Ericsson's responses to IMDA's consultation on 5G Mobile Services and Networks

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5G MOBILE SERVICES AND NETWORKS

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2 About Ericsson

Over the past 140 years, Ericsson has been at the forefront of communications technology. Today, we are committed to maximizing customer value by continuously evolving our business portfolio and leading the ICT industry.

We are a global leader in delivering ICT solutions. In fact, 40% of the world's mobile traffic is carried over Ericsson networks. We have customers in over 180 countries and comprehensive industry solutions ranging from Cloud services and Mobile Broadband to Network Design and Optimization.

Our services, software and infrastructure - especially in mobility, broadband and the cloud - are enabling the communications industry and other sectors to do better business, increase efficiency, improve user experience and capture new opportunities.

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3 Ericsson's responses to IMDA's second consultation on the proposed framework for the allocation of spectrum for IMT and IMT-Advanced services

5G is one of the most anticipated advances in the ICT industry. The introduction of 5G will accelerate transformation in many industry verticals, enabling new use cases in areas such as automation, IoT and big data.

With increases in radio performance and the flexibility enabled by network slicing and Network Functions Virtualization (NFV), networks can serve a much broader range of use cases. The first examples of services deployed with NFV were VoLTE, Wi-Fi calling and the expansion of mobile broadband to locations and industries needing high capacity or remote area connectivity. NFV enables faster and more flexible introduction of services, such as distributed mobile broadband, IoT, communication services and enterprise services. It is also a key building block on the path to future 5G deployments.

Capacity and throughput remain drivers, with user data consumption continuing to rise with increased use of video. Some specific use cases, like massive IoT and FWA, are likely to be implemented faster, as they can take advantage of the early evolution steps towards 5G.

Growth of 5G is linked to growth of the complete ecosystem. Network development and rollout needs to happen at pace with the development of devices, and this will be influenced by access to and licensing of suitable spectrum bands in a timely manner.

4 Ericsson’s Responses

4.1 Question 1

IMDA would like to seek views and comments on the estimated timeline for the deployment of 5G. Besides ensuring that spectrum is made available in a timely manner, what other regulatory measures could assist in facilitating the deployment of 5G technology and applications? What other use cases should IMDA take note of when developing the regulatory framework?

Ericsson’s Response:

It is expected that many operators worldwide will introduce 5G from 2020, which is closely linked to the initial timeline for 5G standardization. There now exists an accelerated plan in 3GPP where an important milestone was reached in March 2017 on an intermediate target for early completion of Non-Standalone (NSA) 5G deployments as well as Standalone (SA) deployments.

With early deployments of pre-standard networks being anticipated in selected markets e.g. US, Korea and Japan starting from 2017, this could accelerate the commercial introduction of 5G. At present, more than 30 operators have publicly announced 5G introduction plans, with several trials already taking place. Rollout is expected to commence in metropolitan and urban areas, and is forecasted to reach around 10 percent population coverage by 2022.

It is commendable that IMDA will be waiving frequency fees for 5G trials with immediate effect. This will definitely encourage the industry to explore the potential benefits and applications of 5G networks in Singapore. Another suggested measure is to subsidize the commercial trial deployments which is similar to what was being done for the HetNet trials.

In terms of use cases, the following industries are most likely to benefit from 5G: Automotive, Utilities, Public Safety, High-Tech Manufacturing, Internet/Digital Natives, Healthcare, Financial Services, and Media/Gaming.

4.2 Question 2

To facilitate and understand potential spectrum requirements for IoT deployments in Singapore, IMDA would like to seek views on the following:

i) Based on the current spectrum allocated for mobile services in the sub-1 GHz frequency bands, are there further suitable spectrum resources that could be released to support both IoT and LTE services?

ii) How will future generations of mobile networks (e.g. high capacity, low latency) support the growth of IoT and what would be the spectrum requirements?

