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DIGITALEUROPE Views on 5G Licensing and Authorisation

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Introduction

Wireless innovation and technologies all rely on a common resource to deliver benefits: the radio spectrum. Without access to spectrum, there is no wireless innovation. It is unanimously recognised that spectrum policy, i.e. decisions about the terms and conditions under which technologies and networks access spectrum, have a decisive influence on wireless innovation and on the benefits that society derives from such innovations.

Spectrum access management and 5G are two critical policy topics which are both trying to address the needs of future wireless applications in terms of spectrum access. This paper tries to address these spectrum access needs regarding the terms and condition of access to spectrum, irrespective of specific bands, technologies and services.

Access to spectrum and putting equipment on the market/in use

Licensing can cover several aspects of offering a wireless service. Licensing can refer to how wireless equipment is put into the market (sold to customers) or put in use (switched on by an operator). In Europe, these aspects are covered by the Radio Equipment Directive (2014/53/EU). This aspect of licensing is not discussed in this discussion paper, but rather focuses on licensing in the aspect of access to spectrum.

In that sense, spectrum licensing – or spectrum authorisation – refers to the terms and conditions for a user to get access to a specific frequency band. This aspect of licensing is covered in Europe by articles 5, 6, 7 and 8 of the Authorisation Directive (2002/20/EC). In the context of the directive, spectrum licensing is referred to as 'rights of use for radio frequencies'. The provisions on spectrum in the proposed European Electronic Communication Code (EECC) are expected to supersede the Authorisation Directive.

In the remaining of this paper, the term 'spectrum licensing' refers to the 'rights of use for radio frequencies' in the context of the directives.

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Licensed vs license-exempt spectrum, benefits and drawbacks

The spectrum is usually accessed in a licensed mode – licensed spectrum – with an individual right of use that indicates that a specific user gets an explicit authorisation to access the spectrum, or in an license-exempt mode – spectrum under general authorisation – where any user can access the spectrum as long as some pre-requisites are fulfilled.

Licensed spectrum in theory

Licensed spectrum enables the regulator to provide guarantees to the licensee, about the sharing situation in a given frequency band. For example, the regulator may deliver an exclusive license to an operator to deploy a network in a specific frequency block.

The benefits of exclusive licensed spectrum are that the licensee has perfect control of the interference within its spectrum block. For example, in the case of mobile phones this enables the mobile operator to be able to plan coverage, capacity and provide different levels of quality of service with certainty. Thus, millions of users can be served within the exclusively licensed spectrum.

The drawback of licensing is that it restricts users (other than the operator and its customers) from having access to spectrum and that it requires a process to deliver such licenses (see section 'Licensing mechanisms: the pitfalls of spectrum auctions' below).

License-exempt spectrum in theory

License-exempt spectrum enables the regulator to allow access to spectrum for as many users as possible. For example, the regulator may permit any user to access a specific frequency band based on some minimum technical requirements that enable the sharing without unacceptable interference.

The benefits of license-exempt spectrum are that any user can access the spectrum, reducing spectrum scarcity and enabling immediate deployment of wireless services.

The drawback of license-exempt spectrum is the impossibility to control the interference with certainty.

Reality behind licensed and license-exempt spectrum

It is important to underline that the theoretical characteristics of licensed and license-exempt spectrum described above are never fulfilled in practice. Spectrum licensing is very rarely absolutely exclusive, and in any case interference can occur from services using adjacent bands. As such, licensing corresponds more to managing interference than preventing interference. Similarly, the technical conditions attached to a license-exempt band typically reduce the usability of the band for many prospective users.

Furthermore, the benefits derived from licensed or license-exempt access are closely related to specific bands and even specific uses. License-exempt spectrum is typically more appropriate in bands where interference is less important due to shorter range propagation, e.g. 2.4 GHz, 5 GHz or 60 GHz, and for more localised usages. Licensed spectrum is typically more appropriate for bands with higher range of propagation, e.g. 700 MHz, and deployment aiming at specific coverage targets.

The demand for quality spectrum on local/temporal basis

Licensed spectrum is commonly associated with guaranteed quality of service on wide area networks, typically on a nationwide basis. However, there is also a growing demand for quality spectrum on a local and/or temporal basis.

