



16 August 2023

Via Electronic Delivery (npwg.sec@mcmc.gov.my)

The Chairman
Malaysian Communications and Multimedia Commission
MCMC Tower 1
Jalan Impact, Cyber 6
63000 Cyberjaya
Selangor Darul Ehsan
Malaysia

Attention: Spectrum Planning and Assignment Division

Reference: Response to Public Consultation: *Proposed Malaysia's Positions for World Radiocommunication Conference 2023 (WRC-23) Agenda Items*

Dear Chairman:

Kuiper Systems, LLC ("Kuiper"), a wholly owned subsidiary of Amazon.com Services LLC (collectively "Amazon"), respectfully submits these comments in response to the Public Consultation released by the Malaysian Communications and Multimedia Commission ("MCMC") on the Proposed Malaysia's Positions for World Radiocommunication Conference 2023 (WRC-23) Agenda Items.

Project Kuiper is Amazon's plan to launch and operate a non-geostationary satellite orbit ("NGSO") constellation consisting of over 3,000 satellites in low Earth orbit ("LEO"). Amazon will help close the digital divide by delivering broadband communications services to customers, businesses of all sizes, government agencies, and other organizations lacking reliable internet access. The Kuiper System will provide ubiquitous, high-capacity, high-speed, low latency broadband services to schools, hospitals, government offices, first responders, and disaster relief operations, among many other needs, in rural and hard-to-reach areas, including in Malaysia.

Amazon welcomes the opportunity to provide feedback on Malaysia's positions for WRC-23 Agenda Items and respectfully submits the enclosed comments on Agenda Item 7 Topic J and Agenda Item 10.

Yours Sincerely,

Chris Hofer
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Amazon Project Kuiper
chofer@amazon.com

Proposed Malaysia's Positions for World Radiocommunication Conference 2023 (WRC-23) Agenda Items

Comments Submitted by Amazon

Amazon respectfully submits the following comments on Malaysia's proposed positions Agenda Item 7 Topic J and Agenda Item 10.

1. Agenda Item 7, Topic J

Agenda Item 7, Topic J considers modifications to Resolution 76 (Rev. WRC-15) to facilitate the development of a consultation process to ensure that operational non-geostationary satellite orbit (NGSO) fixed-satellite service (FSS) systems do not exceed the aggregate equivalent power flux density (epfd) limits in Resolution 76 (Rev. WRC-15). Malaysia has proposed taking the following position on this Agenda Item, in line with Method J2:

Malaysia supports possible modifications to Resolution 76 (Rev.WRC-15) to introduce the concept of "consultation process/meetings" to collaboratively determine whether the aggregate interference levels in Tables 1A to 1D of the Resolution are exceeded.

Amazon instead recommends modifying Resolution 76 to invite studies ahead of WRC-27 to establish a consultation procedure, as proposed in Method J4. It is premature to introduce the concept of a consultation process or meeting procedure at WRC-23 to evaluate aggregate epfd compliance, as Method J2 proposes. Resolution 76 (Rev. WRC-15)¹ calls upon the ITU-R to develop a methodology containing procedures to accurately model NGSO systems and establish a

¹ See ITU Res. 76 (Rev. WRC-15), *Protection of geostationary fixed-satellite service and geostationary broadcasting-satellite service networks from the maximum aggregate equivalent power flux-density produced by multiple non-geostationary fixed-satellite service systems in frequency bands where equivalent power flux-density limits have been adopted* (2015) (inviting the ITU Radiocommunication sector to, among other things, continue its studies and to develop a methodology for calculating aggregate epfd produced by NGSO FSS systems).

methodology on procedures to be used to evaluate the aggregate efd limits. The development of the methodology is an essential prerequisite to the success of the procedure and initiation of consultation meetings and a requirement under Resolution 76 (Rev. WRC-15). Amazon agrees it will be important to resolve aggregate efd evaluation, but there is harm to introducing the concept of consultations between administrations at WRC-23 without appropriate study, as acknowledged in Resolution 76 (Rev. WRC-15). Indeed, even without a procedure in place, the obligation to ensure aggregate limits are respected is in place today in Resolution 76 (Rev. WRC-15) and associated RR No. 22.5K. Thus, it is critical to study the methodology first before introducing concepts or adopting any procedures.

