9 August 2019

The Chairman
Malaysian Communications and Multimedia Commission
MCMC Tower 1
Jalan Impact, Cyber 6
63000 Cyberjaya
Selangor Darul Ehsan
Malaysia
(Attention: Spectrum Planning Division)
Submitted via email: npwg-19.sec@mcmc.gov.my

Re: Invitation for Comments on Malaysia's Positions for WRC-19

Dear Chairman,

Viasat appreciates the opportunity to comment on MCMC's Invitation for Comments on Malaysia's Positions for WRC-19 ("WRC-19 Consultation"). Viasat provide the following background on satellite broadband services in the Ka band and also specific comments on the pending WRC-19 Consultation (**see, Annex A**).

Satellite broadband services are critical and extensively use and rely on the Ka Band, including the 28 GHz band (and its paired 18 GHz band), for satellite fleet service delivery. Viasat recently launched the Viasat 2 satellite further increasing broadband speeds and coverage resulting in greater capacity for video streaming on airplanes, ships and vehicles, as well as in homes and communities to meet the growing demand for satellite broadband anywhere, especially in places where it has not been affordable. To this end, Viasat also works with partners around the world in places like Europe, Australia, and Brazil to expand affordable satellite broadband to fixed and mobile consumers and will continue to do so in other regions as the next generation of satellites comes online, including in Asia-Pacific.

The next generation of very high-throughput satellites, including the ViaSat-3 global geostationary constellation, is planned to be in service around the world by 2022. The first two satellites will cover the Americas, Europe/Middle-East/Africa, and the third satellite, announced in February 2019, will provide broadband services throughout the Asia-Pacific region, including Malaysia, providing ViaSat-3 class service with global coverage (see, attached **Annex B** for a full description of the Viasat 3 constellation). Viasat announced in February 2019 that it had ordered this third ViaSat-3 satellite for service with Asia-Pacific coverage (ViaSat-3 APAC),[1] which will complete the initial phase of Viasat's global constellation of ViaSat-3 class satellites. The satellites are geostationary and operate across the entire 27.5-29.5 or (28 GHz) uplink band and corresponding 17.7-19.7 GHz (18 GHz) downlink band. The satellites are designed to use the entire 28 GHz band in order to maximize service capabilities at affordable prices for equatorial regions as well as all other areas within their fields of view.

Viasat has also filed for a Ka band Non-Geostationary Satellite Orbit (NGSO) constellation that would serve the entire globe (ViaSat NGSO). It will consist of 20 satellites in four Medium Earth Orbit orbital planes at 8,200 kilometers altitude, with five satellites per orbital plane. The ViaSat NGSO system will operate across the 28 GHz and 18 GHz bands as well.

Viasat's 28 GHz broadband satellites support the following services:

- Government (civil, defence, intelligence, cyber, border protection, and national security)
- Small, medium and large enterprises
- Residential direct broadband
- Aviation
    - Commercial passenger connectivity (https://viasat.com.mx/in-flight-wi-fi/?lang=en)
    - Business Air (https://go.viasat.com/ms-ba-home.html)
    - Crew, Cockpit, Flight Operations, and Aircraft Maintenance (http://www.arconics.com/)
- Maritime businesses
- Satellite-Powered WiFi services (https://viasat.com.mx/community-wi-fi/?lang=en; https://www.viasat.com/news/viasat-introduces-viasat-urban-wi-fi-fastest-satellite-enabled-broadband-service-urban-areas).

As noted above, the Viasat Geostationary and Non-Geostationary constellations use the entire 28 GHz band. To meet the rapidly expanding consumer demand for satellite-powered global high speed broadband services, it is necessary to use the entire Ka band spectrum, just like demand for terrestrial systems requires access to adequate spectrum to meet demand. Viasat has been able to produce the highest throughput satellites ever built by utilising spot beams re-using spectrum efficiently and repeatedly. By taking a holistic approach to the design

[1] See, https://corpblog.viasat.com/viasats-global-satellite-constellation-well-on-its-way-to-completion/.

of the architecture, and basing its design on Geostationary satellites located directly over the equator, Viasat has maximized its ability to serve that region. If the band is segmented it reduces the spectrum available and the overall capacity, and thus affects the cost effectiveness of a satellite network, and thus the price of services to end users.

When satellite operators first began providing Internet services about 20 years ago, they tried to adapt their existing satellites - which were designed to serve low data rate user terminals (VSATs) or distribute video content over a large geographic area - to providing Internet services. Since the satellites they were using were not designed for this purpose, the resulting service was considered slow and expensive compared to terrestrial alternatives.

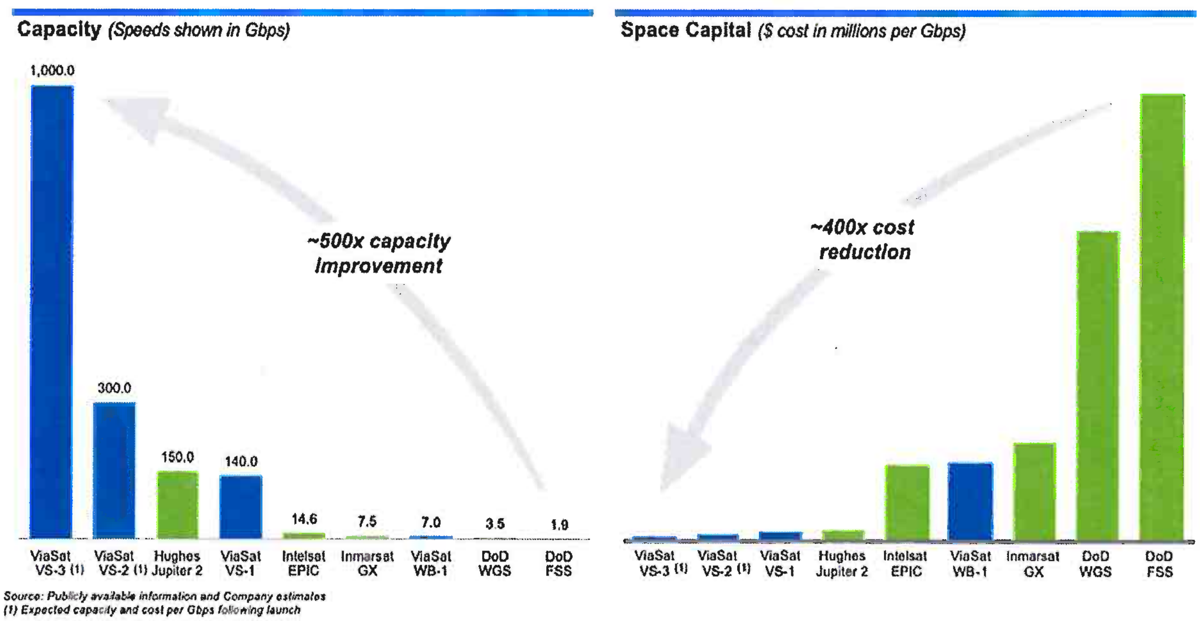

Figure 1 - Revolutionary change in economics of satellite broadband services

As shown in Figure 1 above, all this has changed in recent years with the design and launch of a new generation of Very High Throughput Satellites (VHTS) that have been specifically designed to provide high quality broadband connectivity. A geostationary satellite – whether it be for C band video distribution or a VHTS satellite - costs roughly the same amount to design, build and place in orbit – roughly $300-$500 million.

Whereas traditional C and Ku band satellites could provide at most a few Gbit/s of capacity, each ViaSat-3 satellite will have over 1 Terabit/s of capacity, allowing the cost per bit to be radically reduced, resulting in more affordable service for the end user. This is enabled by access to the full Ka band. Over the past 10 years, the capacity of satellites has undergone a revolution: increasing about 500 times and resulting in a 400 times reduction in the cost per bit. For the first time, satellite services provided over a ViaSat-3 satellite will have similar performance and cost to terrestrial services.

Just like terrestrial systems, reduced capacity because of artificial spectrum constraints would increase the cost of the available bandwidth and leave untapped satellite broadband capabilities for consumers. Also, due to the ViaSat-3 satellite network design, capacity can be dynamically focused on areas where and when it is needed. For example, over major airline hubs and maritime ports, like Singapore, when additional capacity is needed. Other examples would be for major defence training and operations and homeland and national security requirements.

As explained above, Viasat has continued to invest in Ka band satellites and expand the use of all of the Ka band frequencies, including the 28 and 18 GHz bands, to bring affordable broadband to fixed and mobile consumers. As Viasat gets closer to the launch and operation of the ViaSat-3 constellation, it is critical that countries where Viasat's transformative broadband services will be used, like Singapore, ensure that spectrum is available to meet consumer demand for these services.

I. The 28 GHz Band is for Satellite Broadband

First, it is important to state that as a technology leader Viasat supports the development of new technologies, including 5G, both terrestrial and satellite, as part of the 5G ecosystem (see, **Annex C**, *Satellite in the 5G Ecosystem*). In this regard, it is important to note that 5G advances are not unique to terrestrial networks. In fact, satellite broadband is already using many of these advances and has been doing so for many years. These 5G type advances include use of low latency radio interfaces (e.g., Satellite-Powered WiFi), advanced digital frequency modulation, network slicing, and edge computing or caching.

Second, it is also important to keep in mind the limitations that terrestrial 5G deployment may face in the mmWave bands, as acknowledge by the industry itself. For example, early rollouts of terrestrial mmWave 5G networks are proving to be more challenging than originally anticipated. There have been several recent developments in the deployment of both fixed and mobile terrestrial wireless broadband services that are important for MCMC to consider as part of this consultation and for determining the best use of the 28 GHz band spectrum.

