RADIO ADVISORY
BOARD OF CANADA
CONSEIL CONSULTATIF
CANADIEN DE LA RADIO

Comments in Response to SLPB-002-20, *Consultation on the Technical and Policy Framework for the 3650-4200 MHz Band and Changes to the Frequency Allocation of the 3500-3650 MHz Band*

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Introduction

1. The Radio Advisory Board of Canada ("RABC" or "the Board") commends the Department for launching the *Consultation on the Technical and Policy Framework for the 3650-4200 MHz Band and Changes to the Frequency Allocation of the 3500-3650 MHz Band.* The RABC acknowledges the rapid evolution of wireless technology, the increasing demand for high-quality and high throughput wireless communications across all areas of Canada, and the resulting growth in spectrum requirements for several services.

2. The submission of the RABC takes into consideration the many related developments in Canada and other jurisdictions:
   - The Third Generation Partnership Project (3GPP) definition of the bands n77 (3300-4200 MHz) and n78 (3300-3800 MHz) for mobile wireless services;
   - Canada's recent decision that the band 3450-3650 MHz is to be auctioned mid-2021, which is a Canadian-specific band with emission requirements that enable Canadian operators to take advantage of the European base station ecosystem;
   - The recent decision in the United States (U.S.), that the 3700-3980 MHz band is to be auctioned at the end of the year 2020, and is intended to be cleared on an accelerated timeline (100 MHz by December 2021 and the next 180 MHz by December 2023) but with certainty by December 2025 at the latest;
   - The recent U.S. decision to create a 20 MHz guard band in 3980-4000 MHz; and
   - The U.S. release of a consultation regarding the 3450-3550 MHz spectrum allocation for 5G wireless systems.

3. Key objectives behind the RABC submission are:
   - To leverage large equipment ecosystems and avoid imposing Canadian-specific equipment requirements that risk fragmenting these ecosystems;
   - If possible, to define regulations that allow users to operate in the 3500 MHz and 3800 MHz spectrum blocks using the same Radio Frequency (RF) equipment such that there is one Radio Standards Specification (RSS) document covering both bands; and,
   - To provide technical guidance to the Department to facilitate coexistence between services identified for new or continued operation within the band and with adjacent band services.

4. As explained more fully below, the RABC proposes that ISED follow a plan that broadly aligns with the n77 (3300-4200 MHz) and n78 (3300-3800 MHz) ecosystems, which would allow Canada to leverage equipment available from the European Union (EU) and U.S. markets.

5. The RABC believes that the proposals put forward by the Department, and the accelerated proposal from Telesat, are far-ranging in scope and raise a host of technical and policy issues that will affect incumbent users within the bands under consideration, proposed new users of these bands and incumbent users of adjacent bands. The RABC is not addressing all of the questions in the consultation document, because RABC generally comments on policy matters only when it feels it is appropriate to do so. The focus of this submission is

fundamentally on technical matters in the relevant responses to individual questions below. Nonetheless, the RABC notes that there will be significant costs for incumbents that are required to vacate or move frequencies. The options under consideration in this consultation could pose significant costs to satellite operators, earth station operators, broadcasters using C-band satellites, and other incumbent licensees, as well as companies relying on services provided by the licensees. Should ISED confirm its proposal to relocate the WBS licensees, they too could be facing significant costs. In addition, fair and efficient coexistence rules between the proposed flexible use licensees and incumbent services are required to avoid significant undue costs for flexible use operators and end users by imposing excessive constraints for the deployment of their systems. It is not possible to quantify the qualifiers "significant" at this stage, as the magnitude of the costs would depend on the technical solution being implemented.

Q1
ISED is seeking comments on the timelines for the development of an equipment ecosystem using 5G technologies in the 3800 MHz band. In particular:
a) the ecosystem maturity level and readiness of equipment under band classes n77 or n78 for the Canadian market
b) the ability of existing or future base station radios to handle multiple technologies and band classes at the same time (i.e. whether all four band classes (B42, B43, n77 and n78) or a subset of these band classes are able to operate on the same base station radio) and how it may affect the adoption of 5G technologies in the 3800 MHz band

6. There are two 5G 3GPP band classes that overlap with the 3800 MHz band: band class n78 (3300-3800 MHz) and band class n77 (3300-4200 MHz). The equipment ecosystem under band class n78 (3300-3800 MHz) is currently more mature than n77 (3300-4200 MHz), mainly driven by the European and Asian ecosystem. n77 ecosystem maturity will follow the deployment of U.S. C-band (3700 MHz-3980 MHz). Both n77 and n78 equipment will be mature at the time of deployment of 3800 MHz in Canada. In the medium to long-term, band class n77 may be preferable due to some advantages, such as intra-band carrier aggregation covering the whole 3800 MHz band.

7. Handling multiple technologies and band classes at the same time on the same base station is not a technical challenge for existing or future base stations operating in the 3800 MHz band. This gives flexibility to service providers. For 5G 3GPP-based New Radio (5G NR), band classes n77 and n78 can operate simultaneously in 3650-3800 MHz, while 3800-3980 MHz is covered by n77. For clarity, however, current technology does not allow a single radio to operate across the entire n77 band class, nor the 3450-3980 MHz band.

Q2
ISED is seeking comments on the potential linkages between the equipment ecosystems using 5G technologies in the 3500 MHz and 3800 MHz bands. In particular:
a) whether contiguity between the 3500 MHz band and 3800 MHz band is preferred given that 3GPP specifications allows for non-contiguous carrier aggregation
b) whether there are any technical or operational impediments (e.g. equipment limitations/challenges to support aggregated use of spectrum, or requirements for additional base station radios) that would be incurred if operators

have a large frequency separation between frequency blocks in one or both bands, and at what point (i.e. how wide the frequency separation) such impediments would become significant
c) whether the equipment ecosystem deployed for the 3500 MHz band will be able to operate in the 3800 MHz band, and whether this equipment could easily be extended to 3800 MHz after being deployed

In providing comments, respondents are requested to include supporting arguments and rationale.

8. Although 3GPP specifications allow non-contiguous carrier aggregation, contiguous blocks are preferred. Contiguous blocks enable networks to realize the full potential of 5G, with wider contiguous channels providing lower latency and lower control signaling overhead compared to aggregating multiple carriers through carrier aggregation. Wider contiguous channels also enable maximum possible transmission bandwidth configuration, and thus provide better spectral utilization, with more physical resource blocks (PRB) and less guard band. While contiguous blocks are preferred, contiguity between the 3500 MHz and 3800 MHz bands may only benefit licensees that hold blocks on either side of the 3650 MHz band edge within the same service tier, given ISED's proposal to release spectrum in the two bands via independent processes and at different release dates. In order to significantly increase the efficient use of the 3500 MHz and 3800 MHz flexible use bands and in light of the strong likelihood that many flexible use licensees will end up holding licences in both bands, ISED should investigate the possibility of providing automatic contiguity to licensees for their holdings across both bands as part of the final stage of the 3800 MHz licensing process.

9. Multiple NR carriers have an inherently higher Peak to Average Power Ratio, resulting in undesirable out of band spectral components and potentially requiring some power back-off. Also, wider spacing between NR carriers creates greater opportunity for spectral regrowth due to nonlinearities in the power amplifier. Another aspect to consider is the limitation of first-generation user devices with respect to non-contiguous carrier aggregation, e.g. number of supported carriers and total number of MIMO layers supported across all aggregated carriers.

10. The current equipment ecosystem deployed for the 3500 MHz band in Canada aligns with European regulation and can operate up to 3800 MHz and no further as the RF filters implemented in these solutions cannot be re-tuned through software. However, this limitation is being addressed such that new equipment will be designed to operate across both 3500 MHz and 3800 MHz spectrum.

Q3
ISED is seeking comments on how the difference in technical rules between the U.S. and EU could impact Canada's ability to leverage the economies of scale from the global 3800 MHz ecosystem. In particular:
a) would the difference in technical rules (such as out-of-band-emission (OOBE) power limits) result in two distinct region-specific equipment ecosystems
b) which equipment ecosystem would be more suitable in the Canadian environment (noting that Canada has, for the most part, aligned with the U.S. on low- and high-band spectrum for 5G but in the mid-band, Canada is more aligned with the EU in the 3500 MHz band (3450-3650 MHz)) and specifically, whether Canada should generally align its technical rules with the U.S. or the EU in the 3800 MHz band

In providing comments, respondents are requested to include supporting arguments and rationale.

11. As discussed earlier, the RABC recommends that ISED align with the 3800 MHz U.S. band plan (which extends from 3700-4000 MHz) and re-align the 3500 MHz portion to have the band defined as 3450-3700 MHz. This will enable Canada to benefit significantly from both the U.S. and EU equipment ecosystems. In fact, noting that the EU ecosystem extends from 3400-3800 MHz, the RABC also recommends that the Department consider extending the lower limit down to 3400 MHz at the earliest opportunity.

12. Further investigation will be needed as we are dealing with differences in the technical rules for the U.S. in the range 3700-3980 MHz and with the EU rules for 3400-3800 MHz. It is not desirable to have different equipment specifically needed for Canada for these two bands as would be the case if ISED's technical rules were more stringent than the already existing EU and U.S. rules. The RABC recommends that ISED create one Radio Standards Specification (RSS) for flexible use equipment in the 3500 MHz and 3800 MHz bands without technical rules more stringent than the already existing EU and U.S. rules.

