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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

Dear Ms Chia,

**Re: Public Consultation on 5G Mobile Services and Networks**

Microsoft commends the IMDA and the Singapore government for its leadership in driving the digital vision for Singapore with initiatives such as the Smart Nation programme, and TV White Space (TVWS) regulatory framework. These forward-looking initiatives, which have consistently adopted a collaborative approach, including an openness to seeking feedback and comments from industry and the public, have propelled Singapore to the forefront of the region in embracing and planning for the digital economy.

5G is set to deliver faster, more reliable and robust wireless communications, enabling more innovative use cases for the Internet of Things (IoT), autonomous driving, machine learning and data analytics, and many more. Beyond higher throughputs and lower latencies which are key attributes of 5G services, Microsoft believes that 5G should also bring about a breakthrough in affordability and ubiquity of wireless services to connect all people and things in an increasingly digital world. We believe that license-exempt and shared spectrum access are key to increasing spectrum supply, lowering the barrier to access, and realizing greater affordability and ubiquity.

5G is anticipated to lead to greater demand for spectrum resources in terms of both availability and capacity. To tackle these challenges, Microsoft favours a balanced policy that aims to promote the availability and efficient use of both license-exempt and licensed spectrum for mobile services. While licensed access provides network operators with the certainty they may need to invest, license-exempt access allows a larger number of

participants individually to make smaller investments, and to introduce new products and services quickly and affordably. Further, the availability of license-exempt spectrum can help to augment the capacity or extend the range of licensed devices.

Spectrum managers often face the dual challenges of making available spectrum in low frequency bands to provide wide-area broadband coverage in unserved and underserved areas, as well as making available additional spectrum in mid- and high frequency bands to add broadband capacity everywhere there is already wireless broadband access. We have seen that over time, the notion of spectrum management has broadened from exclusively preventing harmful interference to primary users to one that also includes maximizing a given band's spectrum utilization efficiency and economic efficiency to increase connectivity.

Maximizing the economic efficiency of a spectrum band ensures that spectrum is allocated and assigned to uses that produce the highest economic value. Maximizing the spectral utilization efficiency of a band enables the most intensive use possible within the interference limits for the licensed services, while making spectrum available when and where it is required, and keeping pace with the need to foster wireless innovation.

Microsoft applauds IMDA's recognition of "the increasing heterogeneity of networks using unlicensed and licensed spectrum bands" in 5G development. We encourage the IMDA to expand license-exempt access to spectrum bands across low-, medium-, and high-frequency ranges when developing its regulatory framework for 5G and make spectrum sharing an enabling attribute of a broader and more affordable 5G ecosystem. We have appended our responses to the questions in this public consultation where applicable. If you have clarifications please do not hesitate to contact us.

Yours sincerely,

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### **About Microsoft Singapore**

Microsoft started operations in Singapore in 1990 and employs now over 850 employees. Working with communities and the Singapore government to meet the aspirations of our country and communities, Microsoft and its partners are committed to working closely with organizations and people across Singapore to fully harness the power of technology and innovation.

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*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?*

Microsoft agrees with the view that 5G deployments will take place over a significant span of time and in phases in accordance to market demand, use cases, technology development, standards maturity, and network economics. The standards and spectrum bands for 5G are still being developed and discussed by industry players, standard bodies, and national governments around the world, and, we believe that such deployments may not likely take a sequential or linear fashion as depicted in Figure 3 of the consultation document. Rather, we believe that various deployments will take place in all bands (low-band below 1 GHz, mid-band between 1-6 GHz, and high-band above 6 GHz) and across all use cases ranging from IoT/machine-to-machine (M2M), to enhanced mobile broadband and ultra-high-bandwidth, low-latency communications.

From our experience, the most innovative use cases of IoT applications actually come from the use of spectrum that is controlled by end users and application providers. As the next generation of mobile broadband and communications is still being developed, we support the IMDA's move to waive the frequency fees for 5G trials and encourage the IMDA to continue to facilitate trials and experimentation, keeping pace with global developments, while refraining from allocating spectrum prematurely.

While Figure 3 may serve as an example depiction of phased deployments, we hope that it does not prevent IMDA and the industry from allowing the accelerated development and deployment of technology, networks, and services in any of the bands for any of the use cases.