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One the fixed side, there have been recent studies on the initial deployment of fixed wireless services in the 28 GHz band. MoffettNathanson, a respected independent research firm, recently published a report titled "Fixed Wireless Broadband: A Peek Behind the Curtain of Verizon's 5G Rollout". This report finds that 5G deployment costs are much higher than initially expected and 5G penetration rates lower due to a variety of potential factors, but importantly linked to the much smaller cell radii than in lower frequency bands.[2] On the mobile side, Intel has decided not to enter the mobile modem business because, according to their CEO, "[i]t has become apparent that there is no clear path to profitability and positive returns," Intel leader Bob Swan said in a statement.[3]

Third, it is important to note that, global momentum is for *expanded satellite use* of the 28 GHz band for fixed and mobile satellite broadband services worldwide, not for terrestrial 5G. This is essentially the same circumstance as at the time of the final decision at WRC-15. Most countries are following the WRC-15 decision and oppose any terrestrial 5G in the 28 GHz band. For example, the CEPT Roadmap for 5G, covering 48 members states, provides that the 28 GHz band is for satellite broadband, including aeronautical connectivity, and not for terrestrial 5G. Other regions, including the RCC and Arab Spectrum Management Group, also oppose introducing 5G into 28 GHz band. China, Brazil, India, Australia and recently Indonesia have all also recognized the importance of preserving the 28 GHz band for existing satellite broadband services. In addition, recently African countries, represented by their main sub-regional groups, support expanding satellite use of the 28 GHz band, not terrestrial 5G. All told, the number of countries supporting satellite use of the 28 GHz band is over 120, and growing.

Many satellite investment and deployment decisions have been made based on the vast majority of countries deciding that the 28 GHz band is for current and rapidly expanding satellite broadband requirements. Just like terrestrial systems, reduced capacity because of artificial spectrum constraints will increase the cost of the available bandwidth and leave untapped satellite broadband capabilities for consumers in countries that decide not to follow the world community.

II. The 26 GHz Band is a Good Band for Terrestrial 5G Deployment

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[2] https://venturebeat.com/2019/03/22/report-verizon-5g-home-service-too-expensive-to-scale-attracts-few-users/

[3] *Intel says it will exit the 5G phone business as Apple and Qualcomm strike multiyear deal*, The Verge, 16 April 2019.

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The 26 GHz band looks like a much more promising band for terrestrial 5G than the 28 GHz band due to international support and the light deployment in the band. Based on many countries' proposed mmWave deployment plan, the 26 GHz band can easily accommodate multiple 5G operators. There is no need to accommodate terrestrial 5G within the 28 GHz band. This is especially true given that many regulators have found that there is excess spectrum supply in the 26 GHz band alone.[4]

In this respect, Viasat notes that any desire to accommodate mmWave 5G should be able to be fulfilled using the *entire 3.25 GHz of the 26 GHz band (24.25-27.5 GHz)* for terrestrial 5G systems that are designed in accordance with 3GPP standards and otherwise using good engineering techniques, including employing the latest filtering technology optimized for whatever protection level is adopted for the earth exploration satellite service (EESS) operating below 24 GHz. There has been independently-developed information made available to MCMC to explain this significant technical development enabling the use of the most, if not all, of the 26 GHz band for 5G.

III. MCMC Can Have Both Terrestrial 5G and Fixed and Mobile Satellite Broadband

Viasat believes that that mmWave bands are only likely to see limited 5G terrestrial deployment given propagation characteristics of the bands. On the other hand, there is already growing satellite broadband use and additional investment in the full 28 GHz band, not just the upper part of the band. As requested by WRC-15 in Agenda Item 1.5 (Earth Stations in Motion or ESIMs) for the 27.5-29.5 and 17.7-19.7 GHz paired satellite frequency bands, the international community is moving forward to expand the use of the full 28 GHz band for ESIMs use with geostationary satellite networks, like ViaSat-3. There is also growing demand for non-geostationary (NGSO) fixed and mobile use of the 28 GHz band and the paired 18 GHz band.

Viasat appreciates MCMC's acknowledgement of satellite use of the bands for expanding port-to-port and gate-to-gate maritime and aviation satellite broadband, respectively. The reality is that satellite broadband, just like terrestrial networks are facing extensive demands from end user customers in both of these industries. In addition, land mobile industries, like trains, buses and other vehicles, like cars, are becoming heavier users of mobile satellite broadband services as well and these markets are expected to grow rapidly. This is in addition to expanding fixed broadband satellite use in the 28 GHz band around the globe (e.g., Community and Urban WiFi).

[4] See, Second 5G Consultation at para. 123.

On the other hand, the 26 GHz band is an excellent band for terrestrial 5G deployment and offers over 3.25 gigahertz of spectrum. This is more than enough spectrum to accommodate terrestrial 5G in Malaysia and other countries. Therefore, in recognition of the vast amount of spectrum available in the 26 GHz band for terrestrial 5G deployment and the desire of the international community for expansion of satellite broadband in the 28 GHz band, Viasat respectfully requests that MCMC authorize and support expanding satellite use throughout the 28 GHz band and offer terrestrial spectrum for 5G in the 26 GHz band. This approach allows both services to flourish and is consistent with the direction of the international community and technology developments in each band. In addition, Viasat requests that MCMC look at refarming options for terrestrial 5G in the low and mid bands. This should be done instead of considering making any spectrum in the 28 GHz band available for 5G.

Again, Viasat appreciates the opportunity to provide comments in this WRC-19 Consultation and remains ready to respond to any additional questions from the MCMC.

Sincerely,

Christopher J. Murphy
Associate General Counsel
Regulatory Affairs

Viasat Response

No.	Agenda Item	Proposed Malaysia (MLA) Views and Positions
Working Party 1: Land Mobile and Fixed Services		
1.	1.11	
2.	1.12	
3.	1.14	
4.	1.15	
Working Party 2: Broadband Applications in the Mobile Service		
5.	1.13	
6.	1.16	
7.	9.1 (Issue 9.1.1)	
8.	9.1 (Issue 9.1.5)	
9.	9.1 (Issue 9.1.8)	

No.	Agenda Item	Proposed Malaysia (MLA) Views and Positions	
Working Party 3: Satellite Services			
10.	1.4		
11.	1.5	Please see attached response – Annex A. The response provides specific comments on the Conference Preparatory Meeting (CPM) text.	
12.	1.6		
13.	7	A	
		B	
		C1	
		C2	
		C3	
		C4	
		C5	
		C6	
		C7	
		D	
		E	
		F	
		G	

No.	Agenda Item	Proposed Malaysia (MLA) Views and Positions	
13.	7	H	
		I	
		J	
		K	
14.	9.1 (Issue 9.1.2)		
15.	9.1 (Issue 9.1.3)		
16.	9.1 (Issue 9.1.9)		
Working Party 4: Science Services			
17.	1.2		
18.	1.3		
19.	1.7		
Working Party 5: Maritime, Aeronautical and Amateur Services			
20.	1.1		
21.	1.8		
22.	1.9.1		

No.	Agenda Item	Proposed Malaysia (MLA) Views and Positions
23.	1.9.2	
24.	1.10	
25.	9.1 (Issue 9.1.4)	
Working Party 6: General Issues		
26.	2	
27.	4	
28.	8	
29.	9.1 (Issue 9.1.6)	
30.	9.1 (Issue 9.1.7)	
31.	10	

Conference Preparatory Meeting for WRC-19
Geneva, 18-28 February 2019

International Telecommunication Union

PLENARY MEETING

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27 February 2019
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Working Group 3

CHAPTER 3, AGENDA ITEM 1.5

Agenda item 1.5

1.5 to consider the use of the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) by earth stations in motion communicating with geostationary space stations in the fixed-satellite service and take appropriate action, in accordance with Resolution ***158 (WRC-15);***

Resolution **158 (WRC-15)** – *Use of the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) by earth stations in motion communicating with geostationary space stations in the fixed-satellite service.*

~~3/1.5/1 Executive summary~~

~~WRC-19 agenda item 1.5 considers the use of the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) by earth stations in motion (ESIM) communicating with geostationary (GSO) space stations in the fixed-satellite service (FSS). The studies under this agenda item considered three types of ESIM: aeronautical, maritime and land, depending on the type of vehicle on which they are installed.~~

~~Studies have been carried out on sharing and compatibility between ESIM and space as well as terrestrial services allocated in the frequency bands above. Not all studies have been concluded. The studies carried out so far have identified example provisions to protect such services and example guidelines to assist an administration wishing to authorize ESIM to operate on the territory under its jurisdiction.~~

~~There are various responsibilities for the authorization and operation of ESIM and their interference management. These responsibilities are described in the draft new Resolution **[A15] (WRC-19)** in section 3/1.5/5 below.~~

~~For this agenda item, two methods have been identified:~~

~~**Method A**~~

~~This method proposes no changes to the RR and suppression of Resolution **158 (WRC-15)**.~~

Method B

This method proposes to add a new footnote No. **5.A15** in RR Article **5** and a reference to a new WRC Resolution providing the conditions for the operation of ESIM and protection of the services to which the frequency bands are allocated, and consequential suppression of Resolution **158 (WRC-15)**. An example modification to RR Appendix **4** called for by the new WRC Resolution is also included.

3/1.5/2 Background

ESIM are earth stations that communicate with GSO FSS space stations but operate on platforms in motion in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz. There are three types of ESIM:

– ESIM on aircraft (aeronautical ESIM);

– ESIM on ships (maritime ESIM), and

– ESIM on land vehicles (land ESIM).

