the TS2 Notional Winner, it is possible to have a scenario where one winner (i.e. the TS2 Notional Winner) has 'won' both edge lots plus some, but not all, frequency-generic lots in time slice 2, in which case it is impossible to keep all of the unsold time slice 2 lots contiguous; the unsold frequency-generic lots can be contiguous to the upper edge lot or the lower edge lot, but not both. To support the objective of providing winning bidders with a range of frequency options, it is recommended to apply a methodology that generates assignment options that allow for the unsold frequency-generic lots to be contiguous to either the upper edge lot or the lower edge lot. The approach would be similar to the methodology for Case 3b described in the Draft IM, whereby the contiguity requirement for the TS2 Notional Winner would first be applied at one end of the band, and then at the other end.
30. The final IM will include an updated methodology for assignment option generation to take into account the simpler approach to dealing with the edge lots now possible due to the removal of the lower edge lots in the 2.3 GHz band.

2.2.2 Alignment of Eir with RurTel

31. In its Decision¹³, ComReg determined that the assignment stage should prioritise Eir receiving frequencies in the 2.3 GHz band (if it wins any lots in the main stage) that overlap with existing frequencies used by RurTel. This is aimed at easing the transition of spectrum currently used by RurTel.
32. In particular, ComReg sets out in its Decision that "*regardless of how many blocks it won, Eir's assignment would be contiguous beginning at 2300 MHz, and assignments to all other winning bidders would begin immediately above Eir's spectrum rights of use*"¹⁴.
33. In this case, Eir's frequencies would be fixed (in both time slices) and other winners would be given assignment options within the remaining frequencies, in accordance with the principles and rules for generating assignment options.
34. An obvious consequence of this rule is that if, in a given time slice, Eir wins the 2.3 GHz fixed frequency lot and some, but not all, of the frequency-generic lots, it will not be possible to assign Eir a single contiguous frequency block within that time slice. Practically, this can be dealt with in the methodology by simply disregarding any 2.3 GHz edge lots won by Eir for the purposes of

¹³See paragraph 5.107 of ComReg document 20/122.

¹⁴ See footnote 225 of ComReg document 20/122.

evaluating the frequency options, although a more formal procedure is now incorporated into the final IM.

2.3 Minimum prices

35. In its Decision, ComReg decided to lower the minimum prices for the 2.6 GHz TDD lower and upper fixed frequency lots and the 2.3 GHz fixed-frequency lots, relative to the minimum fees for other lots in those bands. This is in recognition of the tighter power limits or potential for greater levels of interference¹⁵ imposed on those lots that may lead to those frequencies having lower value relative to the rest of the band, a point that Three raised in relation to the 2.6 GHz TDD lower and upper fixed frequency lots in its response to the Draft IM.
36. Specifically, ComReg decided:
 - to set the reserve price of the upper 2.3 GHz frequency-specific lot (2390 – 2400 MHz) to €197,000 for the first time slice and €285,000 for the second time slice, with an annual SUF of €52,575; and
 - to set the reserve price of the 2.6 GHz TDD lower and upper fixed frequency lots to €25,000 for the first time slice and €35,000 for the second time slice, with an annual SUFs to €5,000.
37. These are reflected in the minimum prices set out in the final IM.
38. More generally, the minimum prices for the final IM have been reviewed, and adjusted as necessary, following an update to our previous benchmarking exercise, and to take into account:
 - ComReg’s revisions to the mobile WACC since publication of the Draft IM; and
 - any final adjustments to the licence terms at the time of publishing the final IM.
39. In documents 20/122 and 20/122a, revised minimum prices for each lot category were set out, updated to account for the modified WACC. For the avoidance of doubt, those minimum prices were indicative and subject to revision for the final IM. Our recommendations to ComReg are set out in a separate self-contained report. (“MBSA Benchmarking Update”).
40. ComReg received additional comments on the minimum prices in stakeholder responses to the Draft IM. In summary:
 - Eir and Three both highlighted that the reserve prices in the Draft IM had been changed, without any explanation, relative to those set out in previous documents. Eir suggested that the

¹⁵ Where for the 2.6 GHz Band TDD fixed frequency block (upper) the full in block power is permitted but in TDD mode the uplink would be susceptible to a greater level of interference.

changes could only result from a change in methodology but this should not happen without a proper consultation process.¹⁶

- Imagine agreed with the two-part payment structure (SAF and SUFs), but would prefer a larger proportion than proposed to be given to the SUFs, in effect backloading the overall spectrum fees payable.
 - Vodafone agreed with 40/60 split between upfront and ongoing fees (SAF and SUFs), but expressed concern that coordination restrictions and uncertain transition in the 2.3 GHz band will significantly reduce the value of the band, and this is not reflected in the minimum prices. Vodafone also agreed with NERA's opinion that the spectrum prices per MHz should be expected to fall relative to prices achieved in the 2012 MBSA.
41. These points have been carefully considered by ComReg in the Decision, and no further changes to the minimum fees have been deemed necessary as a result. The discussion is not repeated here, but stakeholders are referred to Section 5.7 of Document 20/122 and Chapter 7 of Document 20/122a for further details.

2.4 Implementation of exposure pricing

42. A familiar criticism of the CCA, highlighted by some stakeholders during the consultations for this award, is that the (opportunity-cost based) second-price rule means there can potentially be a large difference between a bidder's bid for a package and what they will end up paying. This can create problems for internal governance. It has been suggested that this might be problematic for budget-constrained bidders, but this is a lesser concern. Regardless of how relevant budget constraints are in practice, there are strategies to manage budget constraints within a CCA by focussing bids on packages that a bidder is likely to win and expressing appropriate relativities between bid amounts for those packages reflecting the bidder's preferences.
43. In light of these concerns, ComReg contracted DotEcon to carry out a separate study on the pricing methodology used in the CCA, and to consider whether ancillary information could be given to bidders during the clock rounds that would help them to anticipate how close their final price would be to the clock price if they were to win with a particular bid. This study was published by ComReg as Annex 12 to the Draft IM.
44. As a result, DotEcon considered that improvements could be made to the CCA information policy, leading to proposals set out by ComReg alongside the Draft IM to implement a new feature of the CCA, referred to as 'exposure

¹⁶ Provisional minimum prices (which were generated on the assumption of 15-year licence terms) were set out in ComReg documents 19/59R and 19/59b. ComReg subsequently (with its assessment of responses to document 19/59R) proposed to issue licences with a longer 20-year duration (slightly shorter for the 2.1 GHz band). The minimum prices were therefore updated for the draft IM to simply reflect the longer licence terms, but there was no change in the methodology applied.

pricing'. Under this new feature, bidders would be told, in each clock round, the minimum difference between their clock bid amount and the price they would have to pay (their bidder-specific 'discount') in the event that the clock rounds were to end with no excess supply and that bid became a winning bid. We recognise that this does not perfectly resolve the uncertainty issues raised, but nevertheless believe that it should provide bidders with significantly improved information about what they could ultimately expect to pay for a package if there were to win it.

45. ComReg received comments on the potential for implementing exposure pricing from stakeholders in their responses to the Draft IM but considered it relevant to consider these as part of the process for forming its Decision.
46. The discussion is not repeated in detail here but, in summary, the responses received were generally positive. While some stakeholders do not consider exposure pricing sufficient to resolve all of their concerns regarding the CCA, all responses suggested that if a CCA were to be used then exposure pricing would be a welcome addition, without any expected downsides.
47. We have carefully considered the potential that providing additional information in the clock rounds through exposure prices could facilitate gaming strategies. This issue is discussed in our previous report forming Annex 12 of the Draft IM. Our conclusion was that because the information provided through exposure prices is aggregated and anonymous, it would be unlikely to facilitate gaming, especially as bidders would be uncertain about the objectives and strategies of rivals. Respondents have not highlighted any particular mechanisms or general reasons why exposure prices would create such a risk.
48. As a result, ComReg decided to proceed with the implementation of exposure pricing for the CCA in the award. A detailed description of the information to be made available to bidders and how it will be calculated is provided in Annex 10 to the final IM. This includes a rigorous mathematical definition of the exposure prices.
49. For further details on the background behind the exposure pricing proposals, the views of respondents and ComReg's assessment of those views, interested parties may refer to ComReg documents 20/32 (the draft IM, in particular Annex 12), 20/122 and 20/122a.
50. We particularly draw stakeholders' attention to the fact that exposure prices are a contingent upper bound on what a bidder would eventually pay if the current clock round were the final one, but only under the assumption that there would be no unallocated lots in the final clock round. Where there are one or more unallocated lots, these may be subject to competition in the supplementary bids round, potentially within larger packages of lots, and so may affect the winning outcome and winning prices. We also remind potential bidders that ComReg has discretion to make deposit calls and to invalidate some or all of a bidder's bids if deposit calls are not met, or if auction rules are violated, which in turn may have implications for the effective position in the final clock round. Therefore, exposure prices are provided to enrich the information available to bidders and should not be misinterpreted as an absolute guarantee that a bidder will not pay more than its exposure price if its

current clock bid eventually wins. We refer potential bidders to Annex 12 of the Draft IM, which discusses this issue. By including a formal description of the calculation of exposure prices in the Final IM, this will provide full transparency of the underpinning assumptions.

3 Clarifications

51. Both Three and Eir requested clarification (and potential revision) of certain limited aspects of the auction rules. This relates to:
- the bidding constraints that will apply regarding the 2.6 GHz TDD band; and
 - the rounding of base prices.

