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STRATEGIC SPECTRUM ROADMAP TOWARDS 5G FOR EUROPE

DRAFT RSPG Second Opinion on 5G networks

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[Editor Notes]

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Introduction

In November 2016 a strategic roadmap for 5G was first established when the RSPG adopted and published its first "Opinion on spectrum related aspects for next-generation wireless systems (5G) [1]", where it was outlined what spectrum will be needed for next-generation wireless systems.

An opinion was sought in order to build on RSPG's efforts and contribute actively to the development of Europe's spectrum policy strategy regarding 5G.

The work in 2016 focused on identifying the building blocks needed for a rapid launch of new wireless services in the next generation wireless systems:

- 3.6 GHz (3400-3800 MHz) will be the first primary band for 5G and bring the necessary capacity for new 5G services;
- 26 GHz (24,25-27,5 GHz) will be the pioneer band in Europe above 24 GHz to give ultra-high capacity for innovative new services, enabling new business models and sectors of the economy to benefit from 5G;
- 5G can be launched over the existing EU harmonised mobile bands, including in particular bands below 1 GHz which can enable 5G coverage to all areas (e.g. 700 MHz) ensuring that everyone benefits, while enabling the transition from the current to the next generation of networks.

For 2017 the RSPG set up a plan to work on spectrum strategic questions and recommendations with the aim to issue a supplementary opinion focusing on areas set out in the first Opinion, relevant issues brought up in the public consultation[2] and other relevant areas from an RSPG perspective.

The RSPG Second Opinion on 5G networks is a further development of the roadmap to facilitate the launch of 5G on a large scale in Europe starting in 2020. The goal being that the benefits of 5G-based services are available to all European citizens in a timely manner, driving industrial and societal transformation and economic growth in Europe from 2020 and beyond.

[1] http://rspg-spectrum.eu/wp-content/uploads/2013/05/RPSG16-032-Opinion_5G.pdf
[2] https://circabc.europa.eu/d/a/workspace/SpacesStore/4ed94c29-182f-418a-b202-6861f69a4f3a/Responses_5G.pdf

The RSPG Second Opinion on 5G networks

The RSPG recognises that 5G promises to enable the delivery of a diverse set of applications and new services in a number of different markets, going beyond the traditional mobile broadband market.

1. T**he RSPG is of the opinion** that Member States will need flexibility in the way they authorise access to spectrum, for example: appropriate geographical areas (e.g. national, regional, city or hyper-local, e.g. for use in a factory), individual licencing or under a general authorisation framework.

2. **The RSPG is of the opinion** that the Commission, together with Member States, should take actions to fully support 5G related policy objectives in rural areas and wide coverage, taking into account the role of satellite in achieving ubiquitous connectivity.

3. **The RSPG recommends** that the Commission, in its research work-programs, study solutions for improving 5G connectivity and wide area coverage, especially in rural areas, thereby facilitating and progressing technology developments targeting the fulfilment of 5G related policy objectives.

4. **The RSPG is of the opinion** that service performance and availability requirements may be relevant for some 5G cross border services to fully function and would need to be defined by the industry in a timely manner. In some cases an EU coordinated approach could be helpful in this regard to support a common European solution.

5. **The RSPG is of the opinion** that coverage obligations can only be derived as a consequence of national policy objectives and characteristics (i.e. population distribution, geographical morphology, industrial and societal needs) and therefore cannot be harmonised on a EU-level.

6. **The RSPG notes** that solving issues relating to facilitating the efficient deployment of ultra-dense networks is expected to be of high importance for the rollout of 5G in dense urban areas. **The RSPG is of the opinion** that Member States should assess the need for national actions that will enable easier site authorisation and installation, in particular for small cells, in order to make timely 5G deployment possible.

7. **The RSPG is of the opinion** that all commercial licences in frequency bands identified for 5G within the Member States should be subject to trading or leasing to enable new market opportunities.

8. **The RSPG is of the opinion that** Member States should consider appropriate measures to defragment the 3.6 GHz band, the primary 5G band, in time for authorising sufficiently large blocks of spectrum by 2020.

9. **The RSPG is of the opinion that** in relation to the 26 GHz pioneer band (24.25 - 27.5 GHz):

    - the focus of 5G authorisations in the 26 GHz band should be on an individual licence regime. However, the possibility of a general authorisation regime under sharing conditions that protect the other users of spectrum in this band (e.g. EESS/SRS) is not excluded.

