Response to Ofcom Consultation

Executive Summary

This response is to Ofcom's consultation about how to meet long-term future demand for mobile data, and the different high-level approaches to ensuring that the UK can meet demand for connectivity. We suggest that in taking a helicopter view on future demand for mobile data, Ofcom needs to pay particular regard to the following factors:

1. **D**ensification – How to deliver optimally? Wi-Fi vs Mobile
   Today, spectrum policy is artificially constrained by the limited information available to Ofcom and stakeholders. We should be careful not to limit potential future approaches, because of what cannot be done today. In particular Ofcom's conclusions on the viability of densified deployment patterns are suspect - Wi-Fi is a great example of how dense deployments have succeeded. Ofcom should identify where there are shortfalls in the data available (and its quality) to make informed decisions, and needs to rectify these - in the short-term - to generate better outcomes.

2. **R**especting Rural and help close the Digital Divide
   We support Ofcom's conclusion that densification is necessary. We believe that there is likely to be merit in considering mid-band small cell deployment, *especially in rural areas* where mmWave connectivity may have such poor propagation as to make it uneconomic to deploy under the current regulatory regime. Competition between MNOs has not driven investment in rural areas. In fact, the switching off of 2G, 3G and copper voice networks, all in a loosely similar timescale, may have created a time-bomb which Ofcom has the statutory duty to fix. Ofcom's statement at 3.15 of this discussion paper means that Ofcom accepts that how it has released spectrum has disadvantaged rural communities. It is time for some positive discrimination going forwards to sort this unsatisfactory and unsustainable situation out.

3. **O**perational Utilisation and Automation
   Ofcom needs – now - to commission work to understand real-world practical utilisation of existing spectrum holdings by operators. While many may argue this is commercially confidential, it is straightforward for users to do using relatively cheap equipment. Mobile apps have previously been used to "crowdsource" coverage and performance data. Mobile devices could be used to crowdsource details on carrier

widths and aggregation combinations present – apps are already available which can detect this, and they could send these responses to a server. Ofcom should create a national spectrum usage database, showing what spectrum is used in licensed mobile bands, at each mast site, which in turn helps to automate the licensing process and deliver the sharing Ofcom wants to encourage.

4. **N**eutrality
   In this kind of long-term discussion, Ofcom should widen the general principle of technology neutrality to *"provider neutrality"*. We believe that Ofcom should place more weight on their own observations on their mobile strategy discussion around private networks – "We expect to see strong competition to provide private networks". However much of what then follows in the document still focuses on the pivotal role of Mobile Operator (MNO) networks.

   This is especially important when Ofcom itself in the parallel discussion paper "Ofcom's Approach to Mobile Markets," draws attention to MNO feedback that they face a "challenging investment climate."[1] We believe that it would be in the best interests of consumers for Ofcom to take a provider-independent stance, and focus on the technical properties of spectrum where possible. Where densification is concerned, it is not necessarily a given that only a national operator can do this – Wi-Fi shows that mass densification of equipment can take place, without requiring a single operator of this equipment. The benefits of densification, particularly with higher frequency bands such as the mmWave band in question, are likely to be even more apparent, even when considered in a technology and provider-agnostic way.

5. **E**ncouraging investment
   We believe that spectrum fallow is spectrum wasted. We believe that one of the lessons of the Covid-19 pandemic is that the current regulatory regime seems only to focus on the "what is" – we are as interested in "what could be." Interestingly, in Ofcom's paper on mobile markets[1], Ofcom recognises this and identifies major OTT providers as major sources of potential future competition (though almost no mention is made of independent Neutral Hosting – it seems there is an implicit assumption that this will be an MNO-centric operation).

   Whilst progress being made by Ofcom towards shared spectrum access is welcome, it is still abundantly clear that the approach is predicated on preserving as much availability of unused spectrum as possible, rather than seeing that spectrum actually put to use. It is clear that Ofcom has a duty in ensuring spectrum is used efficiently, however it is important that Ofcom considers (particularly in very rural areas where there is little or no contention for spectrum access) that their approach to shared licencing does not in itself act as an impediment to deployment. In a large rural farm, for example, it is a vanishingly small likelihood that there will be a competing demand for shared spectrum that is not coordinated with the landowner (who would need to give land access and consent to deployment of the infrastructure needed by the competing demand!)

