February 16, 2018

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

Attention: Ms. Chantal Davis

Via Email: ic.spectrumauctions-encheresduspectre.ic@canada.ca
Chantal.davis2@canada.ca

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Dear Ms. Davis,

Re: Comments from Huawei Technologies Canada Co., Ltd.
Ref. the *Canada Gazette* Part I:
Spectrum Management and Telecommunications
Consultation on the Spectrum Outlook 2018 to 2022 ("Consultation")
SLPB-006-17-October 2017

Huawei Technologies Canada Co., Ltd. ("Huawei Canada") is pleased to submit these comments in response to the Innovation, Science and Economic Development Canada ("ISED") Consultation (SLPB-006-17 - October 2017)[1]. Huawei Canada appreciates the opportunity to share with ISED its vision and experience related to the outlook for Information and Communications Technology (ICT) spectrum usage over the next half decade.

Huawei Canada appreciates the continuing attention of ISED to spectrum planning as this is critical for facilitating innovation and investment in Canada for future ICT services. A world-class ICT ecosystem, will contribute to Canada's productivity, competitiveness, economy and jobs. Spectrum in support of ICT is thus one of the nation's most precious technology resources and its careful and sustained management is a basic component for ongoing national prosperity.

This Consultation is a necessary part of Canada's ongoing future planning. Huawei Canada is well aware that spectrum management and planning is a delicate balance among many possible applications and that planning for the future is difficult due to the uncertainties of new technology creation, consumer preferences and industrial development. Planning also entails careful consideration of the technical aspects of new applications and the many different established services including terrestrial, mobile, scientific and satellite systems that may inhabit adjacent bands. None-the-less, such planning is essential for future spectrum usage, without which, it is difficult for industry to plan services and equipment development to support the future vision. Huawei Canada is thus pleased to comment on this Consultation.

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[1] See: https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11336.html

As part of this consultation process, Huawei Canada has worked with other members of the Radio Advisory Board of Canada ("RABC") to develop consensus on many of the topics in the consultation. Generally, Huawei Canada supports RABC's comments. Here, Huawei Canada comments in more detail on some specific topics of the Consultation in the area of terrestrial communications with a focus on the longer-term perspective.

In the following sections of this response, Huawei Canada has organized the discussion around the numbered questions in the Consultation. In summary, these comments have three general themes:

1) Given the growth of communications traffic and the expansion to include not just people but also IoT, significant spectrum resources must be dedicated to delivering such services to ensure the future development of the economy. Much of this growth will involve higher frequency bands (mmWaves). Such services will require significant "backhaul". Spectrum resources must be planned for flexible assignment between access and backhaul.

2) With the heavy integration of ICT into industry verticals, the fabric of the economy and society, communications must be ubiquitous and reliable. This need for reliability will become more important with the inclusion of inanimate users (IoT, industrial systems and vehicles). Factories or transport systems, for example, cannot withstand delays or interference in their spectrum even of it is only on a local scale or of short duration. The new spectrum assignments and their operation must ensure that through licensing, regulation and technical specifications, these new systems will achieve the required level of reliability and robustness.

3) Huawei Canada emphasizes the need to have common global band plans as well as channel and emissions specifications in adjacent bands to enable economies of scale of global services and equipment availability. Huawei Canada believes that the new technical standards, application scenarios and business models leveraging 5G technologies should be developed through open cooperation and cross-industry collaboration. Such collaboration requires active involvement of all stakeholders in the global ICT industry, including governments, academia, and vertical industries.

Huawei Canada notes that the questions in the consultation are directed at the longer term strategy for Canadian spectrum planning. Thus, these discussions are in the context of possible future scenarios that may be addressed by strategic spectrum planning. These comments are not directly aimed at ongoing policy discussions and spectrum assignments. Huawei Canada recognizes that the intent of the ISED inquiry is strategic rather than tactical, and the comments in this response provide a longer-term view. Huawei Canada thanks ISED for its strategic thinking on spectrum policy to develop the Canadian ICT market and for its spectrum and technical planning efforts both in Canada and globally with its leadership within the ITU-R. Huawei Canada would be pleased to work further with ISED and others in the industry as we are all stakeholders in this important planning process.

