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February 16, 2018

Innovation, Science and Economic Development Canada (ISED)
c/o Director, Spectrum Regulatory Best Practices
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RE: Canada Gazette, Part I, October 2017 - Notice SLPB-006-17 - Consultation on the Spectrum Outlook 2018 to 2022

Pursuant to the procedures set forth in Gazette Notice SLPB-006-17 - *Consultation on the Spectrum Outlook 2018 to 2022* (the "**Consultation**"), TeraGo Networks Inc. ("**TeraGo**") is pleased to submit the following response letter.

A. Introduction

1. TeraGo welcomes the opportunity to make this submission in response to the Consultation. TeraGo supports ISED's objective with this Consultation to obtain comments from stakeholders on its overall approach and planning activities related to the release of spectrum for commercial mobile services, licence-exempt applications, satellite services and wireless backhaul services over the years 2018 to 2022. We agree that efforts like these will help ensure that Canada is well prepared to meet the spectrum needs of future technology advancements.

2. TeraGo makes note of the fact that there are global efforts underway in many jurisdictions for the release of additional and similar spectrum. This point is also well acknowledged by ISED in the Consultation. As such, we applaud ISED's efforts in considering the decisions of international organizations and other governmental agencies to ensure standardization and harmonization. For example, the release of the recent *Consultation on Releasing Millimetre Wave Spectrum to Support 5G* prior to and in anticipation of World Radiocommunication Conference 2019 (WRC-19) will facilitate the development of 5G technology in Canada and keep it at the forefront of global innovation.

3. Since participating in Industry Canada's 1999 24 GHz and 38 GHz wireless spectrum auction, TeraGo has been proud of its ability to offer economical, reliable and scalable wireless broadband services. These services have been subscribed by thousands of Canadian businesses and public institutions over the years who may not otherwise have access to affordable internet or a choice in carrier. TeraGo has also since expanded and complemented its service offerings to include both cloud and colocation services, some of which is also being delivered through its wireless spectrum, all the while creating additional technology jobs across Canada.

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4. TeraGo submits that the use of wireless spectrum has been critical in the deployment of fixed wireless services over the last fifteen years in both major urban centers and rural communities across Canada. In particular, TeraGo currently utilizes 24 and 38 GHz auctioned licences, as well as licence-exempt spectrum for both network backhaul and last mile direct access to customer business locations. It has also used its spectrum for backhauling mobile traffic.

5. In addition to the costs TeraGo incurred in acquiring its 24 and 38 GHz spectrum licences, it has incurred significant costs to investing and building out its national wireless IP network. These costs have included investment in research and development activities as well as purchasing of Canadian equipment for deployment in the 24 and 38 GHz bands.

B. TeraGo's Responses to Select Questions to the Consultation

Question 2: Do you agree with the above assessment on demand for commercial mobile services in the next few years? Is there additional information on demand, which is not covered above, that should be considered? If so, please explain in detail.

6. TeraGo agrees with the assessment that ISED has made on the demand for commercial mobile services in upcoming years. Certainly, some of the forecasted figures for data usage cited by ISED from the *Cisco Visual Networking Index* ("**Cisco VNI**") are consistent or in line with what TeraGo has reviewed in other reports such as the *5G Americas White Paper – Spectrum Landscape for Mobile Services*[1] (the "**5G Americas Whitepaper**"), the *Ericsson Microwave Outlook 2017*[2] (the "**Ericsson Report**") and the *GSMA's Report on the Mobile Economy - North America 2017*[3] (the "**GSMA Report**").

7. In particular, the GSMA Report anticipates that 5G connections in North America will reach 100 million by 2023 with a higher adoption rate than other global regions. In addition, fixed wireless services will also play an important role in the initial deployment of 5G, citing that major U.S. carriers are launching fixed 5G services throughout 2018, with standardized 5G mobile anticipated in 2019.

Question 13 – 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.