[1] Discussion paper: Ofcom's future approach to mobile markets at 1.21

6. **S**tatutory Duties – do they conflict – it is time for a refresh?
   We think they do, that this puts Ofcom periodically in a "lose-lose" scenario. Duties that seek balance in the statute but require subjectivity will always be open to disputes as to the intention of the Statute.

Densification – How to deliver optimally. Wi-Fi vs Mobile

We believe that in a medium to long-term view of mobile data usage, it is vital to look towards the right models of usage. Whilst it is not Ofcom's position or intent to dictate such models, now is a good time to begin a frank and open dialogue around the role that Wi-Fi plays today in connectivity, and look at ways to ensure we deliver the most efficient use of spectrum.

Wi-Fi has demonstrated, on a practical, global scale, that network densification is viable. Wi-Fi is inherently deployed in a different way to operator base stations (user-deployed and operated, without frequency coordination). Wi-Fi devices operate according to IEEE 802.11 standards, and position themselves in suitable channels based on other users, and attempt to manage and avoid interference with other networks. They have been phenomenally successful, and have delivered mass usage, thanks to international standardisation, at a scale previously never seen in wireless connectivity.

Today, based on Ofcom's consultation document data, MNOs hold 1152 MHz of spectrum below 3.8 GHz (about 30%). Wi-Fi networks have access to 82 MHz of 2.4 GHz spectrum, and 585 MHz of 5 GHz spectrum[2] (we assume very limited uptake of 6 GHz Wi-Fi due to lack of equipment to date). Ofcom data shows that per-household fixed broadband data usage was 453 GB per month in 2021, and that the average monthly mobile data use per mobile data user is 5.3 GB per month.

This shows that Wi-Fi is the digital connectivity workhorse of the UK – with an average UK household consisting of 2.39 people[3], this means that Wi-Fi is effectively delivering 190 GB per person per month, compared with 5.3 GB per person per month on mobile data. Wi-Fi achieves this with CSMA/CA (Carrier Sense Multiple Access/ Collision Avoidance), rather than through carefully planned frequency re-use by a single operator – in essence, everyone with a Wi-Fi network is an independent operator. The standards help to deliver a usable service to users, with automatic frequency selection and listen-before-talk in use.

By this metric, Wi-Fi delivers around 35x more data per person, using around half of the spectrum allocated to mobile data, *making it 70x more spectrally efficient from an end user perspective.* In terms of Ofcom's statutory duties set out succinctly in this paper,[4] we believe Ofcom can be said to have achieved optimal use of Wi-Fi bands. In general, a user wishing to deploy a Wi-Fi network will find they can achieve good performance without requiring

[2] https://www.ofcom.org.uk/__data/assets/pdf_file/0036/198927/6ghz-statement.pdf
[3] • Average household size UK 2020 | Statista
[4] Discussion paper: Meeting future demand for mobile data (ofcom.org.uk) at 2.10

access to licensed spectrum, and this is a major technical and regulatory success with perhaps immeasurable value to the global economy. The same is not true for mobile bands, where effective sharing remains an issue and more work is necessary to consider better regulatory approaches to the handling of "long-term unused" spectrum, which sits fallow following national spectrum auctions. National auctions are a blunt regulatory instrument which generate revenue for the Treasury, but which do not consider the opportunity cost of unutilised spectrum in, for example, rural areas which will never see a commercial roll-out of that spectrum.

Whilst we note the importance of air interface spectral efficiency, as well as the improvements that innovation can deliver in modulation and coding schemes, we would point out that Wi-Fi demonstrates *the importance of considering what matters to end users.* Ultimately, Wi-Fi delivers this efficiency as a result of densification and ease of use. It is almost certain that, were Wi-Fi spectrum licensed and restricted, this would not be so. Reducing barriers to spectrum access is key to ensuring its use and preventing the development of "self-fulfilling prophecies," where Ofcom makes conclusions based on certain assumptions about spectrum and it use that it was responsible itself for creating (we address this in the next section on rural).

Reflecting on the rationale for the greater user-perceived spectral efficiency, it is clear that Wi-Fi is deployed on a local basis, in a densified manner – everyone has their own Wi-Fi hotspot, smartphones can provide a Wi-Fi hotspot on the move, etc. In a sense, Wi-Fi has reached full density deployment.