Sincerely,

Robert Backhouse
VP Marketing and Solution Sales
Huawei Technologies Canada Co., Ltd.

The vast Canadian geography dictates that a variety of communications techniques are required (e.g. broadcast/mobile/satellite and fixed). Obviously the licensing regime, spectrum needs and planning (and economics) for major urban centres is far different than for an isolated (typically northern) community. Thus, all of the areas under discussion in this consultation are important to planning for future developments across Canada.

There is always a great importance in the harmony of spectrum usage in Canada with global usage. It is very important that Canadian licensing conditions, spectrum planning and usage be aligned with major practical global usage. This harmonious usage enables commonality with global equipment and helps to keep (equipment and service) prices low and enables (service) roaming of Canadians globally. The current low prices for equipment and services are what people expect. This is in large part due to the economies-of-scale of manufacture and development of common equipment for global markets. The chips[2] that are the heart of the handsets and that enable the new increasing functionality are based on common global usage.

Canada needs to continue to have in place bands/channel plans/technology for communications services that are common with other major trading partners and global usage. Such commonality enables Canadian users to roam with their common handset and services when abroad. Commonality also enables products and services designed and/or manufactured in Canada to be sold on a global scale.

While mobile broadband will continue to power mobile services for years to come, the Internet-of-Things (IoT) will drive further exponential growth in traffic throughput, capacity and connections. For many applications, IoT will consist of "shorter-range" access (including device-to-device) in addition to traditional wide area coverage. Use of higher frequency bands with shorter range links and wide bandwidth channels can handle the IoT high service data rates in local areas (e.g. for factory automation or health care) while lower frequency assignments may be more appropriate for wide-area IoT services (e.g. meter reading or remote monitoring). These new ubiquitous IoT services may be best served by local area and site-specific licenses to protect the integrity of the associated automation systems. The current unrestricted "unlicensed" model[3] will not be of sufficient quality for many IoT services. To benefit from economies of scale for such IoT equipment however, these must have common channel plans nationally and internationally[4].

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[2] The physical chips including their associated firmware operating programs.
[3] e.g. - as apply in the current "ISM" bands at 900 MHz and 2.4 and 5 GHz.
[4] Vehicles, for example, when crossing provincial or national borders must have compatible band plans and communications protocols.

There are generally three aspects which will increase mobile traffic demand.

(a) The growth for traditional mobile network planning is based on "human" users or computers/entertainment services interacting with people. It is expected that in the future there will be a shift in focus from usage primarily by human users to a model where substantial additional new traffic is due to the communications among machines or "things". Spectrum planning must thus also accommodate the additional traffic of these machine-type communication systems. It is expected that this traffic will exceed the "human" traffic when fully developed.

(b) The growth in installed computing power and storage is now such that it is expanding faster in the user domain at the network edges. Thus it can be expected that future traffic flow models will shift from an "end-user-to-core-server" chain into a web pattern in which significant traffic is also flowing directly "among the edge-nodes" without traversing the core network. It is also expected that there will be much more peer-to-peer traffic among the edge nodes and hence a change in the hierarchical server traffic flows that have dominated the past network planning/provisioning. This will lead to additional traffic growth in the wireless access links at the network edges.

(c) There will be additional traffic demand through the introduction of ultra reliable low latency (URLL) services into the mobile network. These services, which involve typically short messages that must be delivered very quickly and without failure, are expected to become common in many machine type communications. This traffic however, because of its urgent nature, must be delivered using the current channel conditions and without benefit of re-transmission in the event of failure. Such a traffic profile consumes more spectrum resources than traditional traffic that is not delay sensitive. This URLL traffic will have the effect of increasing the apparent traffic demand beyond what might be expected from simply summing the bit count in the packets.

The overall growth traffic will thus increase not only due to increased traditional mobile usage, but also because of the additional machine traffic and the shift in traffic flows from the core to the edges. These increases in traffic may be mitigated somewhat by suitable high frequency short range access radios (e.g. mmWaves) and higher frequency reuse.