Ericsson's Response:

i) For 5G services that focus on e.g. narrow-band (NB) or broad-band (BB) Machine Type Communications or IoT, the 600 MHz and 700 MHz bands have excellent propagation characteristics and are best suited for affordable as well as mobile coverage. The 600 MHz band, in particular the 614-698 MHz band that has an IMT identification from WRC-15 in some countries in Americas and Asia, and has recently been proposed to ITU-R as one of the new frequency arrangement below 698 MHz with a 2x35 MHz reversed duplex mobile arrangement. Following the result of the incentive auction in USA, this arrangement has the potential to be harmonized across the globe wishing to implement this valuable 600 MHz band for mobile use. Ericsson would recommend IMDA to consider this band to be allocated for 5G services and IMT in Singapore.

ii) The 5G use cases can be classified in terms of requirements for three essential types of communication with vastly different objectives: massive machine type communication (mMTC), critical MTC (cMTC), and extreme or enhanced mobile broadband (eMBB).

mMTC is designed to provide wide area coverage and deep penetration for hundreds of thousands of devices per square kilometer of coverage. An additional objective of mMTC is to provide ubiquitous connectivity with relatively low software and hardware complexity and low-energy operation.

In cMTC type of application, monitoring and control occur in real time, E2E latency requirements are very low (at millisecond levels), and the need for reliability is great. The performance objectives of cMTC will be applied to workflows such as the automation of energy distribution in a smart grid, in industrial process control and sensor networking where there are stringent requirements in terms of reliability and low latency at the application layer. These are sometimes referred to as ultra-reliable low-latency communications (URLLC) requirements.

Sub-1 GHz frequency bands, in particular 600 MHz and 700 MHz bands, together with current allocations in 850 and 900 MHz bands, would be suitable to support future growth of IoT services in addition

to existing LTE bands, especially for the case of mMTC where current 3GPP technologies like EC-GSM, LTE-M (Cat-M1), or NB-IoT is suitable for deep indoor coverage or wide area coverage. If the bandwidth requirement for a specific use case is not too large even if the applications are related to cMTC solutions using LTE or 5G NR, spectrum below 1 GHz could be considered also for these. However, for those MTC applications (e.g. industrial) with especially high needs for robustness and low latency, large bandwidths could be required and then sub-1 GHz spectrum is not sufficient but higher frequencies should be made available.

4.3 Question 3

IMDA would like to seek views and comments from industry on what they consider will be the key technologies for 5G and whether current regulatory frameworks sufficiently facilitate the deployment of such technologies.

Ericsson's Response:

The 5G system will imply changes in the implementation and deployment of networking infrastructure, based on software-defined networking (SDN) and network functions virtualization (NFV). Network operations and services are becoming cloud-enabled in almost every industry, and the telecommunications industry is no exception – though it is distinct from other industries owing to the distributed nature of network operations. This creates an obvious opportunity to generate value from distributed storage and cloud computing towards specific clients and services as well.

The main domains of the 5G system are wireless access, transport, cloud, applications, and management including orchestration. One key technology component of the 5G radio access is an innovative air interface called New Radio (NR), which is designed primarily for bands at high frequencies but will also be designed for low frequencies. In industry and academia, it is generally understood that the success of 5G will depend on a diversity of spectrum assets which span low, medium and high spectrum bands.

There is a need for new regulatory schemes to handle all the various new use cases and legal implications may apply for both domestic but also international and cross-border applications and transports. It has been shown from both theoretical simulations as well as experimental testing that there are possibilities by using an ordinary grid from sub-3GHz implementation to cover streets in urban areas also with mm-wave spectrum. Therefore, regarding regulatory frameworks for spectrum below 45 GHz, Ericsson is of the view that as for lower frequencies with dedicated licensed spectrum should be the main approach to secure quality of service and ensure available and timely spectrum for mobile operators.

For spectrum above 45 GHz, where propagation losses are larger and outdoor-to-indoor coverage is difficult, there are benefits for having new regulatory schemes having possibility for sub-leasing, light licensing or local licensing of spectrum to allow for new innovate use of spectrum by industry or mobile operators.

