GSA[1] Response to "CONSULTATION PAPER ON 5G MOBILE SERVICES AND NETWORKS"

[1] *The GSA (Global mobile Suppliers Association) develops strategies and plans, and contributes studies and technical analysis to international, regional and individual country policy-makers and regulators to facilitate the timely availability of spectrum for use by mobile network operators. GSA has a focus group for spectrum topics for technical and regulatory matters of radio spectrum pertaining to the successful evolution of International Mobile Telecommunication (IMT) and associated radiocommunication systems and comprises a team made up of spectrum and regulatory affairs specialists from GSA Executive Member and GSA Member companies. The GSA Spectrum Group is participating in the study work leading up the World Radiocommunication Conference meeting in 2019 (WRC-19). In addition GSA reports regularly on global spectrum harmonisation efforts and developments including auctions, assignments, allocations, and re-farming activities.*

FOR THE ATTENTION OF:
Ms Aileen Chia
Director General (Telecoms and Post)
Infocomm Media Development Authority of Singapore
10 Pasir Panjang Road
#10-01 Mapletree Business City
Singapore 117438

Summary

GSA welcomes the opportunity to provide comments on the “CONSULTATION PAPER ON 5G MOBILE SERVICES AND NETWORKS”, ISSUED BY THE INFO-COMMUNICATIONS MEDIA DEVELOPMENT AUTHORITY OF SINGAPORE.
GSA appreciates the effort of IMDA to enable a timely deployment of 5G in Singapore, by ensuring availability of the required spectrum in different frequency ranges to meet the diverse 5G requirements.
GSA would like to provide the following views on the Questions 1) to 14).

If the IMDA requires any clarification to our response, please do not hesitate to contact:

Hakan Ohlsen,
GSA Spectrum Group Coordinator for APT
Email: hakan.ohlsen@ericsson.com

5G Technology and Use Cases

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?

GSA's comments:

The Figure 3 in the consultation document provides a good estimation of the deployment phases that would be adopted in Singapore market.

- Technologies supporting applications of Internet of Things, such as NB-IoT (narrowband Internet of Things) and eMTC (enhanced machine-type communication) based on 3GPP Rel-13, are being deployed now.
- The first release of 3GPP 5G standard (Rel-15) is scheduled to be finalised by June 2018 including both standalone and non-standalone 5G New Radio (NR) specifications. The deployment of 5G NR network will follow soon after that, starting from frequency bands below 6 GHz, such as 3.4-3.6 GHz. Availability of 700 MHz band before year 2020 is important for provision of 5G services with wide coverage and support of massive machine type communications (mMTC) including deep indoor deployments. MNOs may deploy either evolution of LTE-Advanced or 5G NR technology on the 700 MHz band.
- The ITU is in the process of defining the IMT-2020 specifications that will be finalized by 2020. Guided by Resolution ITU-R 65 on the "Principles for the process of future development of IMT for 2020 and beyond" which outlines the essential criteria and principles which will be used in the process of developing the Recommendations and Reports for IMT-2020, including Recommendation(s) for the radio interface specification, the ITU-R has commenced the process of developing ITU-R Recommendations for the terrestrial components of the IMT-2020 radio interface(s). The ITU-R, in Circular letter 5/LCCE/59 and its addenda, has announced the availability of:
  - draft new Report ITU-R M.[IMT-2020.TECH PREF REQ] – Minimum requirements related to technical performance for IMT 2020 radio interface(s)
  - draft new Report ITU-R M.[IMT-2020.SUBMISSION] – Requirements, evaluation criteria and submission templates for the development of IMT-2020 and
  - draft new Report ITU-R M.[IMT-2020.EVAL] – Guidelines for evaluation of radio interface technologies for IMT-2020.