Microsoft commends the IMDA for considering license-exempt spectrum as a key part of the 5G ecosystem when developing its regulatory framework. We believe that a balanced and coordinated policy framework on both licensed and license-exempt spectrum usage is key to supplying sufficient and efficient spectrum resources for the higher demands and lower costs expected in the 5G era, and will give Singapore an edge in establishing its leadership as a Smart Nation. While licensed spectrum ensures a greater degree of certainty for network operators, the use of license-exempt spectrum allows for low barriers of entry and the opportunity for smaller service providers to innovate and compete, bringing greater vibrancy and competition to the market.

Furthermore, license-exempt spectrum is also utilized by existing mobile network operators (MNOs) to ease bandwidth demands, such as through offloading onto Wi-Fi networks.

Currently MNOs are already using the license-exempt 2.4 GHz and 5 GHz bands to offload mobile data traffic to Wi-Fi networks, and this need for Wi-Fi offloading is likely to rise even further with 5G which will provide greater capacity, speeds, lower latencies, and ubiquitous connectivity for a wider range of devices, and new applications and use cases.

License-exempt use in the 5 GHz and 60 GHz frequency bands is already able to achieve high capacity data rates of over 1 Gbps speeds—the data rate requirements of 5G. In many countries today, these data rates have already been achieved using 80 MHz and 160 MHz channels in license-exempt 5 GHz bands using a 2x2 or greater Multiple-Input Multiple-Output (MIMO) antennas.<sup>1</sup>

Likewise, such high capacity data rates have also been achieved in several countries using 2.16 GHz channels in license-exempt 60 GHz bands.<sup>2</sup> While the 60 GHz band works better over shorter distances and is less able to penetrate through walls, its ability to support multi-gigabit wireless can be used to support applications such as wireless docking, projection, and in data centres for point-to-point links, and outdoor 'wireless fibre' in place of physical fibre infrastructure.

Currently, the IMDA has already allowed for license-exempt use in the 5 GHz and 60 GHz frequency bands for short range devices operating under the maximum approved field strength or power. The IMDA has allocated the 5.150–5.350 GHz frequency bands for wireless LAN, and the 5.470-5.725 GHz and the 5.725-5.850 GHz frequency bands for wireless LAN and broadband access.<sup>3</sup> The IMDA has also allocated the 57-66 GHz frequency bands for license-exempt use for wireless LAN and broadband access for short range devices operating under 10 W EIRP.

License-exempt use on these bands have been proven to be able to handle the data rate requirements of 5G. As the accelerated development of IoT and M2M communications driven by Singapore's Smart Nation vision will likely demand more license-exempt spectrum access, the IMDA should consider opening up more spectrum in the 5 GHz, 6 GHz and 60 GHz frequency bands for license-exempt use as part of the 5G ecosystem as it develops its regulatory framework. This will allow for a more efficient use of spectrum that can be allocated fairly easily. We provide details in response to questions 9 and 10.

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<sup>1</sup> MIMO technologies make use of multiple antennas at both the source (transmitter) and the destination (receiver) to allow for multiple data-carrying radio paths. A 2x2 MIMO antenna refers to one with 2 transmitter antennas, and 2 receiver antennas, where the first number refers to the number of transmitting antennas, and the second number refers to the number of receiving antennas.

<sup>2</sup> SaiShankar et. Al (2012) WiGig and IEEE 802.11ad For Multi - Gigabyte - Per - Second WPAN and WLAN, <https://arxiv.org/ftp/arxiv/papers/1211/1211.7356.pdf>

<sup>3</sup> Subject to the technical requirements specified in IMDA's 2016 Technical Specifications for Short Range Devices, <https://www.imda.gov.sg/~media/imda/files/regulation%20licensing%20and%20consultations/ict%20standards/telecommunication%20standards/radio-comms/imdatssrd.pdf?la=en>

*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?*

The sub-1 GHz frequency bands are often referred to as the “coverage bands” given its long-range characteristics which are essential for many IoT deployments which have a greater demand on range than on capacity. As such, Microsoft believes that it is critical to ensure sufficient spectrum resources in the sub-1 GHz bands are available to support the rapid growth of IoT deployments. Given that many IoT applications exhibit “bursty” or intermittent traffic pattern, it does not necessarily take a static allocation of a specific spectrum band to support such connectivity needs, but rather a dynamic, shared, and ideally license-exempt access to spectrum would often suffice and make the most economic sense for such IoT applications. IMDA’s leadership in enabling license-exempt access to the TV band (a.k.a. TVWS) is a good example of such dynamic and economic utilization of spectrum resources in the sub-1 GHz bands which can be utilized in many IoT deployments.