4.4 Question 4

IMDA would like to seek views and comments on whether going forward, there is a need for further spectrum below 1 GHz to be identified and release for mobile services?

Ericsson's Response:

Sub-1 GHz bands have excellent propagation characteristics and are best suited for affordable mobile broadband wide coverage. It is noted that 700 MHz and 900 MHz bands have been allocated through an auction mechanism. It is important to harmonize within the region and especially with Indonesia and Malaysia to ensure limited interference and cross-border issues. There are now several opportunities to ensure usage of sub-1 GHz spectrum for mobile broadband regardless if it is 3G, 4G, 5G, BB Public Safety or MTC/IoT in the 600 MHz (see also Question 2), APT700, 3GPP bands 26 or 27, 850 MHz and 900 MHz bands. Harmonization across ASEAN should be the main objective and goal to avoid interference and ensuring economy of scale for the region.

Ericsson would recommend IMDA to consider further the use of the 600 MHz band to be allocated for 5G services. In addition, Ericsson agrees that IMDA should re-farm and allocate 800 MHz for mobile services.

4.5 Question 5

IMDA would like to seek views and comments on the following:
i) The frequency arrangement that is better suited for adoption in Singapore for the L band (i.e. SDL, TDD or FDD) and the supporting reasons; and
ii) The timeline for access to the L band and the availability of the equipment (specifically whether it will be available earlier or later than 2020).

Ericsson's Response:

Ericsson recommends that IMDA make available spectrum in the whole range of 1427 – 1518 MHz for mobile use.

3GPP has developed specifications for an SDL solution in 1452-1492 MHz (Band 32) since long and this has been auctioned in some European countries based on a harmonized approach for CEPT countries. This scheme would allow network operators to manage the ever-increasing demand for multimedia services on wireless networks and provides significantly improved performance for end users. For Europe it is thus natural to expand the full L-band for SDL implementation. The SDL plan provide economies of scale in consumer devices and devices based on 3GPP Band 32 are already available.

3GPP is currently working on additional specifications for SDL, FDD and TDD arrangements in the full range 1427-1518 MHz and these are not planned to be finalized until the end of the year 2017.

For Singapore the SDL solutions could thus be implemented in a step approach, start with the center part and then expand with additional licensing with SDL in the full band when available and suitable.

It is clear that the FDD arrangement in the 1427-1518 MHz is attractive to many countries especially in Asia, Africa, and Arab countries. It will be implemented in Japan. Thus, an alternative exist for Singapore to study an FDD solution.

However, it is most crucial for Singapore that when choosing either SDL or an FDD arrangement for the band 1427-1518 MHz that it is aligned with Malaysia and Indonesia to avoid any interference issues. Therefore, before making any decisions related to the L-band, agreements with Malaysia and Indonesia should be ensured but also seeking a harmonized approach for the whole of ASEAN would be beneficial for the region and IMDA could consider taking a leading role in this work within APT or ASEAN.

4.6 Question 6

Considering the spectrum bands within the range of 1-6 GHz to support the deployment of enhanced mobile broadband services, IMDA would like to seek views on whether all of the 91 MHz of spectrum in the L-band should be allocated for IMT to address Singapore's data demand and growth.

Ericsson's Response:

As per response to question 5, Ericsson recommends that the whole range of the band 1427-1518 MHz should be made available for mobile use using and SDL or FDD arrangement.

4.7 Question 7

If it is only the extended C-band that is considered for IMT, would the migration of existing satellite users to the other parts of the C-band (i.e. 3.7-4.2 GHz) impact their service provisioning?

Ericsson's Response:

Ericsson suggest satellite users to higher frequencies. The full band 3300-4200 MHz will be used in different parts of the world for 5G and doing a migration in Singapore to the upper part of the C-band may lead in future to a second migration step to yet higher frequencies. The band 3400-3800 MHz will be "pioneer band" for 5G in EU. The band 3600-4200 MHz is of interest for 5G in Japan and 3800-4200 MHz under discussion for Europe while 3700-4200 MHz in USA. This band will also be of interest for those countries that have satellite only in the lower part, i.e. 3400-3700 MHz. Therefore, it should be avoided to use the range 3300-4200 MHz for new satellite implementations but rather consider how to migrate current satellite users to higher frequencies to allow for mobile use in a long term plan.