For example, some applications require very low latency, e.g. millisecond, which is not compatible with license-exempt features such as LBT ('Listen Before Talk'). Other applications are extremely sensitive to interference. Typical examples include factory floor automation for low latency and professional PMSE ('Program Making and Special Events', e.g. wireless microphones) for low interference tolerance.

Such applications require a local use of licensed spectrum, either permanent or nomadic and represent a growing demand on the access to spectrum. Here, the difference with traditional license spectrum does not reside on the authorisation regime itself, but more on the usage patterns that determine the condition of use and access to that spectrum.

Licensing mechanisms: the pitfalls of spectrum auctions

Licensing spectrum can be challenging when many players are requesting access to a specific spectrum band. Over the years, the principle of spectrum auctions has emerged, under the assumption that the economic actors who are willing to pay the most for a specific asset are also the actors set to benefit the most from it.

Auctions have many pitfalls, for example one company maximising its producer surplus does not guarantee that this option maximises the society's consumer surplus. For example, auctions do not guarantee that spectrum will be put to use quickly. Similarly, many governments view auctions favourably as a source of revenue to balance budgets. This is also counterproductive to the economy, as it reduces the funds available for investments in the infrastructure, while many studies demonstrate that such investment are lacking. Some governments select auctions despite their pitfalls due to their transparency, to prevent future legal challenges.

As 5G network will become a critical infrastructure for the economy, it is paramount for governments to select spectrum award procedures that favour investment. DIGITALEUROPE recommends in particular to prevent excessive spectrum fees and to adopt longer license duration together with any mechanism favouring fast, substantial, and sustained investment in networks and technology. Auction mechanisms should not just be based on spectrum fee but also on commitment to invest.

Spectrum sharing, vertical and horizontal

Spectrum sharing

Several users can typically have access to a given spectrum band, leading to the sharing of spectrum. Sharing enables several users to get access to spectrum, thus optimising its usage. However, spectrum sharing also creates challenges, due to the fact that one user's transmission corresponds to interference for another user. Therefore, there is a need to ensure that both users can get access to spectrum without unduly interfering with each other, to avoid that the spectrum becomes unusable by either user.

Spectrum sharing with manageable interference can be enabled through different sharing mechanisms, such as geographical sharing, time sharing, sharing in the frequency domain or sharing based on specific technology aspects (for example power restrictions, activity factors, antenna diagrams). Spectrum sharing can also be static or dynamic.

Vertical and horizontal sharing

One particularly important aspect of sharing is linked to potential priority between the applications. Vertical sharing refers to sharing between two applications regarded as qualitatively different by the spectrum regulator.

Vertical sharing occurs when one application has higher priority over the other application. One typical example of vertical sharing occurs in the 470-694 MHz band between terrestrial broadcasting and PMSE applications. PMSE applications can access the band only on a so-called non-interference, non-protected basis, i.e. they can only use the spectrum which is not used by terrestrial broadcasting, with no guarantee whatsoever.

Horizontal sharing occurs between users that have no inherent priority over each other. Wireless LANs in Europe implements such type of horizontal sharing: several users can deploy independently several wireless LAN networks, which may be based on different technologies, as long as each equipment respect the spectrum access rules defined on the appropriate harmonised standard. LBT is one such technology solution to enable horizontal sharing.

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Licensing regime, technology innovation and investment

Licensing and technology innovation

Licensed and license-exempt spectrum access both enable some degree of technology innovation. In license-exempt bands, any technology fulfilling the minimum technical requirements can be introduced immediately. Some licensed bands are governed under technology neutrality, where the licensee can deploy any technology, as long as it fulfils the so called 'Least Restrictive Technical Conditions' (LRTCs) applicable in the band.

Modifying the LRTCs for a licensed band or the technical conditions to access a license-exempt band are typically lengthy and difficult processes than imply, among other, the ability to demonstrate that existing users of the band and of adjacent bands will not be unduly impacted by the proposed changes.

Licensing and investment

The spectrum authorisation model in a specific band has a decisive impact on the deployment and investment models that can be sustained in that frequency band.

Licensed spectrum typically enables network operators to invest significant amount of money in large scale networks providing extensive coverage. Operators could not invest such large amount of money without guarantees on the spectrum availability over the time, such as to enable an appropriate return on investment. Licensed spectrum typically enables middle to long term, predictable investment in network deployment and financial returns.