Moreover, as discussed in more detail below, we encourage Malaysia to support a separate proposal for a WRC-27 future agenda item (“FAI”) to study sharing between NGSO FSS systems and geostationary satellite orbit (GSO) FSS and BSS networks in the portions of 14/11 GHz and 30/20 GHz frequency bands in which Article No. 22 efd limits apply. This proposal seeks to ensure protection to GSO FSS and BSS networks from unacceptable interference by NGSO FSS systems in the most spectrally efficient manner while establishing means to ensure that NGSO FSS systems meet the single entry and aggregate efd limits of Article 22. Both efd-related proposals would seek to study the sharing framework between GSO networks and NGSO systems but differ in their scope: The proposed updates to Resolution 76 (Rev. WRC-15) under Method J4 would invite studies to address the methodology and consultation procedures for aggregate interference from NGSO systems, while the FAI would invite studies of the Article 22 interference framework. If adopted, the FAI could impact how the aggregate procedure is developed or implemented. By supporting both proposals, Malaysia would ensure a comprehensive review of these efd limits

ahead of WRC-27 and ensure development of aligned rules on both epfd issues. This underscores why Method J2 on Agenda Item 7 Topic J is premature and should not be supported.

2. Agenda Item 10

Agenda Item 10 requests WRC-23 to recommend to the Council items for inclusion in the agenda for WRC-27, and to give its views on the preliminary agenda for the subsequent conference and on possible agenda items for future conferences, in accordance with Article 7 of the Convention and Resolution 804 (Rev.WRC-19). Malaysia's proposed position on Agenda Item 10 is as follows:

Malaysia is of the view that proposals for agenda item 10 could be supported, subject to further studies and taking into account the potential coexistence with, and protection of the incumbent services.

Amazon respectfully requests that Malaysia support a proposal regarding a new agenda item for WRC-27 under Agenda Item 10 of WRC-23 to conduct studies and develop, based on results of the studies, potential modifications in the epfd limits for the co-existence between GSO FSS and BSS networks and NGSO FSS systems under Article 22 of the ITU Radio Regulations. Current epfd limits, developed 25 years ago to protect GSO networks from unacceptable interference from LEO and other NGSO systems, significantly over-protect GSO networks. This over-protection unjustifiably constrains the performance and efficiency of LEO systems, and therefore the ability of systems such as Kuiper to provide fast and affordable broadband to unserved and underserved communities throughout Malaysia. Updating these limits to take account of major developments in this sector over the past 25 years will enable LEO systems to manifest their full potential for these communities in the form of improved throughput and capacity.

Amazon is pleased to present in Annex I to this submission the technical rationale behind our request for support from the Administration of Malaysia for a WRC-27 agenda item to review

and update Article 22 regulatory provisions for sharing between non GSO systems and GSO networks.

Appendix I: Technical Paper presented by Amazon

***Agenda Item 10:** to recommend to the Council the items to be included in the agenda of the next WRC and the items to be included in the preliminary agenda of future conferences, in accordance with Article 7 of the Convention and Resolution 804 (Rev.WRC-19).*

This contribution presents technical rationale to encourage the Administration of Malaysia to support during the upcoming meeting of APT a WRC-23 agenda item 10 proposal for a WRC-27 agenda item to review and update regulatory provisions for sharing between non GSO systems and GSO networks in the portions of 14/11 GHz and 30/20 GHz frequency bands in which No. 22 efd limits apply.

Overview:

Global demand for broadband connectivity is increasing rapidly, from densely populated urban environments to isolated villages and everywhere in between. Despite this demand, access to basic telecommunication services in remote and developing regions is limited. Terrestrial broadband solutions require extensive infrastructure (e.g., underground cable ducts or network tower construction) to become operational. In regions where terrain can be rugged and sparsely populated, deploying such infrastructure can be prohibitively expensive, particularly in developing countries. By contrast, satellite systems at both GSO and NGSO orbits excel at economically providing coverage to even the most remote areas using minimal ground infrastructure, making these systems essential to bridging the digital divide.