4.8 Question 8

Considering the challenges of co-channel deployment of FSS and IMT services in the extended C-band, IMDA would like to seek views and comments on the coexistence measures for adjacent bands and cross border operations.

Ericsson's Response:

This is under study in both APT Wireless Group and in WP5D. Guardband or various mitigation techniques are being considered in the case of FSS and IMT co-channel deployments.

The band 3300-3400 MHz has an IMT identification in 45 countries from WRC-15 in the Radio Regulations from all three ITU Regions and will be part of an early band for 5G in big markets like India and China. There is thus an interest to see studies in this context of FSS and IMT co-channel deployments in the region in the entire band 3300-4200 MHz. Countries with FSS in 3400-3700 MHz need studies for using IMT in 3300-3400 MHz and in 3700-4200 MHz, while countries using upper traditional part for FSS could have interest using the range 3300 MHz to 3700 MHz or 3800 MHz for IMT.

Please also refer to our response to Question 7.

4.9 Question 9

IMDA would like to seek views and comments on whether there are other frequency bands in the 1-6 GHz frequency band that IMDA should consider for IMT / 5G.

Ericsson's Response:

Ericsson supports the following frequency bands for IMT-2020/5G in the 1-6 GHz range:

- 600 MHz
- 700 MHz
- 3300-4200 MHz
- 4400-4990 MHz

4.10 Question 10

IMDA would like to seek your views and comments on the following:
i) The role mmWave bands will play in delivering the vision of 5G, in particular, what services could not be delivered by alternative frequency bands and / or technologies;
ii) The amount of spectrum required in the mmWave spectrum bands to meet 5G applications that will require higher bandwidths; and
iii) The specific mmWave bands that you consider should be a priority in Singapore for IMT services and why?

Ericsson's Response:

i) The mmWave bands will play a vital role in 5G deployments primarily to address applications requiring very high data rates and/or low latency since they can accommodate very wide channel bandwidths.

ii) The amount of spectrum bandwidths required in the 24 GHz to 43.5 GHz bands is expected to be in the range of one GHz per operator. while for bands above 45 GHz, it is expected to require bandwidths in the order of several GHz per operator.

iii) The 28 GHz band (26.5-29.5 GHz) will be the first 5G band and then in combination with the 3 or 4 GHz frequency ranges.
With the movement also in Europe with the "pioneer band"on 24.25-27.5 GHz (26 GHz band) prior to or during year 2020, there is an overlap of 1 GHz between the 26 and 28 GHz.

The following mmWave ranges have been considered by the industry to be important for 5G:

a) 24.25 GHz to 29.5 GHz, 37 GHz to 43.5 GHz, 45.5 GHz to 50.2GHz, and 66 GHz to 71 GHz;

b) While the ranges 71 to 76 GHz and 81GHz to 86GHz is expected to be dedicated to fixed service and backhaul to 5G to support the above mentioned mobile bands. This E-band is developing fast already now to be in near future a key frequency band for backhaul.

For 5G spectrum above 20 GHz, the mmWave bands which should be considered by Singapore for early implementation prior to WRC-19 and high priority of IMT services should be in the range 24.25-29.5 GHz with a higher probability for early ecosystem in the upper part of this range, followed also later by the 37-43.5 GHz band. For longer term the other bands under study in the WRC-19 process should be considered.

4.11 Question 11

Considering that there are 11 candidate bands under consideration at WRC-19, how would making available the 28 GHz band help in the deployment of 5G services in Singapore? Would this band play a significant role in achieving the targets set out for 5G (i.e. higher throughput, ultra-low latency)?

Ericsson's Response:

The 28 GHz band is of particular interest as parts of it has been decided for 5G use in the United States with the technical conditions defined and is being targeted for early 5G deployments by Japan and Korea as well. With this strong interest, it will also accelerate the whole 5G ecosystem including devices.

