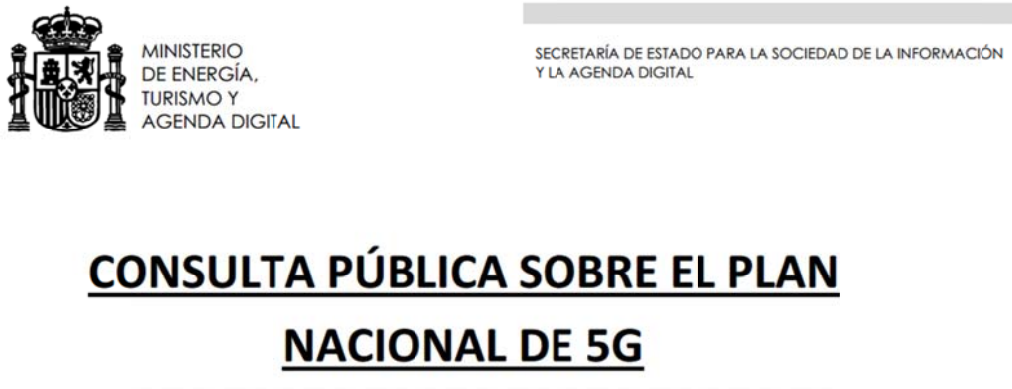




Intel Response “Spain 5G National Plan” Consultation July 2017

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Intel Corporation Generic Comments

None of the Intel Corporation response is confidential and it can be published fully if required.

Similar to the European Commission, Intel supports a technology neutral approach to using existing mobile bands for future 5G deployments as well as supporting identification of the 700 MHz, and 3.4-3.8 GHz as primary bands for introduction of 5G plus the 26 GHz band as a pioneer band suitable for the development of European 5G harmonisation.

Intel believes 5G applications will require access to spectrum in low (<1.5 GHz), mid (2-6 GHz) and high (e.g. mmW bands) frequency bands. For the higher range, 24.25-27.5 GHz and 27.5-29.5 GHz is most desirable since with a suitable radio tuning range it is possible to capitalise on initial 5G deployments in leading markets.

Within CEPT/Europe, Intel fully supports 24.25-27.5 GHz as a 5G “pioneer band” and we note that conditions for harmonisation are currently under study in CEPT project team ECC PT1 to develop a band plan for 5G and study coexistence with the other radio uses. It is our understanding that the technical conditions and band plan will be published in an ECC Decision and the results of the studies will be presented in a CEPT Report with a target date for publication June 2018.

One important factor enabling 5G mobile broadband is spectrum harmonization to facilitate economies of scale and global roaming. However, harmonization is not limited to a situations where all Regions have identical spectrum allocations. The benefits of harmonization can also be derived from “tuning range” solutions covering adjacent or nearly-adjacent bands in which equipment can be reconfigured to operate over multiple bands, i.e. they are within the same “tuning range”. These “tuning ranges” are critical to delivering the benefits of harmonization as the radio units in user devices developed for one band can also be utilized in some nearby bands without requiring entirely new development efforts. As technology and volume manufacturing capabilities advance over time, further widening of radio tuning ranges may become feasible.

It is essential that for the initial 5G “pioneering bands” a clear strategy be adopted to make those bands available for re-use by 5G without undue delay, with incumbents provided with the necessary protection and sufficient notice of intent in order to adopt a coordinated approach for mitigation techniques between the incumbent and the new comer.

Re-purposing (or re-farming) spectrum has a long lead time activity that needs to be carried out at both the national level and in the context of international developments. Intel proposes that whilst international activities develop it is important that national considerations commence in a timely manner to shape international activities and be ready to act to facilitate the roll out of 5G networks.

Intel prefers exclusive dedicated licenses and we consider that auctions are the fairest way to provide access to spectrum since this approach determines fair market value for the spectrum and generally enables spectrum to be assigned to Operators who value it the most. We do urge caution that auctions should not be designed to maximise revenue via the auction process noting the substantial investment costs associated with network rollout; we believe the greatest benefit from spectrum is in its sustained use and not from the release process. Auctions should be designed to be an efficient process to maximize allocation of spectrum. The more operators spend in the auction, the less resources will be available for infrastructure deployment and rollout. Intel believes beauty contest are not perceived as fair or as transparent as an auction.

Where exclusive dedicated licenses are not feasible there may be some circumstances where complementary ways to access spectrum could be considered i.e. LSA (Licensed Shared Access) in the 2.3 GHz band where LSA could be an enabler to access spectrum for mobile operators where exclusive access is not possible.

5G Services and Applications

1) Planning for the Development of 5G Services:

- a. What applications and services will demand 5G functionality and when do you think these services will be introduced? Will industry 4.0 be key in the development of applications for 5G networks? In what sectors do you think 5G services and networks will have the largest/most impactful potential applications?

Intel Response:

5G networks will have to meet increased capacity, throughput, and mobility requirements for consumers and businesses, which will require access to additional new spectrum bands. Intel therefore believes it is beneficial to have access to sufficient additional spectrum able to deliver these higher speed, lower latency, greater bandwidth services and applications.

The ITU Recommendation ITU-R M2083 “IMT Vision - Framework and overall objectives of the future development of IMT for 2020 and beyond” envisages three broad usage scenarios –

- very high data rate services; **enhanced Mobile Broadband (eMBB)**
- massive IoT types of usage with very low power requirements; **massive machine type communication (mMTC)**
- very low latency for time critical applications; **ultra-reliable low latency (URLL)**

In some countries, eMBB is considered the priority service for deployment and the European political goals for the Digital Single Market (DSM) and the Digitising European Industry (DEI) indicate that European priorities should also be for mMTC and URLL use cases applicable in sectors such as health, transport, and manufacturing.

