

Assessment of responses to Consultation 17/85

Prepared for ComReg

February 2018

1 Introduction

ComReg is preparing an award process for the release of usage rights for 2x532 MHz of spectrum in the frequency ranges 24.745 GHz – 25.277 GHz (uplink) paired with 25.753 GHz – 25.781 GHz (downlink), the “Award Spectrum”. The proposals for this award were set out in ComReg’s Consultation 17/85 (“the Consultation”), giving interested parties an opportunity to express their views on the proposals. To support the Consultation, DotEcon has provided advice to ComReg on auction design and minimum prices (ComReg 17/85a).

Eight stakeholders submitted a response to the Consultation:

- Cambridge Broadband Networks Limited (CBNL);
- Eircom Group;
- Ericsson;
- Global mobile Suppliers Association (GSA);
- Imagine;
- Qualcomm;
- Three Ireland; and
- Vodafone.

This report responds to comments made in these responses concerning matters raised in our first report, and also considers the recently published RSPG opinion on 5G.¹ It is structured as follows:

- Section 2 summarises relevant comments made in the responses;
 - Section 3 provides our assessment of the arguments raised in the responses;
 - Section 4 provides an overall summary; and
-

¹ Radio Spectrum Policy Group, Strategic Spectrum Roadmap towards 5G for Europe. Second Opinion on 5G networks, RSPG-18-005, 30 January 2018.

- Annex 1 gives details of our analysis regarding the extent to which existing licensees might be required to relocate within the band.

2 Summary of responses

2.1 Qualcomm

Early deployment of 5G technology

Qualcomm disagreed with the proposal to award new National Block Licences in the frequency range 24.5 GHz – 26.5 GHz, and the maintenance of the existing FWALA and Individual P2P link licensing schemes in the 26 GHz band. Qualcomm considered that the proposals set out in the Consultation will reduce the opportunity for developing 5G services in the country.

Qualcomm proposes that the unused spectrum in the 26.5 GHz to 27.5 GHz range should be considered for a new award consultation as a key band for the deployment of 5G services, and it should be made available in the “very short term” to MNOs and other future users of 5G technology. Qualcomm states that this will be in line with RSPG’s opinion on 5G, which recommends member states to make part of the band available before 2020.

2.2 Imagine

Spectrum hoarding

Imagine believes that under the framework of the current award, hoarding of spectrum being made available in the award could occur. According to Imagine, this is because, along with being a pioneer band for 5G, 26 GHz will also be the spectrum band of choice for the wireless drop (i.e. last 100m) use case for FTTH providers in a PTMP configuration. In Imagine’s opinion, the expected demand for this spectrum will be high given it is a pioneer 5G band and that demand may also come from FTTH providers (in the hope that PTMP will be allowed in the future), along with PTP demand.

Imagine believes that FTTH providers will hoard this spectrum “*in the hope that PTMP will be allowed at some stage in the future*”. Imagine recommend that by specifying that the PTP spectrum already in use will only ever be used for PTP will at least ring-fence this spectrum off from potential hoarding bidders.

Further, given the increased demand for spectrum, as seen by then demand in the other pioneer bands for 5G Imagine believes that the current proposed cap of 5 blocks will lead to hoarding of the spectrum, and drive up the cost due to a limited number of winners.

Imagine believes that demand for this spectrum because of this is higher than DotEcon is predicting, and it will not be a *“matter of cost but a matter of securing the spectrum just-in-case”*. Imagine believes that this will lead to inflated costs for operators who want to use the spectrum for PTP, which could lead to small operators being priced out of the award.

Imagine proposes that the spectrum caps in the award should be set such that there are at least 6 winners in the award process. Given that there would be 19 blocks available, this implies a 3-block cap.

Imagine argues for strict and clear terms of use of spectrum to prevent hoarding in the hope of using spectrum for 5G and PTMP in the future; there should also be restrictions on the existing PTP allocations to just PTP with no possibility of mobile or PTMP use, and obligations of use attached to this spectrum (particularly spectrum already in use).

Migration costs

Imagine states that replacing its hardware for 26 GHz PTP microwave links will cost *“100’s of thousands of euro”* if it has to shift its network to alternative spectrum.

Imagine believes that there is enough unused spectrum (i.e. not allocated currently) on offer at this award to satisfy the 5G NR and FTTH Wireless use cases. Therefore, only unused spectrum should be made available in the award, while spectrum that is currently allocated should be ring fenced for incumbent usage for a *“number of years”* to minimise migration costs.

Duration of licences

Imagine is of the opinion that the duration of the licences being awarded should be 15 years, in alignment with the 3.5 GHz licences.

2.3 Vodafone

Administrative award

Vodafone does not consider it to be the appropriate time for an auction of this spectrum and proposes the use of administrative assignment instead. Vodafone gives the following reasons to support the use of an administrative award:

- The migration costs for moving existing radio links will be considerable. In its response to the consultation, Vodafone provides estimates of the costs that it would incur if it were required to retune its equipment to different parts of the 26 GHz band, as well as greater costs of retuning the equipment to an alternative band outside 26 GHz. It also provides the approximate time it would take to implement these changes in its equipment.

- Vodafone states in its response to the Consultation that Vodafone's current blocks in the 26 GHz are being used very efficiently.
- Vodafone believes that there is enough unused spectrum (i.e. currently not allocated) in the spectrum being awarded, as well as in other parts of the 26 GHz band, to satisfy the current demand for such spectrum.
- Vodafone believes that it would not be possible to award spectrum licences – that are expiring in June 2018 – in the first half of 2018 without causing service disruption. Vodafone considers that to avoid risk of such disruption, it will have to submit bids much higher than their actual value of the usage rights.
- Vodafone highlights that the uncertainty in the standards for 5G use in the 26 GHz band, as well as the uncertainty over the possibility of both radio links and mobile use co-existing in this band, will not be resolved for at least 5 years. Vodafone therefore believes that the appropriate time to re-allocate spectrum licences in the 26 GHz band is at least 5 years away.

Given migration or retuning costs, current efficient usage of spectrum, timing of the award and uncertainty over the standards for 5G use in the 26 GHz band, Vodafone proposes an administrative mechanism for awarding spectrum usage rights with a licence term of 7 years, followed by a complete reallocation of the band in approximately 5 years.

Alternatives to proposed auction format

Vodafone suggests the following alterations to the auction format proposed by ComReg in the Consultation (in the case that ComReg decides to go ahead with an auction):

- A preliminary round seeking bids at the minimum price and then publishing total demand.
- Simple clock auction format of frequency-generic lots, followed by a process to automatically assign frequencies as close as possible to the current assignments.

The reason given for these suggestions is that Vodafone believes that - owing to the investments made in the current 26 GHz links that it possesses - it values them much higher than what it valued them in the 2008 auction.

