



# Business connectivity and digitisation

## Grasping the 5G opportunity

November 2019



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# Introduction

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Over the last years a successful narrative has been developed among spectrum policy practitioners. It begins by emphasizing that 5G will be most valuable when used to digitise and transform supply processes across sectors, a race in which Europe cannot afford to be a laggard. It then casts doubt on the ability of public 5G networks built by MNOs to meet the needs of many business users and public-sector agencies. As a precautionary measure, it concludes, spectrum regulators should create spectrum licenses earmarked for “verticals” in prime 5G bands. Spectrum Regulators in Europe have been responsive, and a form of reservation has been tested in Germany: local licenses in 25% of the coveted 3.5 GHz band, for which only the owner or tenant of the premises can apply. Based on the latest RSPG Opinion, it is likely that the initiative will be exported to other countries and bands<sup>1</sup>.

Economists have warned since the 1950s against spectrum managers trying to decide, in the face of different alternative uses, which one creates more value for society. Along the same lines, GSMA has consistently advocated for market-based awards of spectrum rights<sup>2</sup>. When departing from that principle, we believe regulators should provide very good cost/benefit evidence. Reserving spectrum for verticals through local licensing is no exception. The stakes are high, and the decision should be considered carefully.

This GSMA paper aims to shed light on aspects of the debate that would in our view benefit from a deeper understanding. Beginning with the cost side, it will discuss how granting local licenses to owners of the premises prevents alternative and possibly more valuable uses, and creates ownership fragmentation that makes future innovation difficult. It will also reflect on how the shape of the reservation (band, licensing terms, etc.) can be tailored to minimise those negative impacts. Turning to the benefits, it will evaluate the incremental value, in terms of quality of service and isolation, that a spectrum reservation in different pioneer 5G bands will create for business users.

The main point to draw from that qualitative cost-benefit analysis is that whilst the cost of the reservation, in terms of alternative uses that are denied, is much higher in mid band spectrum than in millimetre wavebands, using the lower band does not significantly increase the benefits for the vertical implementing a local application (like industry 4.0 in a factory). It will also be claimed that even when business users are not willing or able to acquire usage rights in prime 5G bands, they still have alternatives available to find the right balance between isolation from other users and cost efficiency. Given that range of options, in GSMA's view it is hard to see a vertical that would be left out of the 5G race due to lack of a spectrum reservation in a prime 5G band. We understand however that some business users will say otherwise. Some will do it driven by self-interest, in the hope of being awarded spectrum usage rights without having to bid for them. Others will do it out of a legitimate concern that the commercial offers of MNOs will not meet their needs. The last section of the paper has this second category of verticals in mind and explores market-based and regulatory mechanisms that could allow them to express their valuations and directly access the frequencies at a fair price.

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1. [http://rspg-spectrum.eu/wp-content/uploads/2013/05/RSPG19-007final-3rd\\_opinion\\_on\\_5G.pdf](http://rspg-spectrum.eu/wp-content/uploads/2013/05/RSPG19-007final-3rd_opinion_on_5G.pdf)

2. Reference to GSMA position on spectrum awards



# Why reserved local licences can be a bad idea

Advocates of local licences being granted to the owner of the premises seem to assume that there is only one possible end user of the reserved frequencies. It does not do anyone harm, the reasoning goes, if the owner of the premises, as the only possible end user, is given the usage right and allowed to decide what to do with it. Unfortunately, whilst that scenario might be realistic in some situations like indoor deployments using very high frequencies, it is questionable as a general case. A reservation would, particularly in lower bands or where outdoors deployment is envisaged by the beneficiary of the reservation, prevent other potentially more valuable end users from accessing the spectrum. For example, signals from outdoor smart city applications running on public 5G networks would most likely reach the property of the local licensees. If there is a local reservation, it will be very difficult to deploy public 5G networks in the frequencies reserved for local users without interfering with, and being interfered by, the applications that run on their networks.