Intel believes it is important to build the appropriate framework to encourage investment as part of the Digital Single Market for wireless devices and services, in particular in preparation for 5G deployment including, Internet of Things (IoT) applications and Machine-To-Machine (M2M) technology.

Intel notes that by 2020 IoT device deployments will dwarf current user mobile device deployments. IDC predicts 50 billion devices will be connected to the Internet by 2020¹, spanning numerous market sectors

¹ Business Strategy: The Coming of Age of the "Internet of Things" in Government, IDC (April 2013), <http://www.idc.com/getdoc.jsp?containerId=GIGM01V>

and use cases. 5G technology will be foundational to the IoT and critical to its success across numerous market sectors. For example, additional data will also be generated by millions of Connected and Autonomous Vehicles with current estimates of 25 gigabytes² of data uploaded to the cloud per hour. Indeed the IoT will generate significant data demand on network operators. Connectivity requirements moving forward will require networks to be able to cope with increases in data volumes and increasing dependence on mobile data as well as to handle the complexity of a vast increase in the numbers of devices connecting to the internet.

In order to deliver a successful 5G ecosystem, Intel believes that to support the projected growth in data in a widespread, high quality, and affordable way the right regulatory and standardization environments are needed to incentivise new investments with availability to spectrum being a crucial component.

5G connectivity is imperative to realise the full power of the IoT and seize maximum potential of transformational IoT opportunities. However, as more than 85% of existing devices worldwide are based on unconnected legacy systems, it is critical to focus on development and deployment of solutions needed to address connectivity and interoperability of legacy devices. Intel believes to address connectivity and interoperability, it is important to capitalise on intelligent gateway solutions that can connect legacy systems and provide common interfaces and seamless communication between devices and the cloud.

Spectrum is an essential building block for IoT device connectivity. Ubiquitous, affordable, and high-speed broadband connections over licensed and license-exempt frequencies are critical to enable consumers and the public / private sectors throughout the IoT ecosystem. Effective and efficient management of this increasingly scarce resource must be a priority for a thriving IoT ecosystem.

Administrations / Governments need to consider the release of spectrum to deal with this growing need for mobile traffic since significant time is required for that spectrum to become available for use. Intel therefore suggests Administrations / Governments initiate appropriate actions sooner rather than later to address this issue.

- b. In order to create more capacity, do you think that 5G networks could have a relevant role in the provision of fixed broadband services?

Intel Response:

Yes, Intel considers fixed broadband as one of the 5G applications / services should an Operator be willing to deploy. Having flexibility to manage the network is critical to ensure efficient use of spectrum and self-managing the spectrum resource in a manner that delivers the most compelling business case is a key objective for any Operator.

2) Net Neutrality:

- a. Recently, Europe has approved a regulation on net neutrality. Do you think this regulation will affect provision of 5G services? Should other specific regulatory measures be adopted in this area?

Intel Response:

No response.

3) 5G Privacy and Security:

- a. Capacity growth and new demand on the internet means a large flow of sensitive data will be transferred via the network. What related security and privacy characteristics should be taken into account? Are there specific regulatory measures that should be considered in this area?

Intel Response:

No response.

4) Estimating the growth of connectivity demand:

- a. What growth pattern do you think mobile internet traffic will have over the next several years in Spain? Do you agree with current growth forecasts of connected devices? What percentage of these connected devices do you believe will need 5G connectivity specifically?

² Source: <http://qz.com/344466/connected-cars-will-send-25-gigabytes-of-data-to-the-cloud-every-hour/>

Intel Response:

Intel believes it is imperative to provide access to new frequency bands to meet the needs of high-speed mobile services. The needs of existing and future mobile broadband networks data usage³ is forecast to undergo extraordinary growth and that by 2020 global mobile IP traffic is expected to reach a monthly run rate of 30.6 Exabyte, as compared to 3.7 Exabyte in 2015⁴ (a compound annual growth rate of 53%). Video continues to be the most significant source of data demand from mobile networks representing more than half of global mobile data traffic beginning in 2012, and is forecast to grow at a CAGR of 62% between 2015 and 2020, higher than the overall average mobile traffic CAGR of 53%⁵. Video is expected to form 75% of mobile data traffic by 2020⁶. The majority of this data traffic is likely to be delivered via 5G connectivity.

Development of 5G Technical Standards**5) Development of Technical Standards:**

- a. What is your view on the development of 5G technical standards and the estimated schedule? Do you think 5G standards development is adequate to facilitate the deployment of 5G networks and services in Europe?

Intel Response:

Central to the success of 5G is the identification of new spectrum resources and development of appropriate standards. Industry is actively developing 5G technology and the standardisation activities essential for mass market support are well underway.

The European Commission has already recognised the importance of spectrum for 5G having published a 5G spectrum strategic roadmap and CEPT has mirrored this with their own 5G roadmap.

It is Intel's understanding that spectrum availability, regulations and standardisation development, are progressing well to be able to deliver 5G within the anticipated timescales of WRC-19 or indeed before in some instances.

- b. Are there other standards, in addition to those emphasized?

Intel Response:

No response.

6) Network Deployment and Technical Standards:

- a. How will the development of technical standards influence the deployment of networks?

Intel Response:

No response.

- b. Do you consider it appropriate/adequate to begin deployments without having completed the standardization process?

Intel Response:

No response.

- c. How long after the standards are completed will the first equipment and terminals be available?