  Furthermore, these three draft new Reports have been submitted for consideration and approval at the Study Group 5 meeting in November 2017. After approval by Study Group 5, these Reports will be used for the submission and evaluation process of candidate terrestrial radio interface technologies of IMT-2020.
- WRC-19 (Oct. 2019) will make regulatory decisions under the Agenda Item 1.13 on which frequency bands in portion(s) from 24.25 GHz to 86 GHz are identified for IMT-2020. 5G eco-systems of millimetre wave (mmWave) bands are being developed now to support early deployment of 5G systems from year 2018 in some leading markets. Starting to deploy mmWave 5G system after year 2020 will allow Singapore to take the advantage of the WRC-19 decisions and to benefit from global and regional harmonization of mmWave bands for 5G, the established eco-systems, and experiences from leading markets on regulatory, technical, operational and business aspects of 5G on mmWave bands. However, early deployment of 5G on mmWave bands, e.g. in 2020, would bring Singapore to the very frontline of mobile communication innovation and will enhance Singapore's leadership position in defining the direction of 5G development. We encourage the IMDA to consider possibility for 5G

deployment on mmWave bands starting from 2020, taking into account the eco-system development in other leading countries.

In addition to timely availability of spectrum for 5G, it is also important for IMDA to develop national 5G policy that promotes and guides Singapore's 5G networks and services development.

Considering that the 4G networks are the foundation of the 5G infrastructure and that 5G will encompass services for both consumers and business, including vertical sectors, the spectrum policy and regulatory framework needs to be upgraded to the 5G era by aligning the regulation applicable to most applications running on terrestrial networks, but also to the wireless component of transport, audio-visual, health, energy, and Internet of Things/M2M services. Consistency in spectrum management between the different spectrum users should be achieved.

In regards to the licensed spectrum use, the regulatory framework provides certainty of the legal framework and the investments in the networks of the future. A balanced pricing policy for licensed spectrum should be favoured to avoid hampering the investments required in the networks. As such, long licenses durations, accompanied by transparent renewal conditions, would give operators the necessary timeframe and incentives to continuously invest and upgrade their networks to be 5G-ready. Transparent renewal conditions would justify continuing investments at near license end-dates, avoiding investments gaps until the license renewal.

Last but not least, network configurations are evolving constantly to better meet users' needs in terms of indoor and outdoor coverage and to improve quality of service: new radio base stations are installed on a regular basis to increase the networks' capacity and their size deems to better match the ultra-dense architectures. As such a high number of smaller cells is estimated to make part of the new 5G networks and regulatory and administrative frameworks should evolve to take into consideration rules that adapt to the processing of volumes of requests by the administrations.

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?*

GSA's comments:

The sub-1 GHz spectrum is important for low power wider area IoT applications to provide coverage over long distances and deep indoor penetration. 3GPP has already standardized two complementary narrowband LTE IoT technologies in Release 13: eMTC (enhanced machine-type communication) and NB-IoT (narrowband Internet of Things). eMTC can deliver up to 1 Mbps of throughput utilizing just 1.4 MHz of bandwidth, and supports essential capabilities such as VoLTE and full mobility for a broad range of IoT use cases, including asset trackers and wearables. Whereas NB-IoT scales down to extreme simplicity for low-throughput, delay-tolerant applications, such as meters and sensors. These cellular IoT technologies can be deployed on IMT frequency bands, e.g. on guard-band, in-band, or as a stand-alone network.

i) The NB-IoT operating bands specified in 3GPP[2] are as below:

NB-IOT Operating Band	Uplink (UL) operating band BS receive UE transmit	Downlink (DL) operating band BS transmit UE receive	Duplex Mode
	F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	
1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	HD-FDD
3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	HD-FDD
5	824 MHz – 849 MHz	869 MHz – 894MHz	HD-FDD
8	880 MHz – 915 MHz	925 MHz – 960 MHz	HD-FDD
12	699 MHz – 716 MHz	729 MHz – 746 MHz	HD-FDD
13	777 MHz – 787 MHz	746 MHz – 756 MHz	HD-FDD
17	704 MHz – 716 MHz	734 MHz – 746 MHz	HD-FDD
19	830 MHz – 845 MHz	875 MHz – 890 MHz	HD-FDD
20	832 MHz – 862 MHz	791 MHz – 821 MHz	HD-FDD
26	814 MHz – 849 MHz	859 MHz – 894 MHz	HD-FDD
28	703 MHz – 748 MHz	758 MHz – 803 MHz	HD-FDD

The Band 8 and Band 28 have been assigned to MNOs in Singapore (noting that Band 28 the 700 MHz band is not yet available to MNOs), and NB-IoT can be deployed on these two bands by reusing LTE network infrastructure. It's also noted that the 800 MHz band is considered by IMDA for mobile (expected for 2021), which may also be used to support IoT applications using cellular IoT technology but 3GPP will need first to address the use of this spectrum.

ii) It is expected that the cellular IoT technologies (e.g. NB-IoT and eMTC) will play a more and more important role in supporting IoT applications in the coming decade; it is capable to fulfil the market demand in coming years. Nevertheless it's expected that 5G use cases with higher demands than what is achievable today, e.g. higher data capacity, higher data rate, lower power consumption, and more link budget by multi-hop communication, will appear in the market some years in future; those specific technical requirements and technologies are being considered in 3GPP. It is also expected that spectrum demand for IoT applications will increase, and especially after early years of successful NB-IoT business.