Even when there is no interference with signals emitted from outside the premises, a more subtle form of inefficiency can arise if the reservation has a negative impact on the set of alternative connectivity options available to the “vertical”. In Germany, four MNOs had to compete for 300 MHz<sup>3</sup>, instead of 400 MHz, to build their public 5G networks. Considering that it is widely accepted that each operator needs between 80 MHz and 100 MHz of

contiguous spectrum to fully benefit from 5G, it seems clear that the service that MNOs can offer to verticals will be negatively impacted. One could think of the “vertical” transferring the local spectrum usage right to the preferred supplier of a public 5G network, but local licences have yet to be made available, and in any case bundling the rights is not straight forward. For example, the reserved spectrum for local use might not be contiguous to the spectrum of the provider and valuable synergies could be lost. Ironically, by trying to improve the chances of 5G adoption by business users, spectrum managers could be doing the opposite. At the very least, they would be favouring some business users that believe they would be better off with the reservation, and therefore strongly advocate for it, over other silent business users that perhaps do not fully understand the impact the reservation could have on their connectivity options in the future.

Finally, a third argument against local licences is that fragmenting the usage rights today among a myriad of licensees can compromise change of use in the future. Spectrum managers have experience dealing with fragmented legacy bands and know how challenging and time-consuming change of use can be. With the 5G priority bands there is an opportunity to implement primary market rules that promote not only short-term efficiency but also future innovation. That opportunity should not be wasted.



3. Note that 20 MHz were severely impaired, so in practice effective available supply was even less than the full 300 MHz

# The negative impact of a local reservation can be minimised through careful choice of band and licensing terms

When considering a local reservation, it is key that spectrum managers do not only look at the benefits to the owner of the premise and the positive externalities to third parties. Different forms of reservation can have very different impact on users in neighbouring frequencies and regions. Perhaps even more importantly, the value of the alternative use that is prevented can be very different depending on the circumstances of the reservation. There are some simple rules of thumb that can be followed to minimise the negative impact on other users and ensure that the uses that are prevented are not the most valuable ones.

## Frequency band

Recent auctions show that mid-band spectrum has a much higher market value, on a per MHz basis, than millimetre wave bands. In 2018, for example, Italy held a multiband auction for 5G spectrum, in which mobile operators paid in total 4.3 billion euros for the 200 MHz on offer in the 3.5 GHz band. At the same time, they paid just 33 million for each block of 200 MHz they acquired in the 26 GHz band. It is clear that, for mobile operators, the two bands are not substitutes, as shown by the fact that they paid 130 times more for each MHz in the 3.5 GHz band.

The main justifications for the price differential in Italy are to be found in the regulator's choice of blocks bandwidth, that forced operators to bid to win the bigger blocks. However, there are also intrinsic differences between the two bands that justify a value differential, related to the range of the signal, the synergies with the existing networks and the cost of densification:

- Lower frequencies have better propagation characteristics and provide wider coverage essential for certain use cases.
- The propagation characteristics of the mid-bands recently auctioned (3500 MHz, 2300 MHz) are very similar to other mid-band spectrum held by MNOs (1800 MHz, 2100 MHz, 2600 MHz). As a result, 5G deployments in 3.5 GHz can be done re-using the existing grid of sites. This is a significant advantage compared to bands auctioned in millimetre wave bands (26 GHz), facilitating cost efficiencies.
- Related to the previous point, the space attenuation is very high at 26 GHz, requiring the identification of many new sites that need to be authorized and licensed and leading to a large cost differential that results in higher benefits of deploying in mid-bands compared to millimetre wave bands. Given the challenges that operators face when trying to find and license new sites, it is natural that they attach significantly more value to the lower band.

The conclusion is clear: reservations are less harmful, in terms of their impact on 5G deployments, when placed in higher millimetre wave bands as opposed to mid-band spectrum.