Any of the three types of ESIM can be used to provide broadband communications, including Internet connectivity.

Moreover, under Method B, for the operation of ESIM, examples of the technical, operational and regulatory responsibilities of administrations and entities responsible for the operation, authorization and the interference management of the various types of ESIM (on board aircraft, on board vessels and on board land vehicles) are defined and contained in the draft new Resolution **[A15] (WRC-19)**.

3/1.5/3 Summary and analysis of the results of ITU-R studies

3/1.5/3.1 Operation of ESIM in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz

In accordance with Resolution **158 (WRC-15)**, ESIM need to protect the existing services and their future development without undue constraints to which the 17.7-19.7 GHz and 27.5-29.5 GHz frequency bands are allocated: the fixed service (FS), the mobile service (MS), the Earth exploration-satellite service (EESS), the meteorological-satellite service, the fixed-satellite service (FSS), including the non-GSO mobile-satellite service (MSS) feeder links operating in the FSS and the broadcasting-satellite service (BSS) feeder links.

The following sections provide examples on how ESIM can protect the existing services to which the 17.7-19.7 GHz and 27.5-29.5 GHz frequency bands are allocated.

3/1.5/3.2 Sharing studies with terrestrial services

3/1.5/3.2.1 Frequency band 17.7-19.7 GHz

The ITU-R examined sharing conditions for ESIM with terrestrial services in the 17.7-19.7 GHz frequency band and concluded that there would be potential interference from transmitting stations of terrestrial services to ESIM receivers. The ESIM therefore should operate under the condition of not claiming protection from terrestrial services operating in accordance with RR.

3/1.5/3.2.2 Frequency band 27.5-29.5 GHz

The ITU-R examined sharing conditions between ESIM and terrestrial services in the 27.5-29.5 GHz frequency band and concluded that there would be potential interference to receiving stations of terrestrial services from ESIM transmitters. Therefore, aeronautical and maritime ESIM should operate under the specified technical, operational and regulatory conditions to avoid causing unacceptable interference to receiving stations of terrestrial services operating in accordance with RR.

Land ESIM need to operate under the condition of not causing unacceptable interference to receiving stations of terrestrial services operating in accordance with RR.

Further information is provided in the relevant parts of the draft new Resolution **[A15] (WRC-19)**.

3/1.5/3.3 Sharing studies with space services

3/1.5/3.3.1 Sharing studies with the EESS (passive)

The ITU-R examined sharing conditions for receiving ESIM with the EESS (passive) in the 18.6-18.8 GHz frequency band. This frequency band is used by EESS (passive) in remote sensing by Earth exploration. In this frequency band EESS (passive) and ESIM are both receiving. Therefore, no interference can be caused by ESIM into the EESS (passive).

3/1.5/3.3.2 Sharing studies with the meteorological-satellite service

The ITU-R examined sharing conditions for receiving ESIM with the meteorological-satellite service in the 18 GHz range[1]. In this frequency band the meteorological-satellite earth station and ESIM are both receiving. Therefore, no interference can be caused by ESIM into the meteorological-satellite receiver station.

3/1.5/3.3.3 Sharing studies with the EESS (Earth-to-space)

The ITU-R noted that the use of ESIM in the 27.5-29.5 GHz frequency band would not change the current interference environment with respect to the secondary EESS in the 28.5-29.5 GHz range, provided that ESIM operate within the envelope of GSO FSS networks.

3/1.5/3.3.4 Sharing studies with the FSS

3/1.5/3.3.4.1 GSO FSS networks

With respect to GSO FSS satellite networks of other administrations, the ITU-R concluded that ESIM need to remain within the envelope of the satellite network with which these ESIM communicate. In order to implement this, the notifying administration of the GSO FSS network with which ESIM communicate needs to send to the Bureau the relevant RR Appendix **4** information related to the characteristics of the ESIM intended to communicate with the space station of that GSO FSS network. Upon receipt of this information, the Bureau needs to examine it and publish the results in a Special Section of the BR IFIC. If, following this examination, the Bureau concludes that ESIM are not within the envelope of the satellite network, it would return the information to the notifying administration with the reasons thereof.

3/1.5/3.3.4.2 Non-GSO FSS systems

3/1.5/3.3.4.2.1 Frequency band 17.7-18.6 GHz (Resolution 158, *recognizing further e)*)

In this frequency band, since non-GSO FSS earth stations and ESIM are both receiving, no interference can be caused by ESIM into the non-GSO FSS receiving earth stations.

With respect to the interference into receiving ESIM, it was noted that no protection could be claimed by ESIM from non-GSO FSS systems operating in the frequency band 17.8-18.6 GHz in

[1] See RR No. **5.519** for specific frequency ranges.

accordance with RR provisions, including RR No. **22.5C**. Further information with respect to the above is included in the draft new Resolution **[A15] (WRC-19)**.

3/1.5/3.3.4.2.2 Frequency band 18.8-19.3 GHz (Resolution 158, *recognizing further f)* and *b)*)

In this frequency band, since non-GSO FSS earth stations and ESIM are both receiving, no interference can be caused by ESIM into the non-GSO FSS receiving earth stations.

Since GSO FSS networks communicating with ESIM would operate under technical and operational measures contained in the relevant coordination agreements in application of RR Nos. **9.12A** and **9.13**, ESIM would not require any additional protection.

3/1.5/3.3.4.2.3 Frequency band 27.5-28.6 GHz (Resolution 158, *recognizing further e)* and *b)*)

In this frequency band, transmitting ESIM have the potential to interfere with non-GSO FSS satellite receivers. Results of studies to date show that ESIM that comply with *resolves* 1.1.1 of the draft new Resolution **[A15] (WRC-19)** and the provisions contained in Annex 1 to the draft new Resolution **[A15] (WRC-19)** would protect non-GSO FSS satellite receivers in this frequency band.

3/1.5/3.3.4.2.4 Frequency band 28.6-29.1 GHz (Resolution 158, *recognizing further f)* and *b)*)

In this frequency band RR Nos. **9.12A** and **9.13** apply.

Some views were expressed that the provisions of RR Nos. **9.12A** and **9.13** together with *resolves* 1.1.1 of the draft new Resolution **[A15] (WRC-19)** provide enough assurance that ESIM would not cause interference to non-GSO FSS space station receivers.

Some other views were expressed that transmitting ESIM have the potential to interfere with non-GSO satellite receivers and that ESIM should comply with *resolves* 1.1.1 of the draft new Resolution **[A15] (WRC-19)** and the provisions contained in Annex 1 to the draft new Resolution **[A15] (WRC-19)** so that ESIM protect non-GSO satellite receivers in this frequency band.

Studies are ongoing to determine whether ESIM should comply with any provisions so that ESIM avoid causing interference to non-GSO satellite receivers.

3/1.5/3.3.4.3 Sharing with non-GSO MSS feeder links operating in the FSS

3/1.5/3.3.4.3.1 Frequency band 19.3-19.7 GHz (Resolution 158, *recognizing further g)*)

In this frequency band RR No. **9.11A** applies and non-GSO MSS feeder-link systems using the frequency band 19.3-19.7 GHz (space-to-Earth) are not subject to the provisions of RR No. **22.2**. Further, the use of this frequency band for other non-GSO FSS systems, or for the cases indicated in RR Nos. **5.523C** and **5.523E**, is not subject to the provisions of RR No. **9.11A**, but is subject to RR Articles **9** (except RR No. **9.11A**) and **11** procedures, and to the provisions of RR No. **22.2** (RR No. **5.523D**).

In this frequency band, ESIM and non-GSO MSS feeder-link earth stations are both receiving, so no interference can be caused from one into the other.

3/1.5/3.3.4.3.2 Frequency band 29.1-29.5 GHz (Resolution 158, *recognizing further h)* and *j)*)

In this frequency band RR No. **9.11A** applies and non-GSO MSS feeder-link systems using the frequency band 29.1-29.5 GHz (Earth-to-space) are not subject to the provisions of RR No. **22.2**, except as indicated in RR Nos. **5.523C** and **5.523E**, where such use is not subject to the provisions of RR No. **9.11A** and shall continue to be subject to RR Articles **9** (except RR No. **9.11A**) and **11** procedures, and to the provisions of RR No. **22.2** (RR No. **5.535A**).

In this frequency band, ESIM could potentially interfere with non-GSO satellite receivers with which MSS feeder-link earth stations communicate. Studies are ongoing to determine whether any additional provisions are needed so that ESIM avoid causing interference to non-GSO MSS space stations.

Some views were expressed that *resolves* 1.1.7 (Option 1), if retained, and Annex 1 of the draft new Resolution **[A15] (WRC-19)** provide for the protection of non-GSO MSS feeder links from ESIM communicating with GSO FSS networks.

Some other views were expressed that the provisions of RR No. **9.11A** together with *resolves* 1.1.1 of the draft new Resolution **[A15] (WRC-19)** provide enough assurance that ESIM would not cause interference to space station receivers of non-GSO MSS feeder links. This view is consistent with *resolves* 1.1.7 (Option 2), if retained, of the draft new Resolution **[A15] (WRC-19)**.

3/1.5/3.3.4.4 Sharing studies with BSS feeder links

3/1.5/3.3.4.4.1 Frequency bands 17.7-18.1 GHz (Resolution 158, *recognizing further a)*) and 18.1-18.4 GHz (Resolution 158, *recognizing further c)*)

In this frequency band, ESIM are receiving and BSS feeder-link earth stations are transmitting. The ITU-R concluded that ESIM should not claim protection from BSS feeder-link earth stations operating in accordance with the RR and should not affect the future development of BSS feeder-link earth stations.