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.

GSA's comments:

The mobile communications industry is exploring the utilization of mmWave frequency spectrum for future 5G networks, coupled with the densification of networks. By their nature, those higher frequencies provide much more bandwidth than the spectrum below 6 GHz that is currently being used for mobile communication, and mmWave spectrum is more amenable to small cell deployments.

The higher frequencies have several bands available to provide huge capacity and throughput. Industry's researches and trials show that these bands can be used for access and backhaul to help support large volumes of small cell traffic but also coverage along streets in dense urban and urban areas. Time division duplex (TDD) is the preferred duplexing

[2] TS36.802 v13.0.0, http://www.3gpp.org/ftp/Specs/archive/36_series/36.802/36802-d00.zip

method in mmWave cells because it eliminates the need for paired spectrum and is more flexible for handling the elastic demand of uplink and downlink traffic. However, to take full advantage of the small cells technology and the network densification, regulatory steps should be considered to allow for a cost-efficient and timely deployment of small size equipment, including measures to ease acquisition or building small cell sites.

5G will be deployed on multiple frequency bands, e.g. 700 MHz, the L-band, the extended C-band and mmWave bands. As of today, a rooftop site of one operator's may have 6 antennas; and the number of antennas goes much higher if four operators share one site location. Multi-band antenna is therefore necessary for 5G. However, the antenna height of most multiband antenna is more than 2 meters which is higher than the 1.5 meters – the maximum value in HDB scenario. We recommend IMDA to review the related regulation to enable innovation and to facilitate 5G deployment.

Below 1 GHz Frequency Bands

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?

GSA's comments:

GSA supports IMDA's plan to re-farm 800 MHz band and then to release to MNOs using one or combinations of the 3GPP band plans (i.e. band 5 and band 27, or band 26).
In addition to the bands already allocated or planned to be allocate, GSA would like to draw IMDA attention on the potential of the sub-700MHz band. The 600 MHz band is rising in importance in some countries in Asia-Pacific and Region 2 for IMT use, several countries joined the footnotes during WRC-15, and AWG is now developing a frequency arrangement for this band. In the U.S. 600 MHz will be commercialized for MBB around year 2020. We recommend IMDA to put the 600 MHz band in its long term planning for mobile service.

1 – 6 GHz Frequency Bands

5) IMDA would like to seek views and comments on 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).

GSA's comments:

GSA welcomes the position of IMDA regarding the L-Band, which as indicated in IMDA's document, benefits of regional and global harmonization. As such, we are pleased to see that IMDA will provide some inputs to regional and global harmonization processes. When deciding on the arrangement for Singapore in the L-band, IMDA need to consider harmonization with its neighbours and also ongoing work in APT Wireless Group (AWG). It is important that cross-border issues and interference between countries are minimised, especially in South-East Asia with many borders. GSA therefore suggest that IMDA takes a tentative arrangement of SDL now and input this into AWG work for wider support and to facilitate AWG to harmonize to SDL for this region at least among its neighbours to avoid any interference between countries, especially in Southeast Asia. An alternative option is to wait for the work in AWG to conclude with an APT harmonized recommendation, before deciding for the frequency arrangement.

i) For Singapore, we believe that SDL band plan would be a solution when the L band is combined with 700 MHz (Band 28) or other bands below 1 GHz. This indeed would enable operators to use the full L-Band capacity for downlink transmission while taking advantage of: (1) the under used uplink capacity in lower bands (below 1GHz) and (2) the extended UL coverage of band below 1GHz (700, 800, 900MHz).
SDL is a solution for asymmetrical traffic allowing for additional downlink capacity. It optimizes the spectrum efficiency as it does not waste spectrum for duplex gap as needed by the FDD option even if the current work in 3GPP is limiting the duplex gap by adopting a dual duplexer concept as for band 28.