Q4
ISED is seeking comments on the proposal to add a primary mobile service, except aeronautical mobile, allocation in the 3700-4000 MHz band to the CTFA and the specific changes shown in annex B.

In providing comments, respondents are requested to include supporting arguments and rationale.

13. The RABC supports the Department's proposal to add a primary allocation for mobile service, except aeronautical mobile, in the 3700-4000 MHz band. The RABC agrees with the proposed changes to the Canadian Table of Frequency Allocations (CTFA) as given in Annex B of the Consultation allowing the introduction of mobile services on a primary basis in the 3700-4000 MHz band.

14. As outlined in the Consultation document, spectrum is a critical resource for wireless carriers, and additional spectrum in mid-range frequency bands, which provide both coverage and capacity, is required to meet ever-growing demand. The RABC also notes that other jurisdictions, notably the U.S, the EU, Japan and the United Kingdom (UK) have taken steps to allow flexible use in all or parts of the 3700-4200 MHz band. These large markets will ensure availability of equipment in Canada and also provide export opportunity for Canadian equipment vendors.

15. In the past 40 years, many applications in the fixed-satellite service (FSS) have migrated from the 3700-4200 MHz band (C-band) to higher frequency bands (Ku and Ka-bands), and new services have been established in these higher-frequency bands. This usage of higher-frequency bands provides an opportunity to repurpose much of the spectrum in the 3700-4200 MHz band to help address the anticipated demand for mid-band TDD spectrum to support the deployment of new 5G technologies.

16. That said, C-band FSS remains a critical part of Canada's telecommunication infrastructure, providing essential communications in remote areas, collection and distribution of some broadcast signals over the entire country, delivery of broadband services and communications for sensitive government applications. Interference considerations preclude simultaneous, co-coverage and co-frequency use by C-band FSS and mobile (or flexible) use applications. Hence, some C-band spectrum will need to remain allocated for the FSS services listed in the previous sentence.

Q7
ISED is seeking comments on the proposal to implement a 20 MHz guard band between 3980- 4000 MHz to protect FSS operations in 4000-4200 MHz band from proposed flexible use operations in the 3700-3980 MHz band.

17. The FSS services that remain in the C-band will require protection from both in-band and out-of-band interference.

18. The RABC supports the use of a guard band, combined with other technical measures as part of a coordination framework, to ensure coexistence of terrestrial users with FSS earth stations near satellite dependent areas and at the very limited number of gateway locations where the entire 3700-4200 MHz band will continue to be used by the FSS even after the transition of the 3800 MHz band. These issues are discussed in more detail in the RABC responses to questions 48, 49 and 50.

19. FSS services using the upper 200 MHz portion of the C-band (4000-4200 MHz) not re-allocated to terrestrial services will require protection from out-of-band emissions (OOBE) of transmitters in the terrestrial portion of the band.[1] The RABC agrees that this is best achieved through the implementation of a suitable guard band, suitable OOBE limits on flexible use equipment and narrower pass band filter specifications for FSS earth station receivers. The RABC notes the record in the FCC proceeding[2] and recommends implementation of a 20 MHz guard band between 3980 – 4000 MHz to protect FSS operations in 4000 – 4200 MHz band from proposed flexible use operations in the 3700-3980 MHz band.

20. Even with a 20 MHz guard band and an appropriate PFD limit on flexible use, front-end filters on the receive FSS earth stations will be required to avoid interference from the main emissions of nearby terrestrial services transmitters.

21. The RABC notes that for many years WBS in 3650-3700 MHz (operating under SRSP-303.65 rules limiting maximum EIRP to 1W/MHz or, in low population areas, 60W/MHz) and FSS in 3700-4200 MHz have been operating without any guard band and that ISED did not highlight any record of interference issues in its consultation document. The RABC recognizes, however, that a 20 MHz guard band is appropriate for shared licensing flexible

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[1] See response to Questions 14 and 48.

[2] FCC Report and Order and Order of Proposed Modification, FCC 20-22. https://docs.fcc.gov/public/attachments/FCC-20-22A1.pdf

use equipment operating in 3900-3980 MHz at the type of power levels defined in SRSP-520[3].

Q9
ISED is seeking comments on the future demand for C-band in rural and remote areas such as the North, including the following:
a) the trend towards using higher frequencies by FSS operations to provide broadband connectivity
b) the ability of using higher frequencies to replace current C-band capacity and the potential timelines
c) the possibility of a trend towards using 4000-4200 MHz in combination with other connectivity options (e.g. higher frequencies satellites or wireline solutions) and when it would be expected to be available for satellite-dependent areas

22. The RABC notes that there is a significant difference in current C-band FSS usage between Canada and the United States. In the U.S., the bulk of C-band FSS capacity is dedicated to the collection and distribution of signals for the broadcast industry, whereas many, but not all, domestic broadcasters in Canada transitioned to Ku-band decades ago, as confirmed by Hunter Communications.[4] In Canada, the bulk of C-band capacity is dedicated to broadband trunking. Still, many Canadian cable head-ends and IPTV distributors rely on foreign satellites to receive authorized U.S. and other international channels that will be migrating to 4000-4200 MHz as part of the U.S. transition.

23. In Canada, a large share of C-band capacity is used for broadband trunking between the telecommunications backbone in southern Canada and remote communities to enable broadband service offerings. These services include Internet access, voice, video conferencing, and localized mobile services. To meet their future bandwidth demand, remote and northern communities and ISP's are contemplating next-generation satellite platforms such as medium-earth orbit (MEO) and low-earth orbit (LEO) constellations that use higher frequency bands. However, these new platforms need to be available in order for services to migrate from C-band. Absent such platforms having suitable coverage and availability, some broadband services currently on C-band (and accounting for growth in such services) may be required to be accommodated within C-band which is consistent with ISED's proposal not to repurpose any C-band in satellite dependent areas at this time. The RABC recommends that the Department review the treatment of C-band spectrum in satellite-dependent areas in the future after the deployment of next-generation MEO and LEO satellite constellations.

Question 9 a)

24. As is the case for terrestrial telecommunications, FSS connectivity services have evolved from being narrowband telephony-based to broadband IP-data-based. Broadcast services have transitioned to digital signals, which has allowed source compression. On the other hand, broadcast services have greatly increased in number, and the format has changed from

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[3] ISED's SRSP-303.65 specifies a maximum EIRP density of 1W/MHz and 60W/1MHz (rural) for fixed or base WBS stations, whereas SRSP-520 specifies a maximum base station EIRP of 68 dBm/5 MHz – which is equivalent to ~1200W/MHz.

[4] Hunter Communications, Hunter Communications to provide Satellite Space Segment Services to CBC/Radio-Canada; 22 February 2018, https://huntercomm.net/hunter-communications-to-provide-satellite-space-segment-services-to-cbc-radio-canada/.

standard definition to high definition and ultra-high definition. The net result has been an increase in spectrum demand over the past 20 years. Overall, bandwidth requirements for all services have increased, making necessary the use of higher-frequency bands (Ku- and Ka-bands) that use spot beams, have broader bandwidth frequency allocations and/or simply more spectrum available. High throughput satellites (HTS) have been introduced in geostationary (GEO) and MEO to address the broadband requirements of users and future LEO constellations, now under development, all rely on the use of higher frequency bands to drive efficient broadband delivery service. This was noted by Telesat in 2016 CRTC Telecom Decision 2016-27, where Telesat stated that "Ka-band and Ku-band can be used as substitutes for C-band FSS", and that, "the best way to deliver broadband Internet services to remote communities is to expand the capacity of Ka-band HTS".[5] However, only two current generation HTS presently cover the Canadian far North. While HTS is often used to serve individual customer premises, C-band remains the main connectivity option for community-based services.

25. There are also equipment benefits to be gained from the usage of higher bands for FSS, notably smaller antenna diameters on both satellites and earth stations, lower power amplifier requirements and more compact and lighter equipment components. These are important considerations where equipment may only be transported to remote areas by air or annual sealift. That said, lower frequencies, such as C-band remain the most resilient to atmospheric attenuation and therefore enjoy the highest level of availability, which dictates its use for certain services, as further discussed in the RABC response to Question 9 b).

Question 9 b)

26. Some FSS services currently in the C-band can be expected to be implemented in or transitioned to higher frequency bands. Transition plans will need to be carefully crafted to ensure continuity of services and to enable sufficient time for shipping and installation of new higher frequency band equipment, especially in remote areas. New satellites in higher frequency bands may also be required in addition to existing higher frequency band satellites.

27. Notwithstanding the benefits, there are also disadvantages with the higher-frequency bands relative to the C-band. Most important is the higher degree of atmospheric attenuation, which could result in outages during periods of rain or other precipitation. This can be partly mitigated in some cases by incorporating additional margin in the link design and implementation. Atmospheric attenuation means that some services, such as critical defence, air traffic control, monitoring and control of critical infrastructure, and emergency services, where extremely high availability is required, may not easily transition to the higher bands. Any of these remaining services will need to be protected in a smaller portion of the 3700-4200 MHz band. Ultimately, increased use of higher frequency spectrum bands cannot completely replace C-band in all regions.

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[5] CRTC, Review of Telesat Canada's price ceiling for C-band fixed satellite services, para 16 & 19, https://crtc.gc.ca/eng/archive/2016/2016-127.htm.

28. C-band satellite links are particularly valuable for Canada, a very large and Northern country, to reach all remote citizens across the country in a reliable and efficient manner. In the Northern regions, although Ku and Ka band is used today to provide broadcasting and broadband services it is important to note that for the time being, C-band satellite links remain the anchor platform for provision of these services.