3/1.5/3.3.4.4.2 Frequency band 27.5-29.5 GHz (Resolution 158, *recognizing further i)*)

In this frequency band, ESIM are transmitting and GSO FSS satellites with which BSS feeder-link earth stations communicate are receiving.

The ITU-R concluded that the course of action contained in paragraph 3/1.5/3.3.4.1 for the protection of other GSO FSS networks would protect GSO FSS satellite receivers with which BSS feeder-link earth stations communicate.

3/1.5/3.3.4.5 Sharing studies between ESIM and non-GSO MSS feeder-link earth stations operating in the opposite direction in the frequency band 19.3-19.6 GHz

In this frequency band, ESIM are receiving and non-GSO MSS feeder-link earth stations are transmitting and RR No. **5.523B** applies. The ITU-R concluded that ESIM should not claim protection from non-GSO MSS feeder-link earth stations operating in accordance with the RR and should not affect the future development of non-GSO MSS feeder-link earth stations.

3/1.5/4 Methods to satisfy the agenda item

3/1.5/4.1 Method A

No changes to the RR and suppression of Resolution **158 (WRC-15)**.

3/1.5/4.2 Method B

Add a new footnote in RR Article **5** that refers to a new WRC Resolution **[A15] (WRC-19)** with technical, operational and regulatory conditions for the operation of ESIM while ensuring protection of allocated services and consequential suppression of Resolution **158 (WRC-15)**.

~~3/1.5/5 Regulatory and procedural considerations~~

~~3/1.5/5.1 For Method A~~

~~NOC~~

~~ARTICLES~~

~~SUP~~

~~RESOLUTION 158 (WRC-15)~~

~~Use of the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) by earth stations in motion communicating with geostationary space stations in the fixed-satellite service~~

3/1.5/5.2 For Method B

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. **2.1**)

MOD

15.4-18.4 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
17.7-18.1 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A ADD 5.A15 (Earth-to-space) 5.516 MOBILE	**17.7-17.8** FIXED FIXED-SATELLITE (space-to-Earth) 5.517 ADD 5.A15 (Earth-to-space) 5.516 BROADCASTING-SATELLITE Mobile 5.515	**17.7-18.1** FIXED FIXED-SATELLITE (space-to-Earth) 5.484A ADD 5.A15 (Earth-to-space) 5.516 MOBILE
	17.8-18.1 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A ADD 5.A15 (Earth-to-space) 5.516 MOBILE 5.519	

18.1-18.4	FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B ADD 5.A15 (Earth-to-space) 5.520 MOBILE 5.519 5.521

MOD

18.4-22 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
18.4-18.6	FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B ADD 5.A15 MOBILE	
18.6-18.8 EARTH EXPLORATION-SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.522B ADD 5.A15 MOBILE except aeronautical mobile Space research (passive) 5.522A 5.522C	**18.6-18.8** EARTH EXPLORATION-SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.516B 5.522B ADD 5.A15 MOBILE except aeronautical mobile SPACE RESEARCH (passive) 5.522A	**18.6-18.8** EARTH EXPLORATION-SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.522B ADD 5.A15 MOBILE except aeronautical mobile Space research (passive) 5.522A
18.8-19.3	FIXED FIXED-SATELLITE (space-to-Earth) 5.516B 5.523A ADD 5.A15 MOBILE	
19.3-19.7	FIXED FIXED-SATELLITE (space-to-Earth) (Earth-to-space) 5.523B 5.523C 5.523D 5.523E ADD 5.A15 MOBILE	

MOD

24.75-29.9 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
27.5-28.5	FIXED 5.537A FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 ADD 5.A15 MOBILE 5.538 5.540	
28.5-29.1	FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.523A 5.539 ADD 5.A15 MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540	

29.1-29.5	FIXED FIXED-SATELLITE (Earth-to-space) 5.516B 5.523C 5.523E 5.535A 5.539 5.541A ADD 5.A15 MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540	

ADD

~~**Option 1:**~~

5.A15 The operation of earth stations in motion communicating with geostationary FSS space stations in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz shall be subject to draft new Resolution **[A15] (WRC-19)**. (WRC-19)

~~**Option 2:**~~

~~**5.A15** The operation of earth stations in motion communicating with geostationary FSS space stations in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz, or portions thereof, shall be subject to draft new Resolution **[A15] (WRC-19)**. (WRC-19)~~

Comment: Adding "or portions thereof" to the footnote implies that ESIM operation will be subject to Resolution [A15] only in certain parts of the bands, and not in other parts. Very misleading and creates ambiguity. Or portions thereof phrasing in resolves 1 is clear and makes the intended point.

ADD

DRAFT NEW RESOLUTION [AI1.5] (WRC-19)

Use of the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz by earth stations in motion (ESIM) communicating with geostationary space stations in the fixed-satellite service

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

a) that there is a need for global broadband mobile-satellite communications, and that some of this need could be met by allowing earth stations in motion (ESIM) to communicate with space stations of geostationary-satellite orbit (GSO) fixed-satellite service (FSS) operating in the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space);

b) that appropriate regulatory and interference management mechanisms are necessary for the operation of ESIM;

c) that the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) are also allocated to terrestrial and space services used by a variety of different systems and these existing services and their future development need to be protected from the operation of ESIM, *recognizing*

a) that the administration authorizing ESIM on territory under its jurisdiction has the right to require that ESIM referred to above only use those assignments associated with GSO FSS networks which have been successfully coordinated, notified, brought into use and recorded in the MIFR with a favourable finding under Article **11**, including Nos. **11.31**, **11.32** or **11.32A**, where applicable;

b) that for cases of incomplete coordination under No. **9.7** of the GSO FSS network with assignments to be used by ESIM, the operation of ESIM on those assignments in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz needs to be in accordance with the provisions of No. **11.42** with respect to any recorded frequency assignment which was the basis of the unfavourable finding under No. **11.38**;

c) that any course of action taken under this Resolution has no impact on the original date of receipt of the frequency assignments of the GSO FSS satellite network with which ESIM communicate or on the coordination requirements of that satellite network;

d) that the operation of any type of ESIM (land, maritime and aeronautical) within the territory(-ies), territorial waters and airspace under the jurisdiction of an administration, shall be carried out only if authorized by that administration,

e) that protection limits for terrestrial services are needed only in the portions of the band where these services are operated in a given country,

Comment: This new recognizing makes the fairly obvious point – taking the "or portions thereof" formulation in resolves 1 into account – that limits for protection of terrestrial services in any given country are needed only where terrestrial services are authorized in that country. We want to avoid blind application of conditions across the 2 GHz in order to avoid unnecessary loss of flexibility

resolves

1 that for any ESIM communicating with a GSO FSS space station in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz, or portions thereof, the following conditions shall apply:

1.1 with respect to space services in the 17.7-19.7 GHz and 27.5-29.5 GHz frequency bands, ESIM shall comply with the following conditions:

~~**Option 1:**~~

1.1.1 with respect to satellite networks or systems of other administrations, the ESIM characteristics shall remain within the envelope of the satellite network with which these ESIM communicate;

~~**Option 2:**~~

~~1.1.1 with respect to satellite networks or systems of other administrations, the ESIM characteristics shall remain within the envelope of the satellite network with which these ESIM communicate and the satellite network, when using ESIM, shall not cause more interference and shall not claim more protection than was coordinated when using typical earth stations in this satellite network;~~

Comment: Option 2 here is unnecessary, and imposes an "obligation" that has no meaning or enforceability (since bilateral coordination agreements are not routinely provided to the BR).

1.1.2 that the notifying administration of the GSO FSS network, with which ESIM communicate, shall ensure that ESIM operation complies with coordination agreements for the frequency assignments of this GSO FSS network under the relevant provisions of the Radio Regulations;

1.1.3 for the implementation of *resolves* 1.1.1 above, the notifying administration of the GSO FSS network with which ESIM communicate shall send to the Bureau under this Resolution the relevant Appendix **4** information related to the characteristics of the ESIM intended to communicate with the space station of that GSO FSS network, together with the commitment that the ESIM operation shall be in conformity with the Radio Regulations and this Resolution;

~~**Option 1 (examination of ESIM in relation to a GSO satellite network recorded in the MIFR)**~~

~~1.1.4 upon receipt of the information provided in accordance with *resolves* 1.1.3 above, the Bureau shall examine it in relation to the requirements referred to in *resolves* 1.1.1 based on the information recorded in the MIFR and any other reliable information available to it and publish the results in a Special Section of the BR IFIC;~~

~~**Option 2 (examination of ESIM in relation to a GSO satellite at either coordination stage or subsequently recorded in the MIFR)**~~

1.1.4 upon receipt of the information provided in accordance with *resolves* 1.1.3 above, the Bureau shall examine it in relation to the requirements referred to in *resolves* 1.1.1 based on the complete information submitted to the Bureau for the satellite network of the GSO FSS space station with which the ESIM is intended to communicate;~~,~~

1.1.5 if~~*If*~~, following ~~this~~ the examination under *resolves* 1.1.4 above, the Bureau concludes that the ESIM characteristics are within the envelope of the satellite network, the Bureau shall publish the results for information in the BR IFIC, otherwise the information shall be returned to the notifying administration;

Comment: There is very little difference between options for resolves 1.1.4; We re-splits this into two resolves for clarity – separating the BR review obligation from post-review actions. Pseudo editorial.