3.1 Bidding constraints

52. Three has requested clarification regarding the bidding constraints that will be applied to bids for lots in the 2.6 GHz TDD band. Specifically, Three refers to paragraph 3.167 of the draft IM, which reads:
- “In the 2.6 GHz Band, as the fixed frequency A-Lots are best utilised by Bidders also obtaining 2.6 GHz TDD Generic Frequency Lots, a Bidder will be prevented from submitting a Bid for a Package of Lots which includes the 2.6 GHz TDD Fixed Frequency Lot (Lower) and the 2.6 GHz TDD Fixed Frequency Lot (Upper) in a given Time Slice unless the Bidder also places a bid for all Lots in the 2.6 GHz TDD Band in the same Time Slice”*
53. Three asks for confirmation of its understanding that *“this restriction only applies where a bidder submits a bid for both the Upper and Lower Fixed Frequency Lots”¹⁷.*
54. In response, we confirm that Three’s understanding is correct. However, for clarity and to eliminate any scope for misunderstanding, we highlight that the constraint applies if a bidder submits a bid for both the upper and lower fixed frequency lots in the same time slice. Therefore, using the lot category names set out in the Draft IM:
- a bidder cannot bid for both the A2.6TL/1 lot and the A2.6TU/1 lot unless it also includes all eight of the B2.6T/1 lots in the same bid; and
 - a bidder cannot bid for both the A2.6TL/2 lot and the A2.6TU/2 lot unless it also includes all eight of the B2.6T/2 lots in the same bid.
55. For the avoidance of doubt, if a bidder bids for both the A2.6TL/1 and the A2.6TU/2 lots (i.e. 2.6 GHz TDD fixed frequency lots at opposite ends of the band, but in different time slices) and no other 2.6 GHz TDD fixed frequency lots, then there are no restrictions on the number of B2.6T/1 or B2.6T/2 lots that can, or must, also be included in the bid.

¹⁷ ComReg document 20/68, page 34.

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56. Note that this explanation also applies to paragraph 4.16 of the Draft IM.¹⁸

3.2 Base prices

57. Eir has highlighted that the rules set out in the Draft IM state that any base price that is not a multiple of EUR 1,000 will be rounded up to an “even” multiple of EUR 1,000. Eir submits that this could be interpreted to mean that the Base Price needs to be a round multiple of EUR 2,000, but assumes that the intention is for base prices to be rounded up to the next highest round multiple of EUR 1,000. Eir asks for clarification on this matter.
58. In response, we thank Eir for highlighting this and acknowledge that the current phrasing is unclear. We confirm Eir’s assumption that the intention is for base prices to be rounded up to the nearest multiple of EUR 1,000 and recommend that the Final IM be adjusted accordingly to remove the ambiguity.

¹⁸ Paragraph 4.16 of the Draft IM states that “A Bidder will be prevented from submitting a Bid for a Package of Lots which includes the 2.6 GHz TDD Fixed Frequency Lot (Lower) and the 2.6 GHz TDD Fixed Frequency Lot (Upper) in a given time slice unless that Bid also includes all the 2.6 GHz TDD Generic Frequency Lots in the same time slice.”

4 Activity rules

59. In its response to the Draft IM, Eir claims that DotEcon has identified a 'lacuna' in the activity rules used for the MBSA1 (the 2012 MBSA) which ComReg and DotEcon have proposed to fill with "*yet more complex calculations*"¹⁹.
60. This relates to the relative caps that are created during the clock rounds, and the implications for the relative caps arising from the use of time slicing in the 2.1 GHz, 2.3 GHz and 2.6 GHz bands.

4.1 Summary of proposed activity rules

61. We start by summarising the somewhat simpler case of a CCA with relaxed bidding (as proposed), but without time slicing. These are the rules as used in ComReg's award of 3.6 GHz spectrum. They provide a useful jumping-off point to explain the full rules for MBSA2 with two time slices:
 - Each lot has an associated number of eligibility points, and each package of lots has an associated eligibility (the sum of the eligibility points of its constituent lots).
 - A bidder starts each clock round with a number of eligibility points (the bidder's eligibility). In a given clock round, the bidder can submit a bid for any package with an eligibility that does not exceed the bidder's eligibility (subject to other relevant auction rules, such as competition caps). The eligibility of the package the bidder bids for is also known as the activity of the bid.
 - For the following round, the bidder's eligibility is set to the lower of its eligibility at the start of the previous round and the activity of the bid it submitted in the previous round. Whenever a bidder reduces its eligibility (bids for a package with eligibility strictly less than the bidder's eligibility at the start of the round), restrictions are created on the bids that a bidder can subsequently submit in the auction.
 - The first restriction is that a bidder may only submit a clock bid for a package with eligibility that is strictly greater than the bidder's eligibility (known as a 'relaxed bid') if certain conditions are met. In particular, the bidder will only be allowed to make a relaxed bid for a package Y if doing so would be consistent with its bid decision in the earlier round when it had sufficient eligibility to bid for Y, but chose to bid for a smaller package (package X) instead.
 - In addition, whenever a bidder reduces its eligibility during the clock rounds, constraints are created on the supplementary bid amounts that a bidder may subsequently submit for packages with eligibility in excess of the package it bid for in the round,

¹⁹ ComReg document 20/68, pages 11 and 12.

but for which the bidder had sufficient eligibility to bid for at the start of the round. In particular, suppose that the bidder reduces its eligibility by bidding for package X in round n . Any package Y with associated eligibility greater than that for package X , but for which the bidder had sufficient eligibility to bid in round n , would be subject to a constraint. This constraint will limit the amount that the bidder can offer for Y later in the auction in relation to the amount that the bidder offers for X . Specifically, the bidder's bid for Y cannot exceed its bid for X plus the difference in the price of these packages in round n . This is known as the 'relative cap' for package Y .

- The rationale for this cap is that the bidder could have bid for Y when the price difference between Y and X was below this; however, by bidding on X , the bidder indicated that it was not willing to pay this difference to obtain Y instead of X .
 - A round in which a bidder reduces eligibility is known as a 'constraining round', and the package bid for in that round is a 'constraining package'. In the description above, X is the constraining package for Y , and n is the constraining round for Y .
 - Every time a bidder reduces its eligibility in a clock round, additional relative caps are created for packages that were not already subject to a relative cap, and a new round and package are added to the sets of constraining rounds and constraining package.
 - With the exception of the package bid for in the final clock round, all supplementary bids for all packages are also subject to a relative cap with respect to the final clock round – this is the final price cap.
62. Without time slicing (eligibility and activity are scalar quantities), the way the relative caps are constructed means that:
- a package can be subject to at most one relative cap (other than the final price cap); and
 - constraining packages and the relative caps are 'chained' from one constraining round to the next, in the sense that every constraining package has a relative cap with respect to another constraining package, except for the smallest constraining package (which is, however, subject to a final price cap).
63. Consequently, the activity rules impose various constraints on the packages that bidders can choose in clock rounds and on supplementary bid amounts that bidders can submit based on their bidding behaviour in earlier clock rounds. These constraints are designed to provide incentives to bid according to valuation in the clock rounds.
64. The activity rules are similar in the situation when time slicing is used, but there are some additional considerations and consequential adjustments that result from activity and eligibility becoming vector quantities (i.e. one number for each time slice).

65. With two time slices (as proposed for the upcoming award), the bidders will have two eligibilities (one for each time slice), activity is evaluated independently for each time slice, and eligibility is not transferable across time slices (i.e. a bidder cannot use its time slice 1 eligibility to bid for lots in time slice 2). This is to prevent bidders from being able to hide demand in one time slice only to switch it into the other time slice late in the clock rounds, ensuring that information received in the clock rounds is meaningful. Similarly, each package will have two eligibility scores, one for each time slice. A bidder is considered eligible to bid for a package if the bidder's eligibility is greater than or equal to the eligibility of the package for *both* time slices.
66. Whenever a bidder reduces its eligibility in one or both time slice(s), relative caps are created for packages the bidder was eligible to submit a bid for but chose not to in that round, again based on relative prices for the relevant packages in the round when eligibility was reduced. In that sense, the general approach to setting relative caps is the same as when time slicing is not used.
67. Similarly, bidders may submit relaxed primary bids for packages that have eligibility strictly in excess of the bidder's eligibility in *one or both* time slices, provided it would be consistent with the bidder's bidding behaviour in previous rounds.
68. However, a complication arises from the fact that eligibility/activity is evaluated separately for each time slice so, under the right clock price conditions, it is possible for a bidder to submit a bid for a package where the eligibility of the package strictly exceeds the bidder's eligibility in one time slice but is strictly less than the bidder's eligibility in the other time slice. This is, therefore, both a relaxed bid (because the bidder was not eligible to bid for the package at the start of the round) and a constraining bid (because the bidder has reduced eligibility in one time slice).²⁰ In the Draft IM, this situation is referred to as an 'eligibility-reducing relaxed primary bid'. Moreover, the package must be subject to a relative bid with respect to a constraining bid submitted an earlier round in which it reduced eligibility in at least one time slice, but also becomes the constraining package for the constraining package most recently bid for prior to the current round. This creates a loop of constraints.
69. Furthermore, since the bidder would not be eligible to bid for the package in subsequent rounds, without additional provisions for creating relative caps, further reductions in eligibility (in either time slice) would not create any more constraints on the package. The result would be a disconnection in the relative caps, and subsequent clock bids (other than the bid in the final clock round) would have no implications for the constraints on bids for packages bid for in earlier rounds. Such a disconnection would be contrary to the intentions

²⁰ It is important in this case that the bidder's eligibility is reduced (rather than maintained) in the time slice where the eligibility of the package is strictly less than the bidder's eligibility. Otherwise, it might be possible for a bidder to hide demand when submitting a relaxed primary bid i.e. the bidder could bid for a package that exceeds its eligibility in one time slice, but omits lots it would want at given round prices in the other time slice without any consequence for its eligibility or ability to bid for those lots later in the auction.

- behind the activity rules that clock bids and supplementary bids should be constrained to be consistent with bidding behaviour in earlier rounds.
70. With time slicing, we need to impose an additional rule whereby, in the event of a disconnection of the relative caps following an eligibility-reducing relaxed primary bid and following a subsequent reduction of eligibility (in one or both time slices), a new cap is created for a package that the bidder submitted an eligibility-reducing bid for in an earlier round (replacing the existing cap on the package) that ensures the chain of relative caps remains connected.
 71. Further details on the activity rules and the construction of relative caps can be found in the Draft IM, which provides a specification of the rules, as well as worked examples and a detailed discussion of how the relative caps rules would work. Specifically, we refer interested parties to Section 4.2, Annex 5 and Annex 11 of the Draft IM.
 72. Stakeholders should be aware that the additional rules to deal with time slicing only adds complexity in relation to implementation within the auction system to be used for running the award. The system will automatically work out all relevant caps and prevent bidders from submitting bids that do not comply with the caps, and bidders do not need to carry out the calculations themselves to ensure their bids are valid. Furthermore, as discussed below, if a bidder bids in line with a fixed set of valuations, the relative caps (even in the event that some get replaced) will not restrict the bidder's ability to submit all of the bids it wishes to.

