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Feb 15, 2018

Director, Spectrum Regulatory Best Practices
Innovation, Science, and Economic Development Canada
235 Queen Street
Ottawa, Ontario K1A 0H5

*Re: Canada Gazette, Part I, October 6, 2017*

*'Consultation on the Spectrum Outlook 2018 to 2022' (SLPB-006-17)*

Dear Sir or Madam:

Microsoft respectfully submits the following comments in response to Innovation, Science, and Economic Development (ISED) Canada's 'Consultation on *the Spectrum Outlook 2018 to 2022*' ('Consultation'). Microsoft commends ISED for proactively consulting the industry on the longer-term spectrum outlook and plans on future release. We applaud ISED's leading vision and recognition of "new technologies and techniques (e.g. cognitive radio, dynamic spectrum access, smart antennas, and radio resource management techniques) that will change the way spectrum is accessed through intelligent decision-making solutions and geographical/operational awareness of the radio environment."[1] Microsoft fully agrees with ISED's assessment that "these technologies and techniques provide new opportunities for optimizing the use of spectrum and promise

[1] SLPB-006-17 Page 4, Clause 20

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to make it increasingly feasible to share spectrum in real time between multiple different services." Microsoft is pleased that ISED's consultation considers spectrum release plans across commercial mobile services, licence-exempt applications, satellite services and wireless backhaul services, and focuses on the three pillars that matter to Canadian families and businesses: Quality, Coverage, and Affordable Prices.

**Q1 – What future changes, if any, should ISED examine with regard to the existing licensing regime to better plan for innovative new technologies and applications and allow for benefits that new technology can offer, such as improved spectrum efficiency?**

Spectrum is a finite resource and bounded by the physics. In the meanwhile, overall growth of data, which drives demand for spectrum, is infinite and unbounded. Therefore, the only way to satisfy unbounded demand on a finite resource is to improve utilization and efficiency in all dimensions, including time, frequency, spatial, coding, etc.

We recommend that ISED explore the following two stages of future changes to the existing licensing regime and beyond.

1. Within the existing licensing regime, consider a greater balance between licensed and licence-exempt spectrum.

   Microsoft is very much in favor of a balanced policy that aims to promote the availability and efficient use of both licensed and licence-exempt spectrum. In

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developing optimal spectrum policy, we think it is important to bear in mind that licence-exempt spectrum is carrying 16 times more internet traffic than licensed spectrum. That is remarkable considering there is substantially more commercially viable licensed spectrum than licence-exempt spectrum below 6 GHz, where the vast majority of broadband traffic resides. In other words, the utilization and efficiency of licence-exempt spectrum is far higher than its licensed counterparts. It is therefore desirable for ISED to balance the portfolio between licensed and licence-exempt spectrums, especially considering the explosive growth of IoT services which will predominantly utilize licence-exempt spectrum.

**2.** Beyond the existing licensing regime, we encourage that ISED explore the potential application of innovative new technologies and techniques such as cloud computing, big data, and artificial intelligence in the spectrum management practice, making it a more real-time, data-driven decision-making process. The principles underpinning cloud computing, namely virtualization, resource pooling, dynamic allocation and elastic consumption that are applied to computing and storage resources can certainly be applied to spectrum resources, which are even more scarce and cannot be manufactured. Today's spectrum management and utilization regime treats spectrum as an asset to be allocated and owned, mostly by exclusive licence holders. One can envision a new spectrum management regime where spectrum is offered as a service to be accessed on-demand by a much broader set of potential users. Just like Cloud Computing allows any

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individual to affordably access the exact amount of computing power in the cloud for the precise period of time needed, a Spectrum-as-a-Service regime would allow spectrum users to access specific spectrum resources in specific location at a specific time, and release the resource as soon as the transaction is done, allowing the finite spectrum resources to be shared among a much greater number of users and thereby achieving a much higher utilization. To enable such statistically multiplexing usage model, the spectrum management system needs to be fully aware of the spectral environment and current utilization and be able to make real-time coordination among competing usages. This is where cognitive radios, spectrum database, big data and artificial intelligence technologies would be employed to enable such intelligence. Per our understanding, ISED is already a pioneer, through the PRISM (Promoting Regulatory Innovation in Spectrum Management) project, in exploring the usage of big data, analytics, and visualization to track spectrum usage in real-time and enable "evidence-based spectrum management" practices. Ultimately, in order for the limited spectrum resources to serve the unbounded growth of wireless data, spectrum sharing needs to be the norm of future spectrum management rather than an exception.