8. TeraGo agrees with the assessment on demand for backhaul carried out by ISED. TeraGo anticipates that the demand of backhaul traffic across all mediums will exponentially grow at the same rate as mobile data generated by 5G. This will put considerable strain on existing backhaul infrastructure to meet the demands of 5G. With the expected higher adoption rate of 5G in North America, operators will need to deploy advanced mobile broadband stations (outlined in the Ericsson Report) which will require capacities upwards

[1] http://www.5gamericas.org/files/8015/1061/9326/5G_Americas_Whitepaper_Spectrum_Landscape_For_Mobile_Services_11.13.pdf

[2] https://www.ericsson.com/assets/local/microwave-outlook/documents/ericsson-microwave-outlook-report-2017.pdf

[3] https://www.gsma.com/mobileeconomy/northamerica/

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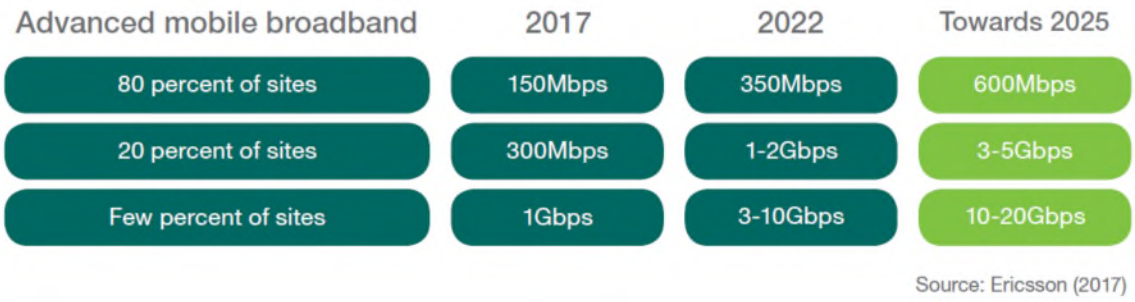
of 1 Gbps, rising to 3-10 Gbps by 2022 in order to meet or exceed the capacity of 5G access.



9. TeraGo also notes that demand for backhaul may also be contributed by the increased use of mobile applications and devices which will require computing and workloads to be pushed to the cloud. In particular, the anticipated proliferation of IoT (Internet of Things) devices in the next four years will generate increasingly large data stores. Although small applications may not be bandwidth intensive, the aggregation of thousands of devices may pose some concerns with capacity.

Question 14 – 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?

10. TeraGo anticipates a similar mix of backhaul distribution between fibre and microwave backhaul outlined in the Ericsson Report where it is expected that microwave backhaul will slightly increase in support of 5G over the next few years. These microwave backhaul deployments could leverage millimetre wave bands identified for 5G and may mesh backhaul with access as new technologies incorporate SON (self-organizing networks) to intelligently route traffic. TeraGo expects these deployments will be more prevalent in urban areas where operators will need to densify their sites quickly and where fibre buildouts may be too costly or take too much time.

11. However, the ability of microwave backhaul growth in Canada may be constrained in suburban and rural areas where traditional microwave backhaul bands (such as 6/11/15/18/23GHz) are used to backhaul services. As operators make plans to upgrade systems to gigabit or multi-gigabit capacity, they must account for the existing licensing fee structure which penalizes operators with undue fees when they provide higher capacity services. Such fees will be cost prohibitive for operators of any size, inhibiting such deployments that will facilitate Canadians in accessing existing and new 5G services. TeraGo urges ISED to review the existing license fee structure for changes to encourage deployment of high capacity and spectrally efficient backhaul solutions.

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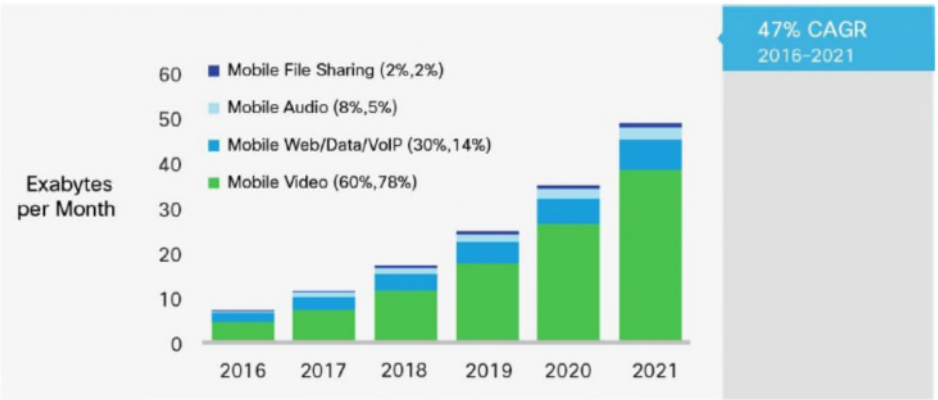
Question 15 – What and how will technology developments and/or usage trends aid in relieving traffic pressures and addressing spectrum demand for backhaul services? When are these technologies expected to become available?