### Incumbent uses

Coexistence with incumbents constrains possible new uses of the band and therefore has an impact on its value. However, the impact is not the same for all possible new uses. It is plausible, for example, that new local and/or indoor 5G deployments can be undertaken without interfering incumbent services, but new 5G wide area outdoor deployments require mitigation measures. In that case, the value that is lost due to a local reservation is not as high as when the reservation is placed on a cleared band with no incumbent use.

European regulators have been for some years promoting shared use in bands where a 4G ecosystem already exists and a 5G ecosystem is very likely to develop, but clearance of incumbents is costly. That is the case for example of the 2300 MHz and the 3.8-4.2 GHz bands in Europe. A natural step, recently proposed by OFCOM, is to introduce local licences that can be used to deploy public or private IMT networks without harming incumbents. That is undoubtedly a better option than reserving spectrum for verticals in bands cleared from other uses and where a mobile ecosystem is taking off, as for example the 3400-3800 MHz band.

In the long term, it is very likely that the constraints imposed by incumbent users will disappear or be substantially reduced. When doing a cost-benefit analysis, it is important that the counterfactual to the reservation is the most valuable alternative use not only in the short term but also in the mid and long term. It should be considered that Regulators can even facilitate the transition, for example through overlay licences or incentive auctions. If, as a result of those actions, the constraints of incumbents are reduced, the case for a reservation is also less plausible.

### Licensing terms

The property rights granted to the local licensee are generally directly related to the constraints imposed on other uses. For example, exempting a local user from a requirement to synchronise implies mandating other spectrum users not to be too “close”, in terms of frequency or distance. Similarly, a long licence duration granted to the vertical negatively impacts the lapse of time in which alternative users can expect to access the band in the future. There is, in other words, a natural trade-off between the degree of exclusivity and isolation granted in the reservation and its negative impact on third parties. When planning a local licence reservation, both sides of the coin should be considered.

Interestingly, there is one possible exception to the rule. Awarding the beneficiary of the reservation a flexible licence (i.e. allowing change of use, trading or leasing) increases the property rights of the licensee but at the same time fosters future innovation. GSMA is in favour of facilitating agreements between verticals and MNOs that result in efficient use of the spectrum. We are concerned, however, that speculative behaviour by landowners could result in many of them expressing demand simply to transfer the right in the future for a profit. To prevent it, local licences should be priced at the cost of the more valuable spectrum use, and include strict use-it-or-lose-it clauses.



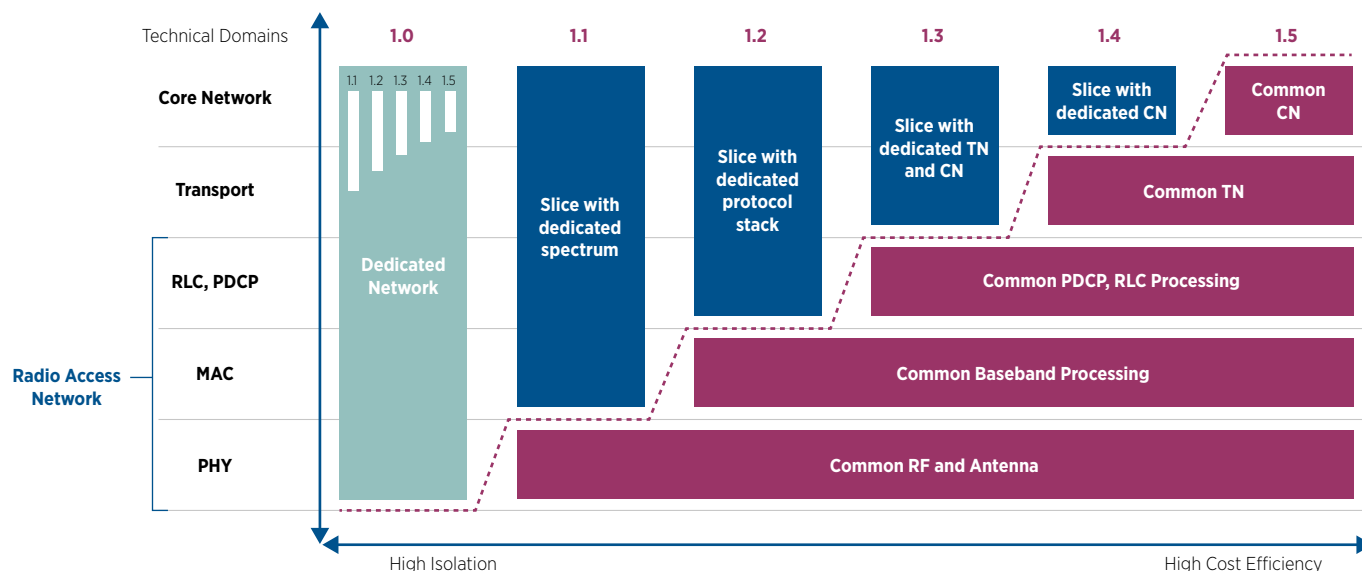
# For most verticals, the incremental benefits of acquiring local usage rights in prime 5G bands are relatively small