2.4 Three

Alternative mechanism for awarding spectrum

Three proposes an alternative award mechanism based on extending existing licences and deferring any auction of new licences. In particular, Three proposes:

- extending the current licences on the same conditions until 2022/2023, with all licence terms being the same except for fees;
- postponing the auction proposed by ComReg in the Consultation until 2020, when standards for 5G use in the 26 GHz band are known;
- that ComReg should “signal” to all current users (including Fixed National, Fixed P2P, FWALA) that the band will be allocated to mobile service on a primary basis at WRC-19. This will ensure that all investments are made in knowledge that there is limited time to recover that investment; and
- making the two unused blocks within the Award Spectrum available to new users during this extension period.

Three has given the following reasons for its proposed alternative:

- Three highlights that the technical standards for 5G bands in Europe have not yet been finalised. Therefore, awarding licences with 10-year terms would risk delaying the availability of millimetre-wave 5G.
- Three believes that awarding spectrum rights of use with a 10-year term would encourage investment in new equipment in the band requiring several years to recover that investment, in turn excluding 5G from the band until 2028. By “signalling” to all current users that the band will be allocated to mobile services on a primary basis after WRC-19, Three believes that ComReg can prevent inefficient investments.
- Three believes that the current use of the band by FWALA and Fixed P2P users (both national and individual) is not compatible with 5G. Three is of the opinion that spectrum operated in TDD mode rather than FDD mode would be the basis for the provision of 5G services. This requires the band to be contiguous. While there is currently 1,863 MHz of unused spectrum in the band, it is disaggregated into three blocks by the use of fixed links (both national and individual) and FWALA, both of which use an FDD layout. The existing FDD use “cuts up” the band and makes it unsuitable for TDD 5G use.
- Three is of the opinion that it will not be possible to convert fixed link licences to liberalised use shortly after 2020. It is of the opinion that even one fixed user in the band would prevent liberalisation of the band and delay the introduction of 5G.
- A minimum of 2 years would be required for transition after the award. This is because there will be significant equipment re-tuning costs.

Frequency generic vs. frequency specific

If ComReg decides to go ahead with an auction, Three has stated its preference for the award of frequency-specific lots over frequency-generic lots, as *“a frequency generic auction that uses a separate assignment stage could deliver a sub-optimal outcome”* in the case that an existing licensee were to acquire frequency-generic lots at a price in excess of the value of the specific frequencies it was

ultimately awarded in an assignment stage. In that regard, Three notes that the cost of re-tuning existing equipment is comparable to the cost of replacing the equipment entirely, making re-tuning commercially infeasible.

2.5 CBNL

Technology and service neutrality

CBNL believes that P2P and PMP are complementary technologies, and it is desirable for an operator to be able to choose freely between them depending on the local environment. Although CBNL agrees that the pace of technological development of 26 GHz P2P has been faster than that of PMP in recent years, it highlights the increasing interest in millimetre-wave spectrum for 5G, owing to which the current trend of comparatively slower growth of PMP technology in the 26 GHz band might reverse in the future. It therefore proposes the National Block Licences (being made available in the Award Process) to be technology and service neutral, i.e. allow for the deployment of P2P or PMP links.

2.6 GSA

Early deployment of 5G technology

GSA disagrees with the current proposal to award National Block Licences in the 24.5 GHz – 26.5 GHz portion of the 26 GHz band, to fixed radio link systems on a primary basis for 10 years. GSA believes that the current proposal would substantially reduce the opportunity for developing 5G services and applications in Ireland in a timely and harmonised manner. According to GSA, the availability of suitable spectrum in the 24.5 GHz – 27.5 GHz range is essential for 5G to unfold its full potential.

GSA envisages spectrum in the upper part of the 26 GHz band (26.5 GHz – 27.5 GHz) being assigned for 5G use in the 2019 timeframe by many countries across Europe. GSA also notes that 5G trials in the millimetre-wave range of spectrum are proliferating in both Europe and outside Europe, and that chipset, terminal and infrastructure manufacturers have announced the availability of equipment for pre-commercial and commercial deployment of 5G implementations in 2018 – 2019.

GSA invites ComReg to consider the following alternatives to the current proposals:

- awarding the upper part of the 26 GHz band (26.5 GHz – 27.5 GHz) for 5G use by means of 400 MHz of contiguous bandwidth for nationwide spectrum per network with availability for deployment in the 2018-2019 timeframe;

- enabling the option of deployment of 5G in the 24.5 GHz – 26.5 GHz spectrum;
- awarding the 24.5 GHz – 27.5 GHz portion of the 26 GHz band in line with the Radio Spectrum Policy Group (RSPG) opinion on 5G, which recommends member states to make part of the 26 GHz band available for 5G before 2020.

2.7 Ericsson

Early deployment of 5G technology

Ericsson acknowledges the current uncertainty regarding the standards for 5G use in the 26 GHz band, but highlights that the development of an ECC Decision on harmonised technical conditions for 26 GHz for 5G is on track for delivery in June 2018. Ericsson also points out the availability of a 26 GHz 3GPP standard in 2018, as well as the assignment or plans for assignment of the 26 GHz band for 5G use in several European countries (i.e. Italy, UK, Germany, France, Sweden and Finland). Further, Ericsson notes that 26 GHz 5G infrastructure and devices are expected to be available from multiple vendors by 2019.

Ericsson has expressed its concern regarding ComReg's current proposal – to award 10 year National Block Licences to be used for fixed radio links systems – without a broader public consultation on the use of the entire 26 GHz band for 5G. According to Ericsson, this has left several questions unanswered, such as:

- Will there be any 26 GHz spectrum released for 5G in the short term?
- What is the future of the block of spectrum reserved for individual links?
- What is the future plan for the FWALA licence blocks?
- What is the expectation for the future usage of the National Fixed Link blocks after the proposed 10-year licence period?
- The current proposal will encourage new fixed link investment but not allow enough time for depreciation. Under these conditions, how will re-evaluation of usage mid-term of the proposed 10-year licence period be conducted?

Ericsson suggests initiating a public consultation on the use of the 26 GHz band for 5G, covering the appropriate time windows for the release of each sub-band for 5G use, and the need to transform the sub-bands from FDD to TDD. Ericsson is of the opinion that this consultation should be completed in advance of a primary award of the National Block Licences for fixed link radio systems.

Ericsson has also suggested that ComReg should limit the fragmentation of the 26 GHz band so that individual licence rights holders can acquire at least 400 MHz – 500 MHz and up to 1 GHz of contiguous spectrum.

2.8 Eircom Group

Eir agrees with the current proposal to award National Block Licences for P2P use in the 26 GHz band. In particular, Eir agrees with the use of the Sealed Bid Combinatorial Auction (SBCA), the size of the National Block Licences, the restriction of using the spectrum rights of use only for FDD and deployment of P2P links, and the registration of 'transmit high' and 'transmit low' sites and the maintenance of a register of site and transmission information. Eir is indifferent between the use of frequency-specific or frequency-generic lots.

Delays in availability of licences

Eir agrees with the 10-year licence terms.

Eir has expressed concerns regarding delays in the availability of the spectrum for actual use after it has been awarded to winners of the award process, owing to the small amount of time available before the current licences expire. Eir has suggested that ComReg should meet the current deadlines for the award process and ensure the spectrum licences are available for use on the 6th June 2018. However, if there is a delay in the award process, Eir recommends the start date for using the licences should be postponed appropriately in order to respect the 10-year term.