This band will be the first 5G band and is expected to play a significant role in early 5G deployments and delivering 5G targets such as higher throughput and ultra-low latency.

4.12 Question 12

If the 28 GHz band is opened for IMT services in Singapore, would there be any future competing services that may be deployed in this band which may cause interference issues?

Ericsson's Response:

The Agenda Item towards WRC-19 consider the use of the frequency range 27.5-29.5 GHz by earth stations in motion communicating (ESIM) with geostationary space stations in the fixed-satellite service. However, the

frequency band 27.5-29.5 GHz is in the ITU Radio Regulations already allocated to both the mobile and fixed service on a primary basis in all the three ITU Regions. It should be noted that in resolves 2 of Resolution 158 from WRC-15, as guidance to the study of sharing and compatibility between ESIM operating with geostationary FSS networks and current and planned stations of existing services allocated in the frequency band 27.5-29.5 GHz should ensure protection of, and not impose undue constraints on, services allocated in those frequency bands.

Ericsson supports that sharing and compatibility studies are done to ensure that ESIM operating with geostationary FSS can coexist with the mobile and fixed service in this band and not put constraints on using this band for mobile 5G/IMT-2020 in future. To avoid undue limitations on the mobile and fixed usage in this frequency band, the sharing and compatibility studies should be based on realistic parameters, deployment scenarios and assumptions.

If co-existance turns out to be difficult, the band should be considered to be divided between satellite and mobile/fixed use like has been done in USA or be left for complete mobile use.

4.13 Question 13

IMDA seeks views and comments on the estimated spectrum demand of 3360 MHz by 2025 and whether this estimate is realistic?

Ericsson's Response:

The ITU-R WP5D have been studying the spectrum needs for IMT-2020 for two years and developed deliverable on this topic by february this year. For IMT-2020 a traffic forecast was not used as was the case for IMT-2000 and IMT-Advanced, but rather spectrum needs estimated using an application-based approach, and two technical performance-based approaches besides information from some countries on estimations of their spectrum needs. The variation depends on user scenario and frequency range but can perhaps be summarized as 2-6 GHz below 43.5 GHz and 5-10 GHz above 43.5 GHz.

4.14 Question 14

Noting that several regulators have made available mmWave bands for IMT services, IMDA would like your views and comments on whether access to the mmWave spectrum should be provided earlier than 2022 for commercial network deployment?

Ericsson's Response:

For 5G spectrum above 20 GHz, Ericsson is of the view that IMDA should provide such bands by 2020 or earlier. Suggested trials should be allowed in these bands prior to 2020 and Singapore should be able to allow for early implementations.

Due to the fact that there has been an acceleration in 5G standardization as well as strong industry interest and commitments to the 28 GHz band, allocation of this band in an earlier time frame would ensure an early 5G introduction to Singapore.

4.15 Question 15

Considering the current regulations/policies for licence-exempt use and the possibility of LTE-U interfering with Wi-Fi users, IMDA would like to seek views and comments on the following:
i) The adoption of LBT to facilitate sharing of licence-exempt spectrum and whether there would be any implication arising from such a requirement;
ii) The need for further technical requirements and regulatory measures to facilitate the sharing of licence-exempt spectrum in an efficient and fair manner; and
iii) The need for companies with commercial LTE-U networks to upgrade to LAA once the software/hardware products are commercially available.

Ericsson's Response:

i) Ericsson sees LAA as a key complementary technology especially with the fast-growing mobile data consumption trends in Singapore. Ericsson agrees with IMDA in the adoption of LBT to facilitate sharing of license-exempt spectrum. LBT mechanism has already been standardized in 3GPP-Rel 13 for DL-only LAA which was finalized in August 2016, and Rel-14 which added LBT for LAA with UL traffic. Moreover, 3GPP conducted extensive coexistence evaluations between Wi-Fi and LAA networks with the objective of ensuring fair access to the license-exempt spectrum.

ii) Ericsson believes current available technical requirements (i.e. LBT mechanism) and regulatory measures are sufficient to ensure efficient and fair sharing of the license-exempt spectrum.

iii) Ericsson is of the view the decision to upgrade commercial LTE-U networks to LAA will depend on the various factors such as the MNOs' business needs and the readiness of the LAA ecosystem. Terminals supporting LAA are expected to be available within the next few quarters.