Intel Response:

No response.

Network Function Virtualization and Software Defined Networking**7) Do you consider NFV and SDN to be key components of 5G network deployments? Or will they be more of a supplementary augmentation to these deployments?****Intel Response:**

Network functions virtualization (NFV) is having a profound impact on the design and deployment of next-generation networking and communications equipment. It is paving the way for more open, flexible,

³ Cellular only, excludes Wi-Fi offload.

⁴ Cisco Visual Networking Index (VNI) Global Mobile Data Forecast 2015–2020.

⁵ Cisco Visual Networking Index (VNI) Global Mobile Data Forecast 2015–2020.

⁶ Cisco Visual Networking Index (VNI) Global Mobile Data Forecast 2015–2020.

and economical networking and communications equipment based on general-purpose computing platforms instead of traditional proprietary, purpose-built products.

Service providers want the ability to deploy new services in hours, not weeks or months but standing in the way are today's networks that are built with proprietary, fixed-function appliances, requiring equipment vendors to be closely involved in new services creation. Vendors must typically develop, test, and integrate the necessary software on their equipment before a service provider can purchase and install the boxes – in all, a costly and time-consuming process. In response, the industry is beginning to embrace NFV, as seen by the availability of more interoperable solutions using software-based network functions that are decoupled from hardware through virtualization.

European Telecommunications Standards Institute's (ETSI) NFV Industry Specification Group (ISG) is chartered with standardizing architecture, framework, and required protocol specifications in this area. Over the last couple of years, NFV ISG has made significant progress and delivered architectural foundational work. A major benefit is network functions are no longer tied to a particular hardware platform, allowing them to be controlled centrally and deployed dynamically throughout the network as needed. The end result is new service deployment that can be as easy as uploading software to an existing networked server – taking just minutes or hours.

Intel fundamentally believes that NFV will have a transformative effect on 5G network architecture.

5G Network Deployments

8) Deployment Scenarios:

- a. When do you think it is probable that each one of the scenarios will be deployed? Is it necessary that all scenarios be deployed by 2020?

Intel Response:

Intel notes that there are currently 5G-type deployments of eMBB, mMTC, and / or uLLC ongoing to various degrees in multiple countries in a variety of frequency bands.

9) Deployment Model for 5G Network Infrastructure:

- a. Regardless of the effect that 5G applications could have over the medium to long term, how will these applications will be integrated into general infrastructure framework and public 5G network services? Conversely, how will 5G networks and/or services be developed for specific services with different development timelines?

Intel Response:

No response.

10) Coexistence between 4G networks and 5G technologies:

- a. Will 4G networks (and their evolutions) be able to fulfill the necessary requirements for some forecasted 5G services i.e. (IOT, connected vehicles, intelligent manufacturing services and infrastructure, future video services)?

Intel Response:

4G/LTE network technology will develop significantly over the next few years and will be able to meet several of the applications and services anticipated. LTE Advanced Pro (3GPP Release 13 and 14) provides a large number of technology improvements, some of which improve features already available in 4G/LTE Advanced. The table ⁷ below lists some of the most significant of the evolving 4G/LTE features, and shows how they will improve networks.

Feature	Improvements and impact
Enhanced Carrier Aggregation	Aggregation of up to 32 carriers to increase throughput
FDD/TDD frame structure flexibility	Dynamic assignment of resources to uplink and downlink to optimize use of capacity and reduce latency; also supports FD-MIMO
Licensed Assisted	Common management for Wi-Fi (at 5 GHz) and LTE (in existing licensed

⁷ GSA "The case for new 5G spectrum" November 2016

Access (LAA) and LTE-Wi-Fi Link Aggregation (LWA)	frequencies acting as the anchor); extending capacity and range in busy environments
Dual Connectivity	Simultaneous connection of user equipment to macro and small cells for more reliable increased throughput at the cell edge, with reduced signalling overhead
3D/FD MIMO	Increasing the number of antenna elements at the base station (up to 64) and using spatial multiplexing (beam forming) to serve more users per cell
Enhanced Machine Type Communication (eMTC)	NB-IoT and LTE-M reduce power consumption of modules and increase indoor coverage for IoT and M2M applications including utility smart metering
Single-Cell Point-to-Multipoint (SC-PTM)	Uses the eMBMS (LTE Broadcast) architecture and delivers more efficient use of downlink capacity for broadcast/multicast applications in busy cells
Mission-Critical Push-to-Talk (MCPTT) over LTE	Provides direct mode voice communications, discovery and relay to deliver the functionality required by emergency services
Device-to-Device Discovery, Direct Proximity, eMBMS and V2X (Rel-14)	Always-on devices that can discover other devices, and broadcast capabilities, provide critical enabling technology for low-latency V2V and V2I communications, proximity-based applications and object tracking

This evolution of 4G/LTE will preserve backward compatibility for network operators and users, guaranteeing longevity of the ecosystem enhancing services provided and enabling new applications to be served.

Despite evolution of 4GLTE, there will be a capacity shortfall as demand for mobile broadband continues to grow, especially due to the rapidly increasing use of video. 4G/LTE enhancements alleviate some of the capacity issues by increasing efficiency, but they are not sufficient on their own to deal with the scale of demand for connectivity expected beyond 2020.

While enhancements to existing mobile networks, such as NB-IoT, will help address some capacity requirements and density of connections, where those connections are infrequent and initially will require only small amounts of data to be transferred, it is expected that the data requirements of many of the expected IoT applications will increase over time, adding to the pressure on capacity.