Caps

Eir suggests that ComReg's objective of ensuring efficient use of spectrum might be better served by a cap of 4 blocks, instead of the current proposed cap of 5 blocks.

3 Our assessment

In this section we set out our response to the points raised above. This is organised thematically within the following subsections.

3.1 Future 5G use and licence duration

Use of the band for 5G

The RSPG first opinion on a 5G roadmap in 2016 (RSPG16-032) identified the band 24.25 GHz to 27.5 GHz as a "*pioneer band*". It recommended that Member States "*make available a portion of this frequency band for 5G in response to market demand, taking into account that 5G deployment in this frequency range is likely to remain geographically limited by 2020*" (emphasis added). This position has been confirmed in the recently published second RSPG opinion on 5G (RSPG18-005). In particular, the RSPG is of the opinion that:

- The 3.4 – 3.8 GHz band is the primary band for initial 5G deployments in Europe; and
- “Member States should make by 2020 a sufficiently large portion of the band, e.g. 1 GHz, available for 5G in response to market demand.” (§9, RSPG18-005).

Note that the RSPG has never recommended that the *entire* 26 GHz band be made available for 5G by any particular date. In particular, the second opinion notes that “[r]egulatory flexibility for the progressive release of the 26 GHz band will facilitate an efficient introduction of 5G without having an unnecessary negative impact on the current users of the band.” (§9, RSPG18-005) Therefore, there is a balance to be struck between making a sufficient part of the band available for 5G and avoiding adverse impacts on existing users.

Note that the RSPG opinion does not imply that the band is anticipated to be in widespread use for 5G by 2020. In particular:

- The RSPG opinion identifies 3.4 GHz as the most likely band for initial deployment of 5G-based services, rather than the 26 GHz band;
- In its response, Vodafone states that it does not foresee the 26 GHz band being used for 5G for at least 5 years (i.e. after 2023). Similarly, Three calls for the extension of fixed link licences to 2022/23, with a further 2 years being needed to reorganise the band for 5G (i.e. 2024 at the earliest before 5G can be used).

The proposed re-award of the 19 blocks in the duplex range 24.745 – 25.277 GHz paired with 25.753 – 26.285 GHz is needed to ensure continuity of existing services using fixed links. This would not preclude 5G TDD use in the upper part (26.5 – 27.5 GHz) of the 26 GHz band, in line with the recommendations of the RSPG roadmap. Both Qualcomm and the GSA identify the 26.5 – 27.5 GHz sub-band as being the most relevant for deployment of 5G within the band.

Calls made by Ericsson, the GSA and Qualcomm for re-consultation on a broader range of options for the band disregard the pressing need for re-award of fixed link licences to ensure continuity of services. In contrast, Eir stresses the need for ComReg to meet the current timetable for this award to ensure continuity of services using fixed links. Qualcomm’s call for award of the upper part of the 26 GHz band for 5G services is premature given current uncertainty about any future harmonisation decision on foot of the RSPG opinion and the expectation that the 3.4 GHz band will see the first deployment of 5G services, not the 26 GHz band.

In our initial report, we pointed out that there was potential for coexistence of 5G and fixed links. However, respondents have noted that many fixed links are in urban areas, potentially frustrating geographically-based spectrum sharing. The extent of future

coexistence is a matter for subsequent detailed consideration based on relevant technical studies. Nevertheless, it remains relevant that that it might be possible for there to be limited coexistence of 5G and fixed links in the in the duplex range 24.745 – 25-277 GHz paired with 25.753 – 26.285 GHz, though this might indeed require some substitution of specific links by fibre or links at other frequencies to mitigate interference in certain areas. It would also remain possible for ComReg to curtail fixed link licences at some subsequent date if it became clear that the demands of 5G services could not be met by spectrum in the 26.5 – 27.5 GHz range (or more broadly, above 26.285 GHz). Therefore, although it is too early at this stage to judge what actions might be needed to accommodate future demand for millimetre wave spectrum for 5G, there are options available to ComReg to use the Award Spectrum to meet such demand at a future time; these options are not foreclosed by re-awarding this spectrum for continued use by fixed links provided that the licence duration is not excessive.

Therefore, ComReg's proposed approach is consistent with RSPG's 5G roadmap. Allocation of the Award Spectrum for fixed links does not preclude 5G use in the other parts of the broader 26 GHz band, with 1 GHz potentially available at the top of 26 GHz band for 5G, in line with the RSPG's second opinion. ComReg retains policy options to comply with any future harmonisation decision by the EC should that arise.

Furthermore, regardless of the licence duration set for the Award Spectrum, it would be possible for ComReg to run a future award process for this spectrum well in advance of licence expiry. This could then take into account any future 5G harmonisation decision relevant to the band and provide reasonable time for transition planning, thereby allowing redeployment of spectrum for new 5G applications shortly after expiry of the previous fixed link licences.

In addition, it would be possible to award spectrum in the 26.5 – 27.5 GHz range prior to expiry of fixed link licences lower in the band. Awarding spectrum in the 26 GHz band for 5G in two separate processes (i.e. 26.5 – 27.5 GHz and then subsequently fixed link spectrum) might require measures to allow reorganisation of spectrum holdings into larger contiguous blocks. Nevertheless, this would allow at least some 26 GHz spectrum to be made available on a timely basis for 5G whilst at the same time ensuring an orderly transition of fixed links out of the band. These are all matters that ComReg may wish to consider in its next Spectrum Strategy Statement; for now, we simply note that these possibilities exist for reducing any potential delays that might be caused to 5G deployment within this band.

Speculative motives for spectrum acquisition

Our first report highlighted the risks of awarding spectrum in this band with a lack of clarity about whether 5G use might be allowed, potentially creating incentives for speculative acquisition of spectrum. This would risk the efficiency of the award process if some bidders valued lots on the basis of providing fixed links and others on the chance that some future regulatory change might possibly enable 5G use. This would be unfair both to fixed link users and also future 5G users, who might find access to this spectrum foreclosed by existing usage rights. It could also encourage speculative acquisition of spectrum that might then lie idle, contrary to ComReg's objective of ensuring efficient spectrum use.

Whilst clarity could be given by permitting future 5G use, there is significant uncertainty about possible future harmonisation and the time at which this spectrum might be needed for 5G; furthermore, the FDD configuration for fixed links is not amenable to 5G use, which would require a TDD plan. For these reasons, we recommended in our first report that ComReg provide clarity and avoid speculative incentives by taking the exceptional measure of restricting licences to fixed link use only.

Imagine raise similar concerns about speculative demand for spectrum. Therefore, the concerns expressed in our first report are far from hypothetical and support restricting the terms of the licence to exclude 5G deployment. This is a deviation from ComReg's usual approach of technology and service neutral licensing, but – as with the atypical approach to license duration - is justified on this occasion due to the special circumstances applying, with it being likely that part of the band will be mandated for 5G use, but the timescale and other details being uncertain.