12. Technological advancements over the years have been employed by Canadian operators to facilitate efficient use of existing spectrum, meeting increased demands. Backhaul technology, now reaching higher order modulations (of up to 4096QAM), are currently available and can provide some relief for congestion. However, these enhancements may only support marginal capacity increases over existing systems and requires ideal spectrum conditions. Utilizing spectrally efficient techniques such as CCDP and MIMO on backhaul systems have provided exponential growth of 2x or 4x capacity over the same amount of spectrum. These methods have been available for some time and have enabled microwave backhaul to reach speeds from 1-2 Gbps over 40-50 MHz of channel bandwidth. To keep pace with 5G demands which supports gigabit+ speeds, TeraGo expects that backhaul technology will have to employ additional measures such as massive MIMO and multi-band aggregation to reach 3-10 Gbps by 2022, as estimated in the Ericsson Report. It should be noted that employing such systems are complex and costly in respect to both hardware and current licensing fees.

Question 16: 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?

13. As referenced in the Cisco VNI, it is expected that mobile video will continue to generate the most demand for backhaul capacity across all mobile networks which in turn results in higher backhaul requirements.

Figure 24. Mobile Video Will Generate More Than Three-Quarters of Mobile Data Traffic by 2021



Note: Figures in parentheses refer to 2016 and 2021 traffic share.

Source: Cisco VNI Mobile, 2017

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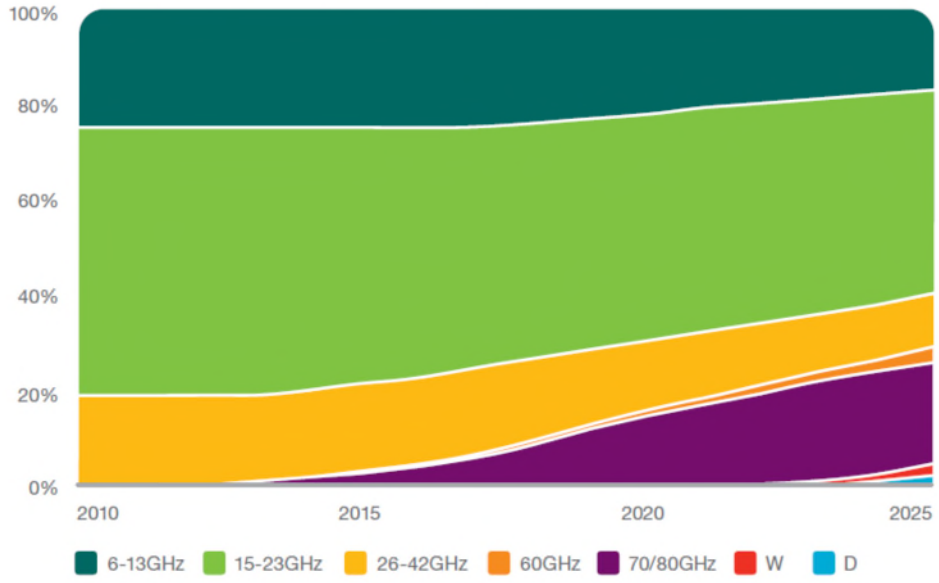
Question 17: Is there a range or ranges of frequencies that will be in higher demand over the next five years? Why is higher demand anticipated for these frequency ranges?

14. Of the frequencies provided in Table 4 of the Consultation, TeraGo expects increased demand in bands which have been identified as "congested", namely the 11, 15, 18, and 23 GHz bands as operators seek to upgrade existing systems to meet forecasted growth. Demand may not only materialize in the deployment of net new links but, will rely on the increase in channel bandwidth and multiplication of carriers to exponentially increase capacity on existing links. In addition, TeraGo expects further growth in the 12.7-13.25 GHz band for medium to long haul applications as equipment becomes commercially available (pending the finalization of the technical standards) and the band being unencumbered. We expect similar increases in demand for the 24 GHz band driven by the need for increased backhaul services.

15. TeraGo would also expect the E Band (71-76 GHz and 81-86 GHz) to experience significant growth in major urban areas given its large channel bandwidth, support for gigabit capacity and short propagation characteristics which allow for extremely dense colocation of systems. This view is shared and outlined in the Ericsson Report where it is forecasted that E band (70/80GHz) links will account for approximately 20% of new deployments.

Figure 10: New deployment share per frequency range



Source: Ericsson (2017)

16. It should be noted that equipment in the E band has been commercially available for some time, is affordable and is highly deployed globally except for in Canada. High licensing fees have hindered its use in Canada and will continue to do so until the fee structure is changed.