In addition applications that need low latency and/or higher bandwidth, and guaranteed always-on two-way communications; very wide coverage – including coverage within entire buildings – will be required in some use cases. Although 4G/LTE will continue to offer good coverage for a long time, several of the applications outlined have requirements that are more difficult to achieve even with an evolution of 4G/LTE technology.

The biggest performance improvements are likely to result from the use of advanced multiple antenna technologies both at the base station and in the user equipment. It is in this area that the link with high frequencies is most apparent as design and manufacturing of antenna and radio systems is tightly linked to the frequency of spectrum used – there is a linear relationship between the size of the antenna elements and the wavelength. There are already commercial antennas and radio systems available, with 4x4 MIMO, designed for use at 60 GHz, for 802.11ad/ay (WiGig) equipment.

In the context of spectrum, radio and antenna components are developed for specific frequency ranges and there is a limit to the extent to which they can be tuned. For devices in particular, greater economies of scale will result from minimizing the number of bands that equipment must support. In turn, this will help to support new 5G applications as cost-effectively as possible.

- b. How do you think coexistence can be assured? And, how will we transition between current mobile technologies and new 5G technologies? After 2020, will both 4G and 5G networks exist that are completely independent? Or will 5G be a complement/extension to 4G? Will the 5G network will be

independent of 4G?

Intel Response:

In many cases, coexistence can be ensured by single or multiple measures e.g. power-restricted channels, media access methods e.g. Listen Before Talk (LBT), local coordination requirements, geographic exclusion zones, and/or introduction of guard bands.

The need to use interference decreasing measures like restricted blocks or guard bands will decrease over time since operators are unifying their networks using the all-IP protocols and LTE standard basing on 3GPP release 13 and higher. In specific and justified cases, restricted blocks may be required to address a specific coexistence situation and in that case should be seen as the more spectrum-efficient and less restrictive measure compared to guard bands.

11) Small Cell Deployments:

- a. How do you see the necessary coverage being achieved to ensure access to 5G networks? How will low power small cell deployments be carried out in rural, suburban and high population density areas? In what year will 5G deployment be generally available, at least in urban areas?

Intel Response:

It is Intel's view that there is no single frequency band solution that will address all 5G service and application bandwidth, latency and coverage requirements. There will be differences in traffic throughput, densities and bandwidth requirements present between densely populated urban areas and less populated urban areas. We believe that due consideration will be required possibly necessitating planned release of appropriate spectrum to meet this demand differences. We suggest that it is unlikely there will be a need for ubiquitous national coverage in mmWave bands (e.g. 24.25-27.5 GHz) thus we believe it would be inappropriate to specify rollout / deployment conditions in this instance.

In addition, Intel believes it would also be inappropriate to specify onerous rollout and deployment conditions in any of the bands suitable for 5G since we prefer an approach that encourages Operators to provide an appropriate level of coverage suitable to their business needs. If Administrations / Governments desire greater geographical coverage further mutually beneficial deployment scenarios should be investigated (but not mandated).

Aspects Facilitating Deployment:

12) Regulatory Measures in order to facilitate deployment:

- a. Are there any regulatory considerations that should be taken into account in order to deploy 5G networks, particularly in the case of small cells? Sharing can refer to passive elements of the network or going a step further, sharing active network elements. Do you believe that sharing could facilitate 5G network deployments?

Intel Response:

Intel believes that market forces should have a part to play in determining the geographical extent of the license since there may be a business need that supports / requires a National license but there may be other business models where a more geographically defined license is more applicable. The frequency band in question will likely be a contributing factor to the type of geographical license required and this may well vary between frequency bands. Administrations will likely have to take into consideration all these factors, and others, when determining the geographical extent of the license / licenses.

Intel believes TDD network synchronisation could be an important element to assist coexistence and sharing but this should be left to the operators adjusting their networks dynamically to optimise their mutual benefits and not be a subject to the regulatory measures.

13) Facilitating Small Cell Deployments:

- a. There are certain kinds of publically owned infrastructure on which small cells could be deployed – such as awnings or lamp posts – which measures should be considered to facilitate access to these kinds of infrastructure installations?

Intel Response:

Intel suggests that planning rules and restrictions should be reviewed to reduce bureaucracy enabling

greater expeditious network rollout at reduced cost of time and money. Having access to new sites for small cell deployments, e.g. street furniture including lampposts, will greatly assist 5G deployment.

Connection of Stations to Network Backhaul

14) Connection of stations to network backhaul:

- a. Which would be the most efficient model to provide different 5G operators access to backhaul in urban zones, suburban zones and rural areas?

Intel Response:

Intel supports technology and service neutrality to guarantee delivery of services meeting user demands and enabling sustainable business models. We therefore support providing access to spectrum with the least technical and regulatory restrictions allowing Operators the greatest flexibility. Thus we are less inclined to support restricting access to spectrum for only fixed access since greater flexibility can be achieved through not restricting mobility.

Intel does not support policies which would restrict Operators from deploying technologies that best suit their business models and we are fully supportive of technology neutrality. We believe that this position is aligned with the European Commission's stance on Mobile Fixed Communications Networks (MFCN) with the least technical and regulatory restrictions implemented to maximise flexibility.

Thus in addition to enabling access within their spectrum allocation Operators should also have the possibility to provide in-band backhaul should they wish to do so. While this is a solution that will help Intel doesn't believe that in-band backhaul will provide sufficient backhauling capacity and access to dedicated Fixed Service bands will also be required (as well as access to fibre).

- b. Would the model demand some type of regulatory measure? Are there differences in the connection to backhaul between conventional stations and small cells?

Intel Response:

No response.