It is ironic that calls for directly granting of spectrum usage rights for verticals to deploy private networks in IMT bands are louder precisely when there seem to be more and better options for users with strict isolation requirements but no spectrum usage rights. Indeed, the latest generation of IMT public networks is designed to simultaneously accommodate the heterogeneous needs of diverse verticals, and there are plenty of successful use cases of private networks, both on unlicensed and licensed bands, where the end user does not need to acquire spectrum usage rights<sup>4</sup>. The question is what incremental value a spectrum reservation would create for the vertical, on the face of those seemingly valid alternatives. That is what we will try to explore in this section, but a remark should be made in advance. Irrespective of the intrinsic value of the local licence for the business user, the fee paid for it is obviously also very relevant. In GSMA's view, there is no economic justification for subsidising local deployments. Local licensees should be charged at least the opportunity cost for their spectrum usage rights (i.e. the foregone value of the alternative use that could have been done if the reserved spectrum had been used differently). The point we would like to discuss is rather whether the local licence is likely to be sufficiently valuable to induce the local licensee to pay for it above that opportunity cost.

From the point of view of the business user or Public agency, the benefit of the reservation is the independence from other spectrum users and from network suppliers. Private networks have traditionally been the connectivity solution for verticals with very demanding requirements. In its purest form, private networks are built and managed in complete isolation from other networks or users. Reaching that sort of independence, however, comes at a

cost, as it is not possible to benefit from economies of scope and scale. The trade-off between isolation and cost efficiency has driven technological evolution in business connectivity. Over time, verticals have gained flexibility to tailor their IT and communications solutions and have been able to reduce the reliance on expensive private assets while at the same time keeping the degree of isolation they desire. 5G slicing is the latest rung in that innovation ladder, building on the success of predecessors like virtual private networks and virtual private clouds.

To gain insight on the wide range of options available to verticals to meet their diverse needs for isolation in a 5G environment, it is useful to look at it from two dimensions: **(1) operational isolation**, meaning that vertical customers could have independent monitoring, control, configuration, or even full operation capability of a network slice; **(2) network level isolation**, meaning that vertical customers do not share network function or resources with the other customers. Network level isolation also has different sub-categories, for instance, shared RAN but isolated core, or isolated RAN as well as core, etc. Operators can provide operational isolation without or with very weak network isolation. For instance, the system could use IDs to differentiate the users belonging to different tenants who share the infrastructure. One example is NB-IoT, which can be treated as a preconfigured network slice, with many different IoT tenants sharing the same NB-IoT network. An overview of the different levels of network isolation is provided in the figure below. It is obvious that the different levels of isolation will have different cost. Most expensive mode will be dedicated RAN (LO or LI), which may only be relevant for very few use cases.