Article 22 (Space services) of the Radio Regulations contain a number of provisions to ensure compatibility of NGSO FSS operations with other co-primary systems and services, like GSO FSS and broadcasting-satellite service (BSS) networks. Among these provisions are equivalent power flux-density (epfd) and aggregate efd limits. NGSO FSS systems operating in certain frequency bands must meet to ensure they do not cause unacceptable interference to GSO FSS and BSS networks in accordance with these limits. However, given the latest advancements in satellite technologies and modern spectrum management techniques such as protection criteria of satellite services, the Article 22 efd framework today is outdated and irrationally applied, ultimately resulting in inefficient spectrum use between NGSO FSS and GSO systems to the detriment of NGSO FSS deployment.

The EPFD (equivalent power flux density) limits established at WRC-2000, as stated in Article 22, were formulated based on the characteristics of geostationary satellite orbit (GSO) conceived in the early-to-mid 1990s and a single non-geostationary satellite orbit (NGSO) that has never come into existence. The systems envisioned during this time period significantly differ from the modern GSO and NGSO systems that are currently in operation. It is important to note that nearly all of the antennas or systems considered during the derivation of these limits are now obsolete and unsuitable for present-day use. Furthermore, the methodology utilized to assess compliance with these limits was developed around the same time and does not consider technologies and spectrum management techniques that are used today. It is only natural to conclude that both the

limits and the methodology are suffering from similar deficiencies which only result in inefficient use of the spectrum. These points have already been studied by the ITU during the last study cycle.

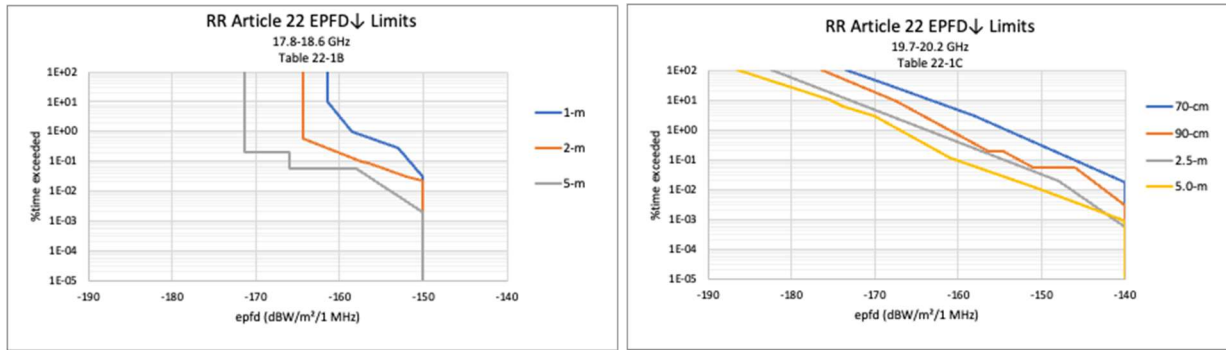
Amazon recognizes that the true ability to bridge the digital divide and provide for much needed services around the world will take a combination of GSO and NGSO services. No. 22.2 specifies that non-Geostationary satellite systems shall not cause unacceptable interference into GSO FSS and BSS networks and this premise is a core tenant for any studies. However, given the importance of both GSO and non-GSO for FSS implementations to the delivery of numerous types of services and applications, including the delivery of high-speed broadband services to rural and remote areas, it is imperative to ascertain whether existing Article **22** EPFD limits are suitable to allow for the efficient use of the orbit and spectrum resources in the 14/11 GHz and 30/20 GHz frequency bands while maintaining the obligations stipulated in No. **22.2**. This will allow upcoming NGSO systems to deliver additional capacity to further help bridge the digital divide.

A prudent approach to effectively tackle these issues would involve addressing them under a dedicated agenda item, wherein the primary focus of the study cycle would be ensuring the optimal utilization of the spectrum. This comprehensive approach would certainly include ensuring the protection of GSO while simultaneously promoting efficient spectrum sharing between the GSO and NGSO systems. Such studies would allow consideration of the impact of modern NGSO systems and the impact of these systems to GSO protections.

