Your response

Question	Your response
Question 1: Do you have any comments on our proposals to gather additional antenna parameters, and would you prefer Ofcom to specify a small number of antenna pattern 'envelopes' or for users to provide details of the specific antenna parameters in use for Ofcom to assess? Please provide reasons for your views.	Confidential? – N Telet runs the largest 5G SA private network in Europe using N77 spectrum, it is perhaps the largest user of this spectrum. Telet is also the holder of the most Local Access Licences and, by coverage holds more Local Access Licence spectrum than all other licence holders combined.
Question 2: Do you have comments on the suggested approach to enable user-led coordination in certain circumstances?	This is an excellent idea. We are very happy to work with other, smaller, licence holders. It won't work with the big MNOs, who are difficult to work with.
Question 3: Do you have any comments on our proposal to increase the power level of our Low Power product by 3dBm in the 3.8-4.2 GHz band?	It is insufficient. More work needs to be done to analyse actual propagation at around 4GHz, the economics of deploying an running a rural network for a very small number of users.
Question 4 Do you have any comments on our proposal to remove the requirement for licensees holding a Low Power 3.8-4.2 GHz licence to keep a record of the address at which mobile terminals connected to an indoor base station will be used?	This is entirely reasonable. Indeed, the past regulation was unworkable, and didn't allow for roamed in devices. Apple support for N77 using a private network PLMN has made it impossible to keep track of devices.
Question 5: Do you agree with our proposals to assume synchronisation between users, and coordinate base station to terminal instead of base station to base station in the 3.8-4.2GHz band? If no, please explain how other measures could increase sharing of the band.	
Question 6. Please indicate whether you support our preferred option of coordination at -88 dBm/20 MHz (based on I/N of + 3dB, at 1.5m) or a more conservative alternative of -91 dBm/20 MHz (based on I/N of 0dB at 3m), with reasons for your view.	
Question 7: Do you agree with our proposals for an increase in BEL in 3.8-4.2GHz? If no, are	

there alternatives which you consider could better achieve similar results?	
Question 8: Do you agree with our proposal that adjacent band protection for Shared Access users is in future limited to considering only the first 5 MHz above and below UK Broadband assignments?	We live in a digital world with error correction. Maintaining guard bands is a waste of spectrum, far better to free it up for use and then deal with problems by resending packets than never use that spectrum.
Question 9: Do you agree with our assessment that, in circumstances where localised shortages of spectrum have occurred, pricing can be used to influence requested spectrum amounts?	Only where there is a shortage. The proposals on pricing are complexly unworkable. The idea that they are there to manage demand is new to this document. The costs of application are supposed to cover the administration of the process. In the light of this there should not be a linear relationship between bandwidth and cost. It should not cost five times as much to process a 100MHz application as it does a 20MHz one. Similarly renewal should not be anything like as much of an administrative burden as the initial licence. Many projects, particularly government funded ones, have an initial budget but do not allow for future years. We'd look to a model which, so long as the spectrum was being used, charged only 10% of the licence cost for a renewal. The proposal to "maintain" the cost for Urban Low Power and Rural Medium Power, retaining the current fees schedule for bandwidths up to 50 MHz does not correlate to the revenue potential from the spectrum. It simply costs too much to deliver the service to rural areas. To implement the pricing shown in table 5.1 will have the opposite effect to that desired by Ofcom, it will leave the rural communities unconnected. In one Telet deployment in rural Wales we are looking at running six cells to serve 120 people. If around 30% of people – which would be pretty much every household – buy the service at £30 a month we are looking at an annual revenue of £14,400. If the licence fee alone is £9,600 it leaves £4,800 to cover backhaul, maintenance, billing, customer service, equipment replacement and servicing. This is clearly not economic. You might argue that the 50MHz option would be a better option but this is to deprive the people who most need connectivity, in an area where there is none, of the bandwidth they need.