**Q5 – Do you agree with the above assessment of demand for licence-exempt spectrum in the next few years? Is there additional information regarding demand, which is not covered above, that should be considered? If so, please explain in detail.**

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Microsoft agrees with ISED's assessment that demand for licence-exempt spectrum in the next few years is going to continue to grow beyond the current provision. In addition to the Cisco VNI data that was referenced in the consultation document, we recommend that ISED reference additional information regarding demand from the Wi-Fi Alliance's Spectrum Needs Study, which shows that as much as 1.8 gigahertz of new licence-exempt spectrum will be needed to satisfy the expected growth of Wi-Fi services over the next decade.[2/] From the WFA study, it is clear that the traditional Wi-Fi backbone band in 2.4 GHz is already highly congested and can no longer support the Wi-Fi traffic volume, nor the kind of channel bandwidth specified by newer generation Wi-Fi technologies such as the IEEE 802.11ax, which demands channel bandwidth of 80 megahertz or 160 megahertz.

We also recommend that ISED explore a broader set of use cases that will drive the demand for licence-exempt spectrum, beyond mobile offloading and IoT use cases. Examples use cases may include wireless docking; 4K video streaming; next generation gaming; 'wireless fibre' connections inside data centres or between an optical fibre strung along a utility pole and one or more structures; multiple users of augmented reality devices in relative proximity on factory floors, in warehouses and retail spaces; and mobile robots that utilise machine vision and telemetry as inputs to cloud-based artificial intelligence. To cater to these type of ultra-high throughput and ultra-low latency

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2/ Wi-Fi Alliance, *Spectrum Needs Study*, Feb. 2017, available at https://www.wi-fi.org/downloads-registered-guest/Wi-Fi%2BSpectrum%2BNeeds%2BStudy0.pdf/33364.

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applications, IEEE 802.11ay[3] standard will allow up to four, 2.16 GHz-wide channels in the 60 GHz band to be bonded to achieve transmission rates in the 10s of gigabits per second.

These application scenarios and emerging technology standards call for the timely release of significantly more licence-exempt spectrum in the 5 GHz, 6 GHz, 60 GHz and 70 GHz bands.

**Q6 – What new technologies and/or sharing techniques are expected to aid in relieving traffic pressures and addressing spectrum demand for licence-exempt applications? When are these technologies expected to become available?**

In general, Microsoft believes that **spectrum sharing** is crucial for meeting the ever-increasing demands for spectrum and for making spectrum more abundant, more efficient, and more affordable in the coming decades. This should include application of dynamic sharing approaches that increase the amount of spectrum which can be used at any given place and time and which, through the use of databases, can enable spectrum managers to monitor and dynamically control the availability of spectrum. Dynamic spectrum sharing techniques can be applied to create a flexible licensing regime that enable both licensed and licence-exempt usage to coexist in the same spectrum band. A

[3] IEEE Task Group ay - Standard for Information technology--Telecommunications and information exchange between systems Local and metropolitan area networks--Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications-- Amendment: Enhanced throughput for operation in licence-exempt bands above 45 GHz.

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potential reference is the Spectrum Access System (SAS) utilised by the Citizen Broadband Radio Service (CBRS) in the 3.5 GHz band in the U.S. The SAS in CBRS is a three-tier spectrum sharing framework that includes a protected incumbent tier, a licensed Priority Access Licence (PAL) tier, and a licence-exempt General Authorised Access (GAA) tier. Such a framework has allowed 150 MHz of CBRS spectrum to be dynamically shared, while also ensuring protection of military and satellite incumbents from harmful interference. More information on SAS can be obtained from the FCC and CBRS Alliance websites.[4]

**Q7 – What existing licence-exempt frequency bands will see the most evolution in the next five years? Are there any IoT applications that will have a large impact on the existing licence-exempt bands? If so, what bands will see the most impact from these applications?**

Microsoft believes that among the existing licence-exempt frequency bands, the mid-band (5 GHz and 6 GHz) and the high band (60 GHz and 70 GHz) will see the most evolution in the next five years, driven by growth of high data rate applications such as video. Following the trend already evident in the 2.4 GHz Wi-Fi band, it is expected that the 5 GHz band will also become congested, as 11ac devices proliferate in both enterprise and consumer markets. Besides opening more 5 GHz bands for indoor and outdoor RLAN

[4] See https://www.fcc.gov/rulemaking/12-354 and https://www.cbrsalliance.org/single-post/2017/06/02/The-Technology-Behind-Spectrum-Sharing-The-Spectrum-Access-System

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operations, regulatory authorities, including those in the United States,[5/] the EU,[6/] and Singapore,[7/] are looking at opening the 6 GHz band to these operations. The propagation characteristics of the 6 GHz band make it particularly useful for Wi-Fi. The proximity of 6 GHz band to the existing 5 GHz Wi-Fi bands makes it particularly suitable and attractive for the Wi-Fi device ecosystem.