From ecosystem perspective, Singapore can benefits from the economy of scale of L-band development in Europe. The sub-band 1452-1492 MHz (3GPP band 32) is already harmonized in Europe for SDL (with EC and ECC decisions). It has been auctioned in several European countries. Base stations and user equipment are already available in the market. Europe will soon finalize the SDL frequency arrangement for the extended L-Band 1427-1517 MHz (1517-1518 MHz is a guard band), for both 4G and 5G (technology neutral). Final approval of the extended L band regulations is expected for Q4 2017. This will provide flexibility to operators to deploy such band either for LTE or 5G NR. Main European operators are strongly supporting specification of such SDL band in 3GPP.

ii) As indicated above, base stations and user equipment are already available for the sub-band 1452-1492 MHz, i.e. 3GPP band 32 for SDL. 3GPP is currently developing specifications for LTE SDL (90MHz and related carrier aggregation with 700/800MHz), LTE TDD (90MHz) and LTE FDD (2x43MHz) operation over the extended L-Band range (1427-1518MHz). The specification work is expected to finalize by Sept. 2017. The extended L-Band is also one of the 5G NR bands to be developed in Rel-15 (target completion June 2018). Equipment supporting the extended L-band will likely be available for regions interested in deployments before 2020, while this timeline is subject to R&D progress and market demand.

iii) It is known that the FDD solution will be implemented in Japan. Therefore, there is an option for IMDA to wait for the work in 3GPP and AWG to be finalized and ensure that a harmonized approach is taken among neighbouring countries, in ASEAN, or in the whole APT region that will indeed also create a healthy ecosystem regardless if it is an SDL or FDD solution.

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.

GSA's comments:

In order to meet the comprehensive requirements of 5G, including ultra-high capacity, deep coverage, ultra-high reliability, ultra-low latency, etc., operators would need spectrum from different frequency ranges, i.e. low frequencies (below 1 GHz, 1.4 GHz), medium frequencies (e.g. 3.4-3.6 GHz, 2.6 GHz, etc.) and high frequencies (mmWave bands). GSA believe that allocating all of the 91 MHz of spectrum in the L-Band to IMT would be a great opportunity for operators in Singapore to deploy 5G services while offering the perfect mix of good deep coverage (Indoor, rural, etc.)

and higher capacity.

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?*

GSA comments:

Migration of satellite use from extended C-band to other parts of the C-band (3.7-4.2 GHz) should be avoided since studies are ongoing in several countries to use this range for future mobile service with focus on 5G.

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.*

GSA's comments:

The C-band, i.e. 3300-4200 MHz and 4400-4990 MHz, offers the unique opportunity for largest amount of spectrum below 6GHz. The amount of contiguous spectrum that can be made available in these ranges offers an interesting opportunity for the exploitation of the innovative capabilities of the latest IMT technologies, with particular reference to the 5G New Radio air interface which will deliver increased capacity and connectivity.

Most of the 5G leading markets consider a portion of C-band as 5G primary band. Considering that the extended C-band, 3.4-3.6 GHz, is identified for IMT in almost every countries of the world; and the adjacent bands 3.3-3.4 GHz and 3.6-3.8 GHz are available for mobile in a large number of countries, there is a great momentum to deploy 5G over this part of C-band. Many countries are working to make available 300-400 MHz contiguous bandwidth in C-band for 5G with a target of at least 100 MHz of contiguous spectrum per MNO within the 3.3-3.8 GHz range. 3GPP is studying 3300-3800 MHz, 3300-4200 MHz and 4400-4990 MHz as 5G NR bands in Rel-15. A great momentum of 5G development over C-band can be observed today on policy, regulation, technology and ecosystem aspects, including migration of existing satellite users on extended C-band 3.4-3.6/3.7GHz to other parts of C-band.

GSA developed a white paper[3] on future IMT development over the 3300 to 4200 MHz band. The mobile manufacturers expect that 5G NR ecosystem for 3.3-3.8 GHz will be commercially ready in 2018.

GSA strongly supports IMDA to make available the 3.4-3.6 GHz band in Singapore for 5G deployment as early as possible.