Three points out that 5G use would require TDD spectrum, rather than FDD spectrum. Therefore, it is likely that any future 5G use would anyway require cessation of FDD use by all licensees to allow reorganisation of the fixed link spectrum into a TDD pattern. This need for a coordinated approach to future migration to alternative uses should reduce incentives for speculative acquisition of spectrum as it is likely to be difficult for any individual licensee to re-purpose their spectrum for 5G when in a FDD configuration.

It would be possible for P2P licences to be liberalised to allow 5G at some future date (subject to reorganisation of frequencies held), rather than these licences expiring and new, technology- and service-neutral licences be awarded. However, we recommend that ComReg – subject to the need to consider future decisions on their merits in the light of the information available at the time - indicate that it does not expect to liberalise these licences for 5G in the hands of existing licensees and instead re-award new licences. This approach is needed because it would be very difficult to determine an appropriate price for 5G liberalisation; in turn, this would create a

significant risk that P2P licences would be demanded to obtain an option on 5G spectrum that could be valued very differently by different bidders according to the expectations they each hold about ComReg's future decisions.

In summary, we consider that incentives for speculative spectrum acquisition are likely to be largely mitigated by ensuring that fixed link licences are relatively short and that there are restrictions on use to just P2P fixed links. Therefore, we consider that Imagine's concerns about speculative spectrum acquisition should be largely addressed by the current proposals for restricted use licences.

Licence duration

In our initial report, we set out how there was a tension between issuing longer licences – that were more likely to run into conflict with future 5G use of this band – and maintaining incentives to invest in new network equipment. As such, we recommended a 10-year licence to balance these considerations, which is shorter than typical spectrum licences awarded by ComReg (for example in the 3.6 GHz award) because of the particular circumstances applying to this spectrum.

Some MNOs responded that they wanted existing fixed link licences extended by 5 years and with an additional transition period for moving to 5G (which was suggested to last 2 years by Three). On this basis, it is unlikely that there would be demand from MNOs for use of this spectrum for 5G for at least 7-8 years, and one would assume that the estimates provided are based on an optimistic view of the likely move over to 5G. Therefore, at least on the basis of the evidence provided in the responses, a licence duration in the range of 8-10 years would be unlikely to significantly delay 5G deployment plans within this band. Furthermore, the 3.4 GHz band is likely to be the initial 5G band and other spectrum within the 26 GHz band, such as 26.5 – 27.5 GHz, could be made available prior to expiry of licences for the Award Spectrum.

In its response, Three considered that 10-year licences would risk delaying 5G deployment. At first sight, this view is not entirely consistent with Three's proposal that fixed link licences be extended to 2022/23 with an additional transitional period then being required. It could be that Three believes it can identify a rather narrow time window when fixed link spectrum would need to be reconfigured for 5G TDD use without either endangering fixed links or delaying 5G. However, such a high degree of certainty about the timing of future developments strains plausibility; it is also unclear what assumptions Three is making about the use of the 3.4 GHz band for initial 5G deployment when offering these views. Therefore, whilst longer licences will inevitably carry a greater risk of delaying 5G deployment within the band, there is little concrete

evidence that a 10-year licence would run a much greater risk of causing substantial delays.

As discussed above, it is important for the efficiency of the award process (and also the subsequent efficient use of spectrum) that these licences do not become a back-door means to acquire spectrum for 5G; there is a risk of both inefficiency and unfairness if some bidders are bidding on the basis of needing spectrum to continue existing fixed links and others are bidding for access to 5G spectrum in the future. A shorter licence duration would assist in reducing any such possible speculative motives for bidders, and in this regard there may be some benefit in applying a somewhat shorter licence term. However, ComReg is using other measures to help mitigate this risk, such as licence restrictions that limit use of the spectrum to P2P. This, combined with expectations over the timing of 5G deployment in the band and the likely use of 3.4 GHz for initial 5G deployment, means that it is unlikely that incentives to speculatively acquire 26 GHz spectrum for 5G would be significantly *further* reduced through applying a licence term shorter than the proposed 10 years.

Eir is in agreement with the proposed 10-year licence term. Although it generally considers longer licence durations to be more supportive of efficient spectrum use and reasonable return on investment, it recognises the exceptional circumstances around the future use of the 26 GHz band and believes that, on balance, 10 years is a reasonable term.

Imagine expressed a contrary view, favouring a longer 15-year licence term to align with the length of 3.6 GHz licences. However, this is not a compelling argument, as very different considerations apply to the duration of the proposed 26 GHz fixed link licences compared with those that applied for the 3.6 GHz licences. In particular, the proposal for atypically short licences is due to the unusual situation prevailing here regarding the likelihood of eventual migration to 5G use. No such consideration applied in the case of 3.6 GHz, so the licence duration was set in line with ComReg's typical policy.

Overall, whilst we consider that there might be some merit in reducing the licence term, we do not believe that there would be a significant advantage in making licences shorter than 10 years. Therefore, we remain of the view that 10-year licences provide a reasonable balance between mitigating the risk of interfering with 5G deployment and allowing for a reasonable return on investment.

3.2 Technological neutrality and FWA

In our first report, we outlined how spectrum allocated for P2MP use in 2008 has over time been migrated to P2P use. On this basis, we considered that there was little evidence of demand for P2MP use in

this band and that the award process could be simplified relative to 2008 by making licences available for P2P use only.

CBNL call for spectrum to be awarded in a technology and service neutral manner to allow P2P or P2MP use (and further call for an increase in the spectrum allocated to FWALA relative to the current position). However, Imagine, as a FWA operator, has a very different view, as they appear to see FWA deployment in this band being linked to future availability of 5G technologies; therefore, Imagine's main concern is that any restriction of usage to P2P be firmly and credibly applied so that speculative acquisition of spectrum for 5G is discouraged, with a subsequent future award of spectrum reconfigured as TDD appropriate for 5G FWA deployments. CBNL do not appear to have made the same link between 5G and FWA deployment within this band.

In the near-term, FWA services are likely to be deployed in the 3.6 GHz band². Use of the 26 GHz for higher bandwidth FWA service is likely to be linked to the use of 5G and occur over a longer time-frame. Therefore, enabling FWA services in the 26 GHz band depends on setting the duration of fixed link licences such that the band can be reorganised into a TDD band plan to support 5G deployments at an appropriate later time. As already discussed above, this also means ensuring that bidders cannot acquire licences for P2P use now that provide a toe-hold on future technologically neutral licences that can be used for 5G applications (including FWA).

The difficulty with permitting P2MP use (along with P2P use) is that this could provide just such a backdoor route to 5G deployment without subsequent re-award of the spectrum as technology- and service-neutral licences. This risks an unfair situation amongst bidders in the current award and an inefficient outcome if just some bidders believe there is a chance that a fixed link licence is an implicit option on future 5G spectrum. Furthermore, widespread P2MP use is likely to both make it more difficult to avail of any coexistence possibilities with 5G and also to transition to a band plan more compatible with 5G. For these reasons, we recommended that licences be offered for P2P use only, in line with currently observed patterns of use.

² FWA services are also provided in the lower part of the 26 GHz band (24.549 – 25.753 GHz) and 10.5 GHz band.