Question 10: Do you agree that we should take measures to reflect the impact of bandwidth, power levels and urban/rural location in our pricing approach for the 3.8-4.2 GHz band? Do you think there are other factors we should be taking into account?	No, The future of spectrum starts with the decision-making. The future is a long time. Since the early days of broadband and mobile communications we have tried to forecast what new technologies would be used for and generally we have done a bad job. At the dawn of 3G, the mobile network Three was convinced that watching football clips was a great use case. The network spent so much on the rights and sold so few subscriptions; one Three executive is on record as saying "For what it cost us we could have bought every subscriber a house". The consultation document states "*When we launched the Shared Access framework in 2019, there was limited experience of how new users sharing these bands would interact, uncertain levels of demand, and limited real-world information on coexistence between services. Through our review, we have sought to build our understanding of developing use cases, ensure the framework remains responsive to stakeholder needs, and put it on a footing that is able to support a greater density of use for the future."* Given the bad job the industry has done of looking to the future it is far better to look to the past and extrapolate. What we have learned is that the availability of bandwidth drives use-cases. Redbus Films launched with a model identical to Netflix but ten years earlier. Redbus failed. It did not drive the technology – which is what it hoped for. It was only when the bandwidth became available that Netflix changed its models from DVDs in the mail to online. It is essential to expand the availability of connectivity to drive innovation, not to merely provide the requisite connectivity for the expected demand. Today 50Mb/s feels like a useful number, if you wanted to support twenty users in a cell that's a gigabit. But that's today and we need to need to look to a petabit future. If that sounds ridiculous you need to think that in 2000 a gigabit sounded outrageous. Numbers are hard to come by but one video streaming site reports 40% year on year growth between 2015

	and 2019. Model that on the 50Mb/s and it's 1.4Mb/s per user or 30Gb/s per cell. It takes a little over 20 years to reach a petabit per cell. Of course, not all the speed comes from radio bandwidth. Some comes from better algorithms; error correction and a lot will come from more processing power meaning we have better real-time compression. And of course, as technology and filtering improve higher and higher frequencies become useable. The question asks about the future but there is a way to expand availability today make the minimum N77 SAL 20MHz. There is no point in 10MHz because Qualcomm chipsets do not support it. Then implement an idea the Spectrum Policy Forum proposed for N258: Anyone with a licence can use as much of the frequency as they like providing no-one else is using it. You are always guaranteed your 20MHz but if there is all 400MHz available they you are free to use it unless another licence holder pops up and starts using their spectrum. This immediately means less spectrum lies idle. Cells can "sniff before transmit" to work out what is free. The way demand for the spectrum evolves is in part shaped by the regulation and in part by the market. We can look to a future which sees a dramatic hockey stick growth in small public and private networks. In the late 1990s we only had four television channels and today we have thousands. Expect mobile networks to follow. Today we have four major MNOs. The growth of small networks means we'll see communities, companies and campuses building their own. Networks with special properties be it beam forming for precision location in a safety application, higher uplink than downlink for video streaming or low power for IoT. Those networks with roaming contribute to the better coverage the country so badly needs.
Question 11: How do you consider the illustrative prices would impact your spectrum requirements and future deployment plans in the 3.8-4.2 GHz band? Please provide evidence in support of your view.	The ideal would be something like the SPF proposal for the mmWave frequencies carried through to all SAL and LAL spectrum. An ability to licence a core, say 5MHz of spectrum, but to sniff around at what is unused and use that, backing off if another licence holder pops up. This makes the best possible use of spectrum.

Question 12: Do you have any comments on our proposals to clarify the circumstances in which exceptions are available, the tests we will apply, and how this supports user flexibility outside our overarching rules?	The proposal to restrict the exceptions process fails to understand the nature of exceptions. There is sometime a need to cover a particular area with high bandwidth, but the only accessible points are some distance away. This may need highly directional antennas with a high level of antenna tilt using high powers. The flexibility of the current exceptions process allows for this. If the process is restricted such deployments become impossible. We would argue that the exceptions process needs to be made more flexible. But perhaps billable.
Question 13: Do you agree with our overall approach based around refining our existing coordination framework for Shared Access, whilst monitoring future opportunities for more user led and outcomes led coordination where evidence suggests it would be of benefit?	The stated aim of Ofcom's review is to "Make spectrum available for a diversity of new users who were calling for access to spectrum which could support mobile technology. We wanted to promote innovation by providing localised access to spectrum under a simple, low-cost framework. ", with this in mind there needs to be more flexibility in what is granted. Some of the elements of the framework should become advisory or guidelines. The regulation needs to follow the use cases not predict it. This review is very welcome but it needs to establish not a new set of rigid guidelines but a methodology for following the evolving needs. This best serves the Ofcom legal obligation to foster innovation. It is instructive to look at the ratio between the grants of licences: Shared access low power has at the time of writing has seen 1,185 licences granted. Of these BT Onephone accounts for 684 which are all band 3, what was DECT guard band. Low power Band 77 accounts for 197 licences. Shared access medium power has 517 of which band 77 accounts for 417. So, at Band 77, medium power has seen nearly twice as many licences granted. That indicates that, despite what Figure 1.1 says, many of upper band 77 licences are being deployed in rural environments. Ofcom is to be applauded for these numbers. The introduction of N77 has not only created a new market it's led the world. This was Philip Marnick's intent and it has worked. Less successful is Local Access licence which has seen fewer that 35 licences granted. Here the process is turgid and failed by Ofcom acquiescing to claims and timescales of the major MNOs. While Local Access Licences are