    - the Commission should include as part of any technical harmonisation for the 26 GHz band, in high level terms, the requirements to maintain the possibility for continued development of incumbent satellite services (FSS and EESS/SRS). Future earth stations should be authorised based on transparent, objective and proportionate criteria to safeguard their future operations and ensuring that they are unlikely to have a significant impact on 5G deployment and coverage. Member States will remain fully responsible for granting or rejecting authorisation to a new satellite earth station application.

- Member States should make by 2020 a sufficiently large portion of the band, e.g. 1 GHz, available for 5G in response to market demand, taking into account that 5G deployment in this frequency range is expected to be used for local coverage.
- Regulatory flexibility for the progressive release of the 26 GHz band will facilitate an efficient introduction of 5G without having an unnecessary negative impact on the current users of the band. Member States should plan any migration of fixed links necessary for ensuring the availability of the band for 5G, taking into account the geographical dimension of the market demand for 5G.

10. **The RSPG is of the opinion** that general authorised frequency use can be an important breeding ground for innovation and contributes towards a dynamic market environment. The application of a general authorisation regime is foreseen in the 66-71 GHz band which could be an important band for 5G.

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ANNEX to the The RSPG Second Opinion on 5G networks

A.1 5G services / 5G technologies and related band use from the RSPG perspective

Wireless communication has become an indispensable commodity for society, resulting in increased societal dependence on its availability. It has become a precondition for economic growth, with strong positive external effects on the economy. It enables the innovation of products and services.

For both economic opportunities and social connection, the availability of mobile communications is important.

Increasing dependence on mobile communications gives rise to specific requirements being imposed on communication systems, such as a high degree of availability and reliability, data rate and network prioritisation.

5G technology and networks are likely to have a different set of spectrum requirements for Member States, because of the different network characteristics and services.

5G networks will not only be used to provide faster mobile broadband (known as EMBB), but also massive machine-type communications (mMTC) and Ultra-Reliable and Low Latency Communications (URLLC). Many mMTC and URLLC services will need reliable wide-area coverage and users will only be able to rely on those if the 5G service is widespread, for example medical and social care services and connected cars.

Development at the core network level will allow a common mobile network to be sliced into virtual private networks, for use by different sectors (network slices)

To enable these services, 5G will make use of bands with radically different characteristics.

The 700 MHz band can be used to provide wide area coverage, the 3.6 GHz band can be used to provide high capacity and coverage, using both existing macro cells and small cells. The 26 GHz band is likely to be deployed in areas with very high demand, for example transport hubs, entertainment venues, industrial or retail sites and similar. Because of its characteristics, the 26 GHz band will not be used to create wide area coverage.

In due course, the mobile operators could perform transition of lower frequency mobile spectrum (800, 900, 1800, 2100, 2600 MHz) to 5G, but some studies suggest that 4G LTE and its evolutions will continue to develop in parallel to 5G deployments (as 3G continues to be used today in parallel to 4G).

5G networks will probably coexist together with 4G LTE and RLAN networks in a more coherent way than previously experienced. 5G networks will not be homogeneous but may for example consist of a thin low capacity layer providing

wide area coverage with limited capacity at 700 MHz, with 3.6 GHz offering high capacity in areas of high demand and smaller hotspots of 26 GHz providing islands of very high capacity. Network "orchestrators" will determine which wireless access delivery network is to be used by a particular mobile terminal at any particular time and place, depending on the overall demand for connectivity and the traffic being handled.

Current discussion in 3GPP suggests that channels up to 80 MHz or 100 MHz, multiples thereof, or combination of narrower supported bandwidths will be used at 3.6 GHz. 5G networks deployed in the mmWave bands (> 24 GHz) will make use of much wider radio channels

The diverse set of services, enabled by both existing and potential new players, may require different authorisation approaches to deliver innovation and meet the socioeconomic policy objectives of each European country.

The following sections of the Opinion set out possible approaches and considerations for Member States when authorising spectrum for 5G. .

A.2 Sharing options and Authorisation models

Spectrum managers will need flexibility to choose the authorisation approaches most appropriate to address their particular circumstances and policy objectives and to build on shared best practice.

