COMMENTS OF TELESAT CANADA

In response to:
Canada Gazette, Part I, June 16, 2018, *Consultation on Revisions to the 3500 MHz Band to Accommodate Flexible Use and Preliminary Consultation on Changes to the 3800 MHz Band*, SLPB-004-18

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1 These comments are submitted by Telesat in response to the *Consultation on Revisions to the 3500 MHz Band to Accommodate Flexible Use and Preliminary Consultation on Changes to the 3800 MHz Band*, SPLB-004-18 (Consultation Document)[1] issued by Innovation, Science and Economic Development Canada (ISED).

I. INTRODUCTION

2 In the Consultation Document, ISED seeks comments on a number of issues relating to use of the 3700 – 4200 MHz band (C-band or the 3800 MHz band), which is a core downlink band for the provision of fixed satellite-service (FSS). Specifically, ISED seeks comments on future fixed-satellite service (FSS) use of C-band, as well as on potential new uses of the 3800 MHz band and the adjacent 3650-3700 MHz band.

3 C-band satellite services play a vital and irreplaceable role in the delivery of essential commercial and government services in Canada. C-band satellite services are heavily used for the delivery of broadcasting services (both Canadian and foreign) to cable head-ends. In Canada, C-band satellite services are also used extensively for broadband and telephony backhaul to rural and remote communities. In so doing, these services play a key role in ensuring rural and remote areas of the country have access to similar communications services as urban areas. In addition, C-band satellites support critical government, military and safety of life communications services. These services demand the extreme reliability made possible by the unique propagation

[1] Published in the *Canada Gazette*, Part I, June 16, 2018 [*Consultation Document*].

characteristics of C-band and, in many cases, the wide coverage areas supported by C-band satellite beams.

4 Demand for C-band satellite services is strong and growing, driven by the explosion in broadband demand and the characteristics of the spectrum, and is supported by a huge investment in space and ground infrastructure. Telesat's C-band satellites, in particular, have been designed to provide highly resilient, Canada-wide coverage. These satellites communicate with a ubiquitous network of terrestrial earth stations throughout urban and rural Canada. New technologies are constantly being implemented in Telesat and customer earth stations, to optimize C-band spectrum utilization and accommodate expanding demand for bandwidth within existing satellite capacity.

5 Therefore, while Telesat appreciates that terrestrial operators are interested in using C-band spectrum and the adjacent 3650-3700 MHz band, it is imperative to recognize that FSS use of C-band is robust, growing and spectrally efficient and supports critical communications services and public interest objectives. Accordingly, any proposed new uses of these bands must be required to demonstrate that they will not disrupt existing and future C-band satellite services or undermine the economic value of C-band satellite operations in Canada.

II. DETAILED COMMENTS

6 In this section, Telesat responds to a number of specific issues raised in the Consultation Document relating to the 3800 MHz band (Section 7). For convenience, the questions and issues set out in the Consultation Document are identified below, highlighted in grey, with Telesat's comments on each issue following.

A. FUTURE CHANGES TO THE 3650-3700 MHZ BAND

Q14: ISED is seeking preliminary comments on how to optimize the use of the 3650-3700 MHz band, including the potential use of a database access model.

7 While Telesat supports the Department's objectives of optimizing use of the 3650-3700 MHz band, any such use must be based on a detailed technical plan that mitigates harmful effects to satellites services in the adjacent 3800 MHz band.

8 Telesat is particularly concerned about an unacceptable increase in noise temperature ($\Delta T/T$) at FSS receivers due to out-of-band interference and overload of the earth station front-end amplifier (or low noise block saturation). These concerns are not new. Indeed, in its 2009 publication, *SP 3650 MHz - Spectrum Utilization Policy, Technical and Licensing Requirements for WBS in the Band 3650-3700 MHz* (June 2009) (SP 3650 MHz), ISED adopted out-of-band emissions limits for Wireless Broadband Service (WBS) in the band. ISED also determined that WBS licensees would be required to notify the FSS operator when deploying a base station in the vicinity of a licensed earth station and to resolve potential interference through mutual agreement.[2]

9 These rules provide a starting point for addressing out-of-band interference between fixed terrestrial service and FSS. However, the trigger for coordination requires further study and likely should be based on the expected change in noise temperature ($\Delta T/T$) at the FSS receiver, rather than distance. When $\Delta T/T$ exceeds a pre-defined threshold, such as 6%, coordination would be required.