License-exempt spectrum typically enables a number of concurrent users to invest in services operating in a band, with a much lower barrier of entry since there is no need to acquire spectrum access rights. License-exempt spectrum typically enables dynamic and organic investment and deployment.

Spectrum Access innovations

Several innovative ways to achieve spectrum sharing have been proposed over the past few years. Some of them are described hereafter.

Licensed Shared Access (LSA)

Vertical sharing leads commonly to one user accessing the incumbent's spectrum on a non-protection, non-interference basis. LSA is a mechanism enabling vertical sharing, while providing a level of spectrum access guarantees to all actors, through a sharing agreement between the incumbent and the new spectrum user. LSA has been studied and specified by ETSI RRS in ETSI TS 103 379. CEPT has developed the respective policies in ECC Report 205 and ECC Decision (14)02 . LSA primarily allows mobile network operators to use spectrum allocated to another service, but sparsely used in time and location by important incumbent applications, e.g. in the 2.3 GHz band (see also our DIGITALEUROPE Response to RSPG Opinion on LSA and Position Paper on LSA).

In continuation of the LSA work, ETSI RRS has started a new work item on "Temporary Spectrum Access For Local High-quality Wireless Networks".

Concurrent licensing

Concurrent licensing has been proposed by regulators in past spectrum award procedure (UK regulator OFCOM's DECT guard band policy). Under concurrent licenses, a restricted number of user have access to a specific frequency block. Specific mechanisms are defined to managed interference between the concurrent users. For example, in the case above (DECT guard band), the licensees agree among themselves about deployment to avoid interference, and they agreed to do so through a database (OFCOM was not involved).

Citizens Broadband Radio Service (CBRS)

The US's Federal Communications Commission (FCC) is defining an innovative spectrum access rights mechanism in the so called CBRS band (3550-3700 MHz).

The Citizens Broadband Radio Service is governed by a three-tiered spectrum authorization framework. The three tiers are: Incumbent Access, Priority Access, and General Authorized Access. Incumbent Access users include authorized federal and grandfathered Fixed Satellite Service users currently operating in the 3.5 GHz Band. These users will be protected from harmful interference from Priority Access and General Authorized Access users. The Priority Access tier consists of Priority Access Licenses (PALs) that will be assigned using competitive bidding. General Authorized Access users are permitted to use any portion of the 3550-3700 MHz band not assigned to a higher tier user (Incumbent or PAL).

Access and operations will be managed by a Spectrum Access System (SAS, i.e. a database). The CBRS proposal is a specific solution for a US situation, with its success depending on the license and usage conditions.

While CBRS is an interesting development in the US context, DIGITALEUROPE does not currently consider it as relevant or applicable in the European 5G context.

'Use it or lease it'

One concept discussed to enable verticals to access 5G spectrum is the idea of setting obligations on license holders to sub-lease their spectrum to interested third parties in areas where they themselves do not have the intention to deploy.

With such regulatory mechanism, a vertical user gains certainty that it would get access either to the service (network slicing) if the MNO intends to cover the area with a 5G network, or to the spectrum itself if the MNO does not plan to deploy in this area.

MNOs still benefit from flexibility to deploy their network and can engage vertical players meaningfully, to determine how best to value their spectrum asset (provide service or sub-lease spectrum).

On pre-requisite for the 'use it or lease it' approach is for regulators to support a flexible and dynamic secondary (including sub-lease) market.

Licensed Assisted Access (LAA)

Mobile broadband networks are also leveraging the best of the licensed and unlicensed worlds with the adoption of technology like Licensed Assisted Access (LAA) which enables an MNO to complement its deployment on licensed spectrum with local additional capacity using license-exempt spectrum. This is useful in order to solve localized capacity challenges without the need to acquired additional licensed spectrum. The QoS can also be sustained by keeping control data on licensed spectrum and only transmitting payload data on license-exempt spectrum.

Licensing for 5G

Multiband, multimode access

Networks and services used to be clearly separated and use different spectrum and access schemes. Increasingly many devices can no longer be categorized so clearly. For example, a smartphone is likely to support LTE in several frequency bands licensed to one operator, while also supporting Wi-Fi access in the 2.4 GHz and/or 5 GHz band, plus a variety of other license-exempt technologies (e.g. Bluetooth, infrared).