4.16 Question 16

During the interim period before regulations are finalised, IMDA plans to facilitate industry trials for LAA/LTE-U technologies. As such IMDA would like to seek views and comments on the following:
i) Besides the information listed in Para 80, should MNOs/MVNOs interested in conducting LTE-U trials submit any further information for IMDA's assessment; and
ii) To minimise impact to Wi-Fi users, should IMDA limit LAA/LTE-U trials to parts of the 5 GHz licence-exempt spectrum?

Ericsson's Response:

Ericsson welcomes the IMDA plans to facilitate industry trials for LAA/LTE-U technologies.

i) Ericsson is of the view that LTE-U/LAA complements existing LTE and Wi-Fi deployments and no further regulations need to be imposed.

ii) Ericsson has done extensive simulations studies, over-the-air test and trial deployments for LAA/LTE-U. None of these testing activities have shown any evidence of adverse impact on Wi-Fi networks. Moreover, these activities clearly showed that LAA/LTE-U device is a better neighbour to a Wi-Fi device than another Wi-Fi device. As such, we do not see a need to place restrictions on LAA/LTE-U trials or deployments in the 5 GHz licence-exempt spectrum.

4.17 Question 17

IMDA would like to seek views and comments on the following:
i) The possibility of deploying LAA and / or MuLTEfire in other frequency bands besides the licence-exempt 5 GHz band; and
ii) The regulatory and coexistence measures that should be adopted for MuLTEfire.

Ericsson's Response:

i) Ericsson is of the view that the possibility of deploying LAA and/or MuLTEfire should not be limited to the licence-exempt 5GHz band, considering that standardization efforts are on-going in MuLTEfire to support other frequency bands, e.g. worldwide operation for IoT in the sub-1 GHz and 2.4 GHz bands. Furthermore, evolution of LAA will target other bands in addition to the already standardized 5GHz band.

ii) Ericsson, as part of the MuLTEfire standardization forum, would like to emphasize that MuLTEfire adopts the same channel access mechanism as LAA and fair access to the license exempt 5GHz band has been a key objective in its standardization. Consequently, Ericsson believes that regulatory and coexistence measures adopted for MuLTEfire should be the same as the ones adopted for other RLAN technologies (i.e. Wi-Fi, LAA, etc.).

4.18 Question 18

Considering that the LWA approach would not create coexistence issue with Wi-Fi users, would this approach be better suited for countries with extensive Wi-Fi usage?

Ericsson's Response:

Ericsson is of the view that both LAA and LWA are offloading solutions to alleviate congestion in current and future MNO's networks. Our extensive studies, test-bed and trials have shown that an LAA/LTE-U network does not cause additional interference to an existing Wi-Fi network in comparison to introducing another Wi-Fi network. Therefore, Ericsson does not see a need to choose between LAA or LWA as a technology that is applicable for Singapore.

4.19 Question 19

IMDA would like to seek views on how the above approaches (i.e. LAA, MuLTEfire and LWA) would enhance the capacity of the mobile network in ways that Wi-Fi offloading is not able to achieve.

Ericsson's Response:

Ericsson is of the view the above approaches (i.e. LAA, MuLTEfire and LWA) are alternative and/or complementary offloading solutions to Wi-Fi offloading. These approaches imply a tight integration between licensed and unlicensed spectrum which leads to an optimized use of available wireless network resources that results in enhanced end user's quality of experience in different scenarios, e.g. highly-loaded traffic scenarios. Furthermore, LAA and MuLTEfire provide a more efficient air interface, better outdoor coverage, better network security and seamless mobility support compared to Wi-Fi offloading.