4.2 Eir's comments

73. As well as suggesting that DotEcon has identified a "lacuna" in the rules, Eir highlighted that although there is a detailed explanation of how the rule would work:
 - there is no analysis of the consequences (e.g. whether new constraints would be tighter or looser than those they replace); and
 - there has been no analysis of alternative ways to deal with the lacuna.
74. Eir further asked if DotEcon and ComReg have considered the option of "*identifying constraining rounds separately for each Time Slice (such that a bid that reduces eligibility in Time Slice 1, but not in Time Slice 2, creates a constraint on future bids in respect of Time Slice 1 but not Time Slice 2, and therefore completely avoids the creation of loops of relative caps)*"²¹. If not, Eir requested that this analysis be carried out with a view to reducing complexity in the award. If it has been conducted, Eir asked that the analysis be shared.

²¹ ComReg document 20/68, page 12.

4.3 Assessment and recommendations

75. The activity rules and methodology for calculating (and potentially replacing) relative caps proposed in the Draft IM are exactly the same as those that were used for the 2012 MBSA (referred to by Eir as MBSA₁). Although the provisions for dealing with looped relative caps (and the disconnection of caps) were not included in the initial set of auction rules set out in the IM for the 2012 MBSA (i.e. Document 12/52), ComReg issued an amendment to the auction rules to the qualified bidders before the start of the auction. All qualified bidders for the award, including Eir ("Meteor Mobile Communications") were notified of the amendment and provided with a report prepared by ComReg and DotEcon that considered the issue in detail and set out appropriate adjustments to the relevant sections of the IM.²² The rules *used* for the MBSA₁ therefore took into account the possibility of a disconnection in the caps, and applied the same rules for replacing a cap where necessary as proposed for MBSA₂.
76. Therefore, we suspect that a misunderstanding may have arisen and Eir may not have appreciated that there was some difference between the rules as originally proposed for the MBSA₁ award and those that were eventually used. Indeed, no other respondent raised similar concerns. To belay these concerns, we confirm that the activity rules proposed here for MBSA₂ are essentially the same as those that were successfully *used* in the MBSA₁ award.
77. In addition, we have also sought to streamline the description of the activity rules within the Draft IM for the current award. However, this simplification of the rules has no functional effect and was made solely for clarity and expositional convenience.
78. In the Draft IM the activity rules while the same, have been described differently, compared with those published in 2012. In particular, whilst the previous rules relating to the creation and potential replacement of relative caps were correct, we have identified an alternative way of presenting them that we believe is simpler, more concise, and easier for participants to understand. However, in practice these rules are exactly the same as those used successfully in 2012. Therefore, it is incorrect that there was a hole, or "lacuna", in the rules used for the MBSA₁. The amended rules used for the first time in MBSA₁ were correctly implemented for that award and the same approach is proposed here for MBSA₂, albeit with a simplified exposition of the relevant rules.
79. It is also incorrect to say that no analysis of alternative ways to deal with the situation has been carried out. First, we do not recognise the problem that Eir claims to have identified, as this issue was considered in depth during MBSA₁, resulting in activity rules that worked successfully for that award. Nevertheless, as with all aspects of the detailed auction rules, the rules in relation to activity and relative caps (and potential alternative approaches) have been carefully considered, both in 2012 when they were initially

²² See ComReg [documents 13/29a–f](#), in particular [document 13/29e](#).

developed for the MBSA1,²³ and again when reviewing the use of the rules in preparation for the MBSA2. ComReg has provided stakeholders with a detailed discussion on how the activity rules work and the reasoning behind these rules. Therefore, we do not consider it necessary, or indeed proportionate, for ComReg to publish a report analysing all of the feasible alternatives that have been ruled out, in particular as the rules proposed were discussed and used successfully in 2012 and there does not seem to be any reason to believe that they are not appropriate. Again, we suspect that a misunderstanding may have arisen if Eir went back to the original *unamended* activity rules for MBSA1.

80. No respondent (including Eir) has provided any material thus far to suggest that there is a problem with the current activity rules (other than the suggestion that it is complex, which in the main is due to the complex mix of licences being offered), and only Eir has proposed an alternative methodology (which is discussed below).
81. Eir has suggested an alternative approach to setting the relative caps where constraining rounds are identified separately for each time slice, and (as is our understanding of its proposal) each relative cap would apply only with respect to one time slice. Eir has not set out specifically how these rules would work, but we foresee a number of problems.
82. First, during the clock rounds, creating and applying constraints independently for each time slice could prevent bidders from bidding in line with valuation. It is important to remember that lots in this auction are likely to be complements for at least some bidders, and we expect there to be synergies across time slices. Therefore, it is the relative prices for different packages of lots that is important for bidders to evaluate when deciding what to bid for (i.e. lots may be complementary in forming bundles of lots, but different bundles may be substitutes). As a result, it is very likely that relative price changes in one time slice can affect what bidders want to bid for in the other time slice. If constraints are set independently across time slices, a bidder could be in a position where it wishes to submit a relaxed bid in the clock rounds that would (when viewed as a whole) be consistent with its preferences implied in earlier rounds, but is prevented from doing so because of a constraint on just one of the time slices where it wishes to bid above eligibility. This is an unjustified and unnecessary restriction on the bids that can be made.

²³ See, for example, ComReg Document 12/51 for previous discussion on the vector eligibility approach. We highlight that stakeholders were engaged in the discussions, and Power Auctions, Eir's advisor for the MBSA1, provided helpful feedback that was ultimately incorporated into the final activity rules. Although we recognise that the need to deal with looped relative caps was not identified until after completion of the consultation process (requiring an amendment to the final IM), the issue was at that time carefully assessed and qualified bidders were provided with a detailed explanation of why the rules were necessary and how they were to be implemented.

Example 1: Bidding in line with valuation under alternative rules

Suppose there are three bands (A, B and C) and two time slices for each band – this gives six lot categories in total.

Call the lot categories A_1, A_2, B_1, B_2, C_1 and C_2 , where A_1 is the category containing lots in band A in time slice 1, A_2 is the category containing lots in band A in time slice 2, and so forth.

All lots are worth one eligibility point. We denote the eligibility of a package of lots as (e_1, e_2) , where e_1 is the sum of the eligibility points of the time slice 1 lots included in the package, and e_2 is the sum of the eligibility points of the time slice 2 lots included in the package.

We use the same notation to represent a bidder's eligibility for a round, where e_1 is the bidder's eligibility in time slice 1, and e_2 is the bidder's eligibility in time slice 2.

A bidder is interested in two packages, X and Y, set out in the table below.

| | A1 | A2 | B1 | B2 | C1 | C2 | Eligibility | Value |
|---|----|----|----|----|----|----|-------------|-------|
| X | 1 | 1 | 0 | 0 | 0 | 1 | (1, 2) | €500 |
| Y | 0 | 0 | 1 | 1 | 0 | 2 | (1, 3) | €540 |

At the start of round n , the bidder has eligibility of (1, 3) and hence can bid for either X or Y without restriction.

In round n , the prices are as follows:

| A1 | A2 | B1 | B2 | C1 | C2 | Price of X | Price of Y |
|------|------|------|------|-----|-----|------------|------------|
| €100 | €100 | €100 | €100 | €50 | €50 | €250 | €300 |

In round n the bidder chooses to bid for package X since, at the given round prices:

- X offers a surplus of $€500 - €250 = €250$; whereas
- Y gives a lower surplus of $€540 - €300 = €240$.

The bidder therefore reduces its eligibility in time slice 2, so that its eligibility for the subsequent round is (1, 2).

In round $n+1$, prices are as follows:

| A1 | A2 | B1 | B2 | C1 | C2 | Price of X | Price of Y |
|------|------|------|------|-----|-----|------------|------------|
| €150 | €100 | €100 | €100 | €60 | €60 | €310 | €320 |

The bidder now wants to bid for Y, since:

- X offers a surplus of $€500 - €310 = €190$; but
- Y now gives a greater surplus of $€540 - €320 = €220$.

Since the bidder only has eligibility of 2 in time slice 2, it must submit a relaxed primary bid if it is to bid for Y in the round. The bidder can do this only if doing

so would be consistent with its preferences demonstrated by its bid decision in round n .

Bidding for Y under the rules set out in the draft IM:

Under the activity rules proposed in the draft IM, the bidder would be allowed to submit a relaxed primary bid for Y if the following conditions are met:

1. the difference between the price of Y and X in round $n+1$ must not exceed the difference between the price of Y and X in round n ; and
2. the difference between the price of Y in round $n+1$ and the highest bid amount submitted for X at any point should not exceed the difference in prices for the two packages in round n .

Note that in this case it is overall package prices that are being taken into account.

Regarding condition 1:

- The price difference in round n was $€300 - €250 = €50$.
- The price difference in round $n+1$ is $€320 - €310 = €10$.
- The first condition is satisfied.

Regarding condition 2:

- The price difference in round n was $€300 - €250 = €50$.
- The price of Y in round $n+1$ is $€320$, and the highest bid for X is $€250$, so the difference is $€70$.
- The second condition is therefore not satisfied. However, the bidder may submit a chain bid to bring the bid amount for X up to the required level of $€270$, ensuring consistency with its implied preferences in round n .

Under the proposed rules, provided the bidder submits a chain bid for X (which it can do as there are no restrictions on the bid amount for X other than that it is capped by current round prices) it is allowed to submit a relaxed bid for Y. This is entirely reasonable and in line with the efficiency objectives for the award, as bidding for X in round n and then Y in round $n+1$ would be fully in line with the bidder's valuations set out above.

Bidding for Y under the alternative rules proposed by Eir:

Under the alternative rules proposed by Eir, the revealed preference constraints would be applied separately and independently for each time slice.

As we have understood Eir's suggestion, following on with the example above:

There would be no constraints in relation the bidder's ability to bid for one B1 lot in time slice 1 as the bidder still has sufficient time slice 1 eligibility; but

Because the bidder reduced its eligibility in time slice 2 and no longer has sufficient eligibility to bid for the 3 time slice 2 lots in package Y, the bidder will only be allowed to make a relaxed bid for Y in round $n+1$ if that would be consistent with its bidding decision relating to time slice 2 in round n – this condition would be specifically related to the prices and lots in time slice 2 only, and entirely independent of prices and what the bidder bids for in time slice 1.