A2.1 Sharing with existing spectrum users

In this sub-section we focus on the sharing potential between 5G and existing users recognising that each European country will need to consider the potential for 5G to share with existing users and that this may influence the authorisation approach.

A2.1.1 General aspects of sharing issues

Sharing will likely increase as 5G players seek additional spectrum and increased bandwidths to support 5G applications. As mentioned before, each European country will need to consider the potential for 5G to share with existing users, and this will influence the authorisation approach

A2.1.2 New ways of sharing

- Access to spectrum at higher frequencies could enable new ways of sharing, given its specific propagation characteristics. In the mmWave bands such as the 26 GHz "pioneer" band, the deployment of 5G will most likely to be for small cells. These cells will have limited coverage and, initially, are likely to be concentrated mainly in urban and suburban areas. They could be deployed indoor or outdoor, including through the use of new physical support such as street furniture.
- The antenna beam forming technologies being developed for 5G will be used to improve link quality and throughput to individual end users. It should be investigated where it is feasible for antenna beamforming technologies to also be used in a way that explicitly minimises radiation in specific directions, i.e. towards receiving stations of other services. If this is feasible then, when coupled with other technical approaches (e.g. database / geolocation technologies), it could potentially be effective in mitigating interference to other services. This may offer the possibility to deploy 5G stations closer to the existing stations to be protected than would otherwise be the case. However, such features would have to be implemented in the antenna beamforming and massive MIMO algorithms in a way that allows operators to define the radiation limitation in any given direction.
- It is important for standards bodies such as 3GPP and ETSI and for research programmes such as the 5G-PPP to investigate these features. Where feasible, manufacturers should include them in the development of 5G equipment to facilitate increased sharing.

- Member States should take into account these potential technology developments when analysing spectrum sharing opportunities between 5G and existing users.

A2.1.3 *Spectrum sharing with fixed service*

- In some countries the existence of other primary services including fixed links operating in the 3.6 GHz band will need to be considered when authorising 5G services. CEPT has provided a technical toolkit[3] for administrations to manage the coexistence with fixed links in this frequency band. Administrations may want to consider how to use the toolkit taking into account specific national situations, while at the same time facilitating deployment of 5G networks and promoting a greater spread of 5G by clearing the band in full for licensing mobile network operators.

- With regard to the 26 GHz band (and similarly with other mmWave bands), large parts are currently used for wireless fixed links in European countries. Depending on the location of the fixed links, the demand for 5G small cells and the extent to which interference can be mitigated using new technologies, it may be possible to deploy 5G small cells within the same frequency range as some of the existing fixed links.

- Technical studies in CEPT need to be carried out regarding the co-existence with Fixed Service applications (PP and PMP) in the 26 GHz band (and in other relevant mmWave bands). These coexistence studies should take into account relevant technology developments that may have a positive impact on the potential for sharing, e.g. improvements in antenna technology such as massive MIMO and beamforming as well as the different antenna mounting positions for 5G and fixed service (street level and rooftop level).

- In areas where adequate coexistence cannot be achieved, it will be necessary for existing fixed service links to be cleared to allow 5G deployment, and Spectrum authorities will need to consider the best approach to this clearance. Fixed links could be removed on a progressive basis, if such an approach is considered appropriate and in line with national policy objectives. A progressive approach would be in contrast with previous cases for lower frequencies bands which had to be cleared in full before licensing mobile network operators. For example, fixed links could be moved out of specific sub-bands of the 26GHz band and/or geographic areas of a country to allow the introduction of 5G. Such an approach could be more cost effective and practical than developing complex technologies and systems to allow 5G small cells and fixed link receivers to operate on the same frequency and at close

[3] ECC Report 254 on "operational guidelines for spectrum sharing to support the implementation of the current ECC framework in the 3600-3800 MHz range" http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP254.PDF

proximity. Alternatively, spectrum authorities may consider that full clearance is the best approach given their national circumstances and policy objectives.

- Therefore, flexibility in timescales for release of the 26 GHz band, in response to the need of the different market players, is important to minimize the overall costs associated with 5G deployment and the burden imposed on incumbent fixed links operators.

- In the longer term, it is clear that 26 GHz will no longer provide a significant resource for the Fixed Service. The possibility to continue to operate a limited number of fixed links in the band on a shared basis with 5G will depend on the effectiveness of potential mitigation techniques and the extent of 5G deployment, particularly in less-populated and rural areas.