	outside the scope of the current review, they do urgently need revision. One of the things Telet pioneered was the implementation of point and radius coverage. Modelled on Innovations and Trials licences this has meant that one, £950 is economic for rural areas as with the 20KM radius we've used we can serve enough population to make it worthwhile. The 42dB limit on SAL rural licence, is not economic. Telet has an extensive Band 77 network in Liverpool and a single cell in Westminster. While a coverage tool shows good propagation, trudging the streets proves that the lack of line of sight and high levels of background noise mean that 150m to 200m is the effective maximum distance before a medium power N77 call drops, even when exceeding antenna heights and using directional antennas we have not been able to improve coverage beyond this. There certainly needs to be the option to have higher powers than 42dB min urban, suburban and rural areas. There are limits on urban antenna heights. This fails to consider that in urban areas many buildings will be taller than the maximum permitted height making signals horribly directional. Since only one Band 258 licence has been granted – to 5G Rural Dorset – and that was an outdoor deployment – the requirement that mmWave is indoor only should be dropped. The biggest problem with Ofcom following the European standard of Band 258 and not the US of band 257 and 261 is lack of equipment particularly terminal equipment. There are currently no commercially available smartphones which support band 258. A wide range of handsets, including iPhones support the US frequencies and while Ofcom is very good at leading the market this is a case where there is a need to follow. Adding band 257 and 261 to Shared Access Licences would make a huge difference to the proposition. We are pleased to see it in the document. The quickest way to build an innovative ecosystem would be to adopt a model based on US CBRS. There is plenty of cheap equipment, lots of vendors and systems integrators who know the territory. Even the same spectrum could be used on the model of giving the

	current licence holders automatic Preferred Access Licences. A UK version of CBRS could be made more efficient by adding DSA. Telet is very disappointed by the comments on Dynamic Spectrum Access in the call for inputs. It offers significant advantages in the use of spectrum.
Question 14: Do you agree with our assessment of the potential impact on specific groups of persons?	
Question 15: Do you agree with our assessment of the potential impact of our proposal on the Welsh language? Do you think our proposal could be formulated or revised to ensure, or increase, positive effects, or reduce/eliminate any negative effects, on opportunities to use the Welsh language and treating the Welsh language no less favourably than English?	
Question 16: Do you have any other comments on the proposals set out in this document?	There is a cliché that spectrum is a precious, finite, resource. Yet when Marty Cooper, the man hailed as the inventor of the handheld cellphone was interviewed by the GSMA's Mobile World Live at Barcelona this year he told a different story. Cooper claimed a growth in spectrum – Coopers Law – akin in Moore's Law. So which is right? Precious and finite, or plentiful and flexible? As is so often the case: both. It's clear that the part of the electromagnetic spectrum we class as radio has limits, and Claude Shannon taught us that how much data we can get through a given amount of bandwidth has physical limits, but two things help us lean towards Cooper's view. **A brief history of bandwidth** Over recent years we've got better at using higher frequencies. Our idea of what is the highest that usable is constantly revised. It's not that long ago that Very High Frequency was 30Mhz to 299MHz. And that the idea of 900MHz was outrageous. Today we regard 900MHz as low band, sub 6 GHz as the main frequencies and tens of GHz as interesting. Already 6G researchers are talking about terahertz.

So there are new unexploited frequencies. But we can also be a lot smarter with those lower down. Cellular introduced the concept of frequency re-use. The days of a national broadcaster needing to have huge amounts of spectrum to cover a country have been replaced by using radio in a more parsimonious manner. More people have access to more spectrum because it doesn't have to be ringfenced over huge areas. This sets a precedent for future, more efficient used of spectrum.

A second area where we've got smarter is in reducing interference. Time was when radio transmitters were not very good at sticking to their allocated frequencies. They would make noise in nearby bands and this meant that licences had to accommodate and leave a bit of latitude. Better transmitters, and more advanced filters mean that users can be put closer together.

Significantly we've seen the introduction of digital technology. Systems of error-correction and retries are much more tolerant of noisy environments. We can sacrifice speed for reliability.

Radio encoding has also improved the efficiency. From the AM technologies of Guglilelmo Marconi to FM and then with mobile phones going from FM to digital with GSM being time division so that seven users could share the same spectrum to 3G being Code Division allowing greater density of users in an area and 4G and 5G being ODFM, stacking frequencies together for sharing we've seen better and better uses of radio spectrum.