Coexistence of FSS and IMT has been analyzed in great detail in various fora. Examples include Report ITU-R M.2368. Further information on this issue has been put together by the GSMA[4]. In addition, CEPT has published ECC-Report

[3] The Future of IMT in the 3300-4200 MHz Frequency Range, https://gsacom.com/paper/future-imt-3300-4200-mhz-frequency-range/

[4] See GSMA papers, "Considerations for the 3.5 GHz IMT range: getting ready for use" (https://www.gsma.com/spectrum/wp-content/uploads/2017/06/Considerations-for-the-3.5-GHz-IMT-range-v2.pdf) and

254[5] "Operational guidelines for spectrum sharing to support the implementation of the current ECC framework in the 3600-3800 MHz range" in order to facilitate the use of the full 3400-3800 MHz band for IMT as set out in the CEPT Roadmap for 5G.[6]

GSA is view of that choosing realistic assumptions on parameters and modeling of either system, including the right protection criteria, is of utmost importance. These realistic assumptions include:

- Realistic FSS parameters in line with those of real satellite systems as registered with the ITU-R
- Appropriate propagation models commensurate with the analyzed scenarios
- Correct modeling of the IMT system as a network (i.e. based on Recommendation ITU-R M.2101)
- Technically sound protection criteria based on a C/(I+N) analysis that captures the real performance of a victim receiver, as opposed to a fixed I/N value which does not convey any information on the actual performance of the victim receiver in presence of external interference
- Power Flux Density (pfd) values based on realistic system parameters for cross-border situations

For coexistence between IMT systems and FSS in adjacent band, those measures that work for co-channel coexistence can also be used, e.g. separation distance, sector disabling and multi antenna techniques. In addition, the suitable guard bands between IMT and FSS or suitable IMT spectrum emission mask can release the adjacent band interference. For the cross border coexistence between IMT and FSS earth station, bilaterally negotiation and PFD limitation are relatively simple and effective ways to protect FSS earth stations.

GSA encourages IMDA to take actions to address the cross boarder co-existence concern and to pave the way for Singapore MNOs to use of the extended C-band for 5G.

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.

GSA's comments:

Other portion of C-band, e.g. the 4.8-4.99 GHz band, could be another potential band for long term 5G development. The frequency band 4800-4990 MHz was identified for IMT at WRC-15 for a number of countries in Region 2 and Region 3. ITU-R WP 5D is working on the technical and regulatory conditions for the use of IMT in this frequency band. China and Japan are planning 5G deployment on this band (in China it is 4400-4500 MHz and 4800-5000 MHz; in Japan it is 4400-4900 MHz). 3GPP is working on 4400-4990MHz band for 5G NR in Rel-15. We recommend the IMDA to investigate the possibility of allocating the 4400-4990 MHz band or a portion of it for 5G and to take actions to make it available in the time soon after 2020.

"Fair FSS Sharing - Safeguarding mobile growth" (https://www.gsma.com/spectrum/wp-content/uploads/2017/06/Fair-FSS-sharing.pdf)