29. One way to accommodate existing services with reduced C-band FSS spectrum availability (as may be required in non-satellite-dependant areas) would be to re-pack them on multiple satellites, by using additional C-band satellites at more orbital locations (to the extent such orbital positions are available) to increase spatial re-use of the reduced amount of spectrum. This may require satellite operators to build and launch additional C-band satellites beyond the available and newly planned capacity from the U.S. transition plan. Earth station operators may need to re-point their antennas (if assigned to a new satellite) and additionally may need to install new filters if the earth station is located in areas where flexible use is deployed.

30. As noted in the response to Question 9a) above, some existing satellite services in the C-band can be expected to transition to satellite systems (whether in GEO, MEO or LEO) in higher frequency bands, subject to factors such as: cost, availability of satellite capacity; suitable coverage; service availability; latency; spot-beam versus broad-beam coverage; and the financial and logistical challenges of replacing earth station equipment in rural and remote areas.

Question 9 c)

31. Whether rural and remote areas might transition to wireline transit will depend on whether there is sufficient density of population and/or government support to make a business case. It is likely, though, that many Northern and remote locations will rely on satellites for the foreseeable future for both direct connectivity and for trunking and backhaul. It may be possible to re-pack existing C-band services connecting such locations into a smaller amount of spectrum by increasing frequency re-use on more C-band satellites (as mentioned in response to Question 9 b), above). Some of these services could also be transitioned to higher frequency bands, subject to the availability of satellite capacity, ground equipment, and the other factors mentioned above.

32. It should also be noted that some rural and remote tiers cover very large areas, with significant variations in population density within such areas. It is conceivable that some towns within the tier area could deploy terrestrial 5G solutions in the 3800 MHz band displacing C-band FSS services to the upper portion of the C-band, while the rest of the tier would continue relying on satellite C-band FSS services across 3700-4200 MHz.

33. Therefore, the RABC believes that to ensure continued service in truly satellite-dependent areas, at least for the foreseeable future, a combination of measures will be required: transition of some services to higher frequency FSS bands, transition to wireline services

where feasible, and preservation of some FSS services in all or a portion of the 3700-4200 MHz band.

Q10
In addition to capacity requirements, ISED is seeking comments on other issues that should be considered in maintaining broadband connectivity in satellite-dependent areas.
In providing comments, respondents are requested to include supporting arguments and rationale.

34. The RABC believes that satellite-dependent areas deserve, to the extent possible, the availability and quality of broadband services that exist in the rest of Canada. Experience has shown that capacity requirements will continue to grow in all regions of Canada, including in remote satellite-dependent communities as demand for Internet capacity increases and as new applications arise. Careful management and consideration of the logistics of transition, where applicable, from C-band, the availability of sufficient capacity to serve current and future demand, and adequate protection from interference of those services that remain in C-band will all be required.

35. Satellite links across multiple bands also have a role in providing critical redundancy, particularly in rural and remote areas where wireline or other terrestrial services provide connectivity, but where the level of redundancy is lower than in more densely-populated areas, and where timelines to access failed equipment and restore terrestrial service may be long. This challenge has been demonstrated in remote communities in the Territories where equipment failure or fibre cuts resulted in long outages for the incumbent terrestrial wireline provider when satellite backup facilities were not available across the communities.

Q13
ISED is seeking comments on:
a) establishing unpaired blocks of 10 MHz for the 3650-3700 MHz band
b) establishing unpaired blocks of 10 MHz for the 3700-3980 MHz band

In providing comments, respondents are requested to include supporting rationale and arguments.

36. From a technical point of view, the 3GPP 5G NR standard for Bands n77/n78 is defined to accommodate a wide range of block sizes (from 10 MHz to 100 MHz). It is noted that to fully benefit from 5G NR technology, each operator would need on the order of 100 MHz of spectrum, preferably contiguous. The block size should be flexible enough to allow the aggregation of spectrum to create as large a block size as possible. It is noted that the U.S. band plan for 3700 - 3980 MHz notionally includes two blocks of 100 MHz and one block of 80 MHz to align with clearing timelines. However, the spectrum is simply auctioned in 20 MHz TDD blocks. In Canada, the 3500 MHz band is to be auctioned as unpaired blocks of 10 MHz. The RABC recommends that as proposed ISED establish unpaired blocks of 10 MHz for 3650-3700 MHz and 3700-3980 MHz to maximize optionality for (exclusive and shared) flexible use licensees. However, as stated in response to question 2 a) above, the RABC encourages the Department to consider how it could enable all operators to deploy contiguous blocks to deliver more efficient services.

Q14
Subsequent to changes to the spectrum utilization described in section 7 and recognizing the need to change the current WBS licensing model, ISED is seeking comments on its proposal to displace the existing WBS licensees and designate 80 MHz of spectrum available for the development of a new shared licensing process in the 3900-3980 MHz band as described in Option 2. Specifically, ISED is seeking comments on:
a) the amount of spectrum proposed (80 MHz) under a shared spectrum licensing process

Preliminary comments on a future shared spectrum licensing process are being sought in section 9.1.4 below.

37. Demand for spectrum is growing significantly for all services, including for WBS. Shared spectrum seems promising to serve the demands of different spectrum users to offer more wireless applications. Network capacity may need to be increased to meet the growing demands of end users, despite expected use of newer more spectrally efficient technologies as proposed by RABC in this document. Spectrum sharing could bring benefits to businesses and consumers and may optimize the use of spectrum. The RABC recommends that ISED carefully consider the options to meet the growing demand for spectrum.

38. ISED considers various possibilities for WBS in the consultation: that WBS licensees remain in 3650-3700 MHz (Option #1); that licensees move and be upsized to 3900-3980 MHz (Option #2 and proposed by ISED), or that these services could be relocated to licence-exempt bands such as parts of the 5 GHz, television whitespace bands, or potentially the 6 GHz band. From a technical and equipment ecosystem point of view, the RABC would like to comment on these and provide other options to help the Department in its final decision whether to relocate WBS, and if so, how.

39. If the Department decides as it has proposed to relocate WBS to a different spectrum block, the RABC recommends that the Department replace WBS with equivalent or better shared spectrum aligned with 3GPP based technologies to take advantage of the large off the shelf equipment ecosystem, as well as to facilitate coordination with other users and the achievement of targeted speeds of at least 50/10 Mbps for Canadian homes and businesses. If the Department decides to keep WBS at 3650-3700 MHz, gradual migration to 3GPP based technologies should be encouraged for the same reasons of facilitating coordination with neighboring users and achieving target speeds.

40. For example, with LTE equipment, a 20 MHz TDD channel throughput using 64QAM modulation can reach 60-80Mbps depending on channel coding and radio frame configured, using two MIMO layers. In uplink (UL), a 16 QAM, 20 MHz, can produce less than 10Mbps. As such a single user can get 50 Mbps downlink but cannot get 10 Mbps in UL. Similarly, by way of examples, with 5G and two MIMO layers, spectral efficiency improves by approximately +30%[6] based on improved spectral usage, lean carrier, and MIMO optimisation. With 5G and massive MIMO, spectral efficiency increases by a further +470%[7]

[6] Antti Toskala / Harri Holma / Takehiro Nakamura, 5G Technology: 3GPP New Radio (WILEY), February 2020, p.286

[7] Ibid

approximately when leveraging multiple transmission streams. In other words, n77 far exceeds the CRTC target downlink speeds with a 20 MHz channel such that the downlink gains could be proportioned to capacity to readily achieve the 50 Mbps target rate. Uplink speeds increase significantly when leveraging massive MIMO and advanced beam management, achieving similar increases in spectral efficiency[8] to readily achieve the 10 Mbps target rate in a rural environment.

41. In an area where two WBS operators share the spectrum, if one operator uses 40 MHz of an 80 MHz allocation, the other operator could use a different 40 MHz channel.

42. While the RABC is not providing a study at this time, it is clear that allocating 80 MHz as opposed to 50 MHz to shared licensing will allow more underserved Canadians to meet the 50/10 Mbps service targets defined by the CRTC for broadband service wherever WISPs are the primary terrestrial broadband option and deploy advanced technology. 80 MHz instead of 50 MHz would also better support co-coverage shared licensing. More spectrum could allow more operators to offer service in the same area and collectively serve broadband to more Canadians. Within certain areas in the country, WBS is fully occupied[9]. In certain busy areas of Ontario and Alberta operators have to deploy their service using as little as 10 MHz. A 10 MHz TDD channel is hard pressed to support the CRTC broadband service targets without advanced technologies (such as 5G as outlined in the example given in paragraph 40).

43. In addition, the RABC recognises that relocating WBS to a band edge as proposed by ISED would facilitate more efficient deployment of exclusively licensed systems. If Option #2 were implemented by ISED, there would be a 450 MHz contiguous block of spectrum to support Mobile Network Operators (MNOs) in the band 3450-3900 MHz and WISPs in the band 3900-3980 MHz. By removing the current 3650-3700 allocation to WBS, co-existence with new 3500 MHz and 3800 MHz flexible use systems would be dramatically simplified by removing legacy technologies from in between the two bands which may prove difficult to coordinate with. However, there would still be the need for WBS in 3900-3980 MHz to use technology that would facilitate coexistence with flexible use below 3900 MHz (such as TDD synchronization).