And then we need to look at what we run over the better radio. Marty Cooper may be styling himself on Gordon Moore, but the Intel pioneer's view on the compound interest like growth of computing power.

Back to the future

The rate at which technology has progressed is not matched by licencing. Read a contemporary radio licence and the language reflects that of the typewritten licences granted by the Home Office fifty years ago. Perhaps the locution is

unimportant but the thinking behind it is not. Spectrum is still looked at as something which is licenced, sold or auctioned to major corporations. Ensuring that there is no interference is paramount and governance is top-down.

In her introduction to the Government's Wireless Infrastructure Strategy, the Secretary of State says "Last year, we met our ambition to deliver a basic 5G signal for the majority of the population by 2027 - 5 years early." This is a statement which reveals the flaws in the top-down approach. That claim that more than half the population can access a 5G signal is based on models propagated by the four major mobile operators. And the models don't reflect real life. Even though it's a head of population figure and that there are more people inside Sadiq Khan's ULEZ zone than the whole of Scotland, those lucky Londoners don't enjoy full 5G coverage. The operators may say that they cover most of the people most of the time, but those people will report that they constantly see drop outs on all technologies, so claiming unfettered 5G is more than stretching it.

Process improvements

We note and welcome the observation that "*As demand has grown over the last four years, especially in 3.8-4.2 GHz, some users have experienced frustration where spectrum has not always been available (because of the presence of other users), or delays in the assignment process. We are now taking steps to improve this user experience (as part of ongoing operational improvements) by providing more information for users to understand the availability of spectrum, and progressing with plans to move user applications online in 2024. Over time, we will automate more of this process and expect to significantly reduce licensing wait times as a result."*

Our experience is that it is very rare for delays to be down to the unavailability of spectrum and always entirely down to problems of process. When making multiple applications it is often hard to follow which response from Ofcom refers to each application. Putting in an

	OFW 588 generates an automatic response with an application number. When the licence is granted, you get a licence number and then there is an invoice number. The licence and invoice paperwork doesn't have the application number on it. It would be very useful if all responses included the application number and the postcode of the application. Working out the OfW84, class of emission is esoteric, time consuming and complicated. Could the form just ask for the individual parameters. **Taking advantage of the Vodafone merger with Three** Something which holds back Band 3 medium power deployments is equipment cost. The unusual 2x3.3MHz channel means buying equipment capable of this. A second-hand Nokia FlexiZone capable of a 5MHz channel can be bought for under £500. One which supports 3.3MHz channels costs over £8,000. Perhaps, if Three and Vodafone merge leading to refarming we could see some frequency reallocation – moving EE/BT down a bit to provide 5MHz channels for Shared Access Licences. This will also open up more LTE use cases in band 3. Band 77 is non-operator spectrum. Operators buy the vast majority of handsets. Most people get a new phone free or discounted when they sign a contract. The major handset manufacturers have three top priorities when they consider which features to include. Overwhelmingly the most important of these is what the operators have specified. Meeting the requirements of customers with very exacting specifications is tough, and often leads to internal battles between sales people, who are responsible for different operators, to get their work done first. As band 77 spectrum is not on any of the operators' lists, it won't be in the requirements. As shipping deadlines are very tight, manufacturers may never get to the second priority, which is the addition of features that rival phones have but that the supplying manufacturer does not. This consideration is also with an eye to the operator buyers. It will

	include features such as a camera with a smile sensor, an under-glass fingerprint reader or a better camera. It's usually something that helps the sales process, such as radio performance, battery life or support for unregarded radio bands. The third priority is the addition of features that will make the phone stand out against rivals. At last, we get to the area in which band 77 gets a bit of a look-in because enterprise customers are increasingly important and are pushing the demand for private 5G networks. In recent years, all manufacturers have been dreadful at finding innovative new features for phones. They have played with reducing the bezel, improving the camera, or having a notch or a punch hole. The Motorola Razr and Samsung Flip apart, there has been precious little experimentation with form factor, so instead it's a race to the bottom on price. That means there's no desire to introduce new spectrum bands with the associated radio testing. So, while MediaTek and Qualcomm might have band 77 available on the chipset, this is unreliable information when trying to determine if the phone will actually work in band 77, as it's often not enabled in the operating system. Which Law? Regardless of whether you are led by Marty Cooper's "Coopers Law", or Claude Shannon's proof that maximum bandwidth was shackled, a more telling law might be Gresham's law, the monetary principle stating that "bad money drives out good". It comes from the time when coinage was debased and coins were no longer fungible. There were "good" and "bad" sixpences. The good ones were hoarded and the bad ones took over in circulation. With spectrum we need as much of it in circulation as possible. If we treat it as too valuable to use everyone suffers.

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