[5] http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP254.PDF

[6] https://cept.org/ecc/topics/spectrum-for-wireless-broadband-5g

Above 6 GHz Frequency Bands

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

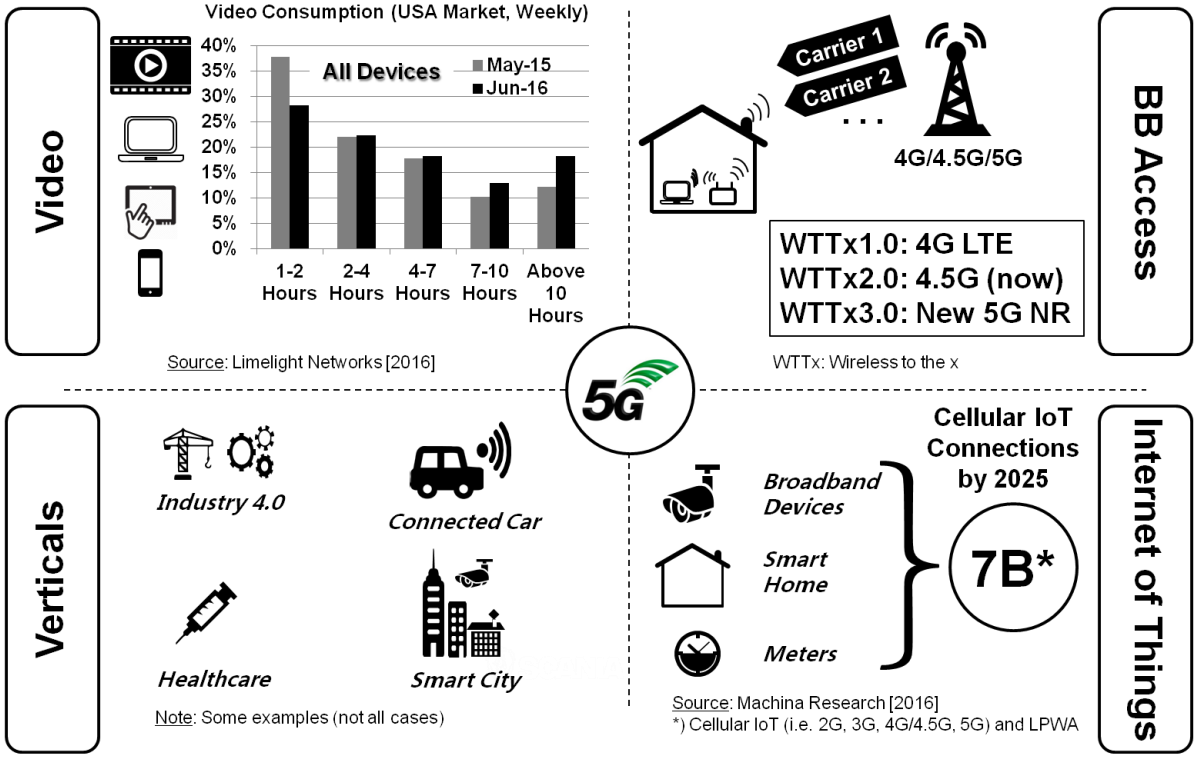
iii) The specific mmWave bands that you consider should be a priority in Singapore for IMT services and why?

GSA's comments:

i) ITU-R identified three usage scenarios for IMT-2020/5G (see Fig. 2 of the consultation document). The frequency bands below 6 GHz are of high value and recognized as "key" bands for 5G because of its capability to support all three usage scenarios and most applications of 5G. The mmWave bands are considered as important complement to the IMT bands below 6 GHz because of the very wide bandwidth that can support extremely high data rates and capacity required for some eMBB applications, e.g. 10-20 Gbps peak data rate and 1 Gbps user experienced data rate.

Given the propagation characteristics of mmWave band, 5G mobile systems working on mmWave band will be mainly deployed in dense urban or urban areas for both indoor and outdoor hotspots with some coverage along streets, and the HetNet architecture may be required in which IMT system working on bands below 6 GHz provide coverage, service continuity and capacity while systems working on mmWave bands provide extremely high data rate and capacity.

The mmWave bands will also be used for provision of wireless broadband (fixed wireless access) service. The wide bandwidth can support a "fibre-like" broadband access to homes, offices and other places, including those that are not connected by fibre. It is identified as one of four major 5G business pillars (see Figure below).



ii) Based on the ITU-R studies, the spectrum needs for mmWave for 5G could be up to around 20 GHz[7] in order to meet the 5G ultra-high capacity requirement, and GSA is of the view that contiguous bandwidth of 800-1000 MHz per MNO is suggested for the initial mmWave deployment. Large bandwidth is the unique merit of mmWave bands comparing with bands below 6 GHz. The 5G NR being developed by 3GPP will support a maximum carrier bandwidth of 400 MHz for mmWave bands but such carrier can be aggregated together to provide even larger contiguous bandwidths. A 5G NR system working on 800-1000 MHz contiguous mmWave band will have less complexity, and thus with less cost, in comparison with working on two separate blocks of 400-500 MHz bands. Mobile communications over mmWave band is new; a successful initial phase of mmWave network operation including business aspect is very important to incentivise further investment. Therefore, we recommend IMDA to make available 800-1000 MHz contiguous spectrum per MNO for the initial deployment of mmWave 5G system.

iii) 24.25-29.5 GHz and 37-43.5 GHz should be considered by IMDA as high priority mmWave bands for Singapore, because these ranges will be the early commercialization bands, and global/regional/multi-countries harmonization can be expected which are key for affordable device ecosystems and reducing co-existence issues.