~~**Option 1 (examination of ESIM in relation to a GSO satellite network recorded in the MIFR)**~~

~~1.1.5 if, following the examination referred to in *resolves* 1.1.4 above, the Bureau concludes that ESIM characteristics are not within the envelope of the GSO satellite network, the information shall be returned to the notifying administration;~~

~~**Option 2 (examination of ESIM in relation to a GSO satellite at either coordination stage or subsequently recorded in the MIFR)**~~

~~1.1.5 should the Bureau find, prior to entering the characteristics for a network into the MIFR, that the information submitted under *resolves* 1.1.3 is not in compliance with the requirements of *resolves* 1.1.1, the corresponding information previously published by the Bureau under *resolves* 1.1.4 shall be suppressed;~~

Comment: The two options for 1.1.5 seem to be addressed. Option 1 is in the end of 1.1.4 already, and should not exist. Option 2, calling for suppression of the ESIM filing if not within the envelope seems inconsistent with the 1.1.4 call to return the notification information to the notifying administration.

1.1.6 for the protection of non-GSO FSS systems operating in the frequency band 27.5-28.6~~/29.1~~ GHz, ESIM communicating with GSO FSS networks shall comply with the provisions contained in Annex 1 to this Resolution;

Comment: The off-axis e.i.r.p. limits should be applied only to the band not subject to No. 9.11A coordination (i.e., 27.5-28.6 GHz). In 28.6-29.1 GHz, protection of non-GSO FSS systems comes through Art. 9 coordination. Same change in Annex 1.

~~Option 1~~

~~1.1.7 for the protection of non-GSO MSS feeder links operating in the frequency band 29.1-29.5 GHz, ESIM communicating with GSO FSS networks shall comply with the provisions contained in Annex 1 to this Resolution;~~

~~**Reasons**: Studies are still on-going with the regard to the actual outcome of this particular item. Furthermore, although coexistence issues may be resolved through coordination, specific provisions would ensure protection in the absence of reaching an agreement through coordination efforts.~~

~~Option 2~~

~~1.1.7 is not needed.~~

~~**Reasons**: The band 29.1-29.5 GHz is allocated co-primarily to GSO FSS and to NGSO MSS feeder links, and hence, coordination in this case is on a first-come-first-served basis. The concern arises when GSO FSS is the first comer and also operates ESIM. When NGSO MSS feeder links comes latter, *resolves* 1.1.7 requires the operational ESIM to comply to conditions in Annex 1 of the draft new Resolution. It will not be feasible for an ESIM to protect NGSO MSS feeder links once it has been operational. Also, *resolves* 1.1.7 inadvertently is establishing priority to NGSO MSS over GSO FSS. The Radio Regulations in force, together with *resolves* 1.1.1 of the draft new Resolution **[AI1.5] (WRC-19)** provide enough assurance that ESIM would not cause interference to space station receivers of non-GSO MSS feeder links.~~

Comment: There is no need for additional provisions for non-GSO MSS feeder link protection, since this protection is ensured by ESIM operation within the coordination envelope of earth stations on the network (and feeder links are coordinated with GSO FSS under Art. 9/9.11A). No 1.1.7 means no provisions in Annex 1.

1.1.~~8~~7 ESIM shall not claim protection from non-GSO FSS systems operating in the frequency band 17.8-18.6 GHz in accordance with the Radio Regulations, including No. **22.5C**;

1.1.~~9~~8 ESIM shall not claim protection from BSS feeder link earth stations operating in the frequency band 17.7-18.4 GHz in accordance with the Radio Regulations~~ and shall not affect their future development~~;

Comment: As recognised in considering c) above and considering g) of Resolution 158, ESIM operation under the FSS allocations in the 27.5-29.5 GHz and 17.7-19.7 GHz band can be permitted only if existing services and their future development is protected. The regulatory measure to protect BSS feeder link future development in the 17.7-18.4 GHz band is to allow ESIM operation only on a non-protected basis. By including this condition in the resolves above, the phrase "shall not affect their future development" becomes superfluous as this outcome is already achieved.

1.2 with respect to terrestrial services in the 17.7-19.7 GHz and 27.5-29.5 GHz frequency bands ESIM shall comply with the following conditions:

1.2.1 the receiving ESIM in the 17.7-19.7 GHz frequency band shall not claim protection from terrestrial services in the above-mentioned frequency band operating in accordance with the Radio Regulations~~ and shall not affect the future development of these services~~;

Comment: As recognised in considering c) above and considering g) of Resolution 158, ESIM operation under the FSS allocations in the 27.5-29.5 GHz and 17.7-19.7 GHz band can be *permitted only if existing services and their future development is protected. The regulatory measure specifying that ESIM shall not claim protection from terrestrial services in the 17.7-19.7 GHz band makes the phrase "shall not affect their future development" superfluous, as this outcome is already achieved.*

1.2.2 the transmitting aeronautical and maritime ESIM in the 27.5-29.5 GHz frequency band shall not cause unacceptable interference to terrestrial services in the above-mentioned frequency band operating in accordance with the Radio Regulations ~~and shall not affect the future development of these services~~ and Annex 2 applies;

Comment : The regulatory measure to ensure protection of current and future terrestrial services in the 27.5-29.5 GHz band is to impose a distance limitation on M-ESIM and a PFD limitation on A-ESIM. The phrase "shall not affect their future development" is both unnecessary (since protection is provided through the limits), and could lead to ambiguity for the future. In fact, the future for terrestrial services is set by them knowing what the environment looks like through the limits – just as it is set for terrestrial services protected by pfd limits in Table 21-4 of Article 21. Also, "protect future development" and "no undue constraints" formulations in the Radio Regulations have no regulatory significance.

1.2.3 the transmitting land ESIM in the 27.5-29.5 GHz frequency band shall not cause unacceptable interference to terrestrial services in neighbouring countries in the above-mentioned frequency band operating in accordance with the Radio Regulations ~~and shall not affect the future development of these services and Annex 3 with appropriate title applies~~;

~~View 1: regarding *resolves* 1.2.2 and 1.2.3 above, the part of the sentence "*and shall not affect the future development of these services*" shall be removed, because the protection of the future development of terrestrial services in the band 27.5-29.5 GHz is already fully ensured by the pfd mask indicated in Annex 2 and because retaining that sentence creates a provision under which the pfd mask in Annex 2 could be periodically reviewed, thus creating a detrimental uncertainty on the technical conditions to be met by ESIM.~~

~~View 2: regarding *resolves* 1.2.2 above, the part of the sentence "*and shall not affect the future development of these services*" shall be maintained and applied to existing terrestrial services and its future development as this text is an element cited in *resolves to invite ITU-R* and *considering g)* of Resolution 158 (WRC-15). Moreover, the obligations of the notifying administration of ESIM to protect terrestrial services is not limited to only comply with the pfd as contained in Annex 2 of this Resolution due to the fact that the validity and accuracy of pfd is yet to be verified and examined. Moreover, the proponents of this view are of the strong opinion that reference to *resolves* 1.2.3 in view 1 directly or indirectly refers to Annex 3 which has not been agreed by CPM19-2 in its totality.~~

Comment: The deletion of the reference to Annex 3 in 1.2.3 is a consequential change due to the deletion of Annex 3 as newly superfluous due to renumbered resolves 3 and 4 below. This supports the deletion of the phrase "shall not affect the future development of these services" for the reasons provided in the comment under resolves *1.2.2. above.*

~~**Option 1**~~

1.2.4 for the implementation of *resolves* 1.2.2 and 1.2.3 above, the notifying administration responsible for the GSO FSS satellite network with which ESIM communicate shall submit to the Bureau together with the Appendix **4** data referred to in *resolves* 1.1.2 a commitment undertaking that in case of unacceptable interference, upon receipt of a report of interference, take necessary action to immediately eliminate this interference or reduce interference to an acceptable level;

Option 2

1.2.4 may not be needed due to the fact that is covered somewhere else in other parts of this Resolution;

Option 1

1.2.5 that for the protection of terrestrial services operating in the frequency band 27.5–29.5 GHz, the aeronautical and maritime ESIM shall comply with the provisions contained in Annex 2 of this Resolution;

Option 2

1.2.5 any transmitting aeronautical or maritime ESIM that conforms to the requirements in Annex 2 to this Resolution are considered to not cause unacceptable interference to terrestrial stations under *resolves* 1.2.2 above;

Option 3

1.2.5 for the implementation of *resolves* 1.2.2 above, any transmitting aeronautical or maritime ESIM that conforms to the requirements in Annex 2 to this Resolution shall be deemed to have met its obligation to terrestrial stations;

Comment: This option for resolves 1.2.5 is the linchpin to the entire resolution. Terrestrial services are protected from aero and maritime ESIM by the measures in Annex 2, which are mandatory. If there is compliance by aero and maritime ESIM with the limits, there is by definition no unacceptable interference. This resolves provides regulatory certainty for both ESIM and terrestrial services by confirming that point. ESIM know that they will not be accused of causing unacceptable interference if the limits are met, and terrestrial services will be able to use the limits as a design standard that characterizes a stable interference environment for their future developments going forward.

Option 4

1.2.5 is not needed due to the fact that compliance with the requirements in Annex 2 would not release the notifying administration from its obligation not to cause unacceptable interference to any stations in the terrestrial service in accordance with the Radio Regulations. Moreover, the concept of pfd used in Article **21** of the Radio Regulations is part of the Radio Regulations to protect the area in which the terrestrial services are deployed. However, it does not protect the assignment of the terrestrial services due to the fact that there are two provisions of Article **9** (i.e. Nos. **9.17** and **9.18**) to this effect;

2 that ESIM shall not be used or relied upon for safety-of-life applications;

3 that for the implementation of this Resolution, administrations may consider relevant parts of Annex 3 when considering to authorize ESIM as well as in their bilateral or multilateral negotiations (this part of the Resolution may be more appropriate to be an invites, depending on the content of Annex 3);

Comment: Resolves 3 becomes unnecessary with the deletion of Annex 3. This adds text on the bilaterial point for land ESIM to the "invites Administrations" section. Land ESIM is taken care of in recognizing (d) and resolves 1.2.3.