A2.1.4 *Sharing with other co-primary services*

a) Sharing with other primary services at 3.6 GHz

- In some countries the existence of satellite earth stations receivers operating in the 3.6 GHz band will need to be considered when authorising 5G services. CEPT has provided a technical toolkit (ECC Report 254) for Administrations to consider coexistence with earth stations in this frequency band.

- European Administrations should ensure the proper balance between the benefits of allowing 5G use and keeping access to satellite operators in this frequency band. Administrations should consider how to use the toolkit taking into account specific national situations while at the same time facilitating practical deployment of 5G networks in this band.

b) Sharing with other primary services at 26 GHz

- As stressed in the first RSPG opinion on 5G, the harmonisation of the 26 GHz band for 5G will need to take into account other services in the same band or in the adjacent bands.

- In some Member States existing users of the 26 GHz band include operators of Wireless Local Loop (WLL) systems that follow CEPT Recommendation T/R 13-02 and ECC/REC/(11)01, under individual licenses. Harmonisation measures should then consider the need for appropriate coexistence plans.

- Of particular importance will be considerations with regards to coexistence with on-board satellite receivers of the fixed-satellite service and the inter-satellite service allocations. Relevant technical conditions, defined as part of the European harmonisation measures, will need to be considered carefully and agreed ahead of WRC-19. It will be important to ensure that informed decisions are taken at WRC-19 and that these reflect the European conditions.

c) Sharing with satellite earth stations (EESS/SRS receiving earth stations and FSS transmitting earth stations)

- Concerning the 26 GHz band, we expect that the impact of satellite Earth stations on the deployment of 5G networks could be minimised if they are deployed in sparsely populated areas, away from major conurbations. Administrations are encouraged to maintain the possibility for additional earth stations to be deployed in their territory.
- To facilitate this, and prior to awarding 26 GHz spectrum for 5G, administrations are encouraged to consult relevant stakeholders to establish if they have plans to deploy additional Earth stations and to work with them to identify potential sites where such future Earth stations could be deployed that would be unlikely to have a significant impact on 5G deployment and coverage. If such sites are identified, Administrations should maintain the possibility for the planned Earth stations to be deployed and they should establish transparent, objective and proportionate criteria to safeguard their future operations. Where necessary, appropriate provisions can be included in the relevant 5G authorisation.
- In order to respond to future requirements for which no current plans exist (including potentially from new stakeholders), it is also possible that further Earth stations may be needed in areas where 5G authorisations have already been granted. Administrations will need to assess requests for such new Earth stations and should consider granting them in cases where they would be unlikely to have a significant impact on 5G deployment and coverage.
- Additional studies are necessary to establish "proportionate" criteria to assess the impact of such yet to be planned future earth stations on 5G deployment. In the case of FSS transmitting earth stations, the impact might be in terms of the geographic area where a 5G service might potentially be degraded (e.g. the area where a relevant 5G protection criteria is exceeded). In the case of EESS/SRS receiving earth stations, the impact might be in terms of a geographic area where further 5G deployment may need to be constrained to protect the receiving Earth station (e.g. by restricting the maximum base station transmit power towards the Earth station). Ensuring that the impact is proportionate could mean ensuring that such areas correspond to areas where demand for 5G is low, e.g. areas with a low population density, and/or are outside highly populated areas, and/or contain a (very) small percentage of the total population of a given administrative entity. It is recommended that CEPT should provide a technical toolkit for the national implementation of such assessment criteria.
- In order to ensure that future earth station requirements could be dealt with after the 5G authorisations have been granted, some administrations may require adequate provisions to be included in the authorisation provisions. However, since the regulatory solutions are likely to vary from country to country, flexibility is necessary at the EU level.

- Administrations should pay special attention to the potential impact on equitable spectrum access between 5G operators in geographic areas where 5G deployment may be constrained by Earth stations, especially where the constraint might apply differentially across the spectrum band (noting that the impact of an Earth station will be limited to a specific sub-band: i.e. a maximum of 600 MHz for FSS and 1.5 GHz for EESS/SRS). If necessary, any impact could be mitigated by various measures (e.g. requiring an operator with fewer constraints to share access with others, or ensuring frequencies in areas potentially impacted are distributed among operators appropriately). For some administrations, this may require adequate provisions to be included in the authorisation provisions. However, since the regulatory solutions are likely to vary from country to country, flexibility is necessary at the EU level.