3.3 Administrative award or award of currently unallocated spectrum

Both Vodafone and Three argue for extension of existing licences with an administrative charge. However, this proposal has a number of difficulties.

First, the proposed licence duration compatible with future migration to 5G is of the order of 10 years, so any extension would be of a considerable length. This means that existing licence holders would be gifted a significant additional usage right. Setting an appropriate administrative charge reflecting the likely market value of the spectrum would be challenging. The band was undersubscribed when awarded in 2008 but, as noted by a number of respondents, is likely to be oversubscribed now; the previous award tells us nothing about likely market value now. Also, there is little benchmark data from other awards of 26 GHz spectrum. Prices of other millimetre wave bands are not relevant in that these are not earmarked for early 5G deployment.

Second, the current arrangement of frequency holdings in the band has fragmented unallocated spectrum. Simply extending existing licences would cement this situation and may deny usable spectrum to new licensees due to the need for contiguous spectrum blocks. An alternative might be to use an administrative process that sought to extend existing licences, but reorganised frequency holdings to consolidate currently unallocated spectrum. However, this would raise the question of how a frequency reorganisation should balance the interests of different licensees, given that each is likely to have their own particular costs of moving to different frequencies depending on the tuning ranges of their current equipment; it would be difficult to elicit that information truthfully without use of a competitive process.

Third, extending licences would protect existing licensees from growth in demand for fixed link spectrum since 2008 (both from new licensees and also licensees holding smaller amounts of spectrum wanting more). The allocation prevailing from the 2008 award would continue, but we cannot assume that this will be the efficient outcome going forward. There is the possibility that it could be more efficient for licensees holding larger number of blocks to free up some blocks to accommodate other licensees. In particular, Three currently holds 5 blocks, whereas with current technologies, the greatest number of blocks that can be used together on a fixed link is 4. Cementing in place a historic allocation that might not now be efficient would be contrary to ComReg's duties to ensure that spectrum is efficiently assigned and used.

Therefore, we recommend that ComReg maintains its current proposals to award licences of a reasonable duration by auction.

3.4 Competition cap

In our initial report, we recommended a competition cap of five blocks. This is a limit on the number of blocks that any one bidder can acquire in the award, not an ongoing limit on spectrum holdings in the band. If there were any subsequent spectrum transfer or merger involving this spectrum, the competition impacts would need to be assessed in the light of the contemporaneous circumstances.

There appears to be broad support for the application of a competition cap to the award process, though there were two calls for the cap to be reduced. In particular:

- Imagine called for the cap to be reduced to three blocks, primarily in response to risks of spectrum hoarding; and
- Eir called for the cap to be reduced to four blocks, as there is no current technical use case for five contiguous 28 MHz blocks for fixed links.

Imagine's proposed 3-block cap would result in two existing licensees (Vodafone and Three) having to reduce their current holdings. It would preclude the use of four contiguous 2x28 MHz blocks together to provide high capacity fixed links and so significantly restricts usage possibilities. Such a cap is also severe in terms of its effects on competition for spectrum, in that at least seven bidders would then be required for a competitive auction. There is no need to ensure such a large number of winners to protect competition in any downstream market.

Furthermore, whilst we agree with Imagine that it is relevant to consider the risk of spectrum hoarding (which could result if there was the possibility that spectrum could be acquired in hope that this might later allow 5G use), this does not justify such a restrictive cap. The primary instruments for mitigating this risk are usage restrictions on licences and setting a licence duration that is not too long.

Eir's argument for a 4-block cap has more merit. In our first report, we set out how the current proposal for a 5-block cap adequately protects competition, in that this ensures at least four winning bidders (given sufficient demand for spectrum). However, we considered that setting a lower 4-block cap would require clear justification given that Three already holds 5 blocks from the 2008 award.

Eir note that a 4-block cap should be sufficiently liberal to allow efficient deployment of P2P links given current technology, a point also noted in our original report. Given this, it seems unlikely that there would be a business case for five blocks unless additional spectrum was being acquired speculatively, rather than for the deployment of P2P links. Therefore, provided the proposed restriction of usage to P2P fixed links is effective and credible, it is

unlikely there would be winners of 5 blocks in any auction in which there was significant competition for the available spectrum. Indeed, we note that Three's holding of five blocks from the 2008 auction was due to demand expressed at reserve prices, which went unchallenged by any competition (as there was under-subscription of the available spectrum at that time). However, we understand that Three is currently using all five blocks at present, and clearly we cannot anticipate whether Three would continue using five blocks or consolidate to four or fewer if it were faced with higher spectrum costs.

A benefit of a cap of four blocks over five blocks is that the greatest amount of unavoidable retuning that any bidder would face is reduced. This is discussed in detail in Section 3.5 below, but the intuition is that with a lower cap, the available spectrum will be more finely divided amongst winning bids. This in turn enhances opportunities for existing licensees to make assignment stage bids for frequency options closer to their existing frequency holdings. However, the impact on assignment options from reducing the cap from five blocks to four is fairly limited, as we demonstrate in Section 3.5 (with fuller details in Annex 1).

On the basis of the concerns discussed above about the possibility of spectrum hoarding driven by speculative spectrum acquisition for 5G, we consider that there could be some merit in reducing the competition cap to four blocks. However, in practice it is unlikely that the outcome of the award will be affected by whether a 4- or 5-block cap is used, given that a number of respondents expect competition for the available spectrum. Given this, and the fact that Three is making use of all 5 blocks currently licenced to it, we consider that overall there is no compelling need to reduce the cap, and recommend proceeding with the original proposal for a competition cap of five blocks.

3.5 Migration costs and design of lots

Nature of migration costs

Both Vodafone and Imagine confirmed that there are costs associated with moving existing licensees fixed links to different frequencies. Vodafone confirmed that these costs are related to either retuning existing equipment or, if the shift frequency is sufficiently large, replacing equipment at greater cost.

Replacement of equipment may be necessary if frequencies are changed beyond the tuning ranges of existing equipment. Tuning ranges are narrower than the award spectrum, which would, depending on the equipment manufacturer, be covered by two or three distinct tuning ranges, although these tuning ranges are not standardised across equipment manufacturers. For example, in its

response Vodafone reports that the equipment it uses is produced for two different sub-bands:

- Sub-Band 1: 24,549 – 24,997 MHz / 25,557 – 26,005 MHz; and
- Sub-Band 2: 24,997 – 25,445 MHz / 26,005 – 26,453 MHz.

Given the location in the band of the blocks currently licenced to Vodafone, it uses equipment manufactured for Sub-Band 2.

Three also provided information about its tuning ranges in confidence. The broad pattern is similar, in that Three has a certain degree of flexible to move up and down within the band by retuning without needing to replace equipment.