Were we to redesign the UK's communications networks and spectrum allocations from scratch today, it is likely that the most efficient solution would be to focus on delivering high-capacity backhaul over fixed fibre networks. Where this was not viable, top-down delivery of long-range backhaul connectivity through cellular networks would sense, which would provide backhaul connectivity to localised and densified edge infrastructure for "last ten metres" connectivity. The RF requirements for "last ten metres" distribution of externally-backhauled connectivity are quite different from the RF requirements for wide-range distribution.

We would point out that there are some potential market distortions at play in service pricing today – a user can take out an "unlimited" 5G contract with included tethering and calls for £10.50 per month with a national MNO, which is a considerably lower price than a user can take out an equivalent speed fixed fibre connection. Whilst this is a good example of the benefits of an open and competitive market driving prices down for users, it introduces potential for a perverse incentive.

From the perspective of efficient use of spectrum, at a macro level, it is arguably better for the UK if home internet usage is delivered over fibre networks, since these do not consume finite mobile spectrum, and often carry considerably higher amounts of data per month, according to Ofcom's own data in this consultation. Carrying this data over 5G due to reduced pricing here is potentially indicative of a market anomaly, where it is cheaper to take "unlimited 5G" than a fixed line internet connection. The spectrum required to deliver this "unlimited 5G" at a lower cost will therefore increase due to user numbers. This will

require more spectrum to be allocated to mobile operators. This demand would, however, be displaceable towards fixed fibre lines, which would free up more spectrum. Ofcom should consider this in their evaluation of mobile data requirements in future – not all use-cases can be as easily shifted towards fixed connections, and it would seem prudent to ensure that the market is suitably aligned to ensure it makes sense for fixed connections to be used where possible.

The physical properties of radio spectrum support this approach – higher frequencies have considerably reduced propagation characteristics compared to lower frequencies. This is fundamentally why densification is possible in mobile networks – higher frequencies can be reused at reduced separation distances, enabling denser deployments. Mobile operators operating in their own dedicated spectrum allocations are able to use inter-cell resource coordination to facilitate better performance at the edges of cells, by blocking out resource blocks used in one cell in another adjacent cell that may otherwise interfere.

In practice however, as frequencies increase beyond a certain point, the benefit of this kind of coordination significantly reduce in practice, due to the reduced propagation distances, and thus the reduced received signal power. This is evidenced in Wi-Fi – most people that do not live in a high-density apartment block with thin internal walls will have little difficulty finding an unused 80 or 160 MHz wide 5 GHz Wi-Fi channel, and in a suburban area may struggle to see any other users' 5 GHz Wi-Fi networks at any meaningful strength.

The difference is that mobile operators are allowed to transmit at higher powers than home Wi-Fi access points, so as to deliver greater range. As frequencies increase and densification happens, the need for operators to have exclusive access to this spectrum is diminished. It is quite conceivable that a mobile operator could use mmWave spectrum in a densified base station at ground level, while a user living in neighbouring apartments successfully uses the same spectrum in a 3rd floor apartment at a suitably low power level for indoor domestic use, with neither party noticing any adverse interference.

We believe that fundamentally, Ofcom needs to consider whether it makes sense any longer when considering how to meet the future demand for mobile data, to allocate bands of spectrum to mobile operators on a national basis, when Ofcom itself recognises this is unlikely to be deployed outside of a very limited number of the most densely populated urban areas. This policy if implemented would assist in closing the digital divide, the area to which we turn next - Network densification simply won't work feasibly in rural areas! It is often hard just to build sites. The Digital Connectivity Accelerator (DCIA) shows future ways to get access to sites, but it's still really hard, and RF propagation in rural environments is often significantly impacted by challenging terrain. Spectrum access approaches available to date for users other than national mobile operators have not made this particularly commercially viable in challenging rural areas, outside of testbeds and trials projects.

Power limits have to be commensurate to the land, terrain etc. One size definitely doesn't fit all! We need to focus on if there is rival/competing demand, or whether this demand is theoretical! We need real-time spectrum intelligence to do this.

Respecting Rural and help close the Digital Divide

There are two issues that the current proposed approach has for rural communities. *We note that Ofcom is focused here on meeting future mobile data demands in dense urban areas only with no mention of rural demand, but argue it would be fundamentally flawed to consider these in isolation. We also acknowledge that recent events raising the importance of "rural" had not happened when Ofcom drafted its document. Rural has its own specific needs, and the one-size-fits all approach to date to urban and rural spectrum is precisely what has helped to worsen the digital divide and caused much spectrum to be left fallow and hindering rural regeneration.*

Firstly, advanced agriculture and other 5G applications are likely to yield a range of new demands for data in rural areas. This is only likely to increase if the UK needs to focus more on greater self-sufficiency in terms of food supply for geopolitical reasons[5] and is already being accorded a considerably higher degree of priority within Ofcom at a senior level – which we wish to acknowledge and are delighted to see. This is a matter of pivotal importance. Ofcom's approach to mobile networks and spectrum will either kill or facilitate improvements in the UK's ability to increase its self-sufficiency.