44. <u>Option #1 (WBS remaining at 3650-3700 MHz)</u>, ISED considers coordination between WBS systems and flexible usage without displacing the existing systems. The RABC supports the proposal that even if WBS remains at 3650-3700 MHz, WBS would be “subject to new technical rules that would also align with the proposed block sizes and increase the efficiency of the band for flexible use”. Option #1 requires WBS systems operating in 3650-3700 to have an improved coordination with adjacent channels operating in 3500 MHz band or 3800 MHz band.

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[8] Ibid, p.290

[9] In many areas across Ontario and Alberta, there exist multiple operators. As of September 2020, there were 65 WBS licensees across Canada with over 5000 sectors.

Pros:

- Full 280 MHz of 3800 MHz spectrum band available without the dependency that would be associated with a WBS transition.
- No impact on legacy services currently delivered. As proposed by ISED, current WBS systems operating in the band would have to evolve to 3GPP based technologies to facilitate coordination with flexible systems in 3500 MHz and 3800 MHz bands.
- Device ecosystem synergies with CBRS, LTE and 5G bands.

Cons:

- Risk of interference from WBS systems to flexible-use systems in adjacent blocks, above and below the WBS band. As such, coordination may be required between licensees in the 3500 MHz and 3800 MHz bands and the WBS band to ensure co-existence (e.g., as already provided for in SRSP-520).
- Breaks up an otherwise large contiguous block of exclusively licensed spectrum.

45. <u>Option #2 (ISED proposal) – WBS relocated to 3900-3980 MHz</u>: The increase in shared spectrum from 50 MHz to 80 MHz helps one or more operators in an area to better meet the 50/10 targets. The 3650-3700 MHz licensed block would not be available for flexible usage before completion of a WBS transition as late as 2025. This option reduces the amount of valuable spectrum available for exclusive licensing (to 250 MHz instead of 280 MHz). The option results in access to 3650-3700 MHz for flexible use by 2025 by which time WBS licensees can acquire n77 equipment. With this option, coordination between new WBS systems and adjacent channels operated by flexible usage systems will still be required at the 3900 MHz edge.

Pros:

- Provides 80 MHz of shared licensing spectrum which allows for larger bandwidth than current WBS and better accommodate multiple operators within shared based spectrum in the same geographical area.
- This option benefits from the n77 ecosystem that aligns with the FCC rules.
- Partially removes the risk of interference from WBS being located in middle of flexible use spectrum.

Cons:

- Less licensed spectrum for flexible usage in 3800 MHz (250 MHz instead of 280 MHz).
- Requires migration of WBS ecosystem to support the new band and new equipment required to operate in 3900-3980 MHz. Device ecosystem limited to 5G n77. No compatibility between equipment currently operating at 3650-3700 MHz and future equipment operating at 3900-3980 MHz.
- Requires full transition of WBS 3650-3700 MHz spectrum before any exclusively licensed flexible usage system can be deployed in 3650-3700 MHz.

46. <u>Option #3 – WBS relocated to the 6 GHz band</u>: The last scenario suggested by ISED is the transition of WBS to the 6 GHz band. That scenario requires 6 GHz regulations to evolve to support WBS as part of that spectrum. This is an ideal scenario for flexible usage because the

end result, regardless of the time required to re-allocate WBS to 6 GHz, would provide the most spectrum available for flexible usage. However, the RABC recognizes that this option would be a difficult one for WBS as 6 GHz spectrum policy is not yet defined, radio characteristics between 6 GHz and 3.8 GHz are different, and an equipment ecosystem is not yet developed.

47. The RABC would like to suggest two other alternative proposals to facilitate the creation of a single flexible-use block of spectrum that would ease the deployment of 5G in the 3500 MHz and 3800 MHz bands.

48. RABC Option #4 – WBS relocated to below the lower edge of the 3500 MHz flexible usage band (3400-3450 MHz): This RABC proposed scenario enables the creation of a contiguous flexible-use block across both the 3500 and 3800 MHz bands. WBS systems deployed within this band would still be required to be coordinated with channels operating in the lower part of the 3500 MHz flexible usage band. Compared to the ISED proposed Option #2, this scenario enables a smoother migration of the WBS ecosystem, since some of the existing WBS equipment already has the ability to switch, via software, operating bands from 3650-3700 MHz to 3400-3450 MHz and WBS systems moving to 3400-3450 MHz would benefit from a mature LTE (E-UTRA) B42 or 5G n78 ecosystem. The RABC recognizes that this option does not provide the expansion of WBS spectrum to support increased bandwidth for end users that ISED's proposed Option #2 does.

Pros:

- Provides 50 MHz of shared licensing spectrum.
- Partially removes the risk of interference from WBS being located in middle of flexible use spectrum.
- Allows the creation of a full 3450-3980 MHz band aligning with European ecosystem for 3500 MHz band (3450-3700 MHz) and with FCC for 3800 MHz band (3700-3980MHz).
- Allows ISED to accelerate clearing of the current WBS band as the WBS relocation would be into largely fallow spectrum and not be gated by an FSS relocation.
- Enables a portion of the current WBS ecosystem to transition through software from 3650-3700 MHz to 3400-3450 MHz. (Older generation equipment does not provide that capability.)
- Provides device ecosystem synergies with LTE and 5G (but not CBRS).

Cons:

- Compromises potential future spectrum licensing in 3400-3450 MHz, supported by the current ECC ecosystem under deployment.
- Requires coordination with existing Radiolocation users.[10]

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[10] SLPB-001-19 (Decision on Revisions to the 3500 MHz Band to Accommodate Flexible Use and Preliminary Decisions on Changes to the 3800 MHz Band) published June 2019: Para 55: "As sharing technologies continue to evolve, ISED is exploring other mechanisms for optimizing spectrum use in the 3400-3450 MHz band. Many countries are including this band in their plans for 5G flexible use, and equipment is being developed to support this frequency range. However, while radiolocation is intermittent in nature, this interference may be more pronounced in areas close to large ports, airports, the border, and other areas where radars are located. Further work is required to address the complexities of potential interference issues with radiolocation services operating in Canada, along the Canada-United States border and in Canadian coastal waters."

49. The RABC notes that while the 3400-3450 MHz band is under review for future spectrum licensing, it remains largely fallow and could be used on an interim basis by ISED to ease the migration of WBS licensees. That is, it could be used by WBS licensees who are to be displaced by future exclusive flexible use licensees while relieving pressure on the satellite industry to complete its vacation of the portion of the 3800 MHz band proposed to be reallocated to flexible use.

50. <u>RABC Option #5 – WBS relocated to a portion of 4900-4990 MHz</u>: WBS reallocation in the 4940-4990 MHz for Fixed use could operate in coordination with the Fixed allocation for Public Safety. Public Safety use in the 4.9 GHz band is limited today. The CTFA allocation of 4900-4990 MHz already includes MOBILE and FIXED as primary. The Spectrum Utilization Policy (SP) 1-20 GHz reserves the band for the Government of Canada. The band 4900-4940 MHz has no other primary service allocation beyond the MOBILE and FIXED allocation. WBS systems operating in that band would benefit from the 5G n79 ecosystem.

Pros:

- Eliminates the risk of interference from WBS located in middle of flexible usage spectrum.
- Allows the potential expansion to 90 MHz of shared spectrum in 4900-4990 MHz band aligning with the Japan/China ecosystem for n79 ecosystem (4400-5000 MHz) and with the U.S. 4.9 GHz band (4940-4990 MHz) plan.
- Allows ISED to propose a flexible transition timeline for WBS to be reallocated outside the band and into a nearly unencumbered band for Fixed services.
- Leverages the existing RSS-111 technical standard that enables Fixed Services equipment development.
- Leverages existing coexistence and U.S. coordination guideline in the SP 4940 MHz that provides operational certainty.
- Enables potentially more exclusive flexible use spectrum in 3800 MHz (330 MHz instead of 250 MHz).

Cons:

- Requires migration of WBS ecosystem to support the new band, along with new equipment to operate in 4900-4990 MHz band.
- Requires full transition of WBS 3650-3700 MHz spectrum before any licensed flexible usage system can be deployed in the WBS band.
- Requires additional standardization to enable the 4900-4940 MHz expanded portion of the band.

51. In options 2, 3 and 5, ISED could consider use of 3400-3450 MHz by WBS on a temporary basis until moved to its final location.

Q19
ISED is seeking preliminary comments on the future spectrum licensing process for 3900- 3980 MHz, including the following:
a) what type of applications are envisioned for this spectrum

b) what type of shared licensing process ISED should consider (e.g. database approach, licensee to licensee coordination)
c) what additional measures ISED should consider employing to manage access to the band in high demand areas, such as major metropolitan centres
d) what technical restrictions should be considered (e.g. technical rules similar to adjacent 3500 MHz flexible use band with reduced power levels, a guard band between new flexible use systems below 3900 MHz, shared use above 3900 MHz, etc.)

In providing comments, respondents are requested to include supporting rationale and arguments.

Question 19 a)

52. The RABC recognizes that flexible use could be licensed for shared access to meet the needs of mobile network operators (fixed and mobile networks), wireless Internet service providers (fixed wireless access networks) and vertical industries (private broadband networks on enterprise campuses or in remote/unserved locations).

Question 19 b)

53. With competing operators, multiple restrictions and measures will be required as compared to the current WBS rules. The ISED Spectrum Management System (SMS) maintains technical data about sectors, however it does not include all of the data elements required for coordination. For example, the SMS does not include contact information for individuals responsible for processing network coordination requests at the operators. In addition, many operators have different brand names than licensee names, which makes it difficult to identify the correct operator to contact. Currently, the ISED process for coordination does not have an escalation path that operators can use if they do not reach agreement to share the band with another operator. Licensing could be improved by strict rules and perhaps following the fixed microwave links process, which includes a coordination action (via the Frequency Coordination System Association (FCSA) now), to ensure no or minimum interference. Ofcom has a similar process for Shared Access Radio Service. The RABC does not recommend that ISED implement a dynamic real time spectrum sharing mechanism in the relocated WBS band.