However, the overall increase in access traffic from both mobile and IoT sources will also require backhaul for the many (new) smaller cells. Some backhaul will use wired/fiber technology in many commercial systems (especially indoors), but there is also a need to plan for integrated wireless access/backhaul capability in spectrum bands so that channels can be reused locally for either access or backhaul as the geography and user traffic requires. Thus, as discussed later, some of the additional spectrum demand may be accommodated by narrow beam

width synergistic combined access/backhaul systems in the higher mmWave bands such as the E-band.

The principal technology development to address the traffic growth is the use of small cells and narrow beam widths, and consequent high frequency reuse that is possible in mmWave bands. These techniques have been in practice in these bands for fixed services and are coming into some use with early trials for mobile services. Also, to the extent that much of the current traffic (e.g. internet access/browsing) has some tolerance for errors and latency, statistical packing can accommodate more traffic in the bands. Additionally, the application of technology such as massive MIMO, high order modulation (256 QAM), wider channel bandwidths, beam steering, better "trunking" efficiency and RF transmission technology such as polar coding and F-OFDM, will result in further improvements in efficiency and network capacity. Thus traffic peaks may be spread into times of lower traffic and hence reduce the traffic pressure. However, as noted earlier (Q2), one major new service aspect of 5G is to reduce the latency to handle real-time applications. These services will require transformation in network architecture to accommodate this traffic.

Huawei cautions, however, that band and channel assignments must be carefully choreographed with the adjacent band and channel usage. The adjacent band services may affect the mobile services due to the effects of out-of-channel emissions and signal strength. Similarly the signals operating the mobile band may affect the neighbouring band services. Compatible signal strengths and low emissions are required of all devices sharing nearby bands. For equipment designed for a single band, this is technically not so difficult to accommodate with suitable filters. But, for the mobile end user devices that must operate in many bands to enable wide area roaming, they may face many different adjacent channel and sometimes foreign in-band services in different areas of operations. The devices must include many sets of filters to protect many different users in nearby bands. This may become impractical if the neighbouring signals are significantly different in power levels. In many mobile handsets, designed to accommodate a dozen or more bands, more than half the signal received at the antenna may be lost due to the various switches and filters needed to select a desired channel. A spectrum plan may seem practical for use in a single band device may prove impossible when combined with multiple other bands. Thus, Huawei cautions ISED to consider carefully also the adjacent channel usage and in-band channel plans when assigning future mobile bands and channels.

The expectation is "license-exempt" traffic will continue to grow significantly. Already "license-exempt" dominates wireless access traffic. Some operators report that up to 80% of network traffic originates or terminates in WiFi links. Currently the license-exempt traffic is (mostly) in the WiFi bands (2.4 and 5 GHz bands), and this traffic will continue to grow. It is expected that as new usage categories develop, greater usage of license-exempt bands will develop. Examples of areas of this traffic growth include factory automation, traffic control, wearables, smarter homes, enterprise applications, home control, and gaming. Some of this traffic and new applications is expected to be absorbed into the 57-71 GHz band when the technology becomes widely available at comparable cost. The short range and wide-channel bandwidth nature of the 57-71 GHz ISM band will also engender some new services and applications.

It is also expected that there will be significant growth in machine and IoT type communications services. While these may be initially trialed in the "unlicensed" bands, these services require quality of service guarantees that go well beyond what is available in the current ISM unlicensed models. One arrangement may be to plan for service dependent "machine-communications" bands rather than mixing all IoT traffic/services together as in the current ISM band model. Specific bands would be designated for different service classes (e.g. factory automation, hospital medical treatment systems, patient monitoring systems, vehicle traffic control, etc.). These would be designated for specific IoT classes of service and licensed on a site basis for specialised users. This is necessary to prevent inadvertent failure of, for example, a hospital medical system through conflicting band use by a game machine in the waiting room. This arrangement follows the previously established practice of having dedicated bands for specialized services such as air traffic control, ambulance, rescue, railway control, police, fire and military operations.