Based on a survey done by GSMA with vertical customers, the majority of those who have isolation concerns have direct requirements on operational isolation instead of network level isolation. 5G offers them the degree of independence they require, and for them sharing spectrum or other network resources is not a problem. In other words, to these businesses a local licence offers no intrinsic incremental benefits compared with the possible alternatives. On the opposite end, there are some other specific vertical industries that have strong network level isolation requirements, e.g. public safety, smart grid, for security and safety purposes, etc. Hence, their network slice(s) may not share any network function and resource with the other network slices. In general, however, virtual separation is enough for most users, perhaps with physical separation at the most critical layers. Only a very small minority of verticals, if any, would require full physical separation at all network layers. If, as an example, we consider the Public Protection and Disaster Relief (PPDR) Networks in the 700 MHz band we may have extreme situations where they will be deployed with segregated frequencies (falling under the L0 and L1 categories) and situations where the spectrum will be owned by the MNOs with isolated Protocol Stack (L2) or cases where the PPDR Networks uses the whole Access Network of the operator but have a physically separated Core network (as in L3 or L4) depending on the security level the MNOs will be able to provide.

It is to be noted that in case full segregation is chosen and a reservation is granted for PPDR services, GSMA advocates for the dedicated frequencies not to be identified in the commercial 700 MHz band, but should be chosen either in the specific channel of the CEPT band plan or in unlicensed bands as indicated below.

It is important to highlight that MNOs have always built and operated private networks, including networks with full physical isolation, and they will continue to do so in the 5G environment if verticals have a demand for it. If access to 5G technology and a high degree of network isolation are the key ingredients of the verticals' demands, they surely can be met by MNOs. Besides their knowledge and experience building and running telecom networks, they can offer several advantages. First, even at the most demanding isolation level shown at the very left end of the picture, where a private network requires complete separation from the public network, some synergies that do not compromise the independence of the vertical are possible, through for example sharing of sites and passive infrastructure. Second, MNOs are in the best position to ensure the seamless integration of the private network with the public network. For example, an IoT device can be used in different circumstances that require different levels of isolation. Finally, MNOs can build the private network using a wide portfolio of spectrum in different bands, reserving part of those frequencies for different business users as required. In a sense, MNOs would be doing the spectrum reservation in a more efficient way than regulators, reserving only the amount that is needed, in the band that is needed, at the time it is needed, where it is needed, and with the level of reliability that is needed.



Those that require even more isolation from the MNOs have another option that does not require buying spectrum usage rights: using unlicensed bands. Standards and technology for 5G stand-alone networks in unlicensed spectrum are developing quickly. Together with the likely identification of additional unlicensed spectrum across the world in mid-bands and millimetre wave frequencies, there is a platform from which verticals can innovate and develop.

A final word should be said about the difference between using mid-band and millimetre wave spectrum when building a local private network. It is a very relevant issue, because as we saw in the previous section the opportunity cost of a reservation is much higher in mid-band frequencies. From the point of view of the business using the spectrum reservation for a local use, on the contrary, it does not make such a big difference whether the reservation is in mid-band or millimetre wave spectrum. As long as the ecosystem is available, range and densification are not critical. Expanding the cell radius from hundredths of meters to kilometres does not add value, because the size of the premise is limited, and densification is not problematic for a vertical that owns the premises where the network is being built. Additionally, and contrary to what would happen if MNOs held the usage right, there are no existing sites that could provide synergies when mid-band spectrum is used.

In sum, the benefits of a reservation are likely to be limited because technical alternatives should be capable of supporting most if not all of the industrial applications that are foreseen. We are left with only a very few users for which outsourcing a private network or using unlicensed bands is not a solution. Those users in principle would be ready to pay at least the opportunity cost for a local license, especially in millimetre wave bands. The next section will analyse what options are available to accommodate their demand for spectrum rights without hampering efficiency.