This has a number of implications:

- Because tuning ranges are fairly broad in comparison with the ranges of frequencies held, any existing licensee using similar equipment on all links should be able to retune in at least one direction (i.e. up or down);
- It is possible that a licensee might have a frequency allocation at the edge of a tuning range, in which case it might only have frequency flexibility in one direction (e.g. if allocated frequencies at the lower end of tuning range, it can retune upwards, but would need to replace equipment to move a frequency allocation downwards);
- Where a licensee has a mix of equipment with different tuning ranges, this might constrain its ability to relocate within the band without having to change at least some equipment. Equally it may have a greater degree of flexibility without having to replace all of its equipment;
- The specifics of what retuning flexibility existing licensees might have cannot be readily anticipated, as this depends on the specific equipment they have installed;
- Costs of retuning and/or changing equipment could vary significantly across licensees according to the number of links affected, their locations and the age of affected equipment.

Should migration costs be minimised?

Because existing licensees may be in rather different positions, any need for frequency changes will not affect different parties in a uniform or predictable manner. Therefore, we consider that Vodafone's proposal that an administrative procedure could be used to assign frequencies to minimise migration costs for existing licensees is highly impractical. We do not know individual licensees' migration costs, nor would we know how to weigh the interests of competing parties (for example, where one of two existing licensees might need to move). Furthermore, asking for statements of migration costs as inputs into some administrative frequency allocation rule would give a clear incentive for existing licensees to overstate them as, in contrast to a competitive auction process for

frequency assignment, there would be no financial consequences from those statements.

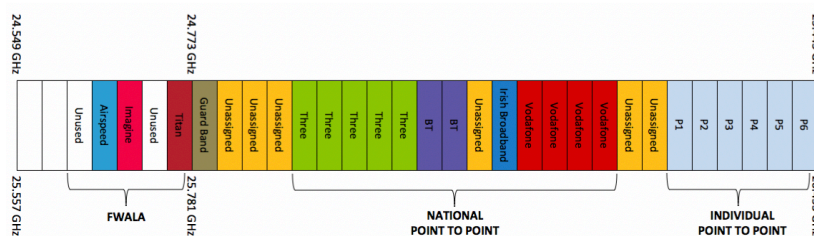
Whilst it is relevant to avoid *unnecessary* costs of changing frequencies, at the same time it is important that existing licensees are not given enhanced rights over spectrum that endure past the end of their licences; to do so would establish a poor regulatory precedent. This would be unfair to parties who wish to acquire spectrum (either new licensees or existing licensees wanting more spectrum). As already discussed above, if existing licensees were given a right to maintain existing frequencies, this would lead to currently unallocated lots being fragmented and limit the contiguous spectrum available to others. For this reason, we consider that the proposal to extend existing licences and award only currently unallocated spectrum could be grossly unfair.

Therefore, the proposed auction design must provide fair opportunities for reallocation of the available spectrum and for new entry, whilst at the same time avoiding unnecessary migration costs due to existing licensees needing to change frequencies. This does not mean that migration cost should not be incurred at all, but rather a balance struck; incurring some moving costs may be necessary and efficient to ensure that other bidders can receive contiguous frequency assignments.

Extent of likely migration

The proposed Sealed Bid Combinatorial Auction – with either frequency-generic lots or frequency-specific lots – would allow competition between existing licensees wanting to maintain existing frequencies with new demand that might require shifting existing licensees to different lots. However, in practice, we would expect that the need for frequency migration would be rather limited, as we demonstrate below.

Figure 1: Current frequency allocations



Considering the current frequency allocations shown in Figure 1 above, we can see that the need for existing licensees to move frequencies to allocate new users (or expanded allocations to existing users) arises from the current fragmentation of unallocated

lots and the possibility that these might need to be combined to meet new demands for contiguous allocations. However, even if all existing licensees hypothetically maintained their existing number of blocks, it would always be possible to consolidate all of the unallocated spectrum by shifting an existing user no more than three blocks along (e.g. consolidate all unallocated spectrum at the bottom of the band).

There are also scenarios for accommodating additional users that do not require any frequency changes at all from existing users. Because the current guard block at the bottom of the band will now be available, there are four contiguous blocks (at present the maximum useable together on a single P2P link) available without any frequency changes being needed. If existing users do not retain all of their current blocks (e.g. if Three were to contract from five blocks to four), then there are further opportunities to meet new demand without frequency changes.

Therefore, in practice, we would not expect that large-scale changes in frequency allocations would be necessary for existing licensees who retain generic spectrum. In most plausible scenarios, it should be possible for most existing licensees holding larger number of blocks (i.e. Three and Vodafone) to retain at least some of their existing frequencies and in any case for all existing licensees to obtain blocks fairly close to existing holdings.

We can formalise these intuitive observations by looking at the frequency assignment options that would be available in the assignment stage to an existing licensee who, in the main stage, had won back the same number of generic blocks as it currently holds. In particular, we can calculate whether there are frequency assignment options on which an existing licensee could bid that are close to their existing frequencies, regardless of how many generic lots were won by other bidders (though taking into account that other bidders would not win more than the proposed five block cap).

For example, considering Vodafone as an example, given the proposed five block cap, the worst-case scenario is that the need to allocate contiguous spectrum to other winners would require Vodafone to either move up two blocks to the band edge, or move down at most three blocks (to accommodate an additional winner above Vodafone); both assignment options would be available for Vodafone to bid on in this scenario. Note, however, that this does not constitute a guarantee to Vodafone that it would move at most two blocks up or three blocks down from its current holdings, but only that it would have the *option* to compete for those frequencies. It is worth highlighting that this worst-case scenario for Vodafone occurs only in the somewhat implausible situation where three other winners have won five blocks each, and arises because of the need to “claw back” the two blocks above Vodafone’s existing holdings in order to assign the other winners contiguous frequencies. In other scenarios, there may be frequency assignment

options that involve Vodafone having the opportunity to bid for frequencies even closer to its current location in the band, and in fact no other scenario would require Vodafone to move by more than two blocks up or down (see Annex 1 for details). The specific options available would, however, depend on exactly how the generic lots divide amongst the winners.

We have computed the frequency assignment options available to each existing licensee (assuming it retains the same number of blocks currently held) across all the possible scenarios for how the available generic lots might be divided across winners under a 5-block cap. We have then found the worst-case scenario in terms of the proximity of frequency assignment options to that licensee's existing frequency holdings. Table 1 below shows the worst-case frequency assignment options available to each existing licensee if it were to retain the same number of blocks as currently assigned.³ For example, suppose that the Irish Broadband licence for a single block would be retained. Given a 5-block cap, there always exists a possibility (but not a guarantee) – compatible with all other winners receiving contiguous assignments – of assigning frequencies to Irish Broadband at most one block below the currently assigned frequencies or at most two blocks above the currently assigned frequencies.

³ There are some scenarios where it would not be possible to assign all winning bidders contiguous frequencies without having to relocate an existing licensee (that has won the same number of blocks as currently assigned) within the band. With the term "necessary movement", we refer to the minimum extent to which an existing licensee will be required to move within the band, relative to the blocks it currently holds, in order to accommodate contiguous frequencies for all winners. This will vary depending on the number of blocks awarded to other winning bidders, but for any existing licensee there will be a maximum amount of necessary movement that it could face, taking into account all possible ways in which the other blocks could be allocated (within the competition cap) – this is the worst-case scenario for that bidder.