A2.2 Authorisation Models

- Mobile spectrum has usually been allocated on an exclusive, national basis. This approach has allowed operators to avoid interference and deliver the expected Quality of Service experience for end users on a national level.
- The use of higher frequency bands (above 24.25 GHz), enabling new services and applications is likely to require different approaches to authorisation, to respond to the diverse set of new market players in addition to the existing network operators. Furthermore, 5G requires much wider channel bandwidths for full speed eMBB and there may be insufficient spectrum to give each operator an exclusive assignment cleared of existing users.
- Member States will require flexibility in the mix of authorisation approaches to use. Alternative authorisation approaches may include general authorisation regimes (licence exemption), licensed shared use between different users, geographical sharing (including sub-national, regional and site specific licensing, including at the local level directly to businesses), or more dynamic approaches to spectrum sharing in time and space, possibly using geolocation databases.
- A possible approach would be to foresee the application of a general authorisation regime in the highest frequency bands (e.g. 66-71 GHz) while focusing on an individual licence regime in the 26 GHz band, where sharing constraints would be higher.
- Licensed and general authorisation regimes could also be combined in a hybrid way, e.g. using carrier aggregation to deliver the information in part via licensed spectrum (e.g. at 26 GHz) and in part via spectrum subject to general authorisation (e.g. at 66-71 GHz).
- Uncertainty in which services and applications will emerge and succeed may introduce investment uncertainty for operators. Enabling trading or leasing of

spectrum can reduce investment uncertainty and more efficient use of spectrum. Member States should ensure that spectrum trading or leasing does not adversely impact on levels of competition.

- To enable optimal use of spectrum, industry should develop suitable protocols to ensure coexistence between various 5G applications in general authorisation bands and at the boundaries of geographic licences.

A2.3 Considerations of the relevance of 5G to IoT, ITS and verticals

- 5G will play a significant role in providing a communications service that meets the specific requirements existing and new users. 5G is even developed with the explicit aim of providing the widest possible range of applications to meet a diverse set of consumer needs. Where formerly different networks and technologies were needed to deliver specific applications, mobile communications are increasingly able to provide all these applications, such as IoT, ITS, as well as other verticals. This may reduce the need for exclusive assignment of spectrum for those specific applications. Authorisation should take into account that different classes of applications have different requirements.
- The demand for business-specific applications could largely be covered by mobile providers. Making spectrum available for niche players could give them the opportunity to offer specific applications, both using their own infrastructure and as service providers using the infrastructure of a mobile operator.
- Some new applications, such as the Internet of Things or providing indoor coverage, may also develop in spectrum under a general authorisation regime. General authorised frequency use for these applications can be an important breeding ground for innovation and contributes towards a dynamic market environment.

A2.4 Coverage

A2.4.1 Coverage and roll-out obligations

- Mobile connectivity is becoming a necessity for society with strong positive external effects on the economy. 5G is being designed to not only provide greater capacity for wireless networks, but also to cater for tailored services that fulfil the requirements needed by different industry sectors. The dependence of the economy and the society-at-large on mobile connectivity calls for a reassessment of mobile.
- Coverage obligations have been used in the past to deliver coverage in areas where the market alone may not have delivered socioeconomic benefits. The increased reliance on mobile connectivity for both the economy and the wider

society may require the regulator to consider different approaches to ensure widespread benefits from mobile connectivity when authorising new spectrum bands.

- Broadly speaking, the requirement for setting coverage obligations can come from two different considerations:
    - Fulfilling Government policy objectives of ensuring wider service coverage (coverage obligations) within a defined timeframe
    - Ensuring that networks are deployed in a timely fashion in a specific frequency range and that an ecosystem is developed (rollout obligation).

  Both kinds of obligations are based on different kinds of policy objective.

- A coverage obligation is an obligation to provide a certain service in a given area or to a certain percentage of the population, usually within a specified time period. This obligation will be part of a national policy to make certain services available to consumer and/or business users. It depends on the national circumstances which services or requirements will be used to meet the national policy. This national policy might be related to the availability of broadband in unserved areas or the availability of services for specific business users. Coverage obligations, which go beyond what the market would deliver on a commercial basis, are expensive, and ultimately funded directly or indirectly by the taxpayer and consumers. As such, they are a national issue.