Specifically, the time slice 2 constraints mean that the bidder would be allowed to submit a relaxed primary bid for Y if:

1. the difference between the price of the time slice 2 lots in Y and the time slice 2 lots in X in round $n+1$ must not exceed the difference between the price of the time slice 2 lots in Y and X in round n ; and
2. the difference between the price of time slice 2 lots in Y in round $n+1$ and the highest bid amount submitted at any point for the time slice 2 lots in X^{24} should not exceed the difference in prices of the time slice 2 lots included in the two packages in round n .

Regarding condition 1

- The price of the time slice 2 lots in Y in round n was €200
- The price of the time slice 2 lots in X in round n was €150
- The relevant price difference in round n is €200 - €150 = €50.
- The price of the time slice 2 lots in Y in round $n+1$ is €220
- The price of the time slice 2 lots in X in round $n+1$ is €160
- The relevant price difference in round $n+1$ is €220 - €160 = €60.

The difference in the price of the time slice 2 lots in the two packages is greater in round $n+1$ than in round n . This means that, based solely on the bidder's bidding behaviour in time slice 2, submitting a relaxed primary bid for the time slice 2 lots in Y in round $n+1$ would not be consistent with the bidder's implied preferences in round n .

Under this alternative approach, the bidder is therefore not allowed to submit a relaxed primary bid for Y in round $n+1$ (we do not need to consider the second condition if the first is not satisfied).

However, as demonstrated above, bidding for Y would be the optimum package to bid for given the bidder's valuations, and doing so would be entirely consistent with its behaviour and implied preferences in the earlier round.

83. Second, additional concerns arise in relation to how the relative caps would be applied in the supplementary bid rounds. For a given package, under Eir's suggestion we would presumably typically have two relative caps applying in the supplementary bids round, one for each time slice (and one or both of which might be a final price cap, depending on the specifics of how the final price cap would be set under Eir's suggestion). However, there would only be one bid amount for the package. A question then arises over how the bid would be 'split' between the two time slices to evaluate whether one or both caps have been violated.

²⁴ Note that it is unclear what exactly the highest bid amount for the time slice 2 lots in X should be under the suggestion from Eir. It could, for example, be interpreted as (i) the portion of the highest bid for X attributable to the time slice 2 lots; or (ii) the highest amount attributable to the time slice 2 lots from amongst all bids for packages that contain the same time slice 2 lots as X. Option (i) might be more relevant from the perspective of setting chain bids, but it could also be argued that option (ii) is appropriate if the activity rules are entirely independent across time slices. This is not an issue in the example (since there are no bids for alternative packages with the same time slice 2 lots as X), and in any case does not affect our recommendations, but it is another ambiguity in the alternative rules proposed by Eir.

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84. The caps could potentially be combined to give an overall cap for the package in the supplementary bids round, but we then have an issue in relation to the package bid in the final clock round. Specifically, it is not clear how we would deal with a scenario where that package had a relative cap applying from an earlier clock round in one time slice, but not in the other time slice. If a constraint applies to the package bid then that would potentially prevent the bidder from bidding up to valuation, but if no constraint is applied then that would render the cap in the relevant time slice meaningless, which would be contrary to the intentions behind the activity rules.
85. Finally, if the bid amount for a constraining package is increased in the supplementary bids round, there is no clear way of determining how that should affect the caps on other relevant packages. As the bid increase would be for the package and not individual lots, lot categories or time slices, we have no reasonable way of knowing how much of that bid increase is attributable to the lots in each time slice. For example, suppose package X is a constraining bid in relation to time slice 1 (i.e. when bidding for X the bidder reduced demand in time slice 1 but not in time slice 2), and in the supplementary bids round the bidder increases its bid for X by €1,000 (relative to its highest clock bid for X). The amount of that bid increase that relates to lots in time slice 1, and that would be relevant for the caps on other package in relation to time slice 1, could be anywhere from €0 up to the full €1,000, but we have no way of knowing.
86. For these reasons, Eir's suggestion is not a viable alternative to the proposed approach and we cannot recommend its use.
87. Eir's other comment on the proposed relative caps rules relates to the question of whether a new cap on a package could be tighter or looser than the cap it replaces. First of all, it is not entirely clear what is meant by "tighter" or "looser" in this context. Whenever a relative cap is replaced, the existing cap is discarded (which can be seen as a loosening of that particular constraint), but an entirely new cap that did not exist previously is then applied with respect to a different constraining package (which is naturally a tighter constraint than existed before relative to the bid/price of the new constraining package). It is therefore not particularly meaningful to look at the two caps (old and new) and say one is tighter than the other, as they are different constraints with different reference points. "Tighter" or "looser" is only meaningful for relative caps with the same reference points and where the set of packages that can be chosen under one constraint is a subset or superset of those that can be chosen under the other.
88. In terms of the supplementary bid that can be submitted for the package for which the cap was replaced, whether the absolute limit on the bid amount is higher or lower under the new cap (compared to what it would have been if the original cap still held) would depend on the supplementary bid amounts that the bidder submits for the relevant constraining packages. Therefore, again the notion of a "tighter" or "looser" cap in this context is not meaningful.
89. In any case, we do not see the resetting of the constraining package on the first eligibility reduction following an eligibility-reducing relaxed bid as problematic. If a bidder is bidding in line with a fixed set of valuations, then

the relative caps should never cause it any problems. Even if an existing cap is replaced, the new cap should be a constraint that the bidder is happy with. Therefore, the activity rules as proposed are consistent with the principle that a bidder who surplus maximises against a consistent set of valuations will never be prevented from making its preferred clock bid.

90. In addition, bidders will know the circumstances in which a new cap will be set and can work out which cap would be replaced. This can be accounted for when making their bid decisions and the replacement of a cap should never be a surprise as there are clearly defined rules for this situation. Moreover, bidders know that whenever they submit a bid during the clock rounds, there is a chance that the clock rounds will end and that bid will be used for setting the final price cap. In the event that a bid does lead to a cap being replaced, the new cap would be the same as the final price cap that would be imposed on the relevant package in the event that the clock rounds ended. Therefore, even if a bidder had not noticed that one of its caps would be replaced, it should still have been prepared for that cap coming into existence as the final price cap.
91. We do not see any particular reason to be concerned about whether new caps are tighter or looser than those they replace, and respondents have not raised any concerns over why that might be a problem. Overall, we consider that Eir's concerns are not clearly articulated, as the question of whether a cap is tighter or looser is not well-defined in this context.
92. In conclusion, we do not see any reason or argument for adjustments to the rules relating to activity and relative caps, or for any further analysis being needed on the matter.

5 Assignment Stage

93. Three has provided comments on the process to be followed during the assignment stage, including suggested adjustments in relation to the role of the negotiation phase.
94. As part of our own review of the Draft IM, we have also identified the need for and recommended an improvement be made to the assignment stage winner determination process.
95. These points are discussed further below.

5.1 Summary of initial proposals

96. As currently proposed, the assignment stage runs according to the following broad steps:
 - For each band, ComReg establishes the range of possibilities for assigning specific frequencies to the winners of frequency-generic lots in the band, subject to a number of conditions and requirements.²⁵
 - If there are multiple options for assigning specific frequencies to winning bidders for a particular band, an assignment round is run for that band. The assignment round allows bidders that could fit into the band in multiple different locations the option to express preferences over those locations by way of assignment bids (i.e. optional bids for specific frequency ranges, on the grounds that they would always be assigned frequencies in accordance with the number of lots won in the main stage).
 - For each band, ComReg then evaluates the assignment bids submitted to determine the specific frequencies to be assigned to each winning bidder. This gives the 'provisional assignment plan' (a provisional set of specific frequency ranges to be assigned to all winning bidders across all of the available bands).
 - For any given band, a winning bidder may be required to pay a price for the specific frequency range it is assigned under the provisional frequency plan, based on the opportunity cost of giving it that frequency range implied by the assignment bids submitted by other bidders. This is the bidder's 'additional price' for that band, and the bidder will be required to pay the sum of its additional prices across all bands.
 - Winning bidders are informed of the identity of other winning bidders, the specific frequency ranges assigned to winning bidders in each band, and their own additional price(s) they must pay for their frequency assignment in each relevant band.

²⁵ See the Draft IM for further details on the requirements regarding how the options for assigning specific frequencies to winning bidders are determined.

- Following the determination of the provisional assignment plan, winning bidders are given a period of 10 working days (the 'negotiation phase') in which they may negotiate between themselves to agree on an alternative assignment of the frequencies. Any such agreement would be subject to approval by ComReg, and bidders would still be liable for their additional prices even if their frequency assignment changed.
- The frequency assignments established following the assignment stage would form the final frequency plan.

5.2 Three's suggestion

5.2.1 Three's alternative proposal

97. Three suggests that instead of following the process set out above, it would be preferable if winning bidders were able to agree on an assignment plan for each band without the need for an assignment phase at all. Three suggests that this would represent the most efficient outcome, as no additional fees would be required, and all winning bidders would be happy with the outcome. However, Three does recognise that in practice a successful negotiation phase cannot be relied on, so an assignment stage is actually necessary.
98. Three asserts that, in its experience, the negotiation phase has not been successful in previous awards because bidders enter the negotiation already knowing the outcome of the assignment round, so there is a default option and bidders already know their additional price. Three argues that since the additional prices must be paid regardless of any reorganisation in the negotiation phase, there is a barrier to further change because:
 - some bidders will not want to pay the opportunity cost for an assignment they "give up"; and
 - other bidders will perceive that their best advantage is to stick to the outcome of the assignment phase.
99. Three has suggested that the ordering of the process be changed such that:
 - Bids are received in an assignment round (as under the current approach), but results are not immediately revealed to bidders.
 - A negotiation phase is then run.
 - If the negotiation phase produces an agreed assignment plan in any band then that should be accepted by ComReg without evaluating assignment bids for that band, and with no additional prices applicable.
 - For any band where agreement cannot be reached, ComReg uses the assignment bids to determine the specific frequency assignments for the band and any applicable additional prices.
100. Three suggests that this revised approach would create incentives for assignment bidders to reach agreement with no additional price and without

requiring ComReg to determine the outcome – this would give the most efficient outcome.