Question 19 c)

54. For the proposed 3900-3980 MHz band, high demand areas such as major metropolitan centers could be licensed based on the application of the user using grid cells to licence the smallest area required in order to maximize the number of licensees that can access shared spectrum. For example, low power licenses could be granted to Industrial and Enterprise users while medium power licenses could be granted to Wireless Internet Service Providers or wide area private networks.

55. To create opportunities for more efficient spectrum use, ISED may wish to further study the use of devices in an extended shared spectrum band of 3980-4195 MHz,[11] fully considering

[11] Ofcom has studied and adopted such an approach, which includes the use of a 5 MHz guard band adjacent to radionavigation frequencies in 4200-4400 MHz.

the framework studied and adopted by Ofcom[12], including the small radius area and site licensing options and use of a 5 MHz guard band adjacent to radionavigation frequencies in 4200-4400 MHz.

56. In such a framework, the RABC recommends that ISED study low levels of EIRP emissions for applications in high demand areas such as major metropolitan centres, and study medium levels of EIRP emissions for applications in rural areas and communities. The Department would need to establish the areas it deems appropriate for Canada's broad set of industries and at specific emission levels that would allow these applications to coexist with FSS and radionavigation services within the same area.

Question 19 d)

57. To reduce interference into adjacent exclusively licensed bands, preference should be given to operators deploying 3GPP compatible equipment that will enable TDD frame synchronization that can minimize interference from one operator to another. As mentioned above, shared licences could have power restrictions based on the application being deployed. For example, lower power licences for Industrial and Enterprise users, medium power in urban areas, and high power in rural and remote areas.

Q21

ISED is seeking comments on whether the Tier 4 service areas identified for exemption of certain provisions in GL-10 for mmWave bands as listed in annex E would be appropriate to apply for FSS operations in the 3700-4200 MHz band. ISED invites alternative proposals for areas that would be considered satellite-dependent (e.g. based on Tier 5 categories).

58. The RABC does not believe that the Tier 4 service areas identified for exemption of certain provisions in GL-10 for mmWave bands as listed in annex E are the correct areas to be classified as satellite-dependent. Whether areas should remain exclusively for FSS services, or whether a segment of the band should be reallocated to the mobile service as in the more populated areas of the country are decisions that depend on many factors as described below but they do not fall on simple Tier 4 or Tier 5 boundaries.

59. If Northern and remote communities, at the licensing tier level, remain FSS exclusive across 3700-4200 MHz, there would not be any sharing considerations with the flexible use services, except at tier boundaries, where on one side would be mobile and on the other FSS. The sharing feasibility would depend on geographical considerations and the required separation distance between transmitting mobile stations and receiving FSS earth stations.

60. Communities that are currently satellite-dependent for their backhaul to the global telecommunications network may still wish to deploy 5G technology, at least in a portion of their geographical area and a segment of the 3800 MHz band.

[12] *Enabling opportunities for innovation: Shared access to spectrum supporting mobile technology*, Dec 2018 https://www.ofcom.org.uk/__data/assets/pdf_file/0022/130747/Enabling-opportunities-for-innovation.pdf

61. It may not be essential that all communities that are currently satellite-dependent for their backhaul to the global telecommunications network remain C-band satellite dependent across the entire 500 MHz, if sufficient capacity can be made available in other bands and/or on other satellites. So, there is an opportunity to band segment between flexible use and FSS, even in these communities if done correctly. FSS operators could transition their operations in C-band into a smaller bandwidth across the entire country, but this would place a larger transition burden on satellite stakeholders.

62. Regardless of the decision in respect to this question, the Department is urged to take all precautions to ensure continued service in these communities and consider the complexity to migrate services so that the North may also benefit from new wireless services being proposed in the 3800 MHz band.

63. RABC agrees in principle that remote communities be considered satellite dependent. However, a portion of the Tier 4 areas contained in Annex E are currently well served by broadband and wireless communications service providers. As an alternative proposal to using the Tier 4 service areas listed in Annex E of the consultation, the Department should adopt a principle which excludes areas where there is currently mobile or fixed terrestrial coverage from the definition of a satellite-dependent area, taking great care however, to distinguish where a community requires a C-band satellite backhaul, e.g., all 25 communities in Nunavut. Even if the Department were to consider Tier 5 areas to designate satellite-dependent areas, there will remain the issue of communities that have terrestrial coverage surrounded by satellite-dependent areas. The Department should be able to make effective, more refined coverage area estimates based on the data for all terrestrial operators currently available in the SMS database.

Q24
ISED is seeking comments on its proposed date of December 2023 as the Canadian FSS transition deadline.

64. To ensure continuity of satellite services, in particular involving multi-site networks, dual-illumination will be required to manage the carrier moves from one transponder to another, changes in polarization and/or moves to other satellites. This is a multi-step process involving the interdependent migration of services to new transponders on the same satellite and/or on other satellites. In many cases, 'swing space' spectrum is required to temporarily accommodate and ensure continuity for services that will transition elsewhere in a later stage of the process.[13] Such "swing space" may become scarce as satellite operators attempt to complete a transition in Canada and the U.S. by 2023. C-band earth stations located within the coverage area of, or in proximity to, flexible use transmitters in the 3800 MHz band will need to have RF filters installed to attenuate interference. This would require a physical visit by one or two experienced technicians, depending on the size of the earth station and its location, to effect the required changes and to install the required filters. C-band FSS earth

[13] Moving carriers on a satellite can be like solving a Rubik's Cube. Carriers often need to be moved multiple times: carrier A is moved to a new spot so that carrier B can be moved into carrier A's spot, which allows carrier C to move, etc.

stations are located across Canada and many in very remote locations (i.e., in proposed satellite-dependent areas) are accessible only by private charter. Critical to any clearing plan will be the need to address timelines based on the time of year that sites are accessible (in particular any affected far northern sites), and the interdependence of the moves.

65. ISED refers to the FCC process, a process initiated in 2017, but does not mention the foundation of the FCC's decision: the final deadline for clearing the lower 300 MHz of C-band is December 2025 and the FCC recognized the cost and complexity of accelerating the clearing process. The FCC is offering 'accelerated relocation payments' to satellite providers in order to potentially achieve a nationwide clearing by the end of 2023. ISED is proposing to synchronize with the accelerated U.S. clearing date, but with a later start date, presumably under the assumption that the U.S. clearing process will facilitate a streamlined Canadian transition.

66. There are moves taking place as part of the U.S. transition that will impact Canada regardless of ISED's plans. The U.S. satellite operators will be optimizing their broadcasting distribution transmissions (migrating existing channels to 4000-4200 MHz); Canadian earth stations receiving those U.S. content signals may need to repoint and will likely need to retune their operations staying on C-band or migrate to terrestrial fibre connections as a consequence of the U.S. process along the U.S. timelines. These Canadian earth stations that are near the U.S. border would also need to add filters to protect themselves from U.S. 5G OOBE. All of this is required in the future even if Canada does not transition the 3800 MHz band as a direct consequence of the U.S. transition.

67. Furthermore, as U.S. satellite operators reconfigure their satellite transponders to optimize broadcasting distribution into 4000-4200 MHz, they may also reconfigure their data services targeting Canadian earth stations. This would also entail the reconfiguration of earth stations, especially remote and northern Canadian earth stations relying on data connectivity, independent of any Canada-specific decision resulting from this consultation.

Q43
ISED is seeking comments on the proposal to rely on technical limits and coordination procedures rather than mandate specific technology solutions (e.g. TDD synchronization between systems) to address interference issues between TDD flexible use systems in the 3650-3980 MHz band.

68. TDD synchronization provides coexistence benefits that should be considered. ISED is recommended not to mandate but to encourage parties to explore synchronization of TDD operations to minimize interference between adjacent channels in the same service area and between co-channel deployments in adjacent service areas. This would be aligned with C-band operations in the U.S., where MNOs indicate that synchronization of two different carriers can be implemented using traditional 3GPP methods based on an absolute timing reference. An approach which does not mandate specific technology solutions would also be consistent with the coordination/coexistence rules established for the 3500 MHz band in SRSP-520 (and supported by the RSS-192 standard). However, the RABC recommends that

ISED mandate requirements to achieve optimal spectrum utilization as discussed in the following paragraph.

69. RABC supports ISED's approach to allow non-mandated operator-led coordination to limit potential interference. RABC does, however, encourage ISED to establish a process to ensure timely coordination and preventing a party to unduly delay such coordination (such as, but not limited to, response to coordination inquiry). RABC also offers to be the forum to develop a common framework for TDD frame and pattern synchronization. This approach would allow for an industry-led solution, flexible enough to be updated for future border coordination requirements with U.S. operators, while providing certainty for flexible use deployments everywhere across the country. Along these lines, although RABC recognizes ISED's long history of being technology neutral, it is recommended that the Department mandate that technology used by all operators using the frequency range 3650-3980 MHz be capable of implementing TDD synchronization, as this is expected to avoid use of guard bands and, therefore, suboptimal use of spectrum.

Q44
ISED is seeking comments on whether any additional measures should be taken to limit potential interference issues between flexible use systems in the 3650-3980 MHz band.