[2] SP 3650 MHz, section 8.3.2, page 10.

10 It is much more difficult to address out-of-band interference to FSS from mobile terrestrial service. As the locations of mobile earth stations change, the aggregate interference to satellite receivers will fluctuate over time. Although database approaches may ultimately be capable of tracking real-time mobile use and aggregate interference levels and inhibiting transmitters in millisecond intervals when the aggregate interference threshold is exceeded, this technology has yet to be fully proven. Given the potential disruption to critical satellite services, the feasibility of a database model should be rigorously tested and proven prior to authorization of mobile service in the 3650-3700 MHz band.

B. OPPORTUNITIES FOR NEW USES OF THE 3700-4200 MHZ BAND

Q15: ISED is seeking comments on the importance of the 3700-4200 MHz band to future FSS operations.

11 C-band satellite services play a vital and irreplaceable role in the delivery of essential commercial and government communications services in Canada. For example, these services support the delivery of broadcasting services, broadband and telephony links to rural and remote areas of the country, national security communications (e.g. military communications that relay advanced radar and surveillance data from areas not accessible in any other way) and safety of life services (e.g. civil aircraft and emergency response communications). These services benefit all Canadians and support key Canadian policy objectives, including ensuring all Canadians, regardless of where they reside, have access to reliable and affordable communications services, ensuring effective and efficient distribution of Canadian broadcasting signals throughout Canada, and promoting safety, national security, and sovereignty.

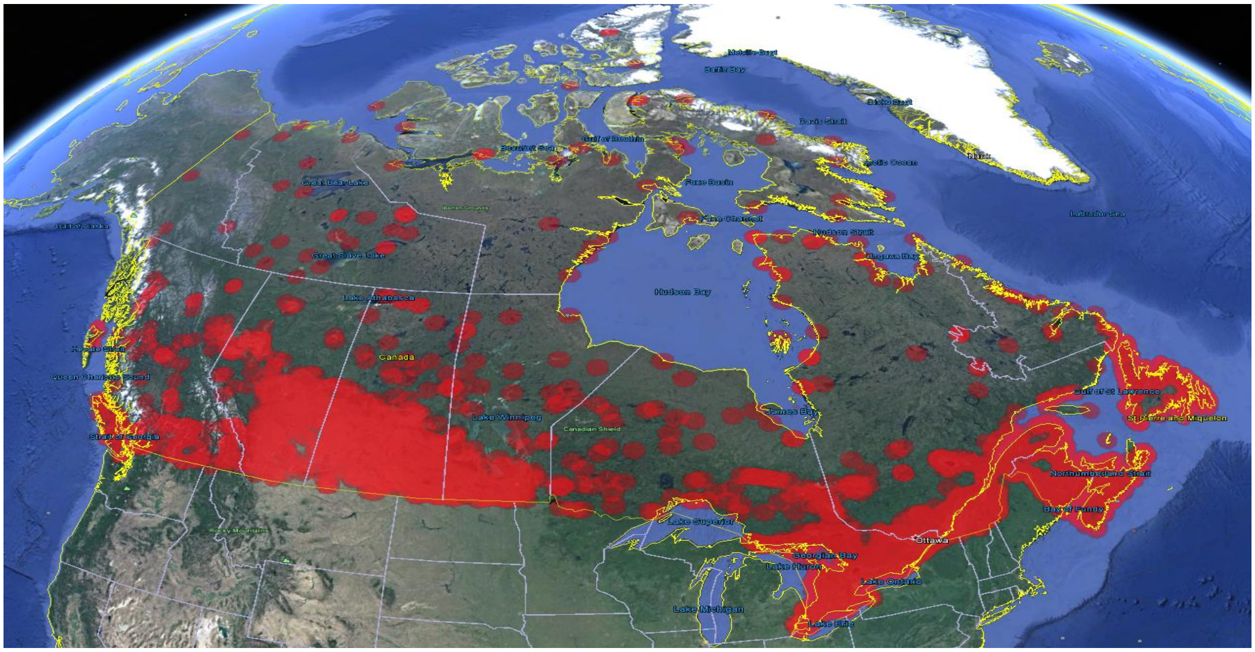
12 Demand for C-band satellite services is strong and increasing, due to exploding demand for bandwidth and the unique propagation characteristics of C-band. As there is less atmospheric water absorption in C-band, C-band satellite signals are less prone to rain fade and provide superior service at low elevation angles including, in particular, at Northern locations. This resiliency is critical to national security services, back up services, safety of life and emergency/national disaster relief services and rural and remote connectivity, and is highly valued by other C-band customers. C-band satellites also support wide beam coverage (and, in Telesat's case, full Canada coverage), which is necessary for efficient distribution of broadcasting signals and for wide area mesh networks. Furthermore, while broadcasting demand for C-band services is relatively stable, it too is expected to increase as 4K TV is rolled out, since new compression technologies will not fully compensate for the increased bandwidth requirement.