Terminals are increasingly likely to combine several ways to access the spectrum in order to benefit from advantages linked to each spectrum licensing method.

5G will support both licensed and license-exempt. However, the activity in the SDOs is initially focused on licensed spectrum, while in the future 5G is also expected to address license-exempt spectrum.

5G will use a range of different bands

5G is being designed to enable a different range and combination of frequency bands to address different requirements (such as data rates & capacity) and population densities. In simplified spectrum terms, one could think of this as low, mid and high bands.

- Low Bands: Spectrum in bands below 1 GHz is effective for providing wide area coverage networks. Typical mobile networks already combine several sub-networks, sometimes referred to as layers, to achieve coverage, capacity and performance. Layers deployed on spectrum bands below 1 GHz are especially useful for coverage. For example, an MNO may have an LTE 800 MHz layer to provide very wide area coverage. 700 MHz is likely to be made available for 5G which will enable wide area coverage.

- Mid Bands: Spectrum in bands between 1 and 6 GHz can provide urban and suburban area coverage and complement deployments in low bands. LTE wide area coverage bands can be augmented with an LTE 1800 layer to provide capacity in urban and suburban areas and completed with a layer of LTE 2600 for dense urban areas. Each of these layers fulfils a role to enable deployment of a network delivering capacity where it is required and affordable coverage everywhere. Specific bands may also have their own characteristics in terms of latency, support for multiple antennas or support for high mobility and indoor coverage. MNOs combine networks deployed across several band to reap the benefits of all these. Spectrum in the 3.4 GHz band (3400-3800 MHz) is being made available for 5G and is suitable for urban and suburban mobile and fixed wireless access deployments.

- High Bands: Spectrum in bands above 6 GHz, such as 26 GHz (24.25-27.50 GHz) are being made available for 5G to provide extreme capacity for very high data rates in urban and suburban outdoor and indoor wireless broadband hotspots and complement low band and mid band deployments.

The three 'pioneer' bands identified by RSPG for 5G in Europe (700 MHz, 3400-3800 MHz, 26 GHz) (RSPG Strategic Roadmap toward 5G) are likely to enable such optimization of the network deployment. The characteristics of these three frequency bands are very different and the cell range and therefore number of base stations required (and therefore investments needed) to cover a given area vary greatly between the bands.

Mobile broadband, coverage requirements and digital divide

License-exempt spectrum can provide so-called fixed network extension, i.e. local area coverage around a fixed access point. However, license-exempt spectrum is, by its technical characteristics, typically less suited for wide area coverage since they imply both long term return on investment (and therefore certainty in spectrum access) and sensitivity to interference (to predict coverage).

Furthermore, there is no interest from an economic perspective to provide coverage in areas where the deployment is not economically justified. MNOs typically contribute to reducing the digital divide by accepting coverage requirements outside of the areas where deployment if economically justified, in exchange of the exclusivity of access in the dense populated areas. This typically takes the form of coverage requirements in an MNO's spectrum license.

In effect, regulators mandate economic actors to invest in low economic interest areas by providing them with exclusivity in high economic interest areas through coverage obligations in spectrum licenses. As 5G networks are expected to become a critical infrastructure, regulators are expected to have an inherent interest to ensure that 5G does not create a new digital divide, i.e. that most citizen have access to 5G irrespective of where they live. This requires regulators to adopt appropriate measures (e.g. investment incentives, low spectrum fees, coverage obligations, spectrum license duration) in order to ensure appropriate 5G coverage in a timely manner.

One such way to ensure coverage is to resort to Public Private Partnerships (PPPs), which combine public and private investment to deliver services in areas where purely private investment may not be appropriate or sufficient.

It should be stressed that there is a direct trade-off between the level of competition achieved in densely populated areas and the coverage of sparely populated areas. It is not realistic to hope for more extensive coverage and a reduction of the digital divide and at the same time a reduction of the revenue from user in densely populated areas, since MNO's finance coverage through the revenues in dense populated areas.

Verticals

5G is not only expected to deliver enhanced mobile broadband services but also to enables vertical services. These vertical services each have different requirements that may require separate approaches to spectrum licensing.