Technical Discussion: Inconsistency

In addition to being technologically outdated, the NGSO FSS limits contained in Article **22** are applied inconsistently across various FSS bands. Figure 1 below plots the Article **22** epfd limits and visually demonstrates the disparity between the limits in the 19.7-20.2 GHz frequency band and the 17.8-18.6 GHz frequency band. Comparing the protections based on a 5 meter antenna, NGSO systems must protect GSO networks with 15 dB of additional protection. It is notable the stark difference in these limits, yet, there is no discernable difference between a GSO satellite or its protection requirements operating in 18.6 GHz from one operating in 19.7 GHz.

Figure 1: Article 22 epfd limits applicable to the NGSO systems in portions of the Ka-band



Previous studies in the ITU-R contained in Report ITU-R S. 2462 identified that it was important to include long term operational aspects in any development of sharing considerations between NGSO and GSO systems. It is a clear deficiency that the methodology to develop the epfd limits in the Ku and Ka band did not incorporate a long-term protection criteria. Many of the issues that are currently being debated within the ITU-R, such as those related to Recommendation ITU-R S.1503 (the functional description of the software used to validate compliance with epfd limits), are associated with issues related to long term protections of GSO. Yet, the long term protection threshold of GSO networks was not considered at the time the epfd limits were developed. This makes sense as the type of GSO systems considered at the time were fixed margin systems, and short term interference thresholds are appropriate for such systems. However, GSO systems that operate today evolved away from fixed margins to adaptive throughput schemes. Thus, long term considerations must be considered in addition to short-term criteria.

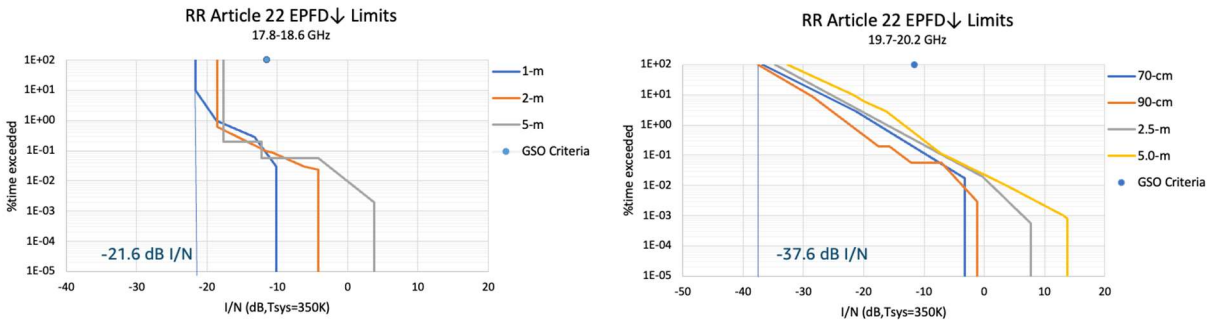
To demonstrate the impact of not considering a long term protection objective in the derivation of the epfd limits for the Ku and Ka band, Figure 2 converts the epfd limits currently in Article 22 for the Ka band into I/N limits by assuming a system noise temperature of the GSO earth station of 350 K. Note that these are the same limits in the Radio Regulations as presented in Figure 1. The blue dot represents a typically conservative FSS protection threshold of -12.2 dB, commonly used in ITU studies and the ITU's Radiocommunication Bureau when confirming coordination requirements under No. 11.32A between GSO satellite networks (*see* Part B Section B3 of the Rules of Procedure for digital signals).

As seen from the curves, in the long term portions of the curve, the I/N for which NGSO must protect GSO are -21.6 dB in the frequency bands 17.8-18.6 GHz and -37.6 dB I/N for the frequency bands 19.7-20.2 GHz. It is notable that these protection thresholds are single-entry. As an example, during the WRC-19 study cycle, WP4A declared that the protection criteria for satellite services (both GSO and NGSO) for studies related to IMT in the long-term should be -10.5 dB I/N² single entry. Interference conditions between GSO services and IMT are very similar to sharing

² Liaison statement for WP4A to TG5/1 under WRC-19 AI 1.13 (TG5.1/411)

conditions between NGSO-GSO due to the time variant nature of interference conditions. A protection value of -37.6 dB I/N results in excessive protection to GSO operations as compared to how these systems are designed and operated and should be studied.