13 These C-band satellite services are supported by large investments by satellite operators and their customers in sophisticated space and ground infrastructure. This infrastructure supports effective and efficient delivery of C-band satellite communications services. Telesat's C-band satellites have been designed not only to provide highly reliable and resilient service, but also to provide coverage of all of Canada. In contrast, terrestrial networks cover only a fraction of Canada. Telesat and its customers have also made substantial investments in the ubiquitous network of earth stations deployed across the country.

14 Figure 1, below, illustrates the widespread use of C-band satellite service in Canada. The figure, which is based on existing licensed earth stations and best available information on unregistered C-band receivers, shows that C-band is heavily used in major urban corridors of the

country, as well as rural and remote areas. Major teleports that are a vital to rural connectivity and broadcasting distribution are also located in large urban areas.

Figure 1[3]



15 C-band satellite use is therefore widespread and increasing and is expected to remain important to future FSS operations and their customers. However, there must be regulatory certainty that these services will be protected from interference from new uses.

[3] Based on 2006 cable head end data and a 50 km exclusion zone around licensed and unregistered earth stations. While some cable head end locations in urban or sub-urban areas may have also implemented fibre connections, even these locations continue to rely on satellite for U.S. signals and back-up. For other locations, fibre is not cost-effective or otherwise feasible.

Q16: ISED is seeking comments on whether unlicensed operators in the 3700-4200 MHz band should be required to submit their technical parameters to ISED to assist in frequency management.

16 While registration of receive-only earth stations would in theory assist in understanding the precise locations of these earth stations, it seems unlikely that comprehensive registration would be achieved. Moreover, registration is not necessary to understand the widespread use of C-band satellite services. Figure 1 illustrates the large number of earth stations in Canada, including the large number of earth stations in the more populated parts of the country where terrestrial wireless service infrastructure is also concentrated and where 5G rollout is most likely to occur.

Q17: ISED is seeking comments on which steps Canada should take to optimize use of the 3700-4200 MHz band in consideration of the current services being provided and the developing technologies that would permit the use of new services in this band (e.g. exclusion zones).

17 Satellite operators and their customers are implementing new technologies on a continuous basis to optimize use of C-band. These new technologies are not sufficient to offset exploding demand for bandwidth, but they are dramatically increasing the spectral efficiency of C-band satellite services.

18 Some of the new technologies being deployed are:

1. DVB-S2X: This technology supports increases in spectral efficiency vs DVB-S systems of 71% to 330%. It also supports lower roll-off factors that provide additional bandwidth efficiencies. The reduction in roll-off factor from 1.35 to 1.05 leads to a 22.2% improvement in spectral efficiency. Telesat has also started testing a further reduced roll-off factor of 1.02. Additionally, DVB-S2X opens the door to higher throughput links, as it can support up to 64, 128 and 256 APSK. The standard also provides increased granularity of MODCODs in order to get the highest possible throughput of a channel. By operating closer to the theoretical limit, the standard pushes the limits of attainable capacity.