Currently, the sub-1 GHz band is already employed on a license-exempt basis in existing TVWS bands in a number of countries including Singapore, Canada, United Kingdom, United States, and South Korea. These countries have established regulatory frameworks allowing for license-exempt use of temporarily unused/ unoccupied spectrum between the frequencies assigned to TV stations in the UHF and VHF frequency bands. Radio waves on TVWS bands have better penetration through common buildings and experience lower path loss than radio waves on higher frequencies such as Wi-Fi. Further they do not require line-of-sight operation to achieve quality reception which allows for communicating around some natural and man-made obstacles. These make the TVWS bands ideal for supporting increased capacity of wireless bandwidth and enable wireless connectivity for M2M applications, to support IoT use cases, and other outdoor environment and security monitoring services.

Globally, where permitted, organizations and governments are already taking advantage of these characteristics of TVWS bands to conduct a variety of wireless monitoring and connectivity services.

- In Washington, USA, TVWS bands are used in the Dancing Crow farm to support the use of “precision agriculture” technologies.<sup>4</sup> Sensors which measure things like moisture, temperature and acidity in the soil across the farm, are able to transmit

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<sup>4</sup> The Economist (2016) Unused TV spectrum and drones could help make smart farms a reality, <http://www.economist.com/news/science-and-technology/21707242-unused-tv-spectrum-and-drones-could-help-make-smart-farms-reality-tv-dinners>

data over the TVWS bands which propagate over long distances, and where license-exempt spectrum is readily available. This system informs farmers when to irrigate, and avoids excessive pesticide use, allowing them to save money and boost their output.

- In Oxford, UK, Internet firm Nominet has been using the TVWS bands to connect sensors for monitoring water levels on a number of small rivers as a wireless flood detection network. The data collected by the sensors are broadcast over the TVWS bands to a base station before being sent over the Internet.<sup>5</sup> This is made possible as TVWS signals travel further than Wi-Fi, allowing the sensors to reach and connect over water bodies and wider areas compared to a wired network.
- Since 2012, the City of Wilmington and New Hanover County in the USA has also relied on TVWS as part of its “Smart City” initiative to provide wireless broadband access, as well as to handle video surveillance in city parks, and manage traffic congestion by providing real-time traffic monitoring to the department of transportation.<sup>6</sup>

Since June 2014, the IMDA (then IDA) has allowed for license-exempt use of designated bands in the TV broadcast bands for alternative wireless communications.<sup>7</sup> This has allowed both local and international companies in Singapore to utilize the TVWS band for a range of applications, including providing connectivity between ships and vessels anchored near Singapore shorelines to the mainland, smart grid meter monitoring at NUS University Town, video surveillance at HDB rooftops and carparks, amongst others.<sup>8</sup>

Apart from the TVWS bands, the 900 MHz band has also been proposed as part of the Wi-Fi HaLow 802.11ah technical standard for license-exempt use to support IoT applications.<sup>9</sup> Wi-Fi HaLow uses the 900 MHz bands to provide extended range and penetration for Wi-Fi networks, requiring lower energy consumption making it ideal for IoT use.

Given the wide range of applications where TVWS and license-exempt Wi-Fi can be used to support IoT and wireless communication services, Microsoft does not think that the IMDA needs to further allocate licensed spectrum resources on the sub-1 GHz band to support IoT. The IMDA should instead further help encourage use of the TVWS band, such as by

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<sup>5</sup> Wired (2015) Drones and TV white space: the future of flood defence, <http://www.wired.co.uk/article/tv-white-space-drones-oxford-flood-network>

<sup>6</sup> CNET (2010) TV white space networks tested, <https://www.cnet.com/news/tv-white-space-networks-tested/>