Secondly, by designing spectrum policy for urban areas and transplanting it across to rural areas, it is likely to further entrench the digital divide. At a time where "levelling up" seeks to break down barriers to communities outside of the urban South East, it is important for Ofcom to ensure it is not building new barriers to improved connectivity.

We believe Ofcom's proposals as set out in the document will create significant barriers to the use and deployment of mmWave spectrum outside of the densest 1% of areas in UK cities. Beyond major rail stations, venues and busy shopping streets, Ofcom's own data shows that density of demand simply is not there today. Even allowing for this to scale, since demand in urban areas scales by user population, it is clear that the same areas will be the ones with highest data use density in future, absent external human factors changing people's movement patterns.

We believe that Ofcom should expressly not allocate mmWave spectrum to mobile operators through any national allocation. Instead, mmWave spectrum should be allocated on a "grid square" basis, more akin to the shared access licence approach taken in shared spectrum allocations. This would help Ofcom to drive forward an automated real-time approach to spectrum licensing, and ultimately make the process more straightforward for all spectrum users.

This approach would have several advantages.

1. *It reduces barriers to spectrum access for new market entrants, including non-traditional mobile network operators.* The 5G RuralDorset project has demonstrated new models for connectivity to be deployed and used in a "customer-first, customer-driven" way, with an agricultural company building their own mobile network for their own business use in supporting precision agriculture and aquaculture. Under a

[5] A fertilizer shortage, worsened by war in Ukraine, is driving up global food prices and scarcity (cnbc.com)

national spectrum licence approach, operators like this would be "locked out" from spectrum, as they currently effectively are from local access licences (due to costs, delays, the need to coordinate with operators, etc.) Fundamentally, in rural areas, there is more than enough spectrum to go around, but it is often allocated to operators who have no intention to put it to use.

2. It is *more spectrally efficient.* In previous projects, we have carried out field work to demonstrate that UK mobile operators make minimal use of their spectrum holdings in rural areas, such as Orkney, as seen in the 5G RuralFirst project. Despite having significant national spectrum holdings, these operators were typically deploying only a single 5 or 10 MHz carrier in the 800 MHz band. Such trends will continue going forwards, and be further exacerbated as higher frequency spectrum is allocated, since without a change in approach, it will continue to sit fallow. The current approach to spectrum allocations punishes rural communities twice – first by allocating the spectrum to a national operator which likely has no commercial intention to deploy in that location; then a second time when those who do wish to deploy in the local area (as an alternative network provider or wireless ISP, for example) are faced with more restrictive spectrum access options than national MNOs have (despite not using the spectrum).
3. *It recognises that harmful interference is a "rural red herring!"* In most rural communities, it is likely that users could operate any radio equipment they wanted to in the mmWave bands, without causing interference to others, simply due to the distance between people, the limited number who are likely to want to use it, and the limited propagation distance. Some rural areas dream of the luxury of interference. It would mean other users (and therefore passing trade or business!)
4. *It recognises reality*. The average UK farmer salary is only £22,461[6] and their costs, especially for nitrogen-based fertiliser, have doubled, whilst their fuel bills have also shot up. The UK average salary is over £31,000[7]. Rural spectrum pricing simply won't work and would actively hinder the drive for self-sufficiency, bringing Ofcom into conflict with wider government. Agricultural communities are used to having to provide for themselves, and build resilience into their businesses and local areas. In successive 5G Testbeds and Trials projects (5G RuralFirst and 5G RuralDorset), the willingness, interest and desire from local communities, including in particular farmers, to get technically involved in building and delivering solutions to their own connectivity challenges has been proven. At a time when life has increasingly shifted online, Ofcom's current approach to spectrum is effectively holding back rural areas – the House of Lords was recently told by a member of farmers they knew with such poor internet connectivity that they "have to go to McDonald's to get broadband coverage"[8].