In providing comments, respondents are requested to include supporting rationale and arguments.

70. An agreed-upon TDD synchronization framework is essential to maximizing the reuse of co-channel spectrum geographically. Without a common framework, large distances, in the order of 60-70 km between co-channel sites, will be required to achieve coexistence. An operator-led coordination approach will only be effective if all parties, from single-site operators to nation-wide service providers, align on a common methodology.

71. In addition, a coordination framework, with set timelines for correspondence between parties, will be required.

72. If a common, national TDD framework can be established, RABC believes that the technical standards set out in RSS-192 and SRSP-520 will be sufficient to limit potential harmful interference between operators in the 3650-3980 MHz band, in addition to standard industry design practices, such as antenna tilt and azimuth optimization.

Q45
ISED is seeking comments on whether specific technical measures should be adopted to address potential interference issues between flexible use systems and WBS systems until the displacement deadline.

a) For co-channel flexible use and WBS operations in the 3650-3700 MHz band, what specific measures may be needed to protect WBS? For example, should new flexible use stations be required to coordinate with WBS stations within a specified distance prior to deployment? Alternatively, should a technical parameter such as a power flux density (pfd) trigger for coordination measured at the WBS receive antenna be adopted? Are there other more appropriate measures that ISED should consider? Should multiple measures, such as a combination of distance and

pfd trigger for coordination, be adopted? How would these requirements impact the deployment of new flexible use stations?
b) For adjacent band flexible use systems, is there a need to adopt any additional measures, beyond what is currently specified in RSS-192 and SRSP-520, to further address coexistence between these flexible use and WBS systems? If so, what should they be? How many flexible use frequency blocks (or MHz) immediately adjacent to the 3650-3700MHz band could potentially affect WBS systems? How would these requirements impact the deployment of flexible use stations?

In providing comments, respondents are requested to include supporting rationale and arguments.

Question 45 a)

73. The requirements for coordination between flexible use systems that are co-channel in adjacent service areas are well defined in SRSP-520, Issue 1, and we propose that those guidelines apply to the operation of co-channel (new) flexible use systems and legacy WBS systems with the following additions:

74. Coordination cannot take place unless the legacy WBS and flexible use stations have entered their data in the ISED site database. Protection of WBS stations shall not apply without this and in any case shall expire upon completion of the WBS transition periods.

75. New flexible use stations shall have priority over legacy WBS in establishing new co-channel stations (i.e. 3650-3700 MHz) during the transition period. This clause is required to allow operators who may have purchased spectrum at auction in this portion of the band the ability to utilize their spectrum before the completion of the transition period.

76. Should a common TDD synchronization framework not be established, then a coordination distance of 70 km would be required for unsynchronized co-channel systems, although this is not recommended as it would lead to suboptimal use of spectrum.

Question 45 b)

77. The response to a) above is equally applicable. SRSP-520 and RSS-192 should apply.

78. Provided that a common TDD synchronization framework is established across the 3650-3980 MHz band, then the measures specified in RSS-192 and SRSP-520 should be sufficient to ensure coexistence between adjacent flexible use and WBS systems.

Q47

After the transition deadline, in all areas for flexible use in the 3450-3650 MHz band: ISED is seeking comments on its proposal that the current SRSP-520 coexistence requirements for flexible use operations in the 3450-3650 MHz band to protect FSS operations in the adjacent band 3700-4200 MHz be removed.

79. The RABC believes that the proposed introduction of flexible use in the 3800 MHz band will enable the Department to eventually eliminate co-existence requirements between flexible use operations in the 3450-3650 MHz band and FSS. Following completion of the transition, as proposed by ISED, protected FSS services in rural and remote areas and at the proposed consolidated gateway teleport locations are permitted to continue to receive in the lower

portion of the band just above 3700 MHz, but the 50 MHz separation combined with the limited number of FSS operations continuing to operate just above 3700 MHz may be sufficient to alleviate the conditions currently contained in SRSP-520. In the rest of Canada, FSS would operate above 4000 MHz and thus would be further protected by the resulting larger guard band. OOBE interference from flexible use operations in the 3450-3650 MHz bands is not anticipated in the upper portion of the band. RABC believes, however, that the current protection requirements in SRSP-520 must be maintained during the transition period and for FSS earth stations at those locations that continue to operate down to 3700 MHz.

Q48
For FSS earth stations licensed in the 4000-4200 MHz band and flexible use in the 3800 MHz band, in all areas: ISED is seeking comments on adjacent band coexistence measures, taking into account the coexistence measures adopted by the EU (i.e. a stringent OOBE limit) and the U.S. (i.e. a combination of guard band, a typical OOBE limit, pfd limits, and baseline minimum filter specifications for earth station operations) and the current Canadian requirements (i.e. a typical OOBE limit and coordination distance):
a) What are the benefits and technical limitations associated with the above coexistence measures?
b) Which set of coexistence measures above (i.e. EU, U.S., Canada) is preferred? If applicable, comments are sought on the values of the limits in relation to the supported measures.
c) Given the proposal in section 9.1 to displace WBS in 3650-3700 MHz and identify 3900-3980 MHz for shared use, are there any additional considerations that may impact the response to a) and b) above?
d) Which portion of the 3800 MHz band should the above measures be applied to in order to protect FSS in the 4000-4200 MHz band (i.e. how many frequency blocks or MHz)?

80. Under ISED's proposal to permit flexible use transmissions in the 3700-3980 MHz band, adequate adjacent band coexistence measures will be needed to protect FSS Earth stations operating in the 4000-4200 MHz band. Such measures would include adequate in-band power limits to prevent earth station receiver overload and out-of-band limitations (OOBE) assessed at satellite earth station receivers, as well as narrower pass band filter specifications for FSS earth station receivers.

Question 48 a)
81. The RABC acknowledges that a more stringent OOBE limit would lead to a more technically complex and potentially smaller ecosystem of base station products, but would allow for quicker deployment since coordination with earth station operators would not be required. The U.S. approach, although more complex, provides a clear set of guidelines for PFD limits and minimum earth station filtering requirements. The Canadian approach of combining an OOBE limit with a coordination distance is simplified on the front end if the coordination distance is exceeded, but otherwise is the same as the U.S. approach. Also, in the event of harmful interference, it falls short of laying out clear guidelines for how to achieve co-existence (e.g., does the flexible use operator reduce PFD or does the FSS earth station operator add filtering?).

Question 48 b)
82. The RABC recommends use of the U.S. model, since it allows for the most flexible access to hardware, but also sets out clear guidelines for achieving co-existence.

83. The RABC recommends the adoption of the FCC PFD limits of -124 dBW/m^2/MHz for OOBE levels from flexible use stations at the FSS Earth station receiver and -16 dBW/m^2/MHz for all flexible use emissions in the 3700-3980 MHz band to limit harmful earth station receiver interference and blocking respectively.

Question 48 c)

84. Should ISED decide to implement Option #2 for WBS, the proposed technical limits would not change regardless of whether ISED licenses certain 3900-3980 MHz licensees with modified parameters as noted in the RABC response to Question 19 c).

Question 48 d)

85. The PFD limit methodology (U.S. approach) or the EU OOBE limit could be applied to all operations within the 3650-3980 MHz band without the need to impose any specific restriction to any portion of the 3650-3980 MHz band. Flexible use systems with greater frequency separation away from 4000-4200 MHz may benefit from the lower OOBE of their specific radio hardware configuration to meet the target PFD limit.

Q49

ISED is seeking comments on what technical requirements should be imposed to ensure co- channel protection of FSS earth stations from flexible use systems, in the relevant scenarios and timeline as stated in sections 9.5 and 9.6. For example, could the pfd limit of -124 dBW/m2/MHz measured at the earth station antenna proposed by FCC above be used to protect co-channel FSS earth station? Alternatively, should other measures be adopted, such as a separation distance as described in section 7.3? Or should a combination of measures be adopted? If applicable, what are the specific values that should be adopted?

86. The RABC notes that co-channel interference could arise at FSS earth stations operating across the full 500 MHz band located at the protected gateways and to earth stations located near the borders between the satellite dependent areas and the adjacent areas where flexible use is permitted in the 3700-4000 MHz band.

87. While the FCC PFD limit could be applied to the desired signal emissions of flexible use stations, this would require detailed calculations for each new base station. Also, contrary to the case covered in response to Question 48 b), this situation deals with the desired signal emissions from flexible use stations into FSS receivers. The FCC adopted the -124 dBW/m^2/MHz limit on the basis that aggregate interference into an FSS receiver would be dominated by a single interferer contributing 40% of the aggregate power (i.e., using a 4-dB aggregation factor). For the situation where FSS gateways or earth stations in satellite-dependent areas are concerned, the aggregation at similar power levels from a number of flexible use stations could necessitate a stricter PFD limit if one were to be applied to individual flexible use stations. An appropriate PFD level that takes all aggregate emissions from flexible use base stations into account should be further determined in a technical study during the development of the associated SRSP.

88. Ultimately, the degree of protection depends upon the C/I at the earth station receiver. The C/I will be a function of several variables, including PFD due to the interferer at the earth station antenna, frequency offset and filtering, antenna discrimination, amount of interference from other flexible use transmitters, etc.