- c. Is it necessary to access the backhaul through radio links? Can those radio links be effective through 5G frequencies or is additional spectrum needed?

Intel Response:

As mentioned previously Intel considers fixed broadband including backhaul as one of the 5G applications / services should an Operator be willing to deploy within their existing allocation. Having flexibility in how one manages one's network is critical to ensure efficient use of spectrum and self-managing the spectrum resource in a manner that delivers the most compelling business case is a key objective for any Operator.

As mentioned previously, Intel also suggests that access to dedicated wireless backhaul Fixed Service bands for point-to-point and possibly point-to-multipoint will likely be required but they do not necessarily have to be part of an Operator's 5G license.

Intel suggests that where wireless can be replaced by fibre this is likely a better solution for backhaul.

European Bands for 5G

15) Predicted services in different frequency bands

- a. What scenarios (eMBB, URLLC, mMTC) and services will be optimized for each of the bands?

Intel Response:

5G networks will have to meet increased capacity, throughput, and mobility requirements for consumers and businesses, which will require access to additional new spectrum bands. Intel therefore believes it is beneficial to have access to sufficient additional spectrum able to deliver these higher speed, lower latency, greater bandwidth services and applications.

As mentioned Industry is actively developing 5G technology and the standardisation activities essential for mass market support are well underway.

The European Commission has already recognised the importance of spectrum for 5G and has

published a strategic roadmap for 5G spectrum and CEPT has mirrored this with their 5G roadmap.

A range of spectrum resources will be required to satisfy the diverse requirements anticipated for 5G networks including eMBB, URLLC, and mMTC with deployments of systems likely to be utilising existing mobile network frequency bands as well as operation in new contiguous spectrum in higher frequency bands.

The European Commission supports a technology neutral approach and the use of all existing mobile bands and has identified the 700 MHz, and 3.4-3.8 GHz as a primary bands for the introduction of 5G and the 26 GHz band as a pioneer band suitable for the development of European harmonisation. Intel is fully aligned with the view of the European Commission.

- b. Do you think that the bands identified should be dedicated to 5G or should they be utilized for other technologies?

Intel Response:

Intel, similarly to the European Commission, supports a technology neutral approach and has identified 700 MHz and 3.4-3.8 GHz as a primary bands for the introduction of 5G and the 26 GHz band as a 5G pioneer band suitable for the development of European harmonisation. We believe that any technology meeting the least restrictive technical characteristics should have the possibility to be deployed assuming an Operators wishes to do so.

Any technological choice should be left to the operators – they know the best balance between costs, efforts and benefits, e.g. while 5G is likely to be the predominate technology being deployed but others shouldn't be precluded. Also the current trend are operators unifying their networks using the all-IP protocols and LTE standard basing on 3GPP release 13 and higher. The operators will offer carrying capabilities with dedicated network throughput for a specific service on demand.

- c. Do other bands exist that can be used for 5G services? Are these already dedicated bands or are there other new bands that should be considered?

Intel Response:

In theory any band could be used for 5G services depending on how the Government / Regulator viewed the ITU-R frequency allocation and how one interpreted the definition of 5G.

As mentioned previously, similar to the European Commission, Intel supports a technology neutral approach to using existing mobile bands for future 5G deployments as well as supporting identification of the 700 MHz, and 3.4-3.8 GHz as primary bands for introduction of 5G plus the 26 GHz band as a pioneer band suitable for the development of European 5G harmonisation.

We recognize that the 26 GHz band is heavily used in a number of CEPT countries for Fixed Service backhaul links (24.5-26.5 GHz) according the ECC Report 173 and a recent questionnaire in CEPT to update this report. The results of this questionnaire also showed that the Fixed Service parts of the 28 GHz band (according to the band segmentation between FS and FSS as defined in ECC-Decision (05)01) are much more lightly used for backhaul links. Considering the equipment implementation possibilities for the 26 GHz and 28 GHz bands as part of a global tuning range (see our response to question 19) it might be easier to accommodate 5G systems together with current backhaul links in the 28 GHz band rather than in the 26 GHz band.

16) Organization of Bands of Frequency

- a. With the end goal of guaranteeing the provision of 5G services with sufficient quality, which would be the ideal distribution in frequency blocks for each of the bands? Is it necessary that operators have different types of frequencies?

Intel Response:

As mentioned in our response to the previous question, 5G networks will have to meet increased capacity, throughput, and mobility requirements for consumers and businesses, which will require access to additional new spectrum bands. Intel believes a range of spectrum resources will be required to satisfy the diverse requirements anticipated for 5G networks. The future will see the deployment of systems likely to be utilising existing mobile network frequency bands as well as operation in new

contiguous spectrum in higher frequency bands.

Intel is not in a position to respond further on the distribution of frequency blocks in each of the possible bands that could be used for 5G since we feel that the Operators are better positioned to answer this question.

- b. What should be the deployment model and minimum coverage for each of the different scenarios in order to secure provision of services?

Intel Response:

As previously mentioned Intel believes that market forces should have a part to play in determining the geographical extent of the license since there may be a business need that supports / requires a National license but there may be other business models where a more geographically defined license is more applicable. The frequency band in question will likely be a contributing factor to the type of geographical license required and this may well vary between frequency bands. Administrations will likely have to take into consideration all these factors, and others, when determining the geographical extent of the license / licenses.

17) Regulatory model to license and utilize frequency bands:

- a. What should be the licensing model (concession, authorization, general...) and type of use (private, self-sufficient, etc.) for the different bands? Which would be the geographic area in each case?