Operational Utilisation and Automation

[6] Salary: Farmer (April, 2022) | Glassdoor
[7] Salary: Average (April, 2022) | Glassdoor
[8] https://www.ispreview.co.uk/index.php/2020/07/lords-told-uk-farmers-have-to-visit-mcdonalds-for-broadband.html

We face a future in which the demand for data from people, from devices, and from applications will continue to grow into the medium term. We also face a technology shift in public networks with fixed and mobile connectivity converging at the network level, massive capacity increases, more flexibly configured and delivered, and with fibre reaching ever deeper into even rural areas. That is even before we consider the continuing growth of private networks into the future. We can therefore expect a dramatic increase in the use of mmWave spectrum – but which will be far easier for Ofcom to accommodate because of the easy of frequency re-use and the avoidance of and risks from harmful interference.

This will require shift in spectrum management thinking by Ofcom… and in particular bringing its licensing capabilities into the modern age by automating more fully the process by which licenses are issued… as well as obviating the criticism constantly levelled at Ofcom that it takes far too long to process licence applications.

Given a "fair wind," a typical application can take up to 2 ½ months based on our knowledge and experience. The licensing team are only doing what they are asked to do - *but how they are asked to do the work needs urgent revision.* Ofcom had assured us earlier this year that more resources were to be allocated to this team – yet during April we have still had sight of information quoting 6 week lead times. That is no change to the previous indicative deadlines for the past 2 years.

As we look for example at the 26 GHz band later this year, then to cover the Country cell-edge-to-cell-edge would take approaching 6 million cells.[9] 5G RuralDorset already has a tool[10] which it built outside the project just to help assess where it would be possible to get licenses… and this could be developed into something which allocated a given say 250m of coverage at 26GHz automatically subject to certain "squares" that Ofcom could simply colour as "red no go zones."

Without a dramatic improvement in the process and more help and resources for what is clearly an Ofcom team working under vast pressure, then we can already assume that it will not be possible for Ofcom to discharge the function of itself making available the spectrum required to meet the future demand for mobile data, based on an increase in demand for local access to spectrum, given the reduced propagation of mmWave, and hence the increased need for local service provision.

Neutrality

In this kind of long-term discussion, Ofcom should widen the general principle of technology neutrality to *"provider neutrality"*. We believe that Ofcom should place more weight on their own observations on their mobile strategy discussion around private networks – "We expect to see strong competition to provide private networks". However much of what then follows in the document still focuses on the pivotal role of Mobile Operator (MNO) networks. This is especially important when Ofcom itself in the parallel discussion paper

[9] Source: Ordnance survey personal discussions

[10] 5GRD are happy to discuss this privately with Ofcom if it assisted

"Ofcom's Approach to Mobile Markets, "draws attention to MNO feedback that they face a "challenging investment climate"[11].

We are not pro or anti any providers – nor should Ofcom be, even if more unconsciously than consciously. However, the way in which mobile spectrum has been allocated has not been "neutral" in its impact on rural areas at all. Fallow spectrum was always inevitable if a band is auctioned on a national basis, because of the high costs paid for mobile spectrum - inevitably those areas generating less return on capital get done last in a competitive market. One can hardly blame operators for that. Policy options such as coverage obligations could be used, which would likely reduce the revenue take for treasury, but increase investment in deployment.

We recommend that Ofcom should actively explore the level of spectrum utilisation across the whole of the UK, taking into account rural areas in particular, and those areas which are most under-served. This should explore whether MNOs are effectively utilising the spectrum which is already available to them. Clearly not all spectrum will be used in all locations – there simply is more demand in urban areas than rural areas – but this will demonstrate the extent to which even existing spectrum allocations are simply not required in rural areas, as they are not being put to use. With this spectrum not in use, there is little case for national allocation of mmWave spectrum. Regardless of whether public or private networks use this spectrum, what matters most is that the spectrum can actually be used by people in the areas where it is available.

Encouraging investment

We believe that spectrum fallow is spectrum wasted. We also believe that one of the lessons of the last few years is that the current regulatory regime for shared spectrum overly values preservation of available spectrum, to ensure there is spectrum to meet future demand, without considering the local context of this. To see a viable ecosystem develop in the shared spectrum bands, there needs to be an economy of scale for equipment suppliers, and this means use of the spectrum. With rigid power and height restrictions, Ofcom's current approach often makes it of low commercial viability to install radios – in the 5G RuralDorset project we found many occasions where it was simply not viable, even in a testbed project, to deploy radios. This was even with use-cases seeking to make active use of them.