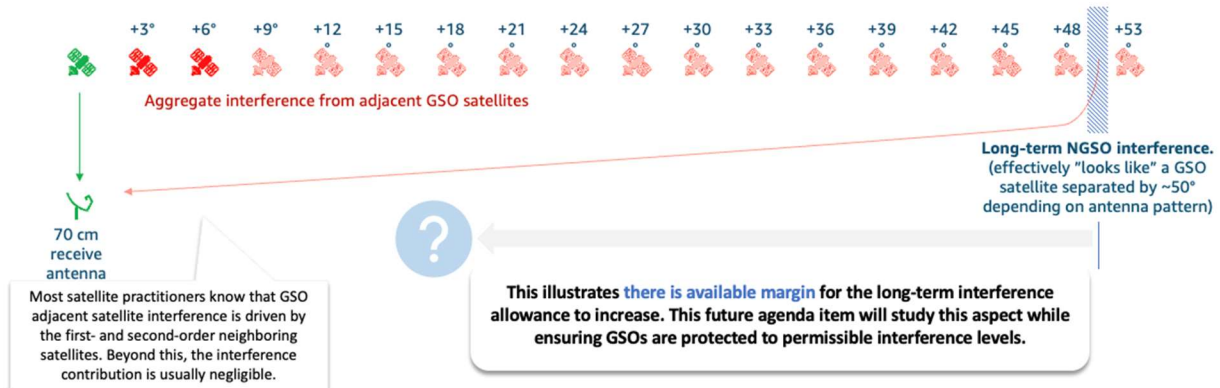
Figure 2: EPFD limits converted to I/N protection criteria



Technical Discussion: Comparison of the limits

Another technical analysis evaluated the power limits from NGSO systems into GSO networks and compared these limits to aggregate power received from adjacent GSO satellites. As is well known, GSO networks are typically designed to operate in an interference environment driven by their first and second order neighbors. In other words, the GSO interference environment is typically assessed based on the aggregate contributions of other GSO satellites up to 6 degrees away from the wanted GSO signal. As shown in the figure below, taking into account regulatory power limits for GSO satellites, long-term NGSO interference effectively “looks like” a GSO satellite separated by 50 degrees from the wanted GSO system. Thus, if GSO systems were limited to the same power limits as limit the operation of NGSO systems, there would need to be a separation of 50 degrees between GSO networks. These large margins of interference should be studied by the ITU-R to improve spectral efficiency and operations of all satellite networks.

The **long-term** EPFD limits are the most challenging and drive the over-protection of GSO networks while significantly and artificially restricting NGSO operations. Consider the following graphical illustration.



Technical Discussion: Comparison of improvements to NGSO operations as compared to GSO protection

As discussed, the conservative nature of how the EPFD limits were derived lead to significant constraints on the operation of NGSO systems. We have studied and can show that when the EPFD limit of a 1-meter GSO earth station antenna operating in the 17.8-18.6 GHz frequency band changed from the existing EPFD limits to an EPFD level corresponding to an interference-to-noise (“I/N”) of -12.2 dB only decreases the spectral efficiency of a GSO system by 0.8%, whereas for a NGSO system the spectral efficiency increase is nearly doubled. This cannot be stressed enough: a change in the long-term EPFD levels allowed an increase in spectral efficiency of 75% for an NGSO FSS system while only yielding a 0.8% decrease in spectral efficiency for a GSO network using the same, shared spectrum.

Conclusion. The merits of situation are clear: shared FSS spectrum can be put to significantly greater use by NGSO systems without materially degrading the operating environment of GSO networks. At the very minimum, the possibility of increasing the efficient use of the finite FSS spectrum is worthy of study. These studies, conducted by NGSO and GSO stakeholders, will be the foundation of any regulatory decisions that may be taken by WRC-27.