<sup>7</sup> IMDA (2016) Regulatory Framework for TV White Space Operations in the VHF/UHF Bands, <https://www.imda.gov.sg/regulations-licensing-and-consultations/consultations/consultation%20papers/2013/proposed-regulatory-framework-for-tv-white-space-operations-in-the-vhf-uhf-bands>

<sup>8</sup> A\*Star (2012) Through the Trees, Over the Water and Into Homes: Commercial Pilots Begin for White Spaces Technology in Singapore, <https://www.a-star.edu.sg/News-and-Events/News/Press-releases/ID/1705/Through-the-Trees-Over-the-Water-and-Into-Homes-Commercial-Pilots-Begin-for-White-Spaces-Technology-in-Singapore.aspx>

<sup>9</sup> Wi-Fi Alliance (2017) Wi-Fi HaLow, <http://www.wi-fi.org/discover-wi-fi/wi-fi-halow>

modifying its current regulatory framework to further allow for narrowband IoT use. For example, the regulatory framework could be enhanced to allow for IoT applications with higher-power but more intermittent traffic to operate in channels with a narrower width.

Singapore has shown that it is a leader in the region with regards to the use of license-exempt TVWS applications, and should continue to demonstrate its leadership by adopting a Dynamic Spectrum stance, as opposed to static allocated spectrum for IoT. When considering the scope of 5G in its regulatory framework, the IMDA should consider 5G beyond mobile broadband networks, and include stationary or nomadic narrowband IoT networks as part of the broader 5G networks and factor in the roles of license-exempt spectrum and dynamic spectrum sharing (such as Wi-Fi and TVWS) in enabling the overall 5G ecosystem.

*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?*

Future generations of high-capacity, low-latency mobile networks will certainly become an important part of the IoT transport layer, although it will likely not be the only transport for IoT data in the broadest sense. Based on our experience with IoT applications and usage, there is currently already a wide range of IoT applications with different capacity and latency requirements. Some IoT applications such as autonomous driving, real-time remote imaging and health diagnostics, will require high capacity and low latency networks as well as a high level of reliability, which will potentially require licensed spectrum. However, there are also other IoT applications such as smart metering and agricultural IoT that require much lower data rates and are less time-sensitive. For these types of IoT applications, longer range, lower power, and lower costs are often higher priority requirements and they can be better served with lower-cost solutions using license-exempt spectrum in lower bands. As such, we encourage IMDA to consider the spectrum requirements for both high-capacity, low-latency applications (typically in the higher bands) and long-range, low-power, and low-capacity applications (typically in the lower bands) in support of the growth of various kinds of IoT applications. In both cases, a balanced mix of licensed and license-exempt spectrum provision is highly desirable and beneficial for the accelerated growth of the IoT ecosystem.

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*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.*

Microsoft commends the IMDA for considering both licensed and license-exempt spectrum as key parts of the 5G ecosystem when developing its regulatory framework. The essential requirements for 5G using licensed-exempt spectrum include large channel sizes and MIMO



to allow for data rates of over 1 Gbps. As mentioned earlier, such data rates can already be achieved on license-exempt use on the 5 GHz and 60 GHz bands. To facilitate 5G deployment, the IMDA should consider allowing for further license-exempt use in the 5 GHz, 6 GHz, and 60 GHz bands as part of its 5G regulatory framework. This would include allowing for new 80 MHz and 160 MHz channels in the 5 GHz and 6 GHz bands, and extending the current 60 GHz band to 71 GHz.

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*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?*

Recently, Singapore successfully concluded an auction that made additional spectrum available for licensed mobile services in the 700 MHz and 900 MHz bands. While there is a need for the IMDA to make available additional licensed and license-exempt “capacity spectrum” to support mobile services, there does not appear to be a need for IMDA to release (re-farm) further spectrum below 1 GHz for that purpose.

Microsoft agrees with IMDA’s view on the complexity and extended timeline required in re-farming spectrum bands for re-allocation. For the sub-1 GHz band, given the incumbency of many existing services, a more immediate approach in making this band more accessible for mobile broadband and IoT usages would be through dynamic spectrum sharing, where the incumbent services are protected from harmful interferences while secondary usages are permitted on a shared and non-protected basis.