- A rollout obligation is designed with the intention of securing the timely deployment of services that the market could be expected to provide in due course, to a particular timetable and in a specific frequency range. It is therefore calibrated to bring forward investment (and the ancillary benefits of that investment) to a fixed point (potentially with a number of interim staging points) rather than to secure new investment into areas where it would not normally be expected to be economic for the provider over the longer term.

- Even if the mobile operator already has a coverage obligation some administrations may consider it desirable to impose a roll-out obligation to ensure that all licences that a mobile operator possesses are actually used. This may be due to concerns about operators strategically acquiring licences, e.g. to hoard spectrum in order to deny its access to others. In principle, a roll-out obligation can be formulated in the same terms as a coverage obligation, albeit with a less stringent requirement.

- A coverage or rollout obligation can have various criteria associated with the obligation in order to ascertain that the obligation is met. For example:
    - minimum field strength;
    - specified service quality;

- uplink and downlink throughput;

- Individual countries may decide to use either or both coverage and roll out obligations to achieve different policy objectives with regard to coverage, efficient use of spectrum, and timely investment.
- An important aspect of a coverage or rollout obligation is enforcement. If the criteria itself and methodology to measure those criteria are not clearly defined, it will be very hard to enforce the obligation and to ensure the fulfilment of the related policy objectives. In other words, it should be clear how the obligation will be defined and measured. There are already a number of documents available in the ECC that can be used to define the criteria and the measurement thereof, such as ECC Report 256 on LTE coverage measurements. However, for obligations based on other service quality parameters, there might be a need to develop new methods[4]
- Harmonised obligations across European countries could prevent each individual country from achieving its own policy objective, as they would not take into consideration the Population distribution, geographical morphology, industrial and societal needs. RSPG is of the opinion that coverage and roll out obligations should be based on national policies, whilst at the same time recognising the importance of sharing best practise and information amongst European countries. Therefore the RSPG is of the opinion that it is not appropriate to introduce an obligation that is harmonised across European countries.

A2.4.2 5G coverage challenges

- Lower frequencies, such as 700 MHz, are better suited to provide widespread coverage (both geographic and indoor) than the other bands identified by RSPG for 5G. Widespread coverage delivered across the different mobile bands is particularly important for the growth of the mMTC market.
- In some counties introduction of 5G in sub 1GHz is likely to be a gradual evolution of LTE rather than in newly released spectrum. As such, there may be limited opportunities to introduce a new, 5G specific coverage obligation in these bands to accelerate or extend 5G coverage. Consideration should be given as to whether competition between operators will drive a timely migration to 5G or whether regulatory intervention should be considered.
- Coverage obligations to-date have typically been set at a national level. Given small cell sizes and the targeted capacity of mm-wave 5G cell sites, it is unlikely that this type of obligation would be feasible for 5G, and therefore it

[4] See also draft BEREC and RSPG joint report on Facilitating mobile connectivity in "challenge areas" (BoR (17) 185 / 26.Septmber.2017)

may be more appropriate for individual countries to consider local (and perhaps specific) obligations that address locations that the market is unlikely to reach e.g. rural public both indoor and outdoor locations and transport links rather than general geographic or premises obligations.

- Coverage obligations placed on mobile network operators have generally benefitted all users of those networks. However, 5G is expected to be designed to serve different industry verticals, with network slices providing virtual private networks, potentially offering different levels of service to different customer segments based on minimum performance for characteristics such as bit rate, latency, availability, reliability, velocity.
- Industry will define such service performance and availability requirement and Member states will have to consider the consequences in terms of coverage obligation. In the case of cross-border services, it would be helpful if common service performance and availability requirements are used across EU.
- There have been a large focus in the definition and development of 5G on developing technology components suitable for facilitating a huge increase in data rate and capacity for urban and suburban areas, this is especially true for the development related to enhanced mobile broadband which has focused on frequency bands above 1 GHz. There are however rural and sparsely populated areas within EU which today are totally reliant on coverage based in bands below 1 GHz. In many of these areas a densification to support coverage in higher frequency bands might be challenging due to the high cost of constructing new green-field infrastructure in-between the current cell sites. It is therefore a risk that customers in these areas will not enjoy the same proportional improvement as in urban and suburban areas as a result of the 5G deployments, especially when it comes to enhancements of the mobile broadband services.
- To be able to fully support 5G related policy objectives in these kind of rural and sparsely populated areas, there is a need to investigate solutions to address these geographical areas including further technology developments especially targeting rural and sparsely populated areas, but also taking into account the role of satellite in achieving ubiquitous connectivity. This work can be driven by industry, the Commission and the Member states.