The principle means of managing interference in the current unlicensed bands are the technical limitations on transmitted power/antenna gains and the consequent limited range of the 2.4, 5 and 60 GHz signals. Furthermore, in these bands there is a generally established "politeness" listen-before-transmit protocol that prevents simultaneous traffic interference (e.g. IEEE 802.11). Although this protocol is not required to be used by equipment in these bands, the chips that operate in the band are inexpensive and generally available so most, but not all, equipment deployed in these bands does follow the basic protocols. Expansion using these same protocols into the new 60 GHz license-exempt band is expected to take up the majority of the additional traffic of unlicensed users when the equipment becomes generally available.

However, for expansion into more "mission-critical" IoT services (e.g. factory automation, hospital medical services) two additional functionalities are needed. One of these is a band separation and access control mechanism to assure that, for example, when people and equipment using the ISM bands visit a factory site they do not disturb the local industrial activity. The second is some widely accepted definition of protocol and messages that enable channel access control and communications in the industrial environment.

It may also be helpful if the factory site owner is a designated band licensee within their site so that conflicts between neighbouring sites can be avoided. It is suggested that there be a designation of IoT bands that are service specific and administered ("licensed") for interference control. With this certainty of spectrum availability, industry will be able to develop and deploy the necessary operational protocols and products. It is expected that unless there is some form of equivalent local licensing control to protect from interference for IoT and machine communications, there will not be a large successful expansion of IoT services.

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?

Huawei believes that the 57-71 GHz band is a major area of growth given the large channel bandwidths in this band. The 57-71 GHz unlicensed band will take much new ISM traffic (as the technology matures). Some administrations are looking at the 90 GHz band to absorb additional short range traffic when RF the technology for these higher frequencies matures. In the longer term, additional unlicensed bands around the absorption frequencies in bands above 100 GHz may also be allocated for unlicensed traffic.

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?

Huawei expects that "carrier-grade" and or "managed Wi-Fi" services will continue to expand over the next five years, or longer. There is a need for a defined, standards-based compatibility and channel selection ability. Such standardisation is also required to establish a flexible innovative equipment market to spur innovation within the applications and services. This may go beyond what the current WiFi standards do now. These new scenarios may require a form of vertical industrial alliances to help drive the technology and standards within given sectors and access to spectrum in which these service capabilities can be guaranteed for users.

Q9 – ISED is seeking comments on the above demand assessment for MSS and earth observation applications for the period 2018-2022. Is there additional information on demand, which is not covered above, that should be considered?

Q10 – ISED is seeking comments on the above demand assessment for FSS/BSS for the period 2018-2022. Is there additional information on demand, which is not covered above, that should be considered with regards to the below bands?

Q11 – What and how will technology developments and/or usage trends aid in relieving traffic pressures and addressing spectrum demand for satellite services? When are these technologies expected to become available?

Q12 – What satellite applications (e.g. broadband Internet, video broadcasting, backhaul, etc.) do you consider a priority for the period 2018-2022?

With respect to Q9 – Q12, Huawei can provide some brief general comments. Huawei agrees that with Canada's extensive geography and large areas of low traffic density, satellite systems play a vital role. GSO satellite systems also play an important role for broadcast services in both areas of high and low user density. There is a continuing place for satellite systems within 5G with respect to access, backhaul and long-haul, particularly for remote communities. Other 5G applications for satellites could include aircraft communication, shipping and cruise ships, natural disaster assistance, military and industrial verticals such as mining. Huawei supports ISED initiatives to accommodate both satellite and terrestrial 5G systems.

Q13 – Do you agree with the above assessment on demand for backhaul in the next five years? Is there additional information on demand, which is not covered above, that should be considered? If so, please explain in detail.

Q14 – Backhaul service in Canada is delivered using a variety of solutions, including fibre optics, microwave radio and satellites. What changes, if any, are anticipated to the mix of backhaul solutions employed?

Q15 – What and how will technology developments and/or usage trends aid in relieving traffic pressures and addressing spectrum demand for backhaul services? When are these technologies expected to become available?

Q16 – Will the demand for commercial mobile, licence-exempt, satellite, or fixed wireless services/applications impact the demand for backhaul spectrum? If so, how and which of these services/applications will create the most impact?