a) 24.25-29.5 GHz:

i. The European Union has identified 24.25-27.5 GHz band as 5G Pioneer band and will promote this band for global harmonization; EU Action Plan also demands to launch trials over this band starting from 2018, with a target of commercialization in big cities from 2020. Recently, China MIIT opened a public consultation on use of 24.75-27.5 GHz, 37-42.5 GHz and other bands for 5G, and China MIIT also issued 24.75-27.5 GHz and 37-42.5 GHz bands for IMT-2020 5G trial. With Regard to the studies towards

[7] Spectrum needs and characteristics for the terrestrial component of IMT in the frequency range between 24.25 GHz and 86 GHz, see a contribution document to ITU-R TG5/1 (R15-TG5.1-C-0036!!MSW-E)

WRC-19 AI 1.13, both ASMG and RCC put high priority on this 24.25-27.5 GHz band. High potential for global harmonization. So the global harmonization on 24.25-27.5 GHz can be expected.

ii. The development of 5G mmWave over 28 GHz band is driven by the US, Republic of Korea and Japan. USA FCC decided to allow mobile service on 27.5-28.35 GHz and USA MNOs plan to start 5G commercial service on this band before 2020. The government of Republic of Korea has assigned 26.5-29.5 GHz band for 5G trials in the 2018 Winter Olympic Games while the time for 5G commercialization over this band is expected before 2020. The government of Japan has assigned 27.5-29.5 GHz for 5G trials, in addition to some other frequency bands; it's understood that Japan MNOs will start 5G commercialization over this band in 2020. Some other countries including Singapore have expressed interest to consider the 28GHz band for 5G. So the multi-countries harmonization on 28GHz can be expected. The frequency band 26.5-29.5 GHz was recently named as 5G Frontier band by those countries.

iii. 3GPP is working on two 5G NR bands for this range: 24.25-27.5 GHz and 26.5-29.5 GHz, and the eco-system are being developed to support the deployment from year 2018. The 28 GHz band would be the first mmWave band seeing 5G commercial deployment, while the 5G ecosystem over 26 GHz would soon catch up via leveraging the existing 28GHz eco-system, as the two bands are adjacent and 3GPP's two separate bands are overlapping by 1GHz.

b) 37-43.5 GHz

i. There is a very high potential that 37 – 43.5 GHz band will become global harmonisation, as a different portion of this band has been widely identified and supported during WRC-15 as well as being considered for IMT-2020 for various regions. And the 37-43.5 GHz frequencies are not extensively used by incumbents and therefore, could provide large 5G capacity. USA FCC decided to allow mobile service on 37-40 GHz and USA MNOs plan to start 5G commercial service on this band before 2020. Recently, China MIIT opened a public consultation on use of 24.75-27.5 GHz, 37-42.5 GHz and other bands for 5G, and China also issued 24.75-27.5 GHz and 37-42.5 GHz bands for IMT-2020 5G trial. EU RSPG identifies 40.5-43.5 GHz as long term 5G band. With Regard to the studies towards WRC-19 AI 1.13, ASMG and RCC put high priority on portion of 37-43.5 GHz band.

ii. 3GPP is working on 5G NR band for 37-40GHz now, while bands 40-43.5 GHz can be added if requested by mobile operators. And the eco-systems are being developed now to support the deployments from year 2018.

The 31.8-33.4 GHz (hereinafter 32 GHz) band has specific challenges regarding the protection of the passive services right below and of military radiolocation service right above that band that significantly limit available RF bandwidth to 5G and also limit and restrict the usability of 32 GHz for 5G. Additionally, 32 GHz band is relatively small (1.6 GHz bandwidth) compared to 26 GHz (3.25 GHz bandwidth) and the band might be further reduced by the need to protect the services operating in the adjacent bands.

Beyond the high priority bands 24.25-29.5 GHz and 37-43.5 GHz, GSA is also studying the bands above 45 GHz for IMT in the long term.

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)?*

GSA's comments:

At moment most of 5G trials over mmWave bands (e.g. USA, Korea, and Japan) are in the 28 GHz band. It is going to be the first mmWave band for 5G commercialization. The 5G ecosystem for this band is developing fast due to early-mover countries opening up this band for 5G. In our view, the 28 GHz band is enjoying a de facto harmonization across regions due to the early-mover actions by certain administrations. Therefore, making the 28 GHz band available for 5G deployment would enable Singapore to benefit from this early ecosystem development and trial/launch possibilities to help achieving the targets set out for 5G for commercial deployments by 2020.