5.2.2 Assessment and recommendations

101. First, we refer back to ComReg document 12/24²⁶, where this very issue was discussed previously in relation to the process for the 2012 MBSA, in light of similar suggestions from Vodafone and Copenhagen Economics. In that document, we highlighted that a significant advantage from running the process as proposed is that agreement in the negotiation phase would not necessarily be required from all parties for a deal to be made. This would avoid a situation where a solution is blocked by just a small number of bidders (who may have adverse incentives to 'hold up' the process), even when all others agree. Using the outcome of the assignment round (in terms of assignment option awarded to each assignment bidder in each band and the additional prices) as a starting point for negotiations means we can allow subsets of bidders to agree on an alternative assignment without the need for cooperation from unaffected bidders. We stand by this argument as a significant reason for not making changes to the proposed approach. The negotiation phase is intended as a corrective to any residual inefficiency after the assignment round.
102. However, we also have further concerns relating to Three's alternative suggestion. First, it could provide a platform for some players to exert pressure on others to achieve a favourable outcome, in particular as other bidders would not know what the alternative outcome (and the consequence of not giving in to any pressure) might be.
103. Similarly, it could provide opportunities for some parties to try and extract a financial payment from others. Whilst we could anticipate that some financial arrangement between parties might reasonably form part of an agreement on the assignment plan (it is difficult to see how a conflict in preferences over specific assignments might be resolved otherwise), there may be incentives for some parties to try to extract rent from others purely for its own financial benefit, rather than as part of an efficient conflict resolution. For example, a bidder that is indifferent between different locations within the band may still try to extract a payment from a competitor that it knows has a higher valuation for specific frequencies, when payment from that competitor would not result from an assignment round in which bidders bid to valuation.
104. Moreover, potential additional prices to be paid could be used as a threat in order to convince one bidder to make a payment to another, rather than face a higher additional price e.g. "*pay me €x for your preferred location, or we revert to the assignment round outcome and (based on my bids) you would have to pay at least €y*". This in itself could then lead to distorted incentives to submit bids in the assignment round that do not reflect valuations for different

²⁶ <https://www.comreg.ie/publication/issues-relating-to-the-award-of-spectrum-in-multiple-bands-in-ireland-2>

assignment options, but are designed to create leverage in the negotiation phase. As highlighted in Document 12/24, if assignment bids do not represent true preferences then they may no longer provide a good basis for determining the assignment plan. Whilst we acknowledge that such a tactic would not come without risk and may be difficult in practice to achieve (particularly if there are a number of other winners within the band that would need to agree on the outcome), the approach proposed by ComReg provides a safer option.

105. Under the proposed approach, bidders have incentives to bid according to their preferences in the assignment round, and they know what their alternative is if they do not enter into any agreement in the subsequent negotiation phase. This should ensure that any deviation from the outcome of the assignment round is a result of a mutually beneficial arrangement between the involved parties and removes incentives/ability for some bidders to pressurise others or exploit the rules for financial gain.
106. We are also not convinced by Three's arguments for why "*the [n]egotiation [p]hase has not been successful*"²⁷ in the past. The purpose of the negotiation phase is to give bidders the opportunity to improve on the outcome of the assignment round.²⁸ Three does not elaborate on what it means by the negotiation phase previously not being successful, but presumably that must involve a situation where the assignment round bidding has not delivered an efficient outcome and then the negotiation phase has failed to correct this. This must mean that, following the assignment round and the determination of a provisional assignment plan and additional prices, two or more bidders could be made better off by agreeing on an alternative arrangement (potentially with some redistribution of fees), but those bidders have been unable to come to an agreement. That the negotiation phase has not resulted in an alternative arrangement by itself does not indicate a lack of success of the negotiation phase, but rather that in all likelihood the assignment bidding itself delivered an efficient outcome (or at least a sufficiently efficient outcome) that further negotiation could not improve.
107. Neither ComReg nor DotEcon was privy to any discussions that took place between bidders in the negotiation phases of previous awards, so we cannot comment on the success or failure in specific cases. However, the barriers to negotiations suggested by Three are unconvincing for a number of reasons.
108. First, Three suggests that bidders may be reluctant to agree on an alternative assignment because they do not want to pay the additional price (opportunity cost) for a frequency assignment that they are giving up. However, if the alternative assignment being put to a bidder is better than its current assignment, the additional price is not relevant to this choice, as it is paid in

²⁷ ComReg document 20/68, page 33.

²⁸ For example, if two bidders have a preference for aligning their frequency assignments (e.g. to facilitate a network sharing or spectrum pooling arrangement) but such an alignment did not result from the assignment round, the negotiation phase provides an opportunity for those bidders to reposition themselves (and potentially others) within the band. Similarly, the negotiation phase provides an opportunity for bidders that perhaps made a mistake in the assignment round to rectify that error.

both cases. If the alternative assignment is less preferable, then it is entirely rational for the bidder to not be willing to switch frequencies but pay the full opportunity cost associated with the assignment it gives up. However, if negotiations can involve a financial transaction to account for any redistribution across bidders of the rents achieved with the alternative assignment, then it should be possible to present a bidder with a suitable alternative proposal that gives it a different frequency assignment alongside some financial compensation for moving frequencies. If that would leave the bidder better off than under the outcome of the assignment round, it is again difficult to see why the bidder would not agree to the change simply because it would technically be paying ComReg for something different. In summary, assignment stage bidding, winner determination and additional price establishes an assignment of frequencies; this is then a starting point for winners to trade from in the negotiation phase, including side-payments as necessary.

109. Three's second argument is that some bidders will perceive that their best advantage is to stick with the outcome of the assignment round. Three does not elaborate on what it means by this, what scenario it has in mind or why this might be a problem. However, it is reasonable for a bidder to want to keep its frequency assignment (allocated as a result of the assignment round), if, for whatever reason, it perceives that to be a preferable assignment than a proposed alternative made during the negotiation phase. We re-emphasise that if the assignment stage bidding delivers an efficient result, which is very likely if bidders' frequency preferences depend only on where they are located, rather than where other bidders are located, then we do not expect the negotiation phase to affect the outcome. The negotiation phase is present as a safeguard against any inefficiency in the outcome and avoids the need for any subsequent spectrum transactions to rectify this after the auction by allowing frequency reorganisation to occur prior to ComReg issuing licences in respect of specific frequencies.
110. For all of these reasons, we do not believe that Three's alternative approach would be preferable to the current process, and we recommend that no changes are made to the IM in this regard.

5.3 Winner determination in the assignment stage

111. In the Draft IM (paragraph 4.221), the determination of winning assignment stage bids was made subject to the constraints that exactly one assignment bid be accepted from each assignment stage bidder, and that the outcome conform to one of the candidate band plans underpinning the generation of assignment options.
112. Although no respondent raised this point, our own review of the Draft IM identified this approach as unnecessarily restrictive (though in practice the implications are minor). In particular, once frequency assignment options have been identified that allow each assignment stage bidder to have both:

- (i) a reasonable choice of frequencies (that could be feasibly accepted as winning bids given other bidders' assignment options); and
- (ii) reasonable alignment across time periods,

then there is no reason to restrict how assignment bids might be accepted, as long as one bid is accepted from each assignment stage bidder and the resulting frequency assignment be feasible (in that no frequency block is assigned to more than one bidder). There is no need to restrict outcomes to those rationalizable from the underlying band plans used to create the assignment options. Therefore, we recommend that ComReg amend the Final IM to reflect that the selection of winning assignment stage bids need only be constrained by feasibility.

6 Assignment options

- 113. Three and Eir provided comments on the methodology for assignment option generation (AOG) and have each suggested potential adjustments to different aspects of the approach.
- 114. In addition, and independent of the comments received from stakeholders, we have also identified a way of streamlining the assignment option generation process, which is discussed further below and which we have recommended that ComReg includes in the procedure set out in the final IM.

6.1 Summary of initial proposals

6.1.1 Objectives

- 115. The proposed method for assignment option generation (AOG) guarantees winners of frequency generic lots a contiguous block of spectrum and minimises misalignment across time slices where possible. The approach is broadly similar to that used in the 3.6 GHz auction, though in that case frequencies needed to be aligned across multiple regions, rather than across two time slices.
- 116. Note that the objectives here are complex and involve a trade-off. Whilst we could give absolute priority to minimising some measure of misalignment in the frequencies assigned to bidders winning in both time periods, this may have the effect of significantly reducing the options available for where some bidders can be located. Therefore, the proposed methodology for AOG seeks a reasonable trade-off between alignment across time and giving winners a broad choice of frequencies across the relevant band.
- 117. In this particular award, whilst it is likely that most bidders will treat all frequency generic lots in a given band as similar and not have strong preferences for particular frequencies, it may be presumptive to assume that all frequencies are identical. There may be preferences that are specific to particular bidders (e.g. alignment with existing uses) and also there could be mild preferences between frequencies that are common to most bidders. For both reasons, we want bidders to have a reasonable variety of frequency options provided this does not cause too much misalignment across time slices.
- 118. A feature of the proposed approach is that any bidders who have won in both time slices are placed in the same frequency order within each time slice. (Note that such winners might be interleaved by winners in just one time slice, but this is not that likely to occur in practice.) This has the merit of avoiding unnecessary changes in the identities of operators' frequency neighbours across the two time slices, which is likely to benefit future interference management and any transitional arrangements

6.1.2 Bands

119. The Draft IM sought to apply a similar approach to assignment option generation across all of the bands, though there are some differences in terms of the configuration of lots at the band edges.
120. From the Draft IM, recall that:
- We refer to frequency specific lots as 'edge lots', as these are at the edges of bands or part thereof (e.g. at the edge of the TDD parts of the band).
 - In the 2.6 GHz (TDD) band, there are edge lots at the top and bottom of the TDD centre band. However, a bidder can only bid for both edge lots in a time slice if its bid also includes all frequency generic 2.6 GHz TDD lots in that time slice.
 - For the purpose of the assignment stage, Eir's existing 2.1 GHz time slice 1 (TS1) lots are treated as if it had won them in the main stage. Therefore, there is no difference in the number of frequency generic lots across the two time periods for the purposes of the assignment round.
121. The rules in the Draft IM assumed that the lower 30 MHz in the 2.3 GHz band would be a frequency specific lot. However, a sufficient number of RurTel customers have been migrated to other services for this to be offered as frequency generic lots. As a result, the 2.3 GHz (TDD) band now has an edge lot only at the top.
122. Eir will continue to serve some RurTel customers for the time being. ComReg considers there is benefit in Eir being assigned frequencies that overlap as far as possible with the RurTel frequencies to ease the transition as Eir will be best placed to manage any interference.
123. The relevant position in each band after these changes is summarised below.