Huawei expects that the traffic growth for data communications generally and mobile services backhaul will mirror the growth in access traffic. In a simple sense, each bit of data passing over the access radio link most likely must also pass over a backhaul link (sometimes multiple backhaul segments) to reach the end service or another user. Indeed, the backhaul growth may be greater than the access traffic as some backhaul traffic may travel over several backhaul links and there is additional network control traffic to manage the users. One technology that mitigates this traffic growth is the concept of local switching and local breakout (LBO). In remote communities, for example, LBO can deal with local traffic, therefore off-loading the requirement for backhaul in areas beyond the local community.

On the access side, the use of mmWave bands, because of their short range and wide bandwidth, will require many access points. This will create a substantial increase in backhaul needs as the number of access points increases. Thus Huawei expects that integrated access and backhaul solutions will be required. In these systems, the same spectrum channels are adaptively shared in local deployments between access and backhaul. This arrangement is expected to become common globally initially in the 71-76 and 81-86 GHz bands to provide flexibility and agility and significant service capacity. In these bands spectrum separation of multiple uses may be maintained through narrow-beam antennas and controlled pointing.

Q17 – Is there a range or ranges of frequencies that will be in higher demand over the next five years? Why is higher demand anticipated for these frequency ranges?
Q18 –Will allowing flexible fixed and mobile services within the same frequency band change how backhaul is planned and used?

There is no question that the need for bandwidth in both access and backhaul will continue at an exponential pace driven by video, IoT applications and industrial services. In general Huawei suggests that allowing flexibility of fixed and mobile (access) services within the same frequency band is a way to improve general efficiency of usage, and will assist planning to enable improved integrated services. Generally, for the high traffic deployments, these are expected to expand mostly into the mmWave bands due to their suitability for small cell sizes and wide bandwidth channels for high throughput services. The use of "pencil beams" and pointing restrictions for access and backhaul links can be used to prevent interference between the fixed and mobile modes of operation. The bands that have commonality with similar services, channel plans and technical parameters with neighbours and globally should be preferred as users will benefit from the synergy for global roaming and the economies of scale of global equipment markets.

Q19 – Provide, with rationale, your view of the above assessments on the bands being considered internationally for commercial mobile, fixed, satellite, or licence-exempt.
Q20 – ISED is seeking comments on the potential frequency bands for release in table 7:
 a) the proposed services and/or applications for each frequency band
 b) the potential timing of releasing for each frequency band
 c) the priority of the release of the frequency bands
Provide supporting rationale for your responses.
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.

Globally, for example in Europe and China, 24.25 – 27.5 GHz is being considered for 5G mobile services. Coupled with the use of 27.5 – 28.35 GHz in the USA, the combined bands could provide a healthy 5G spectrum landscape for Canada in the range 24.25 – 28.35 GHz. These bands are available, or planned to soon be available, in many nations and their early availability in Canada would be helpful to spur innovation. These bands are readily supported with current technology and enable sufficient channel bandwidths to support new high-speed services.

Globally, in the slightly longer view, Huawei also sees strong application for mobile 5G services integrated with backhaul in the 71-76 and 81-86 GHz bands. The bands have the advantage of established wide bandwidth channel plans to adapt to very high throughput services. Such bands would also be globally recognised and the technology for their support is now coming into market focus.

In the longer term, ISED is encouraged to consider multiple bands above 100 GHz for future mobile and associated communications. Channels at the absorption resonance frequencies in this spectral region are also suitable for example for additional "unlicensed" services. Additional licensed channels may also be designated for local fixed, backhaul, mobile and broadcast services. The assignment for these bands would be best arranged in harmony with similar usage plans in the USA.

Q22 – Are there specific frequency ranges/spectrum bands that should be made available for specific applications?

As an integral part of mmWave band assignments, ISED is encouraged to consider multiple bands for further future industrial and associated communications. These bands may also include location site specific factory automation, health-care or other "IoT" services that are locally licensed on a site-specific and service specific basis. It may be advantageous if these industrial assignments can be nearby to the general wide-area assignments to enable synergies with equipment for both the commercial fixed/mobile services and the factory/commercial systems.