43 that the administration responsible for the GSO FSS satellite network with which the ESIM communicate shall ensure that:

43.1 techniques to maintain pointing accuracy with the associated GSO FSS satellite without inadvertently tracking adjacent GSO satellites; are employed for the operation of ESIM;

~~4~~3.2 all necessary measures are taken so that ESIM are subject to permanent monitoring and control by a Network Control and Monitoring Centre (NCMC) or equivalent facility and are capable of receiving and acting upon at least "enable transmission" and "disable transmission" commands from the NCMC or equivalent facility~~ (this *resolves* should be assessed against the content of Annex 3)~~;

~~4~~3.3 measures, when required, are taken to limit the operation of ESIM to the territory or territories under the jurisdiction of the administrations authorizing ESIM;

~~4~~3.4 a point of contact is provided for the purpose of tracing any suspected cases of unacceptable interference from ESIM;

~~5~~4 that in case of unacceptable interference caused by any type of ESIM:

~~5~~4.1 the administration of the country in which the ESIM is authorized shall cooperate with an investigation into the matter and provide, where possible, any required information on the operation of ESIM and a point of contact to provide such information;

~~5~~4.2 the administration of the country in which the ESIM is authorized and the notifying administration of the satellite network with which the ESIM communicate shall, jointly or individually~~,~~ as the case may be, upon receipt of a report of interference, ~~shall~~ take required action to eliminate or reduce interference to an acceptable level;

~~*Note: in resolves 5.1 and 5.2 the administration authorizing ESIM is the administration providing the radio licence to the vehicle on which the ESIM operate.*~~

~~6~~5 that the application of this Resolution does not provide regulatory status to ESIM different from that derived from the GSO FSS network with which they communicate taking into account the provisions referred to in this Resolution,

instructs the Director of the Radiocommunication Bureau

1 to take any necessary actions for the implementation of this Resolution;

2 to take any necessary actions to facilitate the implementation of this Resolution, including assisting in resolving interference, if any;

3 to report to future WRCs any difficulties or inconsistencies encountered in the implementation of this Resolution,

invites administrations

1 to collaborate, to the maximum extent practicable, for the implementation of this Resolution, in particular for resolving interference, if any;

2 authorizing land ESIM to engage in bilateral or multilateral agreements between neighbouring states on free circulation, cross-border movement and use of land ESIM.~~consider Annex 3 when authorizing an ESIM, as well as for bi-lateral or multi-lateral negotiations~~,

instructs the Secretary-General

to bring this Resolution to the attention of the Secretary-General of the International Maritime Organization (IMO) and of the Secretary General of the International Civil Aviation Organization (ICAO).

ANNEX 1 TO DRAFT NEW RESOLUTION [AI1.5] (WRC-19)

Provisions for ESIM to protect non-GSO FSS systems ~~space services~~ in the frequency band 27.5-28.6~~9.5~~ GHz

1 In order to protect those non-GSO FSS systems referred to in *resolves* 1.1.6 of this Resolution, ESIM shall comply with the following provisions:

a) the level of equivalent isotropically radiated power (e.i.r.p.) density emitted by an ESIM in a geostationary-satellite network in the 27.5-28.6/~~29.1~~ GHz frequency band shall not exceed the following values for any off-axis angle φ which is 3° or more off the main-lobe axis of an ESIM antenna and outside 3° of the GSO:

Off-axis angle	*Maximum e.i.r.p. density*
$3° \leq \varphi \leq 7°$	$28 - 25 \log \varphi$ dB(W/40 kHz)
$7° < \varphi \leq 9.2°$	7 dB(W/40 kHz)
$9.2° < \varphi \leq 48°$	$31 - 25 \log \varphi$ dB(W/40 kHz)
$48° < \varphi \leq 180°$	−1 dB(W/40 kHz)

Comment: See Discussion under resolves 1.1.6 for removal of 29.1 GHz reference.

~~**Option 1**~~

b) for any ESIM that does not meet the condition *a)* above, outside of 3° of the GSO arc, the maximum ESIM on-axis e.i.r.p. shall not exceed 55 dBW for emission bandwidths up to and including 100 MHz. For emission bandwidths larger than 100 MHz, the maximum ESIM on-axis e.i.r.p. may be increased proportionately;

~~**Option 2**~~

~~*b)* for any ESIM that does not meet the condition *a)*/Option 2 above, outside of 3° of the GSO arc, the maximum ESIM on-axis e.i.r.p. shall not exceed 55 dBW for emission bandwidths of 100 MHz. For emission bandwidths smaller or larger than 100 MHz, the maximum ESIM on-axis e.i.r.p. may be decreased or increased proportionately, as appropriate.~~

~~**Option 1**~~

~~2 In order to protect those non-GSO MSS feeder links referred to in *resolves* 1.1.7 Option 1 of this Resolution, ESIM shall comply with the following:~~

~~Note: Appropriate measures to be developed based on the outcome of ongoing studies to protect non-GSO MSS feeder-links referred to in resolves 1.1.7 Option 1 of this Resolution.~~

~~**Option 2**~~

~~Consistent with *resolves* 1.1.7 Option 2, item 2 is not required.~~

ANNEX 2 TO DRAFT NEW RESOLUTION [AI1.5] (WRC-19)

Provisions for maritime and aeronautical ESIM to protect terrestrial services in the frequency band 27.5-29.5 GHz

PART 1: MARITIME ESIM

1 The notifying administration of the GSO FSS satellite network with which a maritime ESIM communicates shall ensure compliance of the maritime ESIM with the following conditions:

1.1 the minimum distances from the low-water mark as officially recognized by the coastal State beyond which maritime ESIM can operate without the prior agreement of any administration is (60 to 120 km, with preference to 60 to 70 km, depending on the results of studies)* in the 27.5-29.5 GHz frequency band. Any transmissions from maritime ESIM within the minimum distance shall be subject to the prior agreement of the concerned coastal State;

* WRC-19 is invited to consider this range and decide upon a single value.

1.2 the maximum maritime ESIM e.i.r.p. spectral density towards the horizon shall be limited to 12.98 dB(W/1 MHz). Transmissions from maritime ESIM with higher e.i.r.p. spectral density levels towards the territory of any coastal state shall be subject to the prior agreement of the concerned coastal State together with the mechanism by which this level is to be maintained.

PART 2: AERONAUTICAL ESIM

Option 1 (this option is associated with option 4 of *resolves* 1.2.5 of the Resolution)

The part below is only a guidance to administrations facilitating the bi-lateral and multi-lateral coordination/agreement among the concerned administrations

Option 2 (this option is associated with options 1, 2 and 3 of *resolves* 1.2.5 of the Resolution)

The part below is intended as provisions for aeronautical ESIM to protect terrestrial services operating in the frequency band 27.5-29.5 GHz for the implementation of *resolves* 1.2.2.

Option 3 (this option is associated with options 1, 2 and 3 of *resolves* 1.2.5 of the Resolution)

The part below is intended as provisions for aeronautical ESIM that could protect terrestrial services operating in the frequency band 27.5-29.5 GHz for the implementation of *resolves* 1.2.2.

Comment: None of the 3 subtitle options is needed. Removal of all aligns the text in Section 2 of Annex 2 with the text in Section 1 (where there are no subtitles).

2 The notifying administration of the GSO FSS satellite network with which an aeronautical ESIM communicates shall ensure compliance of the aeronautical ESIM with the following conditions:

2.1 When within line-of-sight of the territory of an administration, within which terrestrial services are operating on a co-frequency basis within portions of the frequency band 27.5-29.5 GHz, the maximum pfd produced in those co-frequency band segments at the surface of the Earth on the territory of thatan administration by emissions from a single aeronautical ESIM shall not exceed:

Comment: Clarifies that the pfd mask is intended to protect terrestrial services operating co-frequency and within the line of sight of the terrestrial services.

Option 1

$pfd(\delta) = -124.7$	(dB(W/m² · 14 MHz))	for	$0° \leq \delta \leq 0.01°$
$pfd(\delta) = -120.9+1.9 \cdot \log10(\delta)$	(dB(W/m² · 14 MHz))	for	$0.01° \leq \delta \leq 0.3°$
$pfd(\delta) = -116.2+11 \cdot \log10(\delta)$	(dB(W/m² · 14 MHz))	for	$0.3° < \delta \leq 1°$

$\text{pfd}(\delta) = -116.2+18\cdot\log10(\delta)$ (dB(W/m²· 14 MHz)) for $1° < \delta \leq 2°$

$\text{pfd}(\delta) = -117.9+23.7\cdot\log10(\delta)$ (dB(W/m²· 14 MHz)) for $2° < \delta \leq 8°$

$\text{pfd}(\delta) = -96.5$ (dB(W/m²· 14 MHz)) for $8° < \delta \leq 90.0°$

where δ is the angle of arrival of the radio-frequency wave (degrees above the horizon).