# Exploring options for Verticals to acquire spectrum usage licenses without hampering efficiency

Advocates of reservations for verticals claim that national licensing prevents them from being awarded rights in an open tender, because they only require spectrum in small areas and are not able to express that demand in the award process. GSMA

acknowledges that it is difficult for regulators not to give every interested party the option to express a demand for spectrum rights. In this section, we explore several ways in which this concern could be addressed.

## Some preliminary considerations

### 1. Local licensing in the primary market is possible but challenging

- Granting local licences to landowners carries the risk of large idle areas in which landowners do not express interest but no one else can use the spectrum. It is important to devise a mechanism to allow others to claim the usage right when the landowner is not claiming it. This also applies to parks, streets and, in general, public spaces.
- The boundaries between licence areas are subject to potential conflict due to interference between licensees. The risk of conflict, which is larger in lower bands with good propagation, is generally addressed with power limits, but those limits constrain network design and increase costs.
- The lower the licence area, the higher the number of boundaries and the scope for hold-ups preventing deployment and innovation in the future.
- It is important that bidders can express complementarities among areas (i.e. the value of a set of licenses is higher than the sum of the individual licenses). The aim from a welfare perspective is not to maximise value in each individual area, but to maximise the aggregated value of all areas.
- Package bidding across licence areas in a simultaneous auction allows bidders to express complementarities but complicates auction design and the auction process itself for both the auctioneer and bidders.

### 2. National licences and voluntary leasing is the preferred option for GSMA, but we acknowledge that regulators and verticals want to be reassured that it will work. An open debate would be useful for example on:

- Market failures that prevent a secondary market, including leasing, from working efficiently (transaction costs, lack of competition on the supply side, etc.)
- How can regulators and operators overcome them?
- Are automatic secondary market exchanges viable? (experience from US CBRS)

### 3. Local licensing is in principle less problematic in higher bands (i.e. 26 GHz) where:

- Propagation distance is shorter
- The increased value from aggregating neighbouring local licences is presumably not as high as in lower bands.

Or in lower bands where clearing incumbents is not possible.

### A pragmatic approach:

#### a) Reserve the 3.4-3.8 GHz in the EU for MNO primary user (and eventually keep local verticals as secondary user)

The most appropriate license format for this band is National. Local secondary uses could be accommodated through voluntary leasing, where there is demand. To further increase an efficient use of the spectrum, regulators should facilitate any rights of use transfer in secondary market and, in specific cases, could impose use-it-or-lease-it obligations locally, so to reduce the concerns of verticals.

#### b) Share the 2300 MHz and the 3.8-4.2 GHz bands

For these bands a sharing approach is a practical way forward. The existing incumbent users seem compatible with the new service. The new licenses could be granted nationally, regionally or even locally through an LSA approach. It is nevertheless important that both MNOs and verticals are allowed to bid for these LSA overlay licenses, with no prioritisation.