89. The PFD limit of -124 dBW/m^2/MHz in the 3700 to 4200 MHz band, when it represents an aggregate from all flexible use stations that could operate co-channel with FSS gateways that remain in the 3700-3980 MHz band, will have negligible impact on the satellite link performance in the case where the angular separation between the earth station antenna boresight and the flexible use transmitter angle from the earth station is greater than 20 degrees. Based on a typical cable television headend receive service with an earth stations antenna diameter of 3 m (at 20 degrees off-axis), the estimated receive C/I is about 27 dB. Below is a sample calculation of the C/I assuming that the FCC PFD limit applies and the angular separation between the earth station antenna boresight and the base or mobile station is 20° or more off-axis:

5G transmissions in 3700 to 4000 MHz (at 20 degrees angular separation from FSS antenna boresight)						
5G PFD (dBW /m^2/MHz)	Off-Axis Gain (dBi)	Maximum IBE Filter input (dBW/MHz)	Filter insertion loss (dB)	Maximum IBE LNB input (dBW/MHz)	Receive power level at LNB input (dBW/MHz)	**C/I (dB)**
-124	0.00	-157.50	1	-158.50	-131.8	26.7

90. The receive C/I is worse in cases where the angular separation is lower than 20 degrees. For example, an earth station in St. John's, NL facing Anik F3 at 118.7ºWL would have an elevation angle of 7 degrees. As a result, the off-axis angle towards mobile stations located south-west of the earth station would be less than 20 degrees. For a typical cable headend link consistent with those assumptions, the predicted overall link C/N reduction is ~ 1 dB. The C/N could be improved in such cases by one or more of the following: narrowing the carrier symbol rate, changing MODCOD, using larger antenna size or locating the flexible use base station to obtain better discrimination from the earth station antenna.

91. Satellites near the eastern and western edges of the visible arc accessed by gateway earth stations such as Allan Park have low angles of arrival of the satellite signal. Such earth stations would be more susceptible to terrestrial interference due to reduced antenna discrimination.

92. For a flexible use station impacting low look angle earth stations, assuming no terrain blockage, a large distance for protection of these FSS earth stations may be required to meet a PFD limit that accounts for aggregate emissions from flexible use base stations. As could be demonstrated, the actual separation distance would depend on several factors, such as the gain of the receive earth station antenna towards the flexible use station(s), the path profile (terrain blockage), and the height of the stations involved. This distance can also be reduced by local clutter that further attenuates the flexible use signal at the earth station.

93. On the other hand, coordination based on such a large distance would lead to significant administrative burden. It would be more efficient for flexible use operators to use appropriate computer-based tools to determine more accurately the cases where their deployment could potentially exceed a PFD limit. It is also noted that the FCC used a coordination distance trigger to protect those TT&C stations that would remain operational below 4000 MHz post-transition, and relied on a PFD approach for OOBE falling into the 4000-4200 MHz band. The ultimate approach, including selecting whether a coordination distance trigger and/or a PFD limit, along with the appropriate values for each, could be finalized as part of the SRSP development process.

Q50
ISED is seeking comments on whether the assumptions made by the FCC about earth stations, including baseline minimum filter specifications for earth station operations as stated above, are applicable to Canadian operations. Is there any additional information that ISED should consider in the development of appropriate technical rules to enable coexistence both co- channel and in adjacent bands?

In providing comments, respondents are requested to include supporting technical arguments and rationale.

In providing comments to Q46-Q49, respondents are requested to consider the coordination burdens such coexistence and protection measures could impose on either flexible use services or FSS earth stations.

94. The FCC approach to protect an FSS earth station from receiver blocking and out of band emissions from flexible use base stations and mobile devices is well understood. The RABC believes that setting maximum PFD limits for flexible use operators combined with baseline minimum filter specifications for earth station operations are effective and clear measures for achieving coexistence and should be adopted by the Department.

<u>Receiver Blocking (overloading)</u>

95. Based on industry findings, the FCC adopted a front-end aggregate saturation limit of -59 dBm. The FCC adopted two measures to mitigate receiver blocking. First, the base and mobile stations operating in the 3700 to 3980 MHz band must limit their PFD to -16 dBW/m²/MHz as measured at the earth station antenna. Second, an RF front-end protection filter must be installed at the earth station. These filters are specified in paragraph 367 of the FCC 20-22 ruling.

96. The RABC is aware of three suppliers that have successfully demonstrated, either with prototype or production units, that their filters can meet or exceed the FCC filter mask performance.

97. An FSS earth station with an angle of incidence between the antenna boresight and base or mobile stations of 20 degrees or more provides maximum antenna gain of 0 dBi towards any potential flexible use transmitter which, along with the filter mask in paragraph 367 of the FCC 20-22 ruling, will mitigate receiver blocking. In cases where the earth station antenna boresight angle of incidence to base or mobile stations is less than 20 degrees, a front end

with a higher saturation point can be used or the fixed or mobile base station placement can be considered so that receiver blocking won't occur.

Q51
ISED is seeking comments on its proposal to not implement any technical requirements for the coexistence between flexible use operation in the 3650-3980 MHz band and radionavigation operations in the 4200-4400 MHz band, noting the 220 MHz frequency separation between the bands of operation. If this is not sufficient for coexistence, what other measures would be appropriate?

In providing comments, respondents are requested to provide technical analysis to substantiate such proposals.

98. The RABC supports the Department's proposal to implement a 220 MHz frequency separation between the bands for flexible use service in 3650-3980 MHz and those allocated on a primary basis to aeronautical radio-navigation and aeronautical mobile (route) service in 4200-4400 MHz. This is the approach the FCC is taking to protect radio altimeters onboard airplanes and helicopters, as well as the operation of Wireless Avionics Intra-Communications (WAIC) systems onboard aircraft. The aeronautical industry is concerned that this safeguard may not be sufficient in all cases.

99. As the Consultation points out in paragraph 180, the FCC concluded that the technical limits (power and emissions) imposed on 5G, coupled with a 220 MHz guard band, is sufficient to protect aeronautical services but encouraged the aviation industry to participate in a multi-stakeholder group to further study the issue. The C-Band Technical Working Group was created as a multi-stakeholder group formed by the industries involved in the C-band discussions. Technical Working Group Sub-Group 3 ("TWG-3"), "5G/Aeronautical Coexistence," was created with the scope of studying aeronautical radionavigation equipment performance, assessing interference cases and modeling use cases for aeronautical radionavigation operating in the 4.2-4.4 GHz band.

100. RTCA Special Committee 239 (SC239) formed a 5G Task Force specifically to lead studies on how to adequately characterize the performance of currently fielded radar altimeters operating in the presence of RF interference from 5G networks in the 3.7–3.98 GHz band, as well as to assess the risk of harmful interference and associated impacts to safe aviation operations, such that appropriate mitigations could be developed and employed. They have produced a report entitled *Assessment of C-Band Mobile Telecommunications Interference Impact on Low Range Radar Altimeter Operations* (RTCA Paper No. 274-20/PMC-2073[14]).

101. The results presented in this report reveal a major risk of harmful interference to radar altimeters on all types of civil aircraft—including commercial transport airplanes; business, regional, and general aviation airplanes; and both transport and general aviation helicopters—which could under some conditions be caused by 5G telecommunications

[14] https://www.rtca.org/wp-content/uploads/2020/10/SC-239-5G-Interference-Assessment-Report_274-20-PMC-2073_accepted_changes.pdf

systems in the 3.7–3.98 GHz band. The aviation industry report finds that this risk is widespread and has the potential for broad impacts to aviation operations, including the possibility of catastrophic failure.

102. Further, the study suggests that impacts are not limited to the intentional emissions from 5G systems in the 3.7–3.98 GHz band, but also may arise from the spurious emissions from such systems which may land within the protected 4.2–4.4 GHz radar altimeter band directly. The study also notes that "While the aviation industry has recognized that changes to the RF environment in which radar altimeters operate are inevitable and performance standards must be updated accordingly, this necessarily takes a significant amount of time…"[15] and further "The first step to improving the resilience of future radar altimeter designs to RF interference in the 3.7 – 3.98 GHz band is updating the MOPS. This process is underway with the creation of SC-239, and the updated MOPS – with additional performance requirements for RF interference rejection – are expected to be completed and approved for release by RTCA by October 2022."[16]

103. The report (RTCA Paper No. 274-20/PMC-2073) is not a deliverable from TWG-3. TWG-3 has received technical comments from CTIA, an association representing the wireless communications industry in the U.S., as well as RTCA's findings and conclusions. Further considerations including the conclusions from the U.S. TWG-3 work are needed to assess the potential of interference, if any, from flexible use operation in the 3650-3980 MHz band to radio-navigation operations in 4200-4400 MHz, as well as potential and appropriate mitigation techniques.

104. The RABC urges the Department to closely monitor developments concerning flexible use/radionavigation compatibility in the U.S., and to engage with both the flexible use and aviation communities in Canada to determine what, if any, additional technical measures or implementation schedule changes may be necessary.