Table 1: Summary of new lot structure following developments with RurTel

| Band | No. of frequency generic lots | Edge lots? | Comment |
|-------------|-------------------------------|--------------------------|--|
| 700 MHz | 6 | None | No time slicing. Rules based approach. |
| 2.1 GHz | 12 | None | |
| 2.3 GHz | 18 | 1 at top | Changed relative to Draft IM Special rules for Eir regarding RurTel frequencies |
| 2.6 GHz FDD | 14 | None | |
| 2.6 GHz TDD | 8 | 1 at top, 1 at bottom | Rule that if you bid for top and bottom edge lots in the same time slice, you must include all the middle frequency-generic lots |

6.1.3 The 700 MHz band

124. The 700 MHz band is not subject to time slicing. All permutations of the order of winners within the 700 MHz band are allowed, subject to the limitations that:
- If there is just one winner of three blocks or more, then that winner will not be assigned the lowest block;
 - Any unassigned lots will be contiguous and will be placed at the bottom of the band.

6.1.4 Measuring misalignment

125. For bands with two time slices, various concepts are defined in the Draft IM to measure misalignment in one particular band. These concepts are used within the algorithm for AOG:
- Frequency generic blocks within a band are numbered sequentially from the lowest frequency block to the highest;
 - *Time slice variation* (TSV) is the difference between the highest number lot and lowest number lot assigned to that bidder in either time slice, plus one, minus the maximum number of lots allocated to the bidder (i.e. how many extra frequency blocks are spanned by the assignment across the two time slices compared with assigning the same frequencies in each time slice);
 - *Total time slice variation* (TTSV) is the sum of TSV across all bidders in that band.
126. The TSV is, by definition, zero for any bidder winning lots in just one time slice.
127. The approach to generating assignment options is based on recursively breaking down bidders into groups (i.e. partitioning the set of bidders) so that, in total, each group receives similar numbers of blocks in both time periods. The 'raggedness' of the boundaries between these groups is measured in the following way:
- the *partition score* is the sum across the subsets of a partition of the absolute value of the difference between the number of lots in TS₁ compared to TS₂;
 - the *corrected partition score* (CPS) is the lowest possible partition score achieved by assigning unsold TS₁ lots to subsets of the partition of bidders; and the
 - an *associated unassigned allocation* (AUA) is an allocation of unsold TS₁ lots to subsets of bidders that achieves the CPS.
128. In summary, this approach results in unsold TS₁ lots not needing to be contiguous and potentially used as padding to improve alignment. In contrast, unsold TS₂ lots need to be kept together (as far as possible) to maintain

options for use later. This can be achieved in practice by treating all unsold TS2 lots as if they had been won by a single notional bidder.

6.1.5 The case with no edge lots

129. The Draft IM sets out various cases according to whether or not there are edge lots in a band. Not all of these cases are now relevant given the change to the 2.3 GHz band.
130. The simplest case is where there are no edge lots. This is called "Case 1" in the Draft IM. This applies to the 2.1 GHz and 2.6 GHz paired categories.
131. We construct a notional winner who won all unsold TS2 lots and nothing in TS1; therefore, all TS2 unsold lots are kept together. Unsold TS1 lots are not kept together and can be used as padding to reduce misalignment.
132. The Draft IM sets out a three-stage process to generate the assignment options for each bidder. We set out this process in the simplest case of there being no edge lots (and ignoring for now the RurTel issue in the 2.3 GHz band).

Step 1: generation of bidder orderings

133. To generate the bidder orderings:
 - select the partition of winners with the lowest CPS;
 - if there are multiple partitions that achieve the lowest CPS, then apply various tie-breaking criteria, aimed at maximising the progress the algorithm makes with breaking winners up into smaller groups;
 - the selected partition has an AUA, and this defines which unsold lots are associated with each a branching from the previous node;
 - reapply the algorithm recursively (i.e. take one set of bidders within the partition and its associated unassigned lots and then start again) until all subsets of bidders are singletons; then
 - the set of possible winner orderings is created by combining all possible orderings of the branches within the constructed tree.

Step 2: Padding with unallocated TS1 lots

134. For each winner ordering identified by Step 1, place winners into the band in the order specified. Then, place unsold TS1 lots between bidders to minimise the TTSV. If there are multiple ways to minimise TTSV, select the one that maximises the size of the largest contiguous block of unassigned TS1 spectrum. If there are still multiple ways to do so, select one randomly. This gives the candidate band plan for that winner ordering.
135. We discuss a modification of this approach below that would carry forward all the various ways that unassigned lots might be used to minimise the TTSV, with the result that in some cases a wider range of frequency options will be generated. This modification avoids the risk of affecting the frequency options offer through an arbitrary choice of tie-break in where unsold lots are located.

Step 3: Symmetrisation of frequency options

136. The assignment options for each bidder are the frequencies that:
- the bidder would be awarded in any candidate band plan; and
 - are offered to any other bidder who won the same lots in the main stage.

6.1.6 Provisions for edge lot winners

137. For bands with edge lots (2.3 GHz and 2.6 GHz unpaired), the Draft IM identifies a number of cases:
- case 2 (when no bidder wins edge lots at both ends of the band); and
 - cases 3a – 3d (where there a winner of both upper and lower edge lots, in various configurations).
138. As discussed in Section 2.2.1 above, given the bidding restriction on 2.6 GHz lots, and that the RurTel frequency-specific lot is no longer required, the process for dealing with edge lot winners in the AOG process can be simplified, and an updated methodology will be provided in the final IM.

6.2 Three's suggestions

6.2.1 Three's proposal

139. Three submits that the proposed AOG algorithm is too complicated for most likely scenarios, which makes it harder to understand and verify, and less than 100% effective by construction. When tractable, Three suggests that brute force searches over all feasible band plans are preferable to complex algorithms, as it exactly minimises misalignment and does not risk excluding appropriate assignment options (or including inappropriate ones).
140. On that note, Three understands that, rather than identifying each and every minimum misalignment band plan, the proposed algorithm identifies a shortlist of band plans from which options are derived. It requests that ComReg clarifies if this is correct. This is indeed correct.
141. On the basis that brute force is often tractable²⁹, and that it is unlikely that there will be more than six winners in a band, Three suggests that ComReg:
- use brute force if there are six or fewer winners; and

²⁹ If there are N winners, including any notional winners of unallocated lots, then there are $N!$ possible orderings in one time slice, which increases exponentially as N increases. With 6 winners, there are 720 orderings, which is clearly a small enough number for all to be considered. With 8 winners (including any notional winners of unsold lots), this increases to 40,320 orderings, and with 10 winners 3.6 million orderings. With orderings chosen independently for the time slices, this creates approximately 0.5 million possibilities with 6 winners, increasing to 1.6 billion with 8 winners and 13 trillion with 10 winners.

- use the proposed AOG algorithm if there are seven or more winners.

6.2.2 Assessment and recommendations

142. First, we observe that Three's proposal is somewhat incomplete, in that it does not address unsold lots. We assume that it would:
- maintain the notional TS2 bidder (a device to gather the unsold TS2 lots), and that the notional winner counts towards the six winners when deciding whether to use brute force; and also that
 - TS1 unsold lots would still be used to minimise misalignment. That is, TTSV for a band plan is calculated after positioning TS1 unsold lots optimally, not immediately after placing bidders in the band in order.
143. Second, it appears that Three is suggesting that ComReg drops the restriction that the bidder ordering is the same across time slices, because it refers to $N!^2$ feasible band plans (note that this is only the exact number of feasible band plans if there are no unsold lots³⁰). This considerably increases the number of band plans to be considered and is unlikely to reduce TTSV relative to the minimum value under the constraint that bidders are placed in the same order in each time slice, unless they are edge winners.
144. We also note that ComReg is likely to have a preference for keeping the bidder order the same across both time periods as:
- this gives stability for interference management between frequency-adjacent licensees and potentially assists with any transitional arrangements; and
 - although not necessary likely if the assignment stage results in an efficient outcome and preferences for frequencies do not change substantially over time, any secondary transactions involving frequency swapping would be facilitated.
145. Third, the brute force search would presumably only keep bidder orderings that minimised TTSV under Three's proposal. On the other hand, the proposed AOG algorithm provides bidders with more choice of frequency locations, as a candidate band plan is generated for different bidder orderings, even if some of these orderings do not minimise TTSV. Therefore, we disagree with Three that the objective is solely to maximise alignment. Rather we are trying to obtain reasonable alignment whilst giving bidders a range of choices for frequencies, which the recursive algorithm achieves. With a brute forcing search for the minimum TTSV, there would typically be far fewer frequency options identified. Therefore, although Three suggests brute force search as a technical amendment aimed at simplification, in fact such a change would

³⁰ All unsold lots in the first time slice are treated different notional winners for these purposes, as unsold lots are not required to be adjacent in the first time slice. In the second time slice, unsold lots are kept together. Therefore, if there are N winners, and U_1 and U_2 unsold lots in the first and second time slices respective, then the number of possibilities is $(N + U_1)! (N + 1)! if $U_2 > 0$ and $(N + U_1)! N!$ if $U_2 = 0$.$

express a somewhat different policy preference, prioritising alignment across time slices over offering a reasonable range of frequency choices.

146. These implications of Three's proposal are illustrated in Example 5 in Annex 9 to the Draft IM. In this example, bidders are given two assignment options, even though only one band plan is compatible with minimising TTSV subject to the contiguity requirements. We assume that, under Three's proposal, the band plan shown under bidder ordering 1 would become the actual band plan, and there would be no assignment stage bidding for this band. This implication of Three's proposal for full TTSV minimisation is not dependent on there being unsold lots, or on Three dropping the restriction that bidders are placed in the same order in each time slice.
147. In making our recommendations to ComReg that informed the Draft IM, we did in fact consider a scheme somewhat similar to Three's proposal for brute search, but maintaining a common ordering of bidders present across both time slices (which Three's proposal seems not to do). We ruled out this alternative for similar reasons to those given above, as in some cases prioritising alignment across the two slices could greatly restrict the frequency options available to bidders and that we had no reasonable basis for setting such a dominating priority for the assignment round.
148. Overall, we do not recommend that Three's suggestion be adopted for the reasons above. In particular, it is important that bidders have a reasonably wide range of frequency options and an objective of minimising TTSV should not override this. The approach proposed in the Draft IM seeks to keep the TTSV low whilst maintain a wide choice of frequency location and strikes a reasonable balance between these two objectives in a way that is robust to all potential auction outcomes.