Table 1: Worst case assignment options for existing licensees under a 5-block cap

Existing licensee	Max. movement up	Max. movement down
Vodafone	2	3
Three	1	1
BT	1	2
Irish Broadband (Imagine)	1	2

This analysis does not imply that there is guarantee that an operator will not move frequencies by more blocks than specified in the table, but only that they will have the option to bid for frequency ranges that are within a certain number of blocks away from their current holdings. The final frequency assignments and the extent to which existing licensees will be moved within the band will be determined based on the bids submitted in the award process (regardless of whether frequency-generic or frequency-specific lots are used).

If a 4-block cap is used instead of a 5-block cap, the analysis above is somewhat changed. A tighter cap means that the generic lots will be more finely split amongst winners of the main stage. This will give greater opportunities for existing licensees to bid for frequency options close to their existing frequency holdings. The corresponding results for a 4-block cap are shown in Table 2 below.

Table 2: Worst case assignment options for existing licensees under a 4-block cap

Existing licensee	Max. movement up	Max. movement down
Vodafone	2	1
Three (winning 4 blocks)	1	1
BT	0	0
Irish Broadband (Imagine)	0	0

In particular, under a 4-block cap, both BT and Imagine will *always* be presented with a bidding option in the assignment round for retention of their existing frequencies. Also, for Vodafone, the worst

case scenario under a 5-block cap was that it would need to move down (at least) three blocks or up two blocks; with a 4-block cap, the worst case improves to having to move down one block or up two.

When considering Three's frequency options, we assume that Three retains four of its current five blocks, in line with the assumed 4-block cap. For Three, the worst case is that there would either be a frequency option with the boundary of these four blocks one block below the lower boundary of its current five blocks, or a frequency option with the boundary of these four blocks one block above the upper boundary of its current five blocks; in either case, three of the four blocks overlap with its existing frequency allocation.

Therefore, reducing the cap from five blocks to four blocks does allow existing licensees to bid for frequency options closer to their existing holdings, but the impact is modest. In both cases, migration costs are likely to be limited to retuning if existing licensees make successful bids for frequencies close their existing holdings.

Annex 1 provides, for each existing licensee, details of the scenarios (i.e. the distribution of blocks amongst other winning bidders) in which the licensee, if winning the same number of generic blocks as it currently holds, would not be provided with an assignment option for retaining its current frequency assignment. For each of these scenarios, we indicate the corresponding distribution of generic blocks amongst the other winners as well as the minimum movement (up or down) that would be necessary to accommodate the other winners. This is shown for both the 4-block and 5-block cap cases.

Frequency-specific vs. frequency-generic lots

Given the discussion above, it is likely that migration costs for existing licensees will be limited to retuning. Therefore, it is reasonable to use a frequency-generic approach. In bidding for frequency generic lots, existing licensees' primary concern will be the number of lots they win, which determines the maximum bandwidth on a fixed link. It would be reasonable for an existing user who won frequency-generic lots to assume that it would be likely to win back its existing frequencies or a frequency assignment that allowed retuning, rather than needing equipment replacement. In addition, (assuming no strategic bidding) we would not expect the total prices to be paid by existing licensees to be substantially different under a frequency-generic or frequency-specific approach. Therefore, we consider that existing licensees would not be unduly affected by using frequency-generic lots.

Indeed, we note that Vodafone appears to support the use of frequency-generic lots, given its stated preference for using a simple clock auction followed by an administrative process to determine the specific frequency allocation that sought to re-award

currently held frequencies. Three disagreed with this view and favoured frequency-specific lots due to the issue of migration costs. However, unlike Vodafone, Three did not provide any specific information about the likely structure of migration costs. However, as seen in the previous subsection, if existing licensees win back spectrum it is likely to be possible to win back a frequency allocation that is fairly close to the existing assigned frequencies.

More fundamentally, the use of frequency-specific lots would raise a number of broad concerns:

- Existing licensees would have strategies available to fragment currently unallocated spectrum to exclude new demand given the need for contiguous frequency allocations;
- It might be possible for a bidder to make price-driving bids intended to increase the price paid by an existing licensee if that bidder knows that the existing licensee would face a significant cost (due to the need for new equipment).

For these reasons, and given the lack of any consensus from existing licensees on this issue, we recommend that a frequency-generic approach is adopted. This would also ensure that the more important main stage of the auction determining the allocation of generic lots was neutral in its treatment of existing licensees and new bidders.

3.6 Choice of auction format

Vodafone believes that although the sealed bid combinatorial auction format was successful in 2008, the format is no longer the most appropriate due to the large investment they have made in radio links within the band, and the implications that has for their value for the spectrum compared to the previous award.

Vodafone believes that an improvement on the proposed format would be to run a preliminary round seeking bids at minimum prices and then publish demand. A second round could then be run if required (presumably if total demand were to exceed supply at minimum prices). Vodafone does not provide details as to what this second round would entail, but we assume it could simply mean running the proposed sealed bid combinatorial auction after the preliminary round. Vodafone's reason for having the preliminary round is that it "*would enable bidders to have some information on demand and bid accordingly should a second round be required*". It is not clear to us what benefit this information would provide, and Vodafone has not elaborated.

As discussed in our auction design report (17/85a), an open auction format can be useful in cases where there is common value uncertainty or where the award is particularly complex. Given that, in the context of this 26 GHz award, common value uncertainty is likely to be limited and the structure of the band is relatively simple,

we do not consider there to be any particular benefit in having an open stage, and we have not been supplied with any compelling evidence that contradicts this view. Furthermore, the single open round that has been suggested by Vodafone (as we understand it) would provide very little information about the value of the spectrum and would likely be of very limited use in informing bids for a second round.

Vodafone also states its preference for use of *“a simple clock auction followed by a process to assign frequencies as close as possible to current assignments”*, although it does not provide any justification for why this would be its preferred format. As above, we do not see any particular need for the using an open auction over a combinatorial sealed bid format. Furthermore, as set out in 17/85a, the simple clock auction (or any other format that imposes a uniform price per lot) is not appropriate for this award given the likely strong synergies between lots and the need for a format that supports non-linear pricing.

For these reasons we do not consider that there is any reason to deviate from using the proposed combinatorial sealed bid auction format.

3.7 Minimum prices

No objections were made to the proposed reserve prices based on the reserve prices set in the 2008 award. We consider that these prices are conservative and no concerns were raised that reserve prices at this level would risk spectrum going inefficiently unsold.

4 Summary

To summarise our proposals in light of the consultation responses to ComReg Document 17/85:

- The proposed approach to allocating the Award Spectrum for fixed link licences is in line with the RSPG 5G roadmap set out in its recent second opinion, and strikes a balance between accommodating future demand for 5G whilst avoiding adverse effects on existing fixed link services. Furthermore, provided that licence duration is not excessive, there are policy options available to ComReg should there become, at some point in the future, a clear need to use the Award Spectrum for meeting demand for 5G services or to comply with any future EC harmonisation decision.
- In line with our initial report, we believe that concerns over speculative bidding are likely to be largely mitigated by applying a sufficiently short licence duration and restricting use to P2P fixed links only.