Mobile learning, mobile government, mobile health:

These applications have characteristics similar to mobile broadband, in that they typically correspond to individual user accessing a mobile service. Therefore, it is expected that such applications can be deployed over the current infrastructure by reusing the existing layers.

Connected and autonomous mobility:

Connected and autonomous cars typically combine several access modes:

- Direct communication between vehicles (Vehicle to Vehicle – V2V) and roadside infrastructure (Vehicle to Infrastructure – V2I) requires all users to use a single band with no interference in order to support applications delivering safety of life services, e.g. emergency braking. Such direct communication – which can be controlled by a network – is typically delivered over license-exempt spectrum (each car can access it) used exclusively for ITS services. In Europe, ITS has access to the 5875-5895 MHz band and would require additional spectrum to ensure sufficient capacity for V2V and V2I traffic.
- Connected and autonomous cars typically also benefit from a connection to the mobile network (Vehicle to Network - V2N) in order to send and receive information beyond their immediate environment, e.g. to receive traffic information. The deployment of mobile networks along roads typically requires licensed spectrum on a national basis due to investment and coverage requirements. Such coverage can be best delivered by any cellular network operating in sub-GHz spectrum, e.g. the 700 MHz band.

Any regulative measures, like licensing of spectrum or mandating of a service, intended to foster the vehicle and traffic safety relevant communication should be issued following the European principle of technology neutrality.

Connected trains will also benefit from 5G. Reliable, consistent and high-speed broadband connectivity on trains helps improve the customers travelling experience by enabling the use of their phones, tablets, laptops etc. This also improves a nation's productivity by allowing people to work while travelling by train by doing email, research, business calls, etc. 5G backhaul from the trackside to base stations on the train with connectivity distributed in each carriage via Wi-Fi and small cells is one option and another is providing 5G direct to devices from base stations near the track.

Industry 4.0 and professional PMSE:

Such applications require stringent security and quality of service features, but are typically deployed on a limited geographical and/or time basis, see Section "The demand for quality spectrum on local/temporal basis" above.

When capacity and/or coverage is not available from an MNO, licensed spectrum on a local basis would typically be ideal for such professional users. However, these users can struggle to find adequate products if they do not get access to band where an existing ecosystem is in place. As such, they typically prefer to get access to standardized and harmonized 4G and 5G bands which already have a competitive eco-system in place leveraging the MNOs investments.

The difficulty for such users to get access to licensed spectrum has triggered attempts to achieve the same features over license-exempt spectrum. While in some environments (factories) undesired interference may be manageable due to absence of public, in other cases such as concerts or live performance, the presence of the public makes it challenging to guarantee interference management on license-exempt spectrum. Such coverage would be best delivered in Mid and High Band spectrum.

Broadcast and PPDR:

These applications typically require extensive coverage and investment in costly infrastructure, pointing towards requirement for licensed spectrum. Moreover, they also typically correspond to common use of spectrum where all users need to access a single network (no point in replicating such infrastructure). Terrestrial broadcast is a good example where typically a single license is delivered in exchange of service requirements (e.g. specific coverage, specific engagement in terms of content creation). Such coverage would be best delivered in 700 MHz for wide area, 3.4 GHz in suburban and 26 GHz spectrum for hot spot coverage.

IOT and smart cities:

IOT and smart cities cover a wide range of requirements from local (smart home) to extremely wide area coverage (agriculture sensor), from time sensitive (alarms and cameras) to non-time sensitive (smart meters) applications, from fixed to mobile devices.

In effect, technical solutions with advantages and drawbacks are emerging for these applications on both licensed and license-exempt spectrum, both high and low frequency bands. The full array of services envisioned is likely to require several spectrum access mechanisms. Such coverage would be best delivered in 700MHz for wide area, 3.4 GHz in suburban and 26 GHz spectrum for hot spot coverage.