6.3 Eir's suggestion

149. Eir disagrees with the selection of just one method of placing unsold TS₁ lots where there is a tie in achieving the TTSV (in Step 2 of the three step procedure set out above). Eir proposes that all such ties should be carried through to generate assignment options.
150. We agree with Eir that this would be a useful improvement, but we also need to ensure that carrying through ties would not be overly burdensome in worst case scenarios for the number of additional possibilities created. We discuss this below.

6.3.1 Eir's proposal

151. Eir objects to the random selection of candidate band plans in the case of ties, which in some circumstances can reduce the number of assignment options offered to bidders (depending on the result of the random selection). It suggests that if, for a given winner ordering, band plans are tied on:
 - the minimum TTSV; and

- the maximum number of contiguous TS1 lots;

then all of these band plans should be used to generate assignment options.

152. Eir points to Example 4 in Annex 9 of the Draft IM, noting that had the random draw gone differently, then bidders would only have been presented with a subset of the assignment options. In that case, two bidders won the same amount in each time slice, and there were two ways of setting TTSV to zero and keeping a contiguous block of four unsold TS1 lots. Therefore, there were two bidder orderings that came to an identical tie-break scenario to decide which of the two options would become the candidate band plan for that bidder ordering. We assumed that there was a different result in each case (which gives the full set of options). However, with a different random tie-break, the same band plan could have been drawn for each winner ordering; in turn, the measure that ensures bidders who won the same lots get the same assignment options would not have come into play, and the bidders would have been faced with fewer assignment options. Therefore, we agree with Eir's analysis of the implications of band-plan tie breaking in this example.
153. Eir submits that "*bidders should always be presented with the widest possible range of options compatible with an efficient assignment. We therefore believe that all tied best Candidate Frequency Plans for each winner ordering should be taken forward to determine the Assignment Options presented to each bidder.*"³¹

6.3.2 Assessment and recommendation

154. Eir's observation is correct, and its point is specific to the random tie breaking in step 2 of the three-step process for assignment option generation. The symmetrisation of frequency options in step 3 of the proposed process partially addresses Eir's issue, but frequency options may nevertheless be restricted by tie break choices.
155. We recommend that ComReg adopts Eir's suggestion, as the computation load implications are not too severe. In particular, we only need to consider how the total number of TS1 unsold lots are allocated to the boundaries between bidders.

6.4 Calculation of corrected partition scores

156. As an entirely technical point, we have identified and recommend that ComReg adopts a means to streamline the calculation of corrected partition scores, making use of the fact that there are just two Time Slices. In particular, this approach (as outlined in Annex 12 of the IM) allows a simple rule-based approach to the treatment of unsold Time Slice 1 lots within the recursive algorithm for generation of bidder orderings in a band. This has no functional effect, but may help bidders both to better understand the calculation of

³¹ ComReg document 20/68, page 12.

assignment options and to perform these calculations themselves without needing to perform various optimisation steps. There are no functional implications from this recommended change.

7 Exclusion of bids

7.1 Eir's comments

157. Eir has provided comments in relation to the potential actions that ComReg may take in a scenario where a bidder is excluded from the auction.
158. In particular, Eir highlights that if a bidder is excluded after failing to meet a deposit call at the end of a main stage, the rules as they stand allow ComReg to exclude some or all of that bidder's bids from the winner determination and pricing algorithm. Eir asserts that if a bidder has been excluded from the auction, it would never be appropriate for ComReg to exclude some, but not all, of that bidder's bids. Eir suggests that, by definition, the bids submitted by an excluded bidder are illegal as they do not conform to the award rules, and any excluded bidder should be prohibited from bidding.
159. Eir requests that ComReg changes the auction rules to remove the possibility for ComReg to exclude some, but not all, of an excluded bidder's bids, or provides an explanation for when it would be needed.

7.2 Comments and recommendations

160. The relevant part of the Draft IM is paragraph 4.154, which states:
- "In the event that ComReg issues a Deposit Call following the completion of the Main Stage of the Auction, but before the results of the Main Stage have been announced to Bidders, and one or more Bidders do not provide their required funds by the deadline set by ComReg, ComReg may at its sole discretion exclude any such Bidder and re-run the winner and price determination algorithm (described below) excluding some or all Bids submitted by any such Bidder during the Award Process."*
161. First, when it comes to addressing breaches of the auction rules (such as failure to meet a deposit call), it is appropriate that ComReg has a range of options available that could be applied, to ensure that any action taken is proportionate given the circumstances relating to each individual case. While there are extreme scenarios where excluding a bidder entirely would be appropriate, there are likewise potential cases where such exclusion would be unnecessarily harsh, and potentially damaging to the award outcome. For example, if a bidder were to fall short of the required deposit update by just €1 (e.g. due to bank charges or foreign exchange movements), and only one of its bids was above its deposit, it would likely be disproportionate to then exclude the bidder entirely from the award, invalidating bids even below the deposit that bidder had already placed.
162. On the other hand, we agree with Eir that if a bidder has been fully excluded from the award, there would be no grounds for allowing any of its bids to be

included in the winner and price determination process. Indeed, this would seem to be a logical consequence of full exclusion.

163. In the case of a bidder failing to meet a deposit call at the end of the main stage, we recommend that ComReg should retain discretion over whether the bidder is excluded from the award or not, but:
- if the bidder is excluded, then all of its bids should be excluded from the winner and price determination algorithm;
 - if the bidder is not excluded, then ComReg should retain discretion over whether to exclude some or all of the bidder's bids from the winner and price determination algorithm (noting, for the avoidance of doubt, that this option would allow for all of the bidder's bids to remain valid).
164. We believe that all of these actions would be available to ComReg under the rules as currently drafted. However, we acknowledge that the phrasing of these rules in the Draft IM is somewhat unclear, and we agree with Eir that it could be interpreted in a way that suggests ComReg could exclude a bidder but then allow some (or all) of its bids to remain valid. This was not the intention. We therefore recommend that ComReg review the relevant paragraph and adjust it accordingly for the Final IM to make it clearer that an excluded bidder's bids would not be included in the determination of winners or prices. However, we also strongly recommend that ComReg retain discretion to exclude some but not all bids made by a bidder to provide for appropriate (e.g. proportionate) action to be taken short of full exclusion (noting, for the avoidance of doubt, that this option would allow for all of the bidder's bids to remain valid).

8 Exclusion of bidders

8.1 Three's comments

165. Three has raised concerns with regards to the procedure that might be followed if a bidder is excluded, as set out in paragraphs 3.100 – 3.108 and 4.107 of the Draft IM. In particular, Three claims that the process lacks transparency as it does not specify whether ComReg will inform the remaining bidders if a bidder has been excluded.
166. Three asserts that, at a minimum, other bidders should be told at the time that a bidder has been excluded and whether or not that bidder's bid made up to that point will remain valid or if they will be removed from the winner determination and pricing process. Three claims that this is necessary for bidders to have confidence in the integrity of the award.

8.2 Assessment and recommendations

167. As an initial comment, we do not agree with Three that adjustments are necessary in the IM for bidders to be confident of the integrity of the award. It is unclear to us why Three considers that the award might lack integrity, or how being made aware of the exclusion of another bidder in the course of the bidding process might resolve that.
168. We highlight that, ComReg has appointed an independent third party to verify the integrity of the award process and the outcome. Therefore, there should be no need for bidders to have any concerns that the award will be not be run properly or that it will lack integrity.
169. Regarding Three's specific objection to the claimed ambiguity over whether ComReg would inform other bidders if a bidder is excluded, we note that this discretion within the rules is deliberate, for several reasons. First, it provides ComReg with the flexibility to make a decision at the time of the event over whether it would be better for the award process to inform the remaining participants or withhold the information. We do not believe that committing one way or the other in advance would be appropriate, and ComReg needs to make an informed decision at the time, taking into account the specifics of the situation in light of the objective of ensuring the overall efficiency of award outcomes.
170. The rules deliberately leave open the possibility that a bidder could be excluded, or some bids excluded after the end of the final clock round, but before the determination of winners. For example, ComReg may need to make a deposit call immediately after the final clock round, or following the supplementary bids round in response to supplementary bids that have been placed. It is also possible that a serious breach of the auction rules could occur in this period. When making supplementary bids, bidders should be aware that these are possibilities. Even in the case that the final clock round finishes

with no unallocated lots in any lot category, no guarantee is offered to bidders that this situation necessarily endures, as there are scenarios in which a bidder might have some or all of its bids excluded subsequent to the final clock round. Bidders should be aware of these possibilities when making supplementary bids. Bidders never have complete certainty over the impact of their supplementary bids on what they might win, which incentivises bidding reflecting valuations given that this may affect what bidders eventually win.

171. As a general principle, the award rules aim to avoid bidders knowing about other participants, so far as possible. Therefore, there would need to be clear benefit in terms of overall efficiency of the award outcome from disclosing that a bidder had been excluded. However, as currently drafted the IM retains discretion to release information about bidder exclusions if the circumstances justified it.
172. In summary, we do not see any good reason to make the changes Three has suggested. There are highly varied circumstances that could lead to a bidder being excluded (or some, but not of its bids excluded). Given the difficulty of anticipating these circumstances, the Draft IM rightly retains discretion for ComReg over whether such a withdrawal would be disclosed.

9 SAF refunds if licences delayed

173. In the event that, following the award, there is a delay to the commencement date of spectrum rights won by winning bidders beyond the envisaged commencement dates set out in the IM or as subsequently amended by ComReg, ComReg would refund some of the fees paid by the affected winning bidders. The amount of the refund would be a pro-rata refund of fees for each whole day delayed.
174. In particular, the Draft IM states that:
- "The refund or adjustment of fees payable to a Winning Bidder for each Lot so delayed shall be calculated as follows:*
- *a pro-rata portion of the SAF already paid by the Winning Bidder on a daily basis for each whole day following the commencement dates as set out in paragraph 2.23 and Table 5 (or other commencement date as indicated by ComReg in relation to the Award Process) that ComReg does not make the Lot available for use; and*
 - *a pro-rata portion of SUFs already paid by the Winning Bidder on a daily basis for each whole day following the commencement dates as set out in paragraph 2.23 and Table 5 (or other commencement date as indicated by ComReg in relation to the Award Process) that ComReg does not make the Lot available for use."³²*

9.1 Three's comments

175. Three has suggested that the methodology for calculating refunds in light of delayed licences should be adjusted, highlighting that the spectrum access fee (SAF) represents a significant investment that must be paid upfront for an asset with a life span of 20-years.
176. Three contends that the methodology currently proposed by ComReg simply assumes a linear division of the licence value across each day of the licence duration, which ignores the discounting that will be applied by bidders when considering the investment. Three asserts that, in reality, the early days contribute to the licence value significantly more than the final days, so the proposed calculation undervalues the loss to a winning bidder of a delay.
177. Three argues that ComReg has applied discounted cash flows when deriving the minimum price and reserve price for each lot, and that the same logic applies for estimating the value for each day of the delay.
178. Three suggests that the IM should be revised to take account of these various issues.