2. Carrier in Carrier Technology (CnC) / Paired Carrier Multiple Access (PCMA): This frequency reuse technology is applied to increase spectral efficiency by consuming up to 50% less bandwidth while maintaining the same throughput. It allows a full duplex satellite link to be allocated the same transponder bandwidth as a single carrier. The technology is based on adaptive cancellation, where both the forward and return channel are superimposed in the frequency domain and are separated at the receiver. It is often used on C-band loopback mode transponders.

3. Automatic Carrier in Carrier Power Control (ACPC): ACPC is an improvement on the CnC technology as is it increases link margin and availability in CnC links by autonomously varying carrier power depending on channel conditions.

4. Adaptive Coding and Modulation (ACM): ACM has been widely deployed for bi-directional links to maximize spectral efficiency and high data throughputs by adapting the modulation and forward error correction to channel conditions at each site served by the satellite service. The combination of C-band's resilience against rain fade and ACM allows for operation at minimal margins even for large geographical areas where there are variations of equivalent isotropic radiated power (EIRP) and G/T. Indeed, ACM is now considered essential for efficient operation at low elevation angles in Canada's Arctic territories.

5. Non-Linear compensation (NLC): NLC technology uses optimized constellations to improve system performance by reducing output back-off due to non-linearity of the transponder.

6. Mx-DMA return technology: This technology combines the benefits of Multi-Frequency Time-Division Multiple Access (MF-TDMA) and Single Channel Per Carrier (SCPC). It modifies the frequency plan, the symbol rate, the modulation, coding and power in real-time based on Service Level Agreements (SLA) and channel conditions, resulting in substantial bandwidth savings and throughput increases.

19 C-band satellite operators and customers are aggressively driving implementation of these technologies, in light of increasing bandwidth requirements and the need to minimize costs. No new regulatory incentives are required to optimize satellite use of the band.[4]

[4] As discussed in response to Question 18, below, large exclusion zones would be necessary for co-existence between terrestrial and satellite use of the 3800 MHz band, making sharing with terrestrial operators (and optimizing on this basis) impractical.

Q18: ISED is seeking comments on the challenges and considerations related to the coexistence of other services, such as mobile and/or fixed wireless access, in the 3700-4200 MHz band.

20 Given the distance between GSO satellites and an earth station, the signal received by the receiving earth station is very low power. Thus, receiving earth stations are very sensitive to interference from terrestrial transmitters. This means that substantial separation distances are required to prevent interference to co-frequency FSS earth stations. The required exclusion zones depend on the technical parameters of the transmitting terrestrial stations, including their peak EIRP, EIRP density, type of antenna, antenna pattern, and the range of antenna orientation.

21 A number of studies on spectrum sharing between FSS and mobile terrestrial services are reported in ITU-R Report S.2368-0.[5] The various studies are based on different assumptions regarding the terrestrial mobile network parameters such as cell size and maximum transmit EIRP. The Report concluded that required separation distances between terrestrial mobile earth stations and FSS receive earth stations would be in the tens of kilometers to hundreds of kilometers. For example, for macro cell deployment the Report states:

> For the long-term interference criterion, the required separation distances are at least in the tens of km. For the short-term interference criterion, the required separation distances, including when the effects of terrain are taken into account, exceed 100 km for most of the cases. Both the long-term and short-term interference criteria would have to be met.
>
> In some cases, the required separation distances are larger, up to 525 km. In other cases, the required separation distances could be reduced by taking into account additional effects of natural and artificial shielding. However these effects are site specific. [6]

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[5] *Sharing studies between International Mobile Telecommunications-Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 MHz and 4 500-4 800 MHz frequency bands in the WRC study cycle leading to WRC-15*, Report ITU-R S.2368-0 (06/2015), available at: https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-S.2368-2015-PDF-E.pdf .

[6] *Ibid*, at page 32.

22 Given the separation distances required to protect C-band earth stations and the widespread deployment of these earth stations, co-existence between FSS and mobile service in the 3800 MHz band is not practical.

III. CONCLUSION

23 In view of the forgoing, it is imperative that ISED ensure C-band satellite services and the economic value of these operations are protected. This means that authorization of new uses of the 3800 MHz band and the adjacent 3650-3700 MHz must be based on robust demonstration that the new operations will not disrupt satellite services.

All of which is respectfully submitted on behalf of TELESAT CANADA

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