- A 10-year licence term is appropriate. There may be some merit in using a shorter licence term, although we do not believe the benefits would be significant. Longer licences would be more likely to create a conflict with migration to 5G use. Overall, we remain of the view that 10-year licences offer a reasonable balance between mitigating the risk of interference with 5G deployment whilst allowing for a sufficient return on investment.
- Allocating spectrum for P2P use only (rather than awarding technology and service neutral licences) helps to simplify the award process and minimise the incentives for speculative bidding under the expectation of using the spectrum for 5G in the future. There is no evidence to suggest that this approach is unsuitable. In contrast, allocating technology and service neutral licences, allowing for P2MP use as well as P2P and/or increasing the amount of spectrum for FWA (as suggested by CBNL) could offer a backdoor route to 5G deployment (creating incentives for speculative bidding), and could complicate the future transition to a TDD band plan more compatible with 5G. Given these concerns, and the currently observed pattern of use, we recommend that ComReg continues with the proposed approach of restricting use of the spectrum to P2P.
- Use of an auction to award the spectrum remains a suitable approach. Extending existing licences and applying an administrative charge would not be appropriate since (i) it would be unfair to simply gift usage rights to existing licensees, and setting a suitable fee would be very challenging; (ii) maintaining the current block assignment for existing users would leave the unallocated spectrum fragmented and potentially deny usable spectrum to others, whilst a reorganisation of the band would be complicated by differing costs to existing users of moving within the band; and (iii) the current assignment may not be efficient, and cementing that in place would be contrary to ComReg's duties to ensure efficient spectrum use.
- We recommend the use of a 5-block competition cap. Although we consider that there may be some merit in reducing the cap to four blocks, we do not see any compelling case to do so given that it seems unlikely to affect the award outcome and there is an existing user with five blocks.
- There are some concerns over the costs that might be faced by existing users if they need to move their fixed links to different frequencies within the band (related to either retuning or replacing equipment). We recognise the relevance of avoiding *unnecessary* migration costs, but this must be balanced with providing fair opportunities for reallocation of the spectrum and new entry, which could require some relocation. It is important that existing licensees are not given enhanced rights to spectrum that endure past the end of their licences,

especially where this would be disadvantageous to potential new users.

- In practice, we do not expect significant changes in frequency allocations to be necessary. In all plausible scenarios, it should be possible (although not guaranteed) for an existing licensee that retains the same number of blocks as it currently holds to obtain frequencies close to existing holdings, and for those holding a larger number of blocks to retain at least some of their existing frequencies.
- We recommend using a frequency-generic lot approach, with the number of lots to be awarded to each bidder determined in a main stage of the auction, and specific frequency assignments established in a follow-up stage. Existing licensees would not be unduly affected as they could reasonably expect to win back frequencies relatively close to current assignment (as above) and any migration costs will likely be linked to retuning, rather than replacing, equipment. Furthermore, use of frequency-specific lots could open up opportunities for strategic bidding aimed at fragmenting currently unallocated spectrum (denying usable spectrum to others) and/or driving up prices for existing users with significant relocation costs. Given these concerns and the lack of consensus from respondents, we consider the frequency-generic approach to be preferable.
- We recommend awarding the spectrum rights using a combinatorial sealed bid auction format with opportunity-cost based pricing, as originally proposed. With a frequency-generic lot approach, this would include two stages: (i) a main stage that would determine the number of frequency-generic lots to be awarded to each bidder; and (ii) a follow-up assignment stage that would establish the specific frequencies to be assigned to each winner of frequency-generic lots. We consider that Vodafone's proposal to include a preliminary round seeking bids at reserve prices and then publishing demand would not offer any benefit, while its preferred option of using a simple clock auction is not suitable for this award (for reasons set out above and in Document 17/85a).

Annex 1: Worst case relocation scenarios

In this Annex we provide details of the scenarios in which existing licensees (if winning the same number of generic lots as currently held) would be required to relocate within the band in order to accommodate contiguous frequencies being assigned to all other winning bidders. We show this for the case in which a 5-block cap is applied, and also for a 4-block cap. Where a 4-block cap is used, we assume that Three is awarded four blocks, rather than retaining all five blocks it currently holds.

Note that for a given licensee that has retained the number of blocks currently held, under any distribution of lots to other winning bidders not shown in tables below, that licensee would have an assignment option to bid for the frequencies associated with its current licence.

For each licensee we show (on the assumption that it has won the same number of lots as currently held):

- **Movement needed:** the minimum movement within the band (relative to its current frequency assignment) required in order to assign contiguous frequencies to all other winning bidders (i.e. this represents the frequency assignment options closest to its current assignment for which the licensee would be able to bid in the assignment stage). For example, “-1 OR +1” means that in the given scenario, it would be necessary for the licensee to relocate at least one block up or one block down within the band in order to give all winning bidders contiguous spectrum; and
- **Distribution amongst other winners:** the distribution of remaining generic lots (i.e. the lots not awarded to the licensee in question) amongst other winning bidders. For example, {5,3,3,3} means that, in the given scenario, there are four additional winners, one winning five blocks and the others each winning three blocks (note that this is one of the scenarios for Three under a 5-block cap, so Three is assumed to have won five blocks, and there are 14 remaining blocks that are distributed across other winning bidders).

Worst case scenarios for relocation with a 5-block cap

Three:

<i>Movement needed</i>	<i>Distribution amongst other winners</i>
-1 OR +1	{5,3,3,3}
-1 OR +1	{3,3,3,3,2}

BT:

<i>Movement needed</i>	<i>Distribution amongst other winners</i>
-2 OR +1	{5,5,5,2}
-2 OR +1	{5,5,5,1,1}

Imagine:

<i>Movement needed</i>	<i>Distribution amongst other winners</i>
-2 OR +1	{5,5,5,3}
-2 OR +1	{5,5,4,4}

Vodafone:

<i>Movement needed</i>	<i>Distribution amongst other winners</i>
-3 OR +2	{5,5,5}
-2 OR +1	{5,5,4,1}
-1 OR +2	{5,4,3,3}
-1 OR +1	{5,3,3,3,1}
-1 OR +2	{4,4,4,3}
-1 OR +1	{4,4,3,3,1}
-1 OR +2	{3,3,3,3,3}

Worst case scenarios for relocation with a 4-block cap

Three:

<i>Movement needed</i>	<i>Distribution amongst other winners</i>
-1 OR +1	{3,3,3,3,3}

Note that in this case Three is assumed to have dropped from five blocks to four blocks, in accordance with the competition cap. In the scenario above, fitting winners in below Three would encroach on at least two of Three's current blocks. However, the extent to which Three would then need to move up in the band and outside its current frequencies is limited to one block, due to the fact that Three is awarded one fewer lot than it currently holds.

BT:

Always has the option to bid for current frequencies regardless of how other lots are distributed.

Imagine:

Always has the option to bid for current frequencies.

Vodafone:

<i>Movement needed</i>	<i>Distribution amongst other winners</i>
-1 OR +2	{4,4,4,3}
-1 OR +1	{4,4,3,3,1}
-1 OR +2	{3,3,3,3,3}