As the demand for spectrum and capacity rises alongside the growing number of devices and applications, the under-utilized TVWS bands for license-exempt use will be able to help manage and support the demand. As highlighted earlier, TVWS bands may be used for a wide range of applications to support wireless communications and connectivity across long-distances without requiring line-of-sight. Microsoft commends the IMDA for demonstrating its leadership in the region and allowing for license-exempt use in the sub-1 GHz channels in the TVWS bands.

As Singapore and the rest of the ASEAN countries complete their ASO, the IMDA should ensure it continues to keep the TVWS bands open for license-exempt use, while also working with neighbouring countries on harmonization and cross-border coordination on TVWS usage.

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*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.*

Microsoft encourages the IMDA to consider and explore spectrum sharing in the 6 GHz band between license-exempt devices and incumbent users. The 6 GHz band allows multiple 80 MHz and 160 MHz channel use, which will enable gigabit wireless speeds. Radio waves operating in the 6 GHz band as typical Wi-Fi can also penetrate through at least one to two walls, making it useful for indoor use.

Currently there are ongoing efforts in the USA that are studying the use of the 6 GHz band on a license-exempt basis on suitability for indoor and outdoor use—sharing the spectrum with incumbent users without interference. Microsoft suggests that the IMDA consider and explore the use of the 6 GHz band on a license-exempt basis to take advantage of the band's ability to support 5G deployment without interfering with incumbent users.

Currently the IMDA has allocated the 6 GHz band for fixed services, and fixed satellite services, and can thus consider exploring the possibility and suitability of the 6 GHz spectrum band sharing for license-exempt use, including 5G deployment.

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*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;*

5G mobile communications will be differentiated from previous generations of mobile services by its significantly higher data rates of 1 Gbps and lower latency rates of around 1 ms. As identified by the IMDA, 5G technologies will need to employ heterogeneous systems consisting of a range of different platforms and networks to provide seamless connectivity and high capacity. The mmWave bands are expected to play a key role in future 5G services as they can accommodate the high capacity requirements through its larger channel sizes. For example, the 2.16 GHz channels in the license-exempt 60 GHz band allow for 5G-like speeds today.

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

Microsoft encourages the IMDA to consider license-exempt use of the 57-71 GHz bands as a priority in Singapore for IMT services and 5G deployment. License-exempt applications in

this band could include both in line-of-sight in-room/ high-capacity applications such as wireless docking and outdoor 'wireless fibre' over short distances.

While the IMDA already allows for license-exempt use in the 57-66 GHz for low radiation equipment where the output power does not exceed 40 dBm EIRP, it should consider extending the available spectrum bands for license-exempt use in the 60 GHz band. For example, in 2016, the Federal Communications Commission (FCC) in the USA, upon recognizing the potential of the 60 GHz band for license-exempt use, doubled the number of available channels from 7 GHz to 14 GHz in the 57-71 GHz frequency band to spur the development of 5G networks and technologies.<sup>10</sup> Additionally, the FCC is considering allowing license-exempt operations in the 71-76 GHz and 81-86 GHz bands.

The IMDA is making available the 71-76 GHz and 81-86 GHz bands for short-term commercial use of up to 12 months for fixed-wireless backhaul, inter-building fixed-wireless network and mobile fronthaul/backhaul in conjunction with the frequency bands made available for 5G trials. However applicants need to apply for short-term commercial use of the band. Microsoft encourages the IMDA to instead allow for license-exempt use of the 71-76 GHz and 81-86 GHz bands in support of 5G trials and deployments, where license-exempt equipment keeps a low radiation below 40dBm EIRP output power to avoid interference with incumbent use.

The mmWave bands are particularly suitable for ultra-high bandwidth and low-latency connections which would become crucial building blocks for devices and applications such as virtual reality and augmented reality. As Singapore drives forward as a leader in Smart Cities and an exporter of associated technology solutions and innovation, making available plenty of license-exempt spectrum for such applications will spur local innovation and entrepreneurship and help Singapore to achieve its goals.