~~**Option 2**~~

~~pfd(δ) = −122.7 (dBW/m²/1 MHz) for 0° ≤ δ ≤ 2°~~

~~pfd(δ) = −122.7 + 2 * (δ − 2) (dBW/m²/1 MHz) for 2° < δ ≤ 2.3°~~

~~pfd(δ) = −122.6 + 1.5 * (δ − 2) (dBW/m²/1 MHz) for 2.3° < δ ≤ 7.9°~~

~~pfd(δ) = −113.9 (dBW/m²/1 MHz) for 7.9° < δ ≤ 90°~~

~~where δ is the angle of arrival of the radio-frequency wave (degrees above the horizon).~~

~~Note: With respect to Options 1 and 2 above, the effect of aggregate interference from multiple aeronautical ESIM still needs to be agreed upon, including the validity and accuracy of these masks.~~

~~**Option 1**~~

~~2.2 Unless agreement from concerned administrations, aeronautical ESIM shall not transmit below 5/6/TBD km of altitude above the territory of the administration concerned.~~

~~**Option 2**~~

~~2.2 is not needed. A minimum altitude is not required since the compliance with a pfd mask in 1.1 above is sufficient to protect terrestrial services.~~

~~Note: With respect to Options 1 and 2 above, the approach of using a minimum altitude to be complied with still needs to be agreed upon.~~

Comment: The idea of an altitude limit is unsubstantiated, and is inherently in conflict with the ITU-R conclusion (WP 5A) that a pfd mask approach with multiple elevation angle limits is adequate to protect the mobile service.

2.3 Higher pfd levels than those provided in 2.1 within an administration produced by aeronautical ESIM on the surface of the Earth above shall be subject to the prior agreement of that administration.

2.4 within the territory under the jurisdiction of an administration where the ESIM operate, aeronautical ESIM shall comply with the bilateral or multilateral agreements of the concerned administrations.

~~Note: Due to lack of time and the complexity of the issue, the parts of contributions addressing Annex 3, including section 3/1.5/5.2.2 and section 3/1.5/5.2.3 were not discussed in detail at CPM19-2. Therefore, the contents of this Annex and those sections are presented as in input Document CPM19-2/1.~~

Comment: Annex 3 below is deleted. All of the substantive provisions are incorporated clearly and concisely into the body of the resolution.

ANNEX 3 TO DRAFT NEW RESOLUTION [AI1.5] (WRC-19)

Land ESIM and overall responsibilities for the operation of all three ESIM types

or

Guidelines to assist administrations to authorize ESIM in the frequency band 27.5-29.5 GHz

Note: The title needs to be revised in order to align with the responsibilities stipulated in the ITU CS.

Note: It is necessary to carefully review the responsibility and obligation of each entity in this Annex with regard to the mandatory actions mentioned below.

Note: Once the content of this Annex is reviewed and agreed, the list of administrations below could be reduced or deleted, as appropriate, to reflect only the entities involved.

Note: For the operation of ESIM, the technical, operational and regulatory responsibilities of entities operating various types of ESIM (on board aircraft, on board vessels and on board land vehicle) need to be defined:

a) notifying administration of the ESIM assignments corresponding to the satellite networks on which the ESIM operate;

b) satellite operators of ESIM assignments;

c) the gateway administration which facilitates the radiocommunication connection between the ESIM terminal and the satellite space station;

d) administrations on territory (air space, territorial water and land) of which the ESIM terminal will operate.

How the responsibilities mentioned above are assumed by each of these four entities and how the interference management system would be performed need to be defined.

It is understood that there would be a monitoring and control station to take necessary actions in regard with "enabling" and "disabling" the operation of the ESIM terminals. If such actions are envisaged to be performed by the entities mentioned in a), b) and c) above, then it should be clear how such responsibilities are shared between these entities. On the other hand if such "enabling" and "disabling" functions are divided or shared by these three entities, then the responsibility of the fourth entity (the entity on the territory under the jurisdiction of which the ESIM terminals would be located) could act? Suppose that such "enabling" and "disabling" functions are totally performed outside the control of the fourth entity, then that entity which, in fact, licensed the operation of the ESIM terminals has no authority or responsibility on the function of the ESIM terminals that it authorized/licensed. However, according to the *resolves* of Resolution **1 (Rev.WRC-03)** that fourth entity is legally responsible towards other administrations in regard with any potential interference that may occur.

In addition, in case that interference caused by the operation of ESIM terminals to the terrestrial or space services of other administrations, the appropriate course of action and operational procedure on how rapidly reduce the interference to the acceptable level or its elimination is also not addressed, at all.

Shared responsibilities among various entities and administrations need to be defined.

1 For the purpose of this Annex, the entities below are defined as follows:

a) Administration A is the administration on the territory of which an ESIM operates.

b) Administration B is the administration on the territory of which a potentially interfered-with FS receiver is located.

c) Administration C is the administration on the territory of which the ESIM gateway is located. The ESIM gateway is TBD.

d) Administration D is the notifying administration of the GSO FSS network with which the ESIM communicate.

e) Administration E is the administration on the territory of which the Network Control and Monitoring Centre (NCMC) is located. The NCMC is TBD.

f) Administration F is the administration whose licence is mutually recognized by Administration A when an ESIM is operating on the territory under the jurisdiction of Administration A.

Note – An additional guideline may be considered to suggest that administrations authorizing ESIM should notify so to the Bureau.

g) the ESIM network operator is TBD.

or

g) the ESIM network operator is the service provider that uses capacity on the satellite communicating with the ESIM.

The following guidelines are provided for all administrations involved in the authorization and operation of ESIM in the 27.5-29.5 GHz and 17.7-19.7 GHz frequency bands:

2 With regard to Land ESIM (L-ESIM), the administration authorizing L-ESIM has the right to require:

a) That L-ESIM operate within the territory under the jurisdiction of another administration shall only do so if authorized by that administration.

b) The operator of any ESIM network within which the L-ESIM operate ensure that such L-ESIM only have the capability to *limit operations to/operate within* the territory of administrations having authorized those L-ESIM.

or

b) That the ESIM network operator ensures that such L-ESIM have the capability to limit operations to the territory of administrations having authorized those L-ESIM.

c) The administration authorizing L-ESIM shall require that the ESIM network operator put in place all necessary measures so that its L-ESIM are subject to permanent monitoring and control by a NCMC or equivalent facility and are capable of receiving and acting upon at least "enable transmission" and "disable transmission" commands from the NCMC or equivalent facility.

d) The operator of the ESIM network within which the L-ESIM operate provide a point of contact for the purpose of tracing any suspected cases of interference from L-ESIM.

3 With regard to Maritime ESIM (M-ESIM), the administration authorizing M-ESIM has the right to require:

a) That M-ESIM operating within the territorial waters under the jurisdiction of another administration shall only do so if authorized by that administration.

~~*b)* The operator of any ESIM network within which the M-ESIM operate ensure that such M-ESIM only have the capability to *limit operations/operate* within the territorial waters of administrations having authorized those M-ESIM.~~

~~*c)* The administration authorizing M-ESIM shall require that the ESIM network operator put in place all necessary measures so that its M-ESIM are subject to permanent monitoring and control by an NCMC or equivalent facility and are capable of receiving and acting upon at least "enable transmission" and "disable transmission" commands from the NCMC or equivalent facility.~~

~~*d)* The administration authorizing M-ESIM shall require that the ESIM network operator provide a point of contact for the purpose of tracing any suspected cases of interference from M-ESIM.~~

~~3.1 The Administration C on the territory of which the ESIM Gateway is located and the network operator of M-ESIM operating in the international waters are responsible for compliance with all necessary actions related to the implementation of the M-ESIM licensing procedures adopted in the "Flag of the Vessel" State.~~

~~4 With regard to Aeronautical ESIM (A-ESIM), the administration authorizing A-ESIM has the right to require:~~

~~*a)* That A-ESIM operate within the territorial airspace under the jurisdiction of an administration only if authorized by that administration.~~

~~or~~

~~*a)* The administration authorizing A-ESIM shall require that A-ESIM operating within the national controlled airspace under the jurisdiction of another administration shall only do so if authorized by that administration.~~

~~*b)* That the ESIM network operator ensures that such A-ESIM have the capability to limit operations to the territorial airspace of administrations having authorized those A-ESIM.~~

~~or~~

~~*b)* The administration authorizing A-ESIM shall require that the ESIM network operator ensure that such A-ESIM only have the capability to operate within the national controlled airspace of administrations having authorized those A-ESIM.~~

~~or~~

~~*b)* The operator of any ESIM network within which the A-ESIM operate ensure that such A-ESIM have the capability to limit operations to the territorial airspace of administrations having authorized those A-ESIM.~~

~~*c)* That the ESIM network operator provide a point of contact for the purpose of tracing any suspected cases of interference from A-ESIM.~~

~~or~~

~~*c)* The administration authorizing A-ESIM shall require that the ESIM network operator put in place all necessary measures so that its A-ESIM are subject to permanent monitoring and control by an NCMC or equivalent facility and are capable of receiving and acting upon at least "enable transmission" and "disable transmission" commands from the NCMC or equivalent facility.~~

~~*d)* The administration authorizing A-ESIM shall require that the ESIM network operator provide a point of contact for the purpose of tracing any suspected cases of interference from A-ESIM.~~

~~4.1 The Administration C on the territory of which the ESIM Gateway is located and the network operator of A-ESIM operating in the international airspace are responsible for compliance with all necessary actions related to the implementation of the A-ESIM licensing procedures adopted in the "Flag of the Aircraft" State.~~

~~5 At the regional or multi-country level, mutual recognition of national licences (authorizations) for the operation of ESIM is allowed subject to bilateral or multilateral agreements between the interested States on free circulation, cross-border movement and use of different types of ESIM considered in the Resolution.~~