³² ComReg document 20/32, para. 2.97

9.2 Assessment and conclusions

179. We agree with Three that, primarily on grounds of consistency, it might be desirable to apply the same principles for calculating the minimum/reserve prices to the calculation of refunds, i.e. assume a flat cash flow and apply the discount rate to calculate a daily value for the licence. However, there is also a high degree of uncertainty about the timing of the benefits licensees enjoy under the licence and it is debateable what method of allocating the overall value of licence across time might be best. For example, if the cash flow benefit from a licence grew over time at the discount rate, then even with discounting this would yield a daily value of a licence equivalent to a simple pro-rata rule. Therefore, there is no clearly best method and questions of simplicity, predictability, convenience and administrative efficiency also apply. ComReg should consider these factors in determining which approach to use in the calculation of refunds of SAFs and/or relevant SUFs.
180. For the planned award, we do not see any downsides to updating the methodology as suggested, given that similar calculations are used for establishing minimum/reserve prices and there has been no particular objection to the flat cash flow assumption and discount rates used in that context. Therefore, these assumptions can be re-purposed to establish a refund for SAFs and/or relevant SUFs, where appropriate.
181. For the avoidance of doubt, however, while we are of the view that this could be an appropriate approach for this particular award, should ComReg adopt it we are also of the view that it would be appropriate for ComReg to retain discretion in relation to future awards i.e. adopting such an approach should not be seen as a commitment to use the same approach for any future awards, where circumstances may be different. In this particular instance we are applying assumptions over the distribution of benefits for the purpose of several calculations in relation to the award (such as determining the minimum/reserve prices) and it would seem reasonable and consistent to do the same for the calculation of any applicable refunds, as Three has suggested. However, in other contexts such assumptions may be unreasonable (or at the very least questionable) and/or use of the methodology proposed here for the MBSA2 might be disproportionately complex when a simpler approach would be perfectly suitable. We therefore recommend that ComReg retain discretion and flexibility to apply the most appropriate methodology for future awards on the basis of the specific circumstances at the time.

9.2.1 Proposed refund calculation methodology

182. To the extent that ComReg wishes to use a discounted approach for the refund of a SAF and/or relevant SUFs, we propose the methodology set out below.
183. It is of course feasible that the delay will affect only some of the spectrum rights a bidder has won, for example if there are delays for some bands but not

others. In that case the applicable refund would need to apply only to the part of the fees related to the delayed spectrum right(s).

184. The annual spectrum usage fees (SUFs) are specific to each individual lot won so the relevant part of any SUFs already paid by the bidder is easy to identify. However, a winning bidder's spectrum access fee (SAF) is a single one-off payment (determined in the auction) for the package of lots the bidder won. It is, therefore, not possible to know the exact price the bidder is paying for each individual lot, and consequently (where the delay to spectrum rights affects only some, but not all, lots) it is not possible to know exactly how much of the SAF should be subject to a refund. In that case, it would be necessary to form an estimate of the proportion of the SAF attributable to the lots affected by the delay, and use that estimate as the basis for the refund calculation.
185. Our recommendation on forming an estimate of the proportion of the SAF to be used would be to allocate a proportion of the total SAF to each lot included in the package won by the bidder in proportion to the round prices for those lots in the final primary bid round. That would give a SAF per lot for the purpose of calculating any refunds due to that bidder. This approach is similar to, and consistent with, the methodology used to estimate the price of the 2.1 GHz time slice 1 lots achieved in the award for the purpose of calculating any applicable liberalisation fee for Eir. Whilst more complex approaches are available, such as estimating approximate market-clearing prices using all bids made in the auction, this approach is simple and avoids revealing any confidential information about losing bids.
186. Once the SAF has been distributed between the lots won by the bidder, to calculate the level of any applicable SAF refund for a given lot:
- amortise the proportion of the SAF allocated to that lot over the licence term associated with that lot to give a daily value (using a real discount rate³³); and
 - sum the daily values over the period of the delayed access to the licence to give a total SAF refund for that lot.
187. To establish the total SAF refund due to the bidder, repeat the process above for all applicable lots and sum the resulting amounts.
188. In relation to the SUFs, the first payment is due in advance of the licence commencement, so our understanding is a bidder could make a SUF payment for a licence that is subsequently subject to a delay. In this case, the process for determining any refund in relation to that SUF payment could be the same as described above in relation to the SAF, with the exceptions that:
- the SUFs are specific to individual lots, so there is no need for an initial step to estimating how much of the payment is attributable to the affected spectrum; and

³³ The real discount rate would be based on the annual mobile nominal WACC of 5.85% per annum and assumed annual inflation of 1.5% per annum for the part of the licence term still in the future, giving a real discount rate of 4.35% per annum.

- the amortisation of the SUF amount would be over the course of the first year of the licence term (rather than the whole licence term), which is the period covered by the SUF.

10 Bidder association / non-disclosure of participation

10.1 Summary of current approach

189. Bidders must identify relevant insiders on their application forms (based on the definition of insider set out in the Draft IM). If ComReg identifies a common insider across two or more bidders following the submission of applications, the relevant bidders will be informed and will need to resolve the conflict.
190. There are three possibilities for resolving the issue:
1. one or more of the bidders terminates their relationship with the insider; or
 2. the bidders apply for an exemption from the insider rules and are granted this exemption by ComReg; or
 3. one or more of the relevant bidders can withdraw from the auction.

10.2 Three's comments

191. Three raises what it considers to be an issue regarding the rules on common insiders and non-disclosure of participation, resulting from the proposals that:
- bidders are not informed about the identity of other bidders; but
 - if two bidders have common insiders, they will be contacted by ComReg and notified that they need to resolve the conflict.
192. Three argues that if common insiders are identified, the associated bidders would have access to information about participation in the auction that is not available to other bidders. Three further asserts that if the insiders were discovered after the start of the auction then both bidders could be excluded, but this situation could be avoided if they had known about the insider before the auction.
193. Three suggests that the obvious solution is to publish the identity of all applicants at the qualification stage, and highlights that this approach has been used elsewhere, including in the UK.

10.3 Assessment and conclusions

194. Our understanding is that the intention behind the common insider rules is to prevent situations where an insider had access to confidential information

relating specifically to two or more bidders' participation in the planned award. We would expect bidders to ensure that all of its relevant insiders were aware of the award rules, and to have in place appropriate obligations and provisions to ensure in advance of the award that there would be no conflict with other participants. It should not be difficult for applicants to identify the relevant insiders, and it is largely in the power of applicants/bidders to avoid situations where they would get picked up under the common insider rules after submitting an application for the award.

195. In particular, a potential bidder can require that its insiders form an exclusive relationship and does not engage with other bidders, without knowing anything about who else might potentially participate in the auction. Indeed, it is implausible that a prudent bidder would share sensitive commercial information relevant to a major transaction with an insider without such a protection being in place. Therefore, we believe that the risk of ComReg identifying common insiders at the application stage is very low. We note that this situation has not occurred in any of the previous spectrum award processes run by ComReg.
196. It is also important to recognise that there are good reasons for not disclosing the number or identity of other applicants/bidders, in particular to mitigate the risk for strategic bidding. We would, therefore, need a very good reason to deviate from the current approach and change to making all participants known to each other. Given that there is a low probability of common insiders arising we do not see a strong argument for making any such a radical change to the information policy.
197. In any case, we do not believe that the informational asymmetry that Three is concerned about need arise in the first place. It should be possible to ensure conflicts due to common insiders can be resolved without the parties involved being informed of either the identity or the number of other applicants that share its common insider. All an applicant needs to know is that it has a common insider with at least one other party, and that the conflict needs to be resolved. In some cases, the resolution may be very straightforward, with one or all applicants (independently) terminating their relationship with the insider. In other scenarios, and as unlikely as they may be given the points above, it may be appropriate for ComReg to communicate directly with the common insider to ensure suitable information '*siloing*' measures are in place, but this should not require any interaction between the applicants involved. In addition, following a resolution of a common insider conflict, ComReg does not need even to inform the relevant parties of how the conflict was resolved, only that it is no longer a problem.
198. Therefore, in practice, the only thing that applicants with a common insider would learn about the participation of others is that there is at least one other applicant for the award, not the identity of the other bidder(s) sharing their insider. Although this information would not necessarily be available to all applicants at that time, in the event that an auction is required, all qualified bidders would in any case know that there is at least one other bidder, otherwise an auction would not be required. Therefore, applicants that had a common insider at the qualification stage would have no additional information about participation by others going into an auction that is not

available to all other qualified bidders by implication of an auction being needed at all.

199. We recognise that this interpretation of the process for dealing with common insiders is not set out in the draft IM, and that the rules as set out could be read to mean that applicants with a common insider would be informed of each other's identity and able to work together to come to a resolution. We therefore recommend that ComReg review the rules relating to common insiders and adjust them accordingly, but we do not agree with Three that the radical change to the policy on non-disclosure of participation that Three suggests would be appropriate.
200. Finally, we note that even if we were to consider that there could be a problematic informational asymmetry arising from the common insider resolution process, it does not then follow that it would be necessary to resort to full disclosure of all applicant identities. There are alternative approaches that would offer a balance between reducing informational asymmetry and maintaining sufficient uncertainty over the number of participants so as to not undermine the benefits from the current information policy. For example, ComReg could release information about the structure and resolution of any conflicts, but not the identities of the parties involved. This is not necessary, as the resolution of insider conflicts need not involve information leakage, for the reasons set out above. Nevertheless, it illustrates that even if there were information leakage, this would not in any case support Three's claim that the appropriate solution is full transparency about participation.