Overview table

The table below provides that matching between the verticals services and the bands that are most likely to be relevant for their deployment:

Table 1: DIGITALEUROPE recommendations on spectrum for verticals

Verticals	700	3.4-3.8	26	Other bands
Mobile learning	x	x	x	MFCN bands
Mobile government	x	x		MFCN bands
Mobile health				

typical	x	x		MFCN bands
extreme QoS (e.g. remote surgery)		x	x	
Connected and autonomous mobility				
Automotive V2V, V2I				5.9GHz ITS band
Automotive V2N	x			MFCN bands
Industry 4.0		x	x	2.3-2.4GHz Unlicensed bands for less stringent QoS applications
PMSE		x	x	2.3-2.4GHz Unlicensed bands for less stringent QoS applications
Broadcast				Require specific framework to facilitate broadcast service being in cooperation with MBB service
PPDR	x			MFCN bands, likely in sub-1GHz
IOT and smart cities	x	x	x	MFCN bands License-exempt bands

Economies of scale and access to spectrum for verticals

One key aspect of vertical applications is that they previously did not benefit from the economies of scale associated with the mobile broadband market. Conversely, it is challenging for such verticals to compete with mobile broadband for access to spectrum (e.g. through participation in spectrum auctions).

Ideally, verticals need to be able to benefit from the economies of scale generated by mobile broadband while avoiding direct competition for spectrum.

Network slicing and managed services are obvious mechanisms to achieve this, as the MNO in such case regards the vertical as a value generating service instead of a competition to mobile broadband.

Spectrum sub-leasing mechanisms can achieve the same goal as MNOs do not need all spectrum band in 100% of the territory all the time.

Finally, some bands benefit from the mobile ecosystem of other regions, while being of low interest to European MNOs due to specific restrictions due to incumbents (e.g. the 2.3-2.4 GHz band). Such bands can respond to requirements of some verticals.

Regulators' proposals for 5G spectrum licensing

Germany

As indicated above, Germany proposed to license the 2.1 GHz and the 3400-3800 MHz bands on nationwide individual licenses in 3400-3700 MHz and regional/local licenses in 3700-3800 MHz, combined with a 'use it or lease it mechanism'. BNetzA indicates in its Key Elements for the rollout of digital infrastructures and Identification of Demand for nationwide assignments in the 2 GHz and 3.6 GHz bands:

- *Special importance is attached to securing the efficient use of spectrum provided. […] Thus it is especially important to prevent a situation in which spectrum resources are not used, in which they "lie idle", so to speak.*
- *The efficient use of the entire 3.6 GHz band can be promoted in this case by one user group being able to share the resources of the other user group as temporary additional capacity.*
- *In each band a specific user group has the right of first access […]. However, it is possible for one user group to share the frequencies of the respective other user group, provided this right of first access has not yet been exercised or use has not yet been made by the particular user group.*
- *When a network operator with a nationwide business model does indeed use the frequencies for which he has nationwide assignment but does not, for instance, serve areas of low population density, serves them only at a later date or uses other frequencies with which to do so, it should be possible for the frequencies in these regions to be used for the rollout of regional or local networks in order to promote spectrum efficiency.*
- *This contribution to spectrum efficiency can be achieved through temporary frequency transfer (spectrum leasing).*
- *5G is to bring about, in particular, the introduction of new innovative services such as Industry 4.0 or smart city. Expected therefore is heterogeneous demand from the industry, business parks and local authorities.*
- *Holders of nationwide assignments are to enable coverage in areas of demand for 5G at the end of a suitable period after assignment and under non-discriminatory conditions. Assignment holders can:*
    - *realise provision in line with demand with the frequencies assigned, or*
    - *lease to other users the frequencies assigned, or*
    - *build network infrastructures in cooperation with interested users.*
- *If the measures are to be economically efficient it may be necessary for users to contribute to their realisation.*

DIGITALEUROPE recommendations

DIGITALEUROPE believes that the licensing condition in a band have a significant impact on the take up and success of that band. As such, and in order to fulfil the promises of the single market, DIGITALEUROPE supports the harmonisation of licensing conditions for frequency bands across Europe. European countries successfully harmonise the technical conditions relating to frequency bands in Europe, similar processes should be adopted to ensure that the licensing conditions applicable to a specific band are as harmonised as possible across Europe.