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Question 19: Provide, with rationale, your view of the above assessments on the bands being considered internationally for commercial mobile, fixed, satellite, or licence-exempt.

17. TeraGo believes that it is imperative for Canada to work in concert with international communities and industry standards to ensure harmonization. To the extent that certain bands are being considered or have already been approved for use in other countries and regions in the world, it is incumbent on ISED to consider the use cases for such bands here in Canada to leverage on globally developed technologies and their benefits. In particular, due to our proximity and historical harmonization with the United States, we believe ISED should continue to follow closely, the developments and decisions coming out from the Federal Communications Commission (FCC).

18. According to the 5G Americas Whitepaper, spectrum across all bands are suitable for 5G applications, and therefore each band should be looked at closely for consideration to be purposed or repurposed for 5G. Factors that should come into play on the selection of bands is whether such bands are already encumbered or free from any deployments, plus the high potential of global harmonization.

Question 20: 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 response.

19. TeraGo anticipates that the efforts from WRC-19 Agenda item 1.13 will facilitate new spectrum for use with International Mobile Telecommunications (IMT). In particular, the 24.25 GHz - 27.5GHz band has recently received priority from some organizations to be made available for early 5G deployments.

20. On November 16, 2017, the FCC adopted the Second Report and Order, Order on Reconsideration, and Memorandum Opinion and Order (the "**FCC Order**") that made available 1,700 MHz of additional high-frequency spectrum, including in the 24.25-24.45 GHz and 24.75-25.25 GHz band, for flexible and 5G use.

21. On June 30, 2017, The Office of Communications in the United Kingdom (Ofcom) noted that either 24.5 - 27.5 GHz or 31.8-33.4 GHz could be utilized for early implementation for 5G implementation.[4] The Radio Spectrum Policy Group, a high level advisory group that assists the European Commission in the development of radio spectrum policy are also considering these bands for early 5G implementation.

22. In March 2017, The European Conference of Postal and Telecommunications Administrations (CEPT) and the Electronic Communications Committee (ECC) in Europe noted that it intends to harmonize the 24.25 - 27.5 GHz band for 5G in Europe before

[4] https://www.ofcom.org.uk/__data/assets/pdf_file/0033/79584/update-strategy-mobile-spectrum.pdf

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WRC-19. This will be done through the adoption of a harmonization decision and then plans will be made to promote it for worldwide harmonization. Hence the 24.25 - 27.5 GHz band is clearly a priority band within CEPT.[5]

23. In light of all this, TeraGo believes there should be the same priority and urgency given to the release of the 24 GHz band for flexible use to keep pace with the United States and Europe in order to leverage the technological benefits for Canadians. A consultation not too dissimilar for the most recent *Consultation on Releasing Millimetre Wave Spectrum to Support 5G* should be issued in 2018 to get such process started. Once such consultation has been completed, existing 24 GHz licences in Canada should be converted to flex use and license holders should be permitted to use their spectrum for initial 5G deployment, with an auction to follow for any unallocated spectrum in the band.

Question 21 – 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.

24. In addition to the bands identified in the Table 4 of the consultation and outlined in WRC-19 agenda item 1.13, TeraGo suggests that there may be additional opportunities for spectrum in the W-band (92-114.25 GHz) and D-band (130-174.8GHz), as identified in the Ericsson Report. The amount of spectrum available may provide significant capacity to address 5G needs beyond 2022. TeraGo advises ISED to keep these bands in scope for future consideration as technology development in these bands progress.

Question 22: Are there specific frequency ranges/spectrum bands that should be made available for specific applications?

25. While TeraGo does not have a specific opinion on which spectrum bands should be made for any specific applications, it urges ISED to always consider existing deployed services in such context. No material impact should be caused on existing and legitimate users of the spectrum when converting spectrum bands over to flexible use for 5G. When releasing spectrum for 5G use, ISED must ensure that the interests of existing licence holders (including the businesses that they have built under the reliance of spectrum) be taken into consideration and that their interests do not become secondary to the latest technological trend or application.

[5] https://www.itu.int/en/ITU-R/seminars/rrs/2017-Africa/Forum/CEPT-ECC.pdf

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TeraGo thanks ISED for the opportunity to provide input on these important issues and hopes that our comments provide ISED with noteworthy perspectives on the various questions set out in this Consultation.

Sincerely,

TERAGO NETWORKS INC.

Antonio (Tony) Ciciretto
President & Chief Executive Officer