The eco-system, use cases and business models developed for 28 GHz band will accelerate the development of the other mmWave bands, especially the adjacent 26 GHz band. Along Europe and China's potential trial and commercialization on 26 GHz band before year 2020, the 5G ecosystem over 26 GHz band would soon catch up. GSA recommends that Singapore, one of the leading countries of the world on ICT development, considers mmWave deployment from 2020, taking into account the development of mmWave eco-systems in other countries.

However, as indicated by the consultation document, 28.5-29.5GHz is allocated to Fixed Satellite Service, while the mobile satellite user terminals are allowed in 28.6-29.1GHz but will mostly be confined to air platforms or vessels, it is highly related with WRC-19 AI 1.5 for ESIM development over 27.5-29.5 GHz. GSA supports sharing and compatibility studies between earth station in motion operating with geostationary FSS and current and planned stations of existing services, in particular mobile and fixed services, to ensure protection of services allocated in those frequency bands. We encourage administrations and related international organizations such as ITU-R and APT to facilitate such studies. It is also of paramount importance that in order to avoid undue limitations on the mobile usage in this frequency band, the sharing and compatibility studies should be based on realistic parameters, deployment scenarios and assumptions.

When making a decision for the 28 GHz band, the above factors should be taken into account, in particular on the available bandwidth, the eco-system development, potentiality of global or regional harmonization, and Singapore's time line for introducing mmWave system and services.

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?

The 28 GHz band is under study for Earth Stations in Motion (ESIM) under WRC-19 Agenda Item 1.5 and technical conditions for such use will be developed by ITU to ensure protection of, and not impose undue constraints on, services allocated in this frequency band, i.e. the Fixed and the Mobile service. One such condition was already agreed by WRC-15 for ESIM operation in the adjacent 29.5-30.0 GHz band which, according to Resolution 156 (WRC-15), states that ESIM, with respect to any terrestrial systems operating in the bands, shall not claim protection or impose constraints on the development of these services.

As stated by the IMDA in the consultation document, ESIM usage is restricted to only 28.6 – 29.1 GHz in Singapore and the band is currently under-utilized with uplink transmissions mostly confined to air platforms or vessels, restricted to certain technical parameters such as emission power and minimum operating elevation angle. It will be important to implement the conditions as developed for WRC-19 in order to ensure the protection of the use of the entire 28 GHz band i.e. 27.5-29.3 GHz for 5G terrestrial systems.

Future Spectrum Estimation

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

GSA's comments:

The spectrum demand of 3360 MHz for year 2022 seems realistic; however, the value might be conservative for year 2025 and additionally if it is possible to allocate in an early phase 800-1000 MHz per MNO in the mmWave this number may be exceeded. It's expected that 5G deployment will gain considerable scale in developed markets at around 2022 in particular on bands below 6 GHz. The mobile data traffic by year 2025 is expected to increase a lot from previous years, also because the availability of 5G network will trigger further usages – both for human and for machines, and will also enable new applications that will consume additional traffic. The mobile data traffic will increase a lot in 2025, which is probably under estimated.
The projected supply of frequency bands 24.25-24.45, 25.05-25.25 and 42-42.5 GHz are fragmented and not sufficient to meet 5G requirements, GSA recommends IMDA to provide large continuous spectrum within 24.25-29.5 GHz and 37-43.5 GHz to meet the potential demands.

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?*

GSA's comments:

To achieve a full 5G/IMT-2020 experience, spectrum both below 6 GHz and above 6 GHz (mmWave) are needed to allow for both capacity and coverage aspects fulfilling 5G/IMT-2020 requirements.

If Singapore wants to be an early adopter of 5G the IMDA will need to consider the introduction of both mmWave frequencies (e.g. 24.25-29.5 GHz and 37-43.5 GHz bands) and mid-band (e.g. 3400-3600 MHz band) for 5G as early as possible, but not later than 2020. This requires technical and regulatory decisions during 2018 to make clear direction for the industry development for Singapore and ahead of the WRC-19 in a similar way as will be done in US, Japan, Korea and EU.