With regards to the individual 5G bands, DIGITALEUROPE recommends following the indications in the table below:

Table 2: DIGITALEUROPE licensing recommendations in various bands

Band	Licensing recommendation
5G pioneer bands	
700 MHz	National individual licenses, >=2x10MHz*
3400-3800 MHz	National individual licenses, >=80-100MHz Regulatory obligation may be introduced to ensure productive verticals-MNO cooperation
26 GHz	National individual Licenses, >=400-1000MHz. Several options to enable both MNOs and verticals including network slicing, 'use it or lease it'.
MFCN bands with intensive use	
800 MHz	National individual licenses, >=2x10MHz*
900 MHz	National individual licenses, >=2x10MHz*
1800 MHz	National individual licenses, >=2x20MHz
2100 MHz	National individual licenses, >=2x20MHz

2570/2620-2690 MHz	National individual licenses, >=2x20MHz
Other MFCN bands	
1427-1517 MHz	National individual licenses, >=20MHz
2300-2400 MHz	Licenses, according to demand from verticals
2570-2620 MHz	Licenses, according to demand
License-exempt bands	
Sub-GHz license-exempt bands	License-exempt
2.4GHz and 5GHz bands	License-exempt
5855-5925 MHz	License-exempt for ITS
5925-6425 MHz**	License-exempt
57-66GHz	License-exempt

* In the future, we expect MNO to be able, through spectrum swapping, to rationalize their spectrum holdings in the sub-1GHz bands

** There is an on-going discussion in ETSI to extend the range in the ETSI ERM System Reference Document to 5925-6725 MHz

Spectrum licensing and the European Electronic Communications Code (EECC)

The EECC does not profoundly modify the spectrum access principles that were already included in the authorization directives. These include as two basic principles:

- infrastructure competition
- favouring license-exempt spectrum over licensed spectrum

Both principles were justified in the context of the previous framework with competition between actors was seen as a powerful incentive to trigger faster network and services deployment.

In the context of 5G, it is however clear that certain services, in particular specific verticals, will need specific conditions (see section Verticals). As such, generic principles such as those above, are unlikely to prove adequate for all 5G services; on the contrary, they trigger a significant risk of inadequacy for services.

5G – and the services deployed above it – will require economies of scale. As such, 5G would benefit immensely from the harmonization of the condition to access each of the pioneer bands, and later on all 5G bands. While technological harmonization is fairly successful in Europe under the current organization (CEPT, RSPG, RSCom), there is a lack of harmonization when it comes to actual spectrum authorization in a band (harmonization of license-exempt bands and of license conditions such as duration, spectrum price, coverage requirements, etc.).

DIGITALEUROPE recommends harmonizing at European level not only the technical conditions to access a band, but also the associated regulatory conditions. It is clear that a 'one-size fits all' regulatory approach would not be appropriate for 5G and the various services expected to leverage 5G. The adequate regulatory framework should be selected on a per band, per service basis, in a similar manner that technical conditions are not uniformly selected for all bands, but adequate technical conditions are harmonized at European level for each specific band.

In particular, both joint investment and infrastructure competition are expected to play a role in deployment of 5G, the same way that licensed spectrum, license-exempt spectrum, and other hybrid spectrum access mechanisms are all expected to play a significant role going forward.

Conclusions and Recommendations

While European countries have been extremely successful in the technical harmonisation of spectrum, there is still little to no harmonisation of the licensing conditions applicable to each band. With different licensing conditions applicable in different countries of Europe, there is little hope to achieve the promises of the single market, especially for vertical applications which do not necessarily benefit from large economies of scale. While pan European licensing mechanisms have been regularly rejected by Member States, DIGITALEUROPE notes that most European countries manage to adopt CEPT/ECC decisions without ending up unduly restricted in their national flexibility. **DIGITALEUROPE recommends adopting mechanisms to ensure as comprehensive as possible a harmonisation of the licensing conditions (license duration, price, spectrum packaging and availability, regulatory conditions) applicable in each European country to any spectrum band.**

License duration and license cost have a significant and potentially negative impact on the investments in 5G networks and technologies. **DIGITALEUROPE recommends adopting spectrum award mechanisms maximising investments in network and technologies.** Longer license options enable safer investment by MNOs, irrespective of the regulatory control mechanisms. Ideally, unlimited licenses with adequate regulatory mechanisms are the most investment friendly option. Similarly, spectrum costs are typically deducted from the overall budget of the operators, reducing their investment power, when it is clear that investments are lacking and would be beneficial to the economy. Spectrum award mechanism should favour investment, not suppress it.