A.3 Delivering ultra-dense networks

A number of challenges will need to be addressed in order to achieve ultra-dense networks which are required to achieve widespread 5G services. Many of these are national issues that should not be addressed at the European level, but Member States should be aware of them. Key amongst these is the fibre necessary to backhaul high capacity data from the base stations to the network core. Fixed telecommunications operators will need to play a central role if dense networks of small cells are to be deployed. Access to ducts and poles is likely to be important in enabling the necessary fibre to be provided for small cell deployments.

Suitable arrangements amongst operators in terms of fibre and duct access flexibility, maintenance, sharing of contractual obligations and future deployment will also be necessary. In the coming years, a new challenge will be the extension of fibre and connecting cells into non-typical locations, such as small base stations mounted on lampposts and building walls as well as more conventional street furniture, so that operators can roll out new sites in a cost effective and timely manner.

A notable feature of small cell densification will be the need for access to very large numbers of these new locations for small base stations. This will require collaboration between network operators and property owners, local and civil authorities to handle agreements and issues that might occur due to deploying telecommunications equipment on infrastructure not designed for that purpose. In many parts of Europe, there is currently no common approach to this type of collaboration.

Early signs are that the process tends to be fragmented across different local authorities and negotiations are often legally complex and protracted, making MNOs reluctant so far to get deeply involved. Aspects such as planning policy, national legislation codifying the rights and obligations of mobile operators, and guidelines for deployment in the street environment will need to be addressed before dense site deployment can take place.

Taken together, these challenges suggest it would be unwise to assume that small radio cells will necessarily be cheaper or quicker to deploy than other types of cell architecture. Significant backhaul requirements together with the sheer volume of sites required will result in the need for significant investment. And urban restrictions such as local authority permits and traffic management needs could prove to be costly obstacles, causing delays and expense.

Therefore, to make timely 5G deployment possible, and ensure networks can expand to meet future requirements in dense urban areas, active local government engagement and support will be necessary. This should include the development of robust and coordinated plans for the deployment of enhanced mobile networks, drawn up by local or national authorities in collaboration with the broader economic development authorities and incorporating input from network providers.

In this context, there is also a role for central governments, which should keep under review legislation and regulation impacting the sector, to help encourage dense small cell deployments, including simplifying necessary licence processes. Governments will need to monitor how these efforts to stimulate network investment end up working in practice and keep open the possibility of legislative changes if necessary, for example to establish national rules for access to small cell locations not previously regarded as appropriate and to mandate site-sharing in relevant cases.

Governments and their national spectrum regulatory authorities will also need to consider the requirements for wireless backhaul spectrum. While the increasing roll out of fibre will play a significant part in providing the necessary backhaul for future ultra-dense networks over the longer timeframe, the complementary need for fixed wireless links will continue to be required, particularly in the short to medium term while fibre networks expand. Wireless networks will continue to be important and particularly for shorter hop lengths and with very high capacity requirements i.e. as fibre expands further out towards the peripheries of the network, the wireless component will get shorter but with much higher capacities (nx1 Gbps to nx10 Gbs). The higher mmWave bands such as the 70/80GHz (E-Band) and potential new bands above 90 GHz (such as 'W[5] and 'D[6] bands) are also likely play a significant role in this aspect.

[5] W Band: 92 – 114.5 GHz
[6] D Band 130 – 174.8 GHz

A.4 Frequency bands for long term development

The various bands under consideration for 5G above 24 GHz as part of the WRC-19 preparatory process are summarized in the following table:

Frequency Bands under study as part of the WRC-19 process	RSPG Comments
24.25-27.5 GHz (26 GHz)	Pioneer mm-wave band for the initial launch of 5G services in Europe focusing on individual authorisation regimes. (under harmonisation)
[31.8-33.4 GHz (32 GHz)]* and 40.5-43.5 GHz (42 GHz)[7] and 66-71 GHz	European priority in terms of studies for second stage mm-wave 5G bands. 66-71 GHz has potential as a primary European band for 5G services under general authorisation.
37-40.5 GHz and 45.5-50.2 GHz and 50.4-52.6 GHz and 71-76 GHz and 81-86 GHz (70/80 GHz)	Other bands being studied as part of the preparation process for WRC-19