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*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)?*

Microsoft supports the use of the 28 GHz band for the deployment of 5G services in Singapore. Apart from the 60 GHz band, the 28 GHz band is the most mature band in the mmWave spectrum. The USA has rules in place for mobile use of the 28 GHz band, while technology trials are also being conducted in Japan and South Korea. Despite the fact that it is highly unlikely the 28 GHz band will be identified globally for 5G mobile services, there

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<sup>10</sup> FCC (2016) Fact Sheet: Spectrum Frontiers Rules Identify, Open up Vast Amounts of High-band Spectrum for Next Generation (5G) Wireless Broadband, [https://apps.fcc.gov/edocs\\_public/attachmatch/DOC-340310A1.pdf](https://apps.fcc.gov/edocs_public/attachmatch/DOC-340310A1.pdf)

appears to be a critical mass of major economies interested in moving forward with the technology and that will lead to future economies of scale. By adopting the 28 GHz for 5G deployment, Singapore stands to benefit from cheaper device costs leading to higher take-up and a virtuous cycle of falling prices and rising adoption.

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

Microsoft encourages the IMDA to take into account both licensed and license-exempt spectrum when estimating spectrum demand for 5G and other wireless services. To handle the increasing demands for spectrum by 2025, the IMDA will need to identify both license and license-exempt spectrum to handle the rising demand.

When estimating the amount of license-exempt spectrum required, the IMDA may take reference from the Wi-Fi Alliance commissioned study "Wi-Fi Spectrum Needs Study" which analyses the amount of license-exempt spectrum necessary to support the expected traffic growth.<sup>11</sup> In its analysis the study takes into account existing and future Wi-Fi device capabilities and deployment needs for business, residential, and public locations. The study evaluates two demand scenarios: the expected traffic growth and the potential unexpected increase that may come from new and novel applications.

The study does not look specifically at Singapore, but at regions including China, USA, and Europe and Japan, to predict the spectrum demands for the years 2020 and 2025. The key findings of the study estimate that:<sup>12</sup>

- Between 500 MHz and 1 GHz of additional license-exempt spectrum in various world regions may be needed to support expected growth in Wi-Fi by 2020;
- If demand for Wi-Fi exceeds expected growth, then between 1.3 GHz and 1.8 GHz more spectrum may be required by 2025; and
- Wi-Fi spectrum needs to be sufficiently contiguous to support 160 MHz wide channels, which are required to support a growing number of bandwidth-intensive applications and to allow maximum Wi-Fi benefits to be attained.

License-exempt use of Wi-Fi will be key to supporting the expected 5G traffic growths by helping to manage and offload traffic. It is therefore very important that the IMDA consider the amount of license-exempt spectrum that should be made available as part of the 5G ecosystem when forecasting spectrum demands for future use.

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<sup>11</sup> Quotient Associates for the Wi-Fi Alliance (2017), Wi-Fi Spectrum Needs Study, [https://www.wi-fi.org/download.php?file=/sites/default/files/private/Wi-Fi%20Spectrum%20Needs%20Study\\_0.pdf](https://www.wi-fi.org/download.php?file=/sites/default/files/private/Wi-Fi%20Spectrum%20Needs%20Study_0.pdf)

<sup>12</sup> Wi-Fi Alliance (2017) Additional unlicensed spectrum needed to deliver future Wi-Fi® connectivity, <http://www.wi-fi.org/news-events/newsroom/additional-unlicensed-spectrum-needed-to-deliver-future-wi-fi-connectivity>

*Question 14: Noting that several regulators have made available mmWave bands (30GHz to 300GHz) 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?*

Microsoft encourages the IMDA to make the mmWave spectrum available for 5G deployments, including both licensed IMT and license-exempt operations, once standards have been finalized and the technology has been successfully demonstrated. License-exempt mmWave spectrum in the 60 GHz band that can support 5G data rates for several different use cases is available today. While the IMDA already allows for license-exempt use in the 57-66 GHz band, it should consider increasing the amount of spectrum for license-exempt use, such as the 66-71 GHz, 71-76 GHz, and 81-86 GHz bands to further support commercial network deployment, under the same technical rules.

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*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;*

The LTE-U technical specification does not require LBT. Consequently, LTE-U conformance does not indicate that devices are able to share the medium fairly with Wi-Fi devices operating in 5 GHz band. In dense urban areas within Singapore, where there is already a large installed base of 5 GHz Wi-Fi devices in operation, the introduction of LTE-U would present potentially a significant challenge and problem for Wi-Fi co-existence and use. Given the limitations and high potential for LTE-U devices to interfere with an extensive base of Wi-Fi users, Microsoft strongly discourages the IMDA from authorizing the use of LTE-U devices and applications in Singapore.