#### c) Evaluate different possibilities for the 26 GHz millimetre wave band

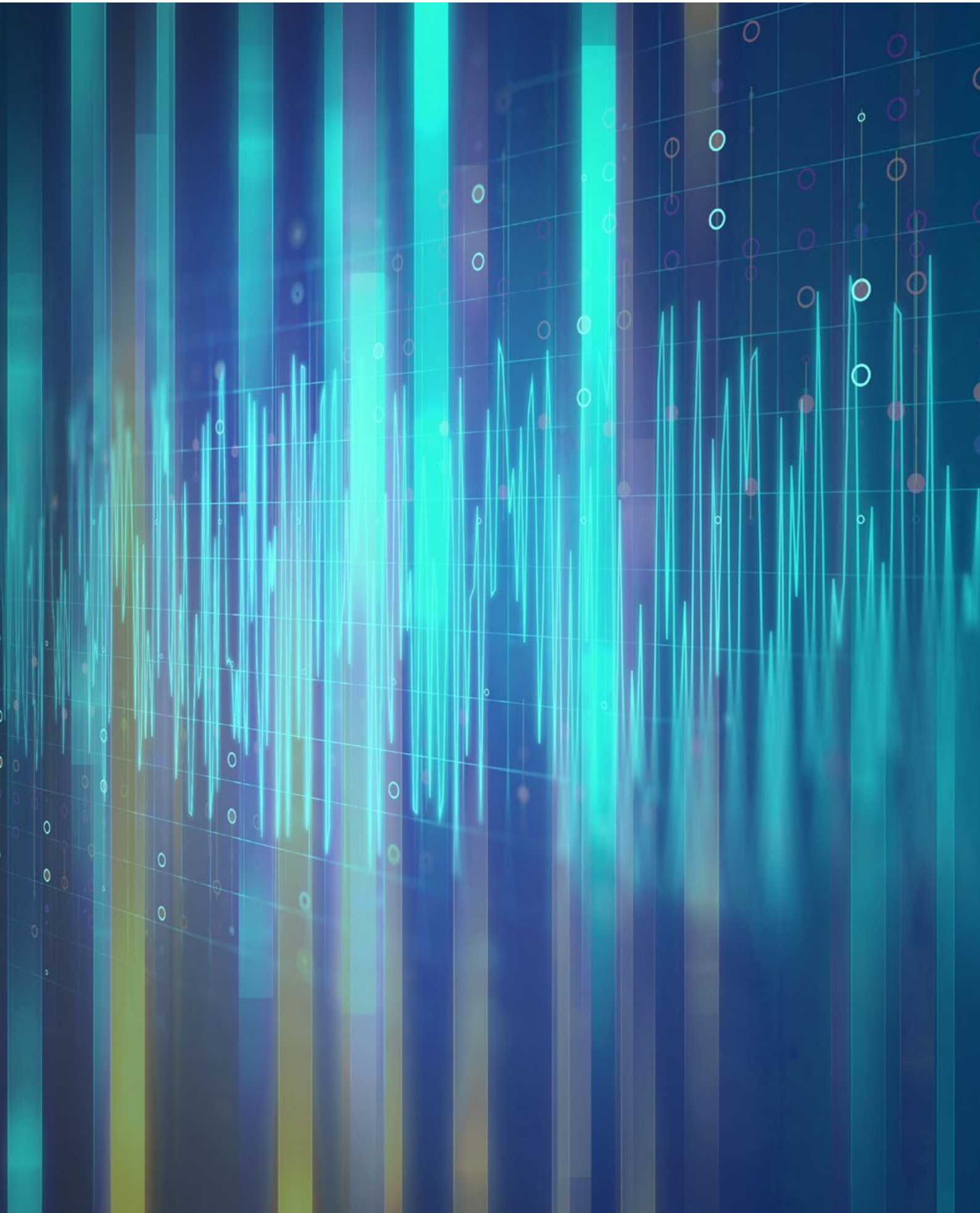
As the propagation characteristics of this band allow a high reuse, part of the band could be identified for local use from verticals as primary use, and for MNOs use as secondary:

- Local licenses to owners or tenants of real estate (i.e. German model) at an administrative price that reflects the opportunity cost of the spectrum
- Local licensees would be “primary users” of that part of the band
- National or Regional overlay licences could be issued, protecting the local incumbents, including LSA where there is no local demand.

Ideally, that portion could be placed in the lower part of the band where indoor uses can coexist more easily with incumbent services in the band and in adjacent frequencies.

Other portions of the band could be licensed nationally with similar mechanisms of the 3.4-3.8 GHz band (i.e. with or without possible use-it-or-lease-it obligations attached.: i.e. Italian “club use” model). Alternatively, national licences could be auctioned, but each just covering all the pre-defined areas forecasted to be locations of highest traffic density, with individual more local licences made available outside these areas.









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