Intel Response:

Intel prefers exclusive dedicated licenses and we consider that auctions are the fairest way to provide access to spectrum since this approach determines fair market value for the spectrum and generally enables spectrum to be assigned to Operator who value it the most. We do urge caution that auctions should not be designed to maximise revenue via the auction process itself noting the substantial investment costs associated with network rollout; we believe the greatest benefit from spectrum is in its sustained use and not from the release process. Auctions should be designed to be an efficient process to maximize allocation of spectrum. The more operators spend in the auction, the less resources will be available for infrastructure deployment and rollout. Intel believes beauty contests are not perceived as fair or as transparent as an auction.

Where exclusive dedicated licenses are not feasible there may be some circumstances where complementary ways to access spectrum could be considered i.e. LSA (Licensed Shared Access) in the 2.3 GHz band where LSA could be an enabler to access spectrum for mobile operators.

Intel believes it would be inappropriate to specify onerous rollout and deployment conditions and we'd prefer an approach that encourages Operators to provide an appropriate level of coverage suitable to their business needs. If Administrations / Governments desire greater geographical coverage further mutually beneficial deployment scenarios should be investigated (but not mandated).

Situation in Spain

18) Organization and Licensing of Frequency Band 3.4 GHz – 3.8 GHz

- a. What would be the most efficient distribution of frequency blocks, taking into account the current situation in Spain? In particular, should the band be reorganized or should the current situation be maintained? Should only the sub-band 3.6 – 3.8 GHz be licensed? When would be the most appropriate time to reorganize the bands and/or initiate an auction? Which would be the best model: an auction or issuing a tender? Which would be the ideal geographic scope for the license? Would it be appropriate to include some type of obligation (coverage, investment commitments, etc.) associated with the auction?

Intel Response:

Intel supports efforts to introduce 5G at a pan-European level as expeditiously as possible in the 3.4-3.8 GHz band. Access to this mid-band spectrum is crucial to facilitating 5G but this should not reduce other initiatives to secure access to additional bands suitable for 5G in higher mmWave bands above 6 GHz e.g. 24.25-27.5 GHz, and/or indeed bands below 6 GHz, e.g. 700 MHz, 3.4-3.8 GHz.

Intel believes the 3.4-3.6 GHz and 3.6-3.8 GHz band, with 400 MHz of continuous spectrum, is ideally

suitable for licensed terrestrial mobile 5G applications. 5G is intended to support a wide range of usage scenarios, with various applications having significant differences in the types and amounts of spectrum needed to support them. The maximum benefits accrue through the use of wide channels provisioned to support multiple network operators.

The recently published Radio Spectrum Policy Group "Strategic Roadmap Towards 5G for Europe; Opinion on spectrum related aspects for next-generation wireless systems (5G)", as detailed in the extract below, clearly places great emphasis on both the 3.4-3.6 GHz and 3.6-3.8 GHz bands.

This roadmap has been developed to facilitate the launch of 5G on a large scale in Europe by 2020. The goal is 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. *The RSPG considers the 3400-3800 MHz band to be the primary band suitable for the introduction of 5G -based services in Europe even before 2020, noting that this band is already harmonised for mobile networks, and consists of up to 400 MHz of continuous spectrum enabling wide channel bandwidth. This band has the possibility to put Europe at the forefront of the 5G deployment.*

Plus the European Commission in their "5G for Europe: An Action Plan" addressing "Pioneer spectrum bands" state -

Member States and the Commission, working together in the Radio Spectrum Policy Group (RSPG), have recognised the importance of the early identification of common EU-wide pioneer spectrum bands to enable 5G take-up as early as in 2018. This is indispensable to give proper guidance to industry and keep the EU on a par with spectrum availability in other regions of the world. This first set of such pioneer bands should include a mix of spectrum with different characteristics to address the versatile 5G requirements. The identified bands should also have a potential for global harmonisation and take advantage of the sizeable amount of harmonised spectrum already allocated in the EU for wireless broadband below 6 GHz. The spectrum mix should include:

- *Spectrum between 1 GHz and 6 GHz, where EU-wide harmonised bands are already available and licensed in a technology neutral way across Europe. In particular, the 3.5 GHz band seems to offer high potential to become a strategic band for 5G launch in Europe*

Given the global identification of 3.4-3.6 GHz for IMT, plus the CEPT rules for mobile broadband in 3.4-3.8 GHz, supplemented now by the RSPG 5G Opinion, manufacturers are already developing equipment to operate in 3.4-3.8 GHz. The ability to implement wide tuning ranges in the radio front-end also permits harmonisation with other countries and regions which are utilizing parts of the same band or adjacent bands for mobile broadband services including 5G.

Therefore, it is critically important that the entire 3.4-3.8 GHz band is available for 5G networks as set out in the above mentioned CEPT and EC plans to enable to full capabilities of 5G. Furthermore it will be important to defragment the current authorizations as set out in the CEPT Roadmap for 5G (Item A.2 "Provide guidance to administrations for defragmenting the 3.4-3.8 GHz band, in which there are existing licences in many CEPT countries and for developing plans and intended timescale for the future utilization of this band").

Intel supports the current preferences at stated in existing ECC Decision (11)06 "Harmonised frequency arrangements for mobile/fixed communications networks (MFCN) operating in the bands 3400-3600 MHz and 3600-3800 MHz" as stated in "decides" 2 and 3 as detailed below noting ECC DEC (11)06 is subject to review regarding suitability for 5G.