*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*

Microsoft would like to highlight that the ability of large number of independent Wi-Fi networks to coexist in license-exempt spectrum, which can be exemplified in local office buildings and shopping malls, is made possible by truncated exponential back off and Wi-Fi preamble detection down to -82 dBm in addition to LBT. Energy detection as the lone sharing mechanism between license-exempt LTE technologies and Wi-Fi would represent a

significant step backwards from the operational realities of how the band is currently shared in extremely dense deployments in Singapore.

- iii) *The need for companies with commercial LTE-U networks to upgrade to LAA once the software/hardware products are commercially available.*

Microsoft strongly discourages the IMDA from authorizing LTE-U devices and applications in Singapore. There are no longer any barriers to LAA commercialization and the complexity of deploying LTE-U for a month or two cannot be justified given that it is still currently unclear how all LTE-U products could be modified to operate as LAA.

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*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*

Microsoft discourages IMDA from allowing LTE-U trials given the high potential interference to the extensive Wi-Fi user base, and the fact that the 3GPP specification for LAA has been finished for some time and trial equipment is readily available.

- ii) *To minimise impact to Wi-Fi users, should IMDA limit LAA/LTE-U trials to parts of the 5 GHz licence-exempt spectrum?*

Microsoft suggests that if IMDA wants to conduct LAA trials, it should conduct these trials in 5 GHz sub-bands that are most heavily used by Wi-Fi users and perform the trials in uncontrolled dense urban environments. Such trials will provide IMDA with the most realistic assessment on potential impact to existing Wi-Fi usage. The 5725-5850 GHz band seems the most likely candidate band for such trials.

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*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*

Before IMDA considers deployment of LAA and / or MuLTEfire devices in frequency bands besides the license-exempt 5 GHz band, it should thoroughly understand how fairly these license-exempt LTE technologies share access to the medium with Wi-Fi in the 5 GHz band.

- ii) *The regulatory and coexistence measures that should be adopted for MuLTEfire.*

MuLTFire exists as a technical specification and not a rigorously vetted standard. Based on the technical specification, Microsoft has serious concerns about the ability of MuLTFire devices to share spectrum with Wi-Fi devices. At this stage if IMDA were to propose regulatory and coexistence measures, it should include as a minimum of LBT, truncated exponential back off, and Wi-Fi preamble detection down to -82 dBm, until an equally effective solution can be agreed to by the industry.

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*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?*

Microsoft agrees that the LWA approach would be preferred in a country like Singapore which has extensive Wi-Fi usage. In 2016, the 3GPP approved three different standards for aggregating licensed and license-exempt spectrum, namely the LAA, LWA, and LWIP specifications. Devices using LWA and LWIP will not create coexistence issues with Wi-Fi users as each combine a cellular uplink with different versions of a Wi-Fi downlink.

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*Question 19: IMDA would like to seek views on how the above approaches (i.e. LAA, MuLTFire and LWA) would enhance the capacity of the mobile network in ways that Wi-Fi offloading is not able to achieve.*

Microsoft is not clear how use of license-exempt LTE technologies would actually be able to enhance the capacity of the mobile network in ways that Wi-Fi offloading is not currently able to achieve. LAA specifications are only applicable for downlink (although Release 14 is looking at LAA uplink), and is thus unclear if LAA would also be able to significantly enhance the capacity of the mobile network in ways that Wi-Fi offloading is not currently able to achieve. What LAA does do is provide considerably more control over Internet access to the operators, which has the potential to interfere with consumer choice and stifle innovation.

It is also worth noting that Wi-Fi offloading capacity can be significantly increased should IMDA expand the license-exempt spectrum available for Wi-Fi access, including in the sub-1 GHz band (e.g., via TVWS), the 5 GHz and 6 GHz band, and in the mmWave bands.

Microsoft encourages the IMDA to take into consideration the broader ecosystem and ranges of technology and spectrum policy options when developing its regulatory framework for 5G, rather than taking a cellular-centric approach. This includes the use of both licensed and license-exempt spectrum to support 5G, the role of Wi-Fi offloading, and dynamic spectrum sharing as part of the 5G ecosystem.

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