On the mmWave front, we strongly support ISED's plan to extend the 60 GHz licence-exempt operation to 64-71 GHz and encourage ISED to consider additional licence-exempt allocation in the 71-76 GHz, 81-86 GHz and above 95 GHz bands.

Microsoft is of the view that business IoT applications, rather than consumer IoT applications will see the most significant growth and therefore have the largest impact on on existing licence-exempt bands. One type of IoT applications such as autonomous driving vehicles requires ultra-high throughput and ultra-low latency which will create demand on millimeter wave bands, as discussed above. Another type of IoT applications requires relatively low throughput, is not latency-sensitive, but require long-range coverage and ultra-long battery life. Moisture sensors used in Agriculture IoT is a good

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5/ *In the Matter of Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, GN Docket No. 17-183 (rel. Aug. 3, 2017).

6/ European Commission, Radio Spectrum Committee, *Working Document, Commission Paper on a draft mandate to CEPT on RLAN in the 6 GHz band*, Oct. 9, 2017 (available at https://circabc.europa.eu/d/d/workspace/SpacesStore/d63ea67f-8171-4619-a53d-8feb57387c27/RSCOM17-40_RLAN%206%20GHz.pdf ).

7/ Infocomm Media Development Authority of Singapore, *5G Mobile Services and Networks,* Consultation Paper (May 23, 2017).

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example. This type of IoT applications will demand more licence-exempt spectrum in the sub-1 GHz band in order to satisfy the coverage range. ISED's leading role in enabling licence-exempt access to TV White Space in Canada can well serve this demand, especially if the rules are enhanced to support narrow-band operations more suitable for this type of IoT applications. We commend ISED's recent Consultation on the Technical and Policy Framework for White Space Devices which aims to update and improve the White Space Device rules to support both rural broadband and "other applications such as machine-to-machine communications as part of the Internet of Things."[8] We encourage ISED to continue to ensure that sufficient spectrum is made available for licence-exempt White Space operations, which serve as important and affordable connectivity options for both broadband and IoT applications.

**Q8 – Will the trend for offering carrier-grade or managed Wi-Fi services continue to increase over the next five years? If so, will this impact congestion in Wi-Fi bands and which bands would be most affected?**

Microsoft believes that the trend for offering carrier-grade or managed Wi-Fi services will continue to increase over the next five years and beyond. As competition among mobile carriers continues to intensify, mobile carriers are increasingly reliant on Wi-Fi offloading in order to sustain unlimited data plans. In addition to mobile carriers, traditional wireline

[8] SMSE-108-17 ISED Consultation on the Technical and Policy Framework for White Space Devices, Page 2, Paragraph 9

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carriers such as cable companies are also increasingly using Wi-Fi as the last-mile extension to their wireline networks in order to provide more "sticky" services to their subscribers wherever they are, untethered. The Xfinity Wi-Fi services from Comcast in the U.S. market is a good example. All these will impact congestion in Wi-Fi bands. As commercial mobile services evolve to 5G with multi-gigabit throughputs, so will the offloading infrastructure be expected to support gigabit operations. Mobile carriers will also look towards using gigabit Wi-Fi as a supplement to small cell deployments in dense urban or indoor locations. Therefore, the mid-band (e.g., 5 GHz and 6 GHz) and high-band (e.g., mmWave in 60 GHz and 70 GHz) which are capable of supporting gigabit operations will be most affected by these trends. Accordingly, it is recommended that ISED considers significantly greater allocation of licence-exempt spectrum in these bands.

**Q21 – Are there any other bands that should be considered for release in the next five years for commercial mobile, fixed, satellite, or licence-exempt that are not discussed above? Provide rationale for your response.**

A significant omission in Table 7 is the opportunity for ISED to consider the 6 GHz band for licence-exempt operations in order to address the foreseeable congestion in the existing 5 GHz Wi-Fi band. As mentioned earlier, regulatory authorities across US, UK, EU, and Singapore are actively consulting on opening the 6 GHz band for additional RLAN operations. The propagation characteristics of the 6 GHz band make it particularly useful

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for Wi-Fi. Like other mid-band spectrum, such as the 5 GHz band, the 6 GHz band allows higher throughput than low-band spectrum, but does not suffer from the same short-range and penetration issues that are found with high-band spectrum. In addition, it is located near spectrum which already hosts Wi-Fi operations, the 5 GHz band, allowing devices to easily utilize different spectrum bands at the same time.