**The frequency band 31.8-33.4 GHz was considered in the first RSPG opinion on 5G as a priority band for studies. The RSPG notes that the preliminary results of these sharing studies highlight some difficulties, and that the interest for this frequency band appears to be declining. Therefore, the RSPG considers that this frequency band should not anymore be considered as a priority for studies and invites views from stakeholders during the public consultation*

A4.1 Bands above 24 GHz

The 26 GHz has been established by the first RSPG opinion on 5G as the pioneer mm-wave for 5G. This first opinion also identified the 32 and 42 GHz band as priority for studies. The RSPG is of the opinion that the 66-71 GHz band should now also be

[7] Industry has indicated that 40.5-43.5 GHz is expected to be part of a tuning range for equipment from 37-43.5 GHz. The potential of this tuning range would be for different regions to be able to identify the most appropriate frequencies to be used for 5G.

prioritised in terms of studies for second stage mm-wave 5G bands for the following reasons:

- A recent CEPT questionnaire found there was no reported use of 66-71 GHz in most CEPT countries.
- Its proximity to the 57- 66 GHz band, already designated and used for WiGig, indicates that 5G equipment could potentially be available in this band relatively early by benefiting from the ecosystem being developed in the adjacent band.
- Access under general authorisation is an important enabler of new 5G services and applications; 66-71 GHz has a potential to become a primary European band.
- It has already a primary allocation for mobile.
- It has better propagation characteristics than the adjacent 57-66 GHz band (as it's outside the O_2 absorption peak) and therefore can be a viable alternative to lower mm-wave bands for cell radiuses ranging from 50 to 200m.

The RSPG opinion on 5G has emphasized the interest of investigating the 32 and 42 GHz bands as additional bands complementing the 26 GHz «pioneer band»

There is no urgency in potential harmonisation of these bands since the 26 GHz band will provide a capacity of up to more than 3 GHz of spectrum for 5G above 24 GHz which is likely to cover in the next few years any demand from mobile network operators, given the potential investment level required for 5G deployment above 24 GHz

WRC-19 will be an opportunity to gather complete information about sharing opportunities as well as about global availability of all frequency bands studied by ITU for 5G above 24 GHz including the 32 GHz and 42 GHz bands

Therefore, RSPG will review the situation after WRC-19 in order to provide a roadmap for European harmonisation of further bands for 5G above 24 GHz.

A4.2 Bands other than those in the 1st Opinion – generic discussion and possible timelines.

A4.2.1 Existing bands below 4 GHz

- The use of lower frequency bands, in particular below 1 GHz, for 5G will be necessary for implementing machine-type communication (MTC) services, including high-reliability low-latency MTC.
- It is expected that a 5G radio interface which will be adapted to these frequency bands, ie to channel bandwidths of 5 and/or 10 MHz and to paired channelling arrangements, will be specified only in 2020 (e.g. by 3GPP).

- This emphasizes the importance of the European-wide availability of 3.6 GHz as the primary band for 5G since this band will be the only band below 4 GHz which will enable 5G deployment in 2020, both for MTC and for Enhanced mobile broadband.

A4.2.2 *Policy / regulatory issues & spectrum management aspects relating to second stage/long term 5G mm-wave frequency bands.*

- A new regulatory framework is necessary in order to provide a flexible and predictable environment for 5G short-term and long-term development. The framework should enable the harmonious co-existence of all primary services and corresponding applications in the identified mm-wave bands.
- Spectrum management challenges similar to those faced with existing mobile technologies will remain with 5G, while spectrum sharing solutions, such as Licensed Shared Access and light-licensed or unlicensed 5G operations, will need to be exploited regarding the most appropriate spectrum assignment methods and spectrum sharing schemes for 5G mm-wave frequency bands, taking into account the high degree of frequency reuse in these bands.
- The consideration of new long term 5G mm-wave frequency bands will depend highly on recognition of incumbent and planned usage of these bands by other services and applications. Opportunities and difficulties (based on current and planned spectrum usage) of each of the potential long term 5G mm-wave bands will be identified during the WRC-19 cycle.

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