~~Note: Due to lack of time the guidelines for the A-ESIM case have not been considered in detail. Conditions similar to the L-ESIM and M-ESIM cases, but tailored for A-ESIM operational characteristics, need to be given further consideration.~~

3/1.5/5.2.2 Example modification to Appendix 4 to implement *resolves* 1.1.2 to draft new Resolution [A15] (WRC-19)

APPENDIX 4 (REV.WRC-15)

Consolidated list and tables of characteristics for use in the application of the procedures of Chapter III

ANNEX 2

Characteristics of satellite networks, earth stations or radio astronomy stations[2] (Rev.WRC-12)

Footnotes to Tables A, B, C and D

MOD

TABLE A

GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK, EARTH STATION OR RADIO ASTRONOMY STATION (Rev.WRC-~~15~~19)

Items in Appendix	*A - GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK, EARTH STATION OR RADIO ASTRONOMY STATION*	**Advance publication of a geostationary-satellite network**	**Advance publication of a non-geostationary-satellite network subject to coordination under Section II of Article 9**	**Advance publication of a non-geostationary-satellite network not subject to coordination under Section II of Article 9**	**Notification or coordination of a geostationary-satellite network (including space operation functions under Article 2A of Appendices 30 or 30A)**	**Notification or coordination of a non-geostationary-satellite network**	**Notification or coordination of an earth station (including notification under Appendices 30A or 30B)**	**Notice for a satellite network in the broadcasting-satellite service under Appendix 30 (Articles 4 and 5)**	**Notice for a satellite network (feeder-link) under Appendix 30A (Articles 4 and 5)**	**Notice for a satellite network in the fixed-satellite service under Appendix 30B (Articles 6 and 8)**	Items in Appendix	Radio astronomy
A.18	**COMPLIANCE WITH NOTIFICATION OF AIRCRAFT EARTH STATION(S)**										**A.18**	
A.18.a	a commitment that the characteristics of the aircraft earth station (AES) in the aeronautical mobile-satellite service are within the characteristics of the specific and/or typical earth station published by the Bureau for the space station to which the AES is associated Required only for the band 14-14.5 GHz, when an aircraft earth station in the aeronautical mobile-satellite service communicates with a space station in the fixed-satellite service				+	+					A.18.a	
A.19	**COMPLIANCE WITH § 6.26 OF ARTICLE 6 OF APPENDIX 30B**										**A.19**	
A.19.a	a commitment that the use of the assignment shall not cause unacceptable interference to, nor claim protection from, those assignments for which agreement still needs to be obtained Required if the notice is submitted under § 6.25 of Article 6 of Appendix **30B**									+	A.19.a	
<u>**A.20**</u>	<u>**COMPLIANCE WITH *resolves* 1.1.2 OF DRAFT NEW RESOLUTION [A15] (WRC-19)**</u>										<u>**A.20**</u>	-
<u>A.20.a</u>	<u>indicator (yes) if an assignment for the 27.5-29.5 GHz and/or 17.7-19.7 GHz band in the satellite network will be used by ESIM</u>	-	-	-	-	-	<u>**O**</u>	-	-	-	<u>A.20.a</u>	-
<u>A.20.b</u>	<u>if yes under A.20.a, a commitment that the ESIM operation would be in conformity with the Radio Regulations and **draft new Resolution [A15] (WRC-19)** (including its Annexes)</u>	-	-	-	-	-	<u>**±**</u>	-	-		<u>A.20.b</u>	-

3/1.5/5.2.3 Example consequential suppression of Resolution 158 (WRC-15)

SUP

RESOLUTION 158 (WRC-15)

Use of the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) by earth stations in motion communicating with geostationary space stations in the fixed-satellite service

ATTACHMENT

UPDATE OF THE ANNEX TO THE CPM REPORT

Reference List of ITU-R Resolutions, Recommendations and Reports, as well as other ITU and non-ITU publications, used in the CPM Report

...

3 List of existing ITU-R Recommendations

ITU-R Series	Recommendation number*	Latest publication	Recommendation title	Agenda item	CPM chapter
S.524-9		Rec. ITU-R S.524-9	Maximum permissible levels of off-axis e.i.r.p. density from earth stations in geostationary-satellite orbit networks operating in the fixed-satellite service transmitting in the 6 GHz, 13 GHz, 14 GHz and 30 GHz frequency bands	1.5	3

...

6 List of draft new (DN) or draft revised (DR) ITU-R Reports (may include preliminary draft new (PDN) or revised (PDR) ITU-R Reports and working documents toward preliminary draft new (WDPDN) or revised (WDPDR) ITU-R Reports)

ITU-R Series	Report draft number*	Available document / status	Report title	Agenda item	CPM chapter
S.[AGENDA ITEM 1.5]		WDPDN Rep. ITU-R S.[AGENDA ITEM 1.5] (Doc. 4A/826, Annex 12)	Operation of earth stations in motion (ESIM) communicating with geostationary space stations in the fixed-satellite service allocations at 17.7-19.7 GHz and 27.5-29.5 GHz	1.5	3

ITU-R Series	Report draft number*	Available document / status	Report title	Agenda item	CPM chapter
S.[ESIM]		WDPDN Rep. ITU-R S.[ESIM] (Doc. 4A/826, Annex 15)	Earth stations in motion (ESIM) compatibility with non-GSO MSS feeder links in the bands 19.3-19.7 GHz and 29.1-29.5 GHz	1.5	3
S./F.[ESIM-FS]		WDPDN Rep. ITU-R S./F.[ESIM-FS] (Doc. 4A/826, Annex 13)	Sharing and compatibility between earth stations in motion operating with geostationary FSS networks and current and planned stations of the FS in the frequency bands 27.5-29.5 GHz and 17.7-19.7 GHz	1.5	3
S./M.[ESIM-MS]		WDPDN Rep. ITU-R S./M.[ESIM-MS] (Doc. 4A/826, Annex 14)	Sharing and compatibility between earth stations in motion operating with geostationary FSS networks and current and planned stations of the MS in the frequency band 27.5-29.5 GHz	1.5	3
[LESIM-FS]		WDPDN Rep. ITU-R [LESIM-FS] (Doc. 4A/826, Annex 16)	Statistical methodologies to estimate the interference from land earth stations in motion (L-ESIM) communicating with geostationary space stations in the fixed-satellite service into fixed service (FS) stations operating in the frequency band 27.5-29.5 GHz	1.5	3
[LESIM-MS]		WDPDN Rep. ITU-R [LESIM-MS] (Doc. 4A/826, Annex 17)	Statistical methodologies to estimate the interference from land earth stations in motion (L-ESIM) communicating with geostationary space stations in the fixed-satellite service into mobile service (MS) stations operating in the frequency band 27.5-29.5 GHz	1.5	3

...

ANNEX B

Description of ViaSat-3 Constellation

Viasat has a long history of innovation in satellite technologies and is a leading provider of communications solutions to businesses, consumers and government users. Viasat has a proven ability to successfully deploy new satellite technologies that it develops, including groundbreaking capabilities that reduce the "cost per bit" of delivering satellite broadband service, making it possible to provide reliable high-speed broadband connections that are comparable to what consumers have come to expect for terrestrial broadband services, at competitive prices. Viasat's first-generation broadband satellite, ViaSat-1, supports maximum throughput of approximately 140 Gbit/s. When ViaSat-1 commenced operations in 2012, it had more than 14 times the throughput of any other Ka-band satellite in orbit at that time. Viasat's second-generation high-capacity satellite provides approximately 260 Gbit/s of capacity. With each evolutionary step of Viasat's satellite technology, the bandwidth economics improve because of the significantly greater capacity Viasat has enabled on a single spacecraft.

In turn, the ViaSat-3-class design represents the next giant leap forward in broadband satellite capabilities, with unprecedented capacity, service speed and flexibility for a satellite platform. With over 1 terabit per second of capacity, this satellite will offer over four times the throughput of the best performing satellite in the marketplace today (ViaSat-2), and approximately five times that of the next highest-throughput Ka-band satellite currently in orbit (Jupiter 2). The service area of this ViaSat-3-class design covers approximately one-third of the Earth's surface—about four times the coverage of ViaSat-2. In addition, the ViaSat-3-class design supports even more individual users with 100 Mbit/s service (and up to 1 Gbit/s) anywhere within the service area. And through its ability to dynamically direct capacity to where customers and demand are located, the satellite can extend capacity and coverage where and when it is most needed. One of the key advances that has led to these developments and enabled these capabilities is the ability to substantially reduce the size and mass of the communications modules on the spacecraft, as depicted in the figure below.

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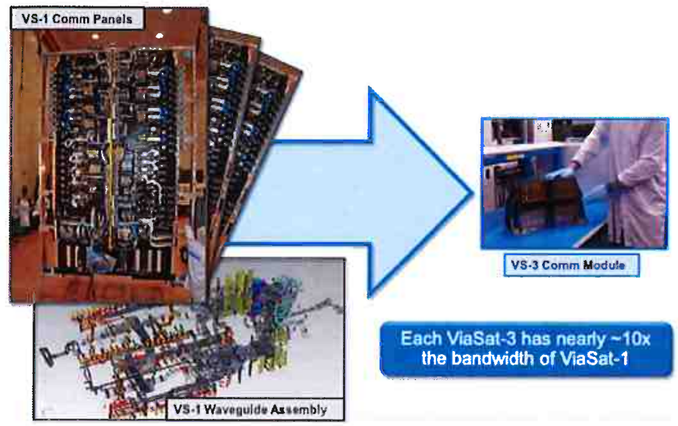