2. *that administrations wishing to implement MFCN in the 3400-3600 MHz band should follow the preferred frequency arrangement given in Annex 1 (TDD) or the alternative frequency arrangement given in Annex 2 (FDD);*
3. *that administrations wishing to implement MFCN in the 3600-3800 MHz band should adhere to the harmonised frequency arrangement given in Annex 3 (TDD)*

Intel prefers exclusive dedicated licenses and we consider that auctions are the fairest way to provide access to spectrum since this route determines the fair market value and generally enables spectrum to be assigned to the Operator who values it the most. That said, we believe that auctions should not be designed to maximise revenue via the auction process itself noting the substantial investment costs associated with network rollout; we believe the greatest benefit from spectrum is its sustained use and not from the short-term monetary gain due to the release process.

Intel believes market forces can assist determine the geographical extent of licenses since some business models may require a National license while others require a more geographically defined license.

19) Organization and licensing of the Frequency Band 26 GHz

- a. What would be the most efficient distribution of frequency blocks, taking into account the current situation in Spain? Is there sufficient spectrum available in this band already? What is the minimum amount of contiguous spectrum that should be available to an operator? When should this band be available for 5G? Which will be the best authorization models for the deployment of this band?

Intel Response:

5G applications will require access to spectrum in low (<1.5 GHz), mid (2-6 GHz) and high (e.g. mmW bands) frequencies. For the high range, 24.25-27.5 GHz and 27.5-29.5 GHz is most desirable and with a suitable radio tuning range can capitalise on initial 5G deployments in leading markets.

There are many frequency bands above 24 GHz that are of potential interest for 5G including the 27.5-29.5 GHz (28 GHz) band which is not being considered within the current studies undertaken by the ITU-R as part of the Agenda Item 1.13 leading up to the WRC-19. Considering that this band will be used in the first 5G trials and initial deployments by countries outside of Europe we believe it is important for Europe when developing its strategic roadmap for 5G spectrum to take into account the benefits from early ecosystem being developed for the 28 GHz band in other regions. As Europe aims to achieve leadership in 5G, it is of utmost importance to take into account and try to align with these early adopter developments in the 28 GHz band. Noting 24.25-27.5 GHz is directly adjacent to the 28 GHz band implementing a wide tuning-range creates the possibility for globally harmonised equipment, whereas 31.8-33.4 GHz is not adjacent to the 28 GHz and faces 800 MHz of passive service spectrum with stringent protection requirements in-between, thus significantly limiting tuning-range possibilities.

Furthermore, the 28 GHz plans in Korea cover the range 26.5-29.5 GHz which results in an overlap of 1 GHz between the Korean pioneer band for which an ecosystem is already developing rapidly and the 24.25-27.5 GHz band as a suggested pioneer band for Europe. With that, the tuning range benefits are not limited to the two bands being directly adjacent but overlapping which further supports the implementation of such a tuning range as the preferred global solution.

Frequencies that are adjacent to one another can be leveraged for inclusion in a single product design even if they are not all available in every geography. Finding frequency ranges which are available in major markets, or where the available frequency bands are close enough to be supported within a single radio, i.e. "globally harmonised," is critical to achieving the economies of scale necessary to support the business case for both manufacturers and operators. Global harmonisation creates commonalities in regulatory requirements and technical specifications - reducing the cost and complexity of implementing and enabling 5G technologies.

When considering frequency bands within European discussion and within the ITU processes we recommend that realistic tuning ranges and adjacent frequency bands are also taking into consideration within the scope of the WRC-19 Work Item 1.13.

Intel fully supports the European Commission "Mandate to CEPT to develop harmonised technical conditions for spectrum use in support of the introduction of next-generation (5G) terrestrial wireless systems in the Union". Within the Mandate the RSPG "Strategic Roadmap towards 5G for Europe: Opinion on spectrum related aspects for next-generation wireless systems (5G)⁸" sets out its priorities and recommendations for pioneer frequency bands for the introduction of 5G terrestrial wireless systems

⁸ RSPG16-032 FINAL of 9 November 2016

in Europe as follows:–

The RSPG recommends the 24.25-27.5 GHz (hereinafter '26 GHz') band as a pioneer band for Europe to be harmonised before 2020

The European Commission Mandate further states –

When developing harmonised technical conditions, CEPT shall focus its efforts on the pioneer bands as identified in this Mandate and take due account of the relevant RSPG recommendations in respect to other radio services. More specifically, CEPT is mandated to perform the following tasks with view to creating sufficiently precise harmonised technical conditions for the development of EU-wide equipment for the introduction of 5G terrestrial wireless systems in the Union:

2. Study and assess the 24.25-27.5 GHz ('26 GHz') frequency band as a 5G pioneer band for use under relevant 5G usage scenarios taking into account the co-existence issues highlighted in the RSPG opinion¹³ with respect to fixed links, earth exploration satellite and space research services, fixed satellite services, data relay satellite systems and passive services in the frequency band 23.6-24 GHz. In this regard, identify and study common sharing scenarios with incumbent radio services and applications, for which future demand has been identified.

Opportunities for interoperability and economies of scale of equipment such as a common tuning range, including the 26 GHz band, with possible 5G use outside Europe shall be taken into account. The impact of activities outside Europe in the adjacent frequency band for 5G use shall be considered, including a broad range of sharing scenarios that protect existing and future satellite services in the band.

Intel fully supports 24.25-27.5 GHz as a 5G “pioneer band” and we note that conditions for harmonisation are currently under study in CEPT project team ECC PT1 to develop a band plan for 5G and study coexistence with the other radio uses in the band. It is our understanding that the technical conditions and band plan will be published in an ECC Decision and the results of the studies will be presented in a CEPT Report with a target date for publication of June 2018.