5G networks will be more flexible and more adaptable than previous mobile networks to be able to respond to the requirements of many services beyond mobile broadband. 5G will propose mechanisms to enable both verticals and mobile broadband to access the spectrum. **In general, the idea of 5G is to slice the networks, not to slice the spectrum.**

In particular, MNOs require access to licensed spectrum in order to invest massively and deliver both coverage and economies of scale. **DIGITALEUROPE recommends awarding the 700 MHz, 3400-3800 MHz and 26 GHz bands on the basis of individual national licensing.**

While advanced technical spectrum sharing mechanisms have been proposed around the world (e.g. CBRS), they mainly apply to horizontal sharing mechanism between similar players. DIGITALEUROPE does not currently regard sharing mechanisms such as CBRS as relevant in the context of 5G in Europe. The key consideration should be how to ensure adequate access to spectrum to both MNOs (mobile broadband) and vertical services. **To ensure that verticals get access to spectrum, DIGITALEUROPE sees MNO managing the service for verticals (network slicing) as an excellent solution. In addition, DIGITALEUROPE recommends exploring and harmonising options such as:**

- **Sub-leasing the spectrum (possibly with 'use it or lease it' regulatory obligations),**
- **or any appropriate regulatory options ensuring that both MNOs and verticals get access to spectrum in order for all to benefit from investments and economies of scale.**

DIGITALEUROPE proposes the specific recommendations per frequency band and per vertical applications as in the following two tables:

Table 1: DIGITALEUROPE recommendations on spectrum for verticals

Verticals	700	3.4-3.8	26	Other bands
Mobile learning	x	x	x	MFCN bands
Mobile government	x	x		MFCN bands
Mobile health				
typical	x	x		MFCN bands
extreme QoS (e.g. remote surgery)		x	x	
Connected and autonomous mobility				
Automotive V2V, V2I				5.9GHz ITS band
Automotive V2N	x			MFCN bands
Industry 4.0		x	x	2.3-2.4GHz Unlicensed bands for less stringent QoS applications
PMSE		x	x	2.3-2.4GHz Unlicensed bands for less stringent QoS applications
Broadcast				Require specific framework to facilitate broadcast service being in cooperation with MBB service

PPDR	x			MFCN bands, likely in sub-1GHz
IOT and smart cities	x	x	x	MFCN bands License-exempt bands

Table 2: DIGITALEUROPE licensing recommendations in various bands

Band	Licensing recommendation
5G pioneer bands	
700 MHz	National individual licenses, >=2x10MHz*
3400-3800 MHz	National individual licenses, >=80-100MHz Regulatory obligation may be introduced to ensure productive verticals-MNO cooperation
26 GHz	National individual Licenses, >=400-1000MHz. Several options to enable both MNOs and verticals including network slicing, 'use it or lease it'.
MFCN bands with intensive use	
800 MHz	National individual licenses, >=2x10MHz*
900 MHz	National individual licenses, >=2x10MHz*
1800 MHz	National individual licenses, >=2x20MHz
2100 MHz	National individual licenses, >=2x20MHz
2570/2620-2690 MHz	National individual licenses, >=2x20MHz

Other MFCN bands	
1427-1517 MHz	National individual licenses, >=20MHz
2300-2400 MHz	Licenses, according to demand from verticals
2570-2620 MHz	Licenses, according to demand
License-exempt bands	
Sub-GHz license-exempt bands	License-exempt
2.4GHz and 5GHz bands	License-exempt
5855-5925 MHz	License-exempt for ITS
5925-6425 MHz**	License-exempt
57-66GHz	License-exempt

* In the future, we expect MNO to be able, through spectrum swapping, to rationalize their spectrum holdings in the sub-1GHz bands

** There is an on-going discussion in ETSI to extend the range in the ETSI ERM System Reference Document to 5925-6725 MHz

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DIGITALEUROPE represents the digital technology industry in Europe. Our members include some of the world's largest IT, telecoms and consumer electronics companies and national associations from every part of Europe. DIGITALEUROPE wants European businesses and citizens to benefit fully from digital technologies and for Europe to grow, attract and sustain the world's best digital technology companies. DIGITALEUROPE ensures industry participation in the development and implementation of EU policies.

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