Q55
ISED is seeking comments on what elements from sections 7 to 10 of this consultation would still apply or need to change if ISED were to implement the Telesat proposal, in particular:
a) the proposal for maintaining the primary allocation for FSS in the 3700-4200 MHz band
b) the proposed implementation of an exemption to transition for satellite-dependent communities and the proposed changes to satellite licenses to apply it
c) the proposal for treatment of WBS incumbents
d) the proposal to issue interim authorizations for certain existing licence-exempt earth stations in the 3700-4200 MHz band
e) technical considerations for coexistence between FSS and flexible use
f) technical considerations for coexistence between flexible use and aeronautical radionavigation systems
g) the overall impact on existing users in the 3700-4200 MHz band

[15] RTCA Report, Section 11.2 "Mitigating the Risk of Harmful Interference to Radar Altimeters"

[16] RTCA Report, Section 11.3 "Continued Work and Ongoing Aviation Industry Activities"

Question 55 c)

105. If ISED were to implement the Telesat proposal, WBS could be relocated to the upper part of the 3800 MHz flexible usage band (3980-4080 MHz). This scenario benefits from Telesat's proposal to repack FSS systems within the band 4100-4200 MHz by 2025. The proposal enables the creation of a contiguous flexible-use block over 3450-3980 MHz and potentially a future 3400-3980 MHz. A guard-band between WBS and FSS would still be required within 4080-4100 MHz to prevent possible interference toward FSS systems operating above 4100 MHz. WBS systems deployed within the 3980-4080 MHz band would still be required to coordinate with channels operating in the upper part of the 3650-3980 MHz flexible use band. WBS systems operating in this band would benefit from a growing n77 ecosystem already in place in countries like the UK.

Pros:

- Provides more (100 MHz from 3980-4080 MHz) of Shared Licensing spectrum than ISED proposed Option #2.
- Removes the risk of interference from WBS licensees located in the middle of flexible-use spectrum.
- Allows the creation of a full 3400-3980 MHz flexible use band, aligning with ECC and FCC regulations in 3500 MHz and 3800 MHz bands, respectively.
- Aligns ecosystems[17] (Canada and UK).
- Gives more time for WBS to prepare for a transition in 2025 (timeline indicated by Telesat).

Cons:

- Requires full transition of WBS ecosystem – no compatibility.
- No longer aligns flexible use ecosystem with the U.S.
- Requires coordination with U.S. based FSS services.
- May cause interference in the Aeronautical Radionavigation band 4200-4400 MHz.
- Reduces spectrum available for FSS to only 100 MHz (half of the ISED proposal).

Question 55 e)

106. Unlike the ISED proposal, Telesat's proposal does not carve out satellite dependent areas. However, the Telesat proposal does still require protection at a small number of consolidated gateways. As discussed in the RABC response to Question 50, the FCC approach to protect an FSS earth station from receiver blocking/overload and out of band emission from base and mobile stations is well understood and should be adopted by ISED.

<u>Receiver Blocking (overloading)</u>

107. To be consistent with the Telesat proposal, base and mobile stations operating in the 3700 to 4080 MHz band must be limited to a PFD of -16 dBW/m²/MHz as measured at the earth

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[17] Ofcom has designated 3.8-4.2Ghz as Shared Access spectrum with the expectation that there will be 5G technology will become available. https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf

station antenna. An RF front-end protection bandpass filter must be installed on each FSS earth station. The industry recommendation for the filter, which was adopted by the FCC, specifies a front-end aggregate saturation limit of -59 dBm. As noted in the RABC response to Question 50, filters that meet the FCC specification are available from several vendors for the band 4000-4200 MHz. Suppliers of filters compliant with the FCC specification have indicated to Telesat that they could meet the requirement to extend the suppression frequency to 4080 MHz, as proposed by Telesat. With extension of the filter discrimination to the band 3980-4080 MHz, the discussion and conclusion contained in the RABC response to Question 50 would still apply.

Protection from Out-of-Band Emissions

108. The base and mobile stations operating in the 3700 to 4080 MHz band must limit their PFD to -124 dBW/m²/MHz as measured at the FSS antenna. The effectiveness of this limit is discussed in the RABC response to Question 48.

Protection from In-Band Emissions

109. For protected earth stations using the full 3700 to 4200 MHz band, a coordination based on a PFD limit of -124 dBW/m2/MHz would be required, or subject to further study, potentially one based on a pre-determined coordination distance.

Question 55 f)

110. The concerns voiced by the aviation stakeholders with respect to a 220 MHz separation between flexible use and aviation systems, are detailed in the response to Question 51, RABC recommends deferring consideration of flexible use up to 4080 MHz until the aviation community can update its technical requirements and implementation timeline to ensure aviation safety. The recommendation on mitigation strategies that will result from the MSG TWG-3 in the U.S. would inform any such study in Canada on a 120 MHz separation, and the significantly reduced separation would need to be carefully considered.

Question 55 g)

111. If the Department accepts the Telesat proposal, all affected 3700-4200 MHz users would either move up into the band 4100-4200 MHz on an existing or other GEO satellite, or to other frequency bands on GEO, MEO, or LEO satellites in order to clear 3700-4100 MHz. Those users whose services are moved up into the band 4100-4200 MHz will be protected from OOBE and earth station front end overload by relying on the same general rules and specifications detailed in answer to Question 50, in particular through the use of filters on FSS earth stations and flexible use PFD limits. Another factor for consideration is whether additional capacity to accommodate displaced FSS users would be available by 2025, and the extent to which existing earth stations may need to be upgraded.

Q59

Telesat's proposal includes ISED allocating an additional 80 MHz for flexible use in the 4000- 4100 MHz band. ISED is seeking comments on the feasibility of making this extra spectrum available, specifically:

a) whether there would be standardized 5G equipment available for this 80 MHz, given that it does not align with the U.S. band plan
b) whether there would be FSS filters available, given the reduced amount of FSS spectrum and that it would not align with the U.S. band plan
c) whether there would be enough capacity to continue FSS services in Canada with the proposal to reduce the amount of FSS spectrum to 100 MHz
d) to what degree would the requirement to protect U.S. FSS earth stations in the border areas have an impact on the ability to deploy flexible use stations near the border and to what degree would this impact the value of this spectrum

Question 59 a)

112. The 80 MHz proposed band falls within the 3GPP band n77. The implementation of an n77 radio depends on technical characteristics of each region such as the band plan, OOBE and other technical parameters. The support of the proposed band plan can be accomplished through a separate SKU (Stock Keeping Unit) of equipment that covers the band from 4000 to 4100 MHz. The possibility of supporting the U.S. band plan from 3700 to 4000 MHz along the with the additional 100 MHz from 4000 to 4100 MHz in a single equipment SKU depends on the OOBE limits defined at the edge of the 4000 MHz, and whether they can be implemented through software filtering capabilities.

113. The availability of the handset ecosystem in this band is of a primary importance. It has already started to be available and will grow in 2021 as can be seen in GSMA-5G-Device-Ecosystem Report Figure 5.

Figure 5: Announced devices with known spectrum support, by specific band (data not available for all devices)

Question 59 b)

114. As noted in the RABC response to Question 55, 400 MHz filters can be produced to block the lower mid-band frequencies. There may be a cost impact due to lower volumes compared to the 120 MHz and the 300 MHz filters used for the clearing in the U.S. Any additional costs have not yet been determined.

Question 59 c)

115. The RABC notes that Telesat is the only Canadian-licensed FSS satellite operator in the 3700-4200 MHz band, although both SES and Intelsat are authorized to deliver services to Canada using capacity on foreign-licensed satellites. In its proposal, Telesat has stated that it can implement its proposal while ensuring continuity of all services on its satellites and is prepared to work collaboratively with SES and Intelsat to coordinate the clearing and the transition of their customers. Telesat provides C-band services to Canada from three orbital locations. With 100 MHz available across two polarizations at three orbital locations offering a total of 600 MHz of C-band spectrum for continued services, Telesat has determined that there is sufficient capacity to meet the C-band requirements of its customers.

116. The requirements of SES and Intelsat could differ from those of Telesat. Although many Canadian services would not require frequency displacement simultaneously with the U.S. transition as they are completely independent of the U.S. FSS usage, in some instances a single network may be comprised of earth stations in both countries. In addition, there is significant capacity on foreign satellites that are leased for connectivity in remote areas and the North. In these instances, managing the transition will be more complex and additional time may be required. Telesat's proposal may require that these satellite dependent areas transition to a new band plan resulting in only 100 MHz available on each satellite. In fact, SES has determined that it cannot accommodate all its existing Canadian traffic in the upper 100 MHz band. However, Telesat's proposal anticipates that "the Minister would retain the discretion to delay either or both stages of the transition in designated geographic areas if necessary to maintain continuity of existing services, particularly in satellite-dependent communities in the North".[18]

Question 59 d)

117. Because the timelines in the Canadian and U.S. transitions would not align, bidirectional cross-border interference conditions will vary as the transition proceeds. Once the transition is complete, there would be potential for interference from Canadian flexible use transmitters in the 4000-4080 MHz band, in particular from base stations, into FSS earth stations in the U.S. near the border. The FCC data[19] indicates that there is a relatively small number of licensed C-band earth stations in close proximity to the U.S. border that could be impacted by the flexible use signals. Moreover, because the U.S. FSS earth station antennas are pointed at satellites operating in the geostationary arc, and are generally south facing and oriented away from the Canadian border in the majority of cases, the discrimination between the base station transmitted signal and the boresight of the earth station antenna is high, further reducing the likelihood of interference. Still, there is a need to study the particularly difficult geometries, like the Detroit/Windsor area and the Maine/Quebec border where U.S. receive earth station antenna discrimination may not be as large, especially if the earth station is receiving signals from satellites located at the extreme ends of the visible geostationary arc. The RABC believes that a new trans-border coordination agreement will be required to

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[18] Telesat Proposal para 38.

[19] International Bureau Filing System (IBFS), http://licensing.fcc.gov/myibfs/welcome.do

deal with the differences in frequency allocations across the border and that commonly-used mitigation measures such as adapting frequency plans, the use active beam forming and locating transmitters to take advantage of terrain shielding and antenna discrimination would be combined to achieve successful coordination.

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