20) Organization and licensing of the Frequency Band 1.5 GHz

- a. What would be the most efficient distribution of frequency blocks, taking into account the current situation? When should these be made available? Under what model - an auction or by issuing a tender? Which would be the ideal geographic scope for each license?

Intel Response:

Intel recognises access to 1452-1492 MHz for MFCN SDL based on least restrictive technical conditions (LRTC) and a harmonised frequency arrangement will maximise the opportunities and benefits for end users; will reduce capital expenditure for operators and cost of manufacturing equipment; and will secure future investments by providing economies of scale

Intel welcomed the WRC-15 outcome related to L-band (1427-1518 MHz) and the widespread commitment for 1427-1518 MHz to become a global IMT band noting the Identification for IMT services is supported by almost all countries in ITU Region 1 (excluding Russia and CIS countries). The positive outcome at WRC-15 allows Administrations to move forward to make the band available for IMT services

The potential economic benefits from IMT services use of the first 40 MHz of the band (downlink) likely to be released (i.e. 1452-1492 MHz) could amount to at least USD40bn⁹ globally, based on stated country positions at the time of writing.

Much of the band has little use in many countries meaning it could be made available in a relatively short timescale with limited disruption to other services and at low cost. The centre block of 40 MHz could be made available in a 2018-2020 timescale and the surrounding 40 MHz could be available in many countries by 2025.

Intel notes that the ECC Decision (13)03 “The harmonised use of the frequency band 1452-1492 MHz

⁹ GSMA report February 2015 “Global momentum and economic impact of the 1.4/1.5 GHz band for IMT”

for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL)” while allowing individual countries to adapt to specific national circumstances in part of the band for terrestrial broadcasting and other terrestrial applications, it also provides the harmonised technical conditions for the deployment of MFCN SDL within CEPT.

The entire L-band (1427-1518 MHz) should subsequently be made available for SDL based on the work currently undertaken by ECC PT1 (as requested by the ECC Plenary).

21) Other frequency bands for 5G

- a. Are there other frequency bands for 5G services that should be taken into consideration in Spain before 2020? Under which model?

Intel Response:

In addition to existing frequency IMT bands identified sub 1 GHz, 2.3 GHz, 2.6 GHz, and in particular 3.4-3.8 GHz plus 24.25-29.5 GHz and 37-43.5 GHz, Intel is not aware of any additional bands that need to be specifically considered for 5G. Further information relating to the 700 MHz and 2.3 GHz band is provided below.

700 MHz

Timely availability of 700 MHz band for mobile, across Europe, will be beneficial while undue delays could hamper product roll-out and ultimately lead to not only problematic cross-border frequency situations and interference with incumbent users, but also to market fragmentation. Intel therefore recommends no later than 2020 as target for clearance of 700 MHz band for mobile broadband across Europe in line with the ambitions of the EU for 5G deployment.

2.3 GHz

Intel supports implementation of ECC Decision (14)02 “Harmonised technical and regulatory conditions for the use of the band 2300-2400 MHz for Mobile/Fixed Communications Networks (MFCN)” aiming at harmonising implementation measures for mobile/fixed communications networks (MFCN), including broadband wireless systems (BWS) in the frequency band 2300-2400 MHz. We note the possibility of implementing Licensed Shared Access (LSA) as a recognised approach to introduce MFCN while maintaining the current incumbent use.

Similarly to the ECC, Intel also recognises that implementation of MFCN, including IMT systems providing high data rate applications in the 2.3 GHz band, will maximise opportunities and benefits for end users and society; will benefit capital expenditure for operators; reduce development and implementation costs of manufacturing equipment; and will secure future long term investments by providing economies of scale. We believe utilising larger channel bandwidths will assist deliver high data rates for IMT.

Our preference is for 2.3 GHz band to be made available for TDD.

Intel believes market forces can assist determine the geographical extent of licenses since some business models may require a National license while others require a more geographically defined license. The frequency band in question will be a contributing factor plus there may be other reasons for a geographically defined license due to the need to protect incumbent services where other coexistence mechanisms are not as suitable.

5G Network Pilots

22) Network Deployment Pilots

- a. What should be achieved with network deployment pilots? What should be the reach and the extension of these? When should they be implemented in light of the current evolution of technical standards? Over what frequency bands should they be implemented? What applications should be deployed in urban 5G pilots, and what should be the degree of coverage that should be obtained? What should be the role of the Administration? Should a public private model of collaboration be adopted?

Intel Response:

Governments should enable Operators access to spectrum for 5G trials in particular within 3.4-3.8 GHz

band and 24.25-29.5 GHz tuning range.

R&D Efforts

Identification Priority 5G sectors and Services:

- a. What applications and services related to 5G, in your opinion, will create the most value add to the ICT sector in Spain? What key sectors should be focused on? Would it be sufficient to create pilots that test extreme interoperability or would it be necessary to create a bank of tests in order to evaluate different applications? Are there innovative public purchases that can catalyse early demand for 5G applications and services that could be developed by the administration?

Intel Response:

No response.

R&D Instruments to Catalyze 5G Projects

- a. Do you think the instruments that exist in the SESIAD (la Secretaria de Estado de Sociedad de la Informacion y de la Agenda Digital) are adequate to achieve the R&D priorities for 5G? Is it necessary to create a new instrument to deal with certain 5G projects which, due to their specific characteristics, need specific actions?

Intel Response:

No response.

Other Aspects

- 23) If there are essential areas that should be taken into account in the preparation and design of the proceedings that are not dealt with in the public consultation, please indicate them here.

Intel Response:

No response.



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