Interestingly, in Ofcom's paper on mobile markets[12]Ofcom recognises this and identifies major OTT providers as major sources of potential future competition (though almost no mention is made of independent Neutral Hosting – it seems there is an implicit assumption that this will be an MNO centric operation).

Current thinking talks often about improving equipment efficiencies. Nowhere is it ever mentioned that this has an impact on costs. Wi-Fi for example, is heavily used - and we all

[11] Discussion paper: Ofcom's future approach to mobile markets at 1.21
[12] Op cit at 1,15 bullet 2

recognise that Wi-Fi is a hugely successful game-changer. Think back to around 2009, and then think forward to today. People are connected worldwide, using cheap chipsets, on commodity devices!

This raises a broader point. Whilst cellular is great, we need to be technology neutral, and carefully remember these principles! If Wi-Fi delivers more seamless connectivity that might make more sense in a world of abundance of devices, then do we really need SIM cards per device that enable some things, but not other things? We should not allow spectrum policy to be held back by yesterday's business models - especially with the shift to OTT services. All parties must have the freedom to evolve and compete in this context, and spectrum policy should look forward to a future where it is not a given that today's business models will remain intact – spectrum policy should offer the flexibility needed to match incoming business models, and focus on delivering the best options for connectivity in the UK.

Statutory Duties – do they conflict – it is time for a refresh?

We have some sympathy with the view that it is difficult to plan a future strategy for mobile data when having to do so based on a Communications Act that is now approaching 20 years old. Do the duties incumbent on sometimes conflict. We contend that they do, and that this puts Ofcom periodically in a "lose- lose" scenario. Duties that seek balance in the statute but require subjectivity will always be open to disputes as to the intention of the Statute. That suggests that we need to review the Statute to see how it might be refined.

Take in particular the example the duty to ensure the optimal use of the radio spectrum. The definition of optimal or efficient is pertinent here. Bits per second per Hz is the traditional definition used in literature, but we now need to go wider/further, and need to consider these per km^2, because a 2x2 MIMO cell with 5 MHz carrier can give great coverage, but dire capacity! We have to consider use of spectrum holistically, looking at holdings, and ensure that we get the "right" outcome for the UK, rather than any one operator! Might this best be addressed by updating the Statute itself?

Furthermore, the specific guidance regarding differing rural/urban interests in Ofcom's principal duties may be true on paper, but what about in reality? Leaving it to Ofcom to determine a way between conflicting priorities simply has not worked properly – or there would be no digital divide…

Conclusions

We set out above factors we believe to be important if Ofcom is to be able to meet the demand for mobile data. We would additionally add that Ofcom proposes next steps beyond 2030, based on upgrades, using holdings, and deploying mmWave on densified grids. But there are many other different kinds of "mobile" services - not just cellular, but Wi-Fi, as well as the LPWAN, and Bluetooth – to name but some. If as Ofcom claim, the aim is to get people to "make full use of their spectrum holdings" – then definitely... But we also

need to think bigger - do we really want to silo away spectrum based on today's concept of scarcity-driven allocations? Or will we just end up back where we started if we do so?

We think it's time for change – we look to Ofcom to deliver it. In particular, we need to move beyond today's incentive structures which encourages "hoarding" of spectrum as an asset – this is currently a game-theory rational option as a result of national auctions. This leads to setting up infrastructure, leaving it there, keeping legacy equipment running, and pushing for ever more spectrum on a national basis, which increases the costs for a new market entrant, and reduces the need for incumbents to invest in new equipment.

We need to align the challenge and incentives for deployments, so that densification happens at the same time as raising frequencies - we shouldn't do the two at different times. We have to recognise in spectrum access and pricing, the increased efficiency from using higher bands, but also the higher costs for operators deploying this spectrum. The "most efficient" outcome is spectrum being blocked from use by others only in the place it's actually being used! But we need to factor in the "exclusion area" required around it! This requires better understanding and insight around spectrum utilisation.

Finally, should we not consider pricing of spectrum per-radio, using the noise floor distance/level as a parameter? A user with technology more tolerant of other in-band or band-adjacent interference will get cheaper pricing... This rewards good innovation! Someone who needs 60km of exclusion around them at a given lower noise floor would face a significant cost to recognise the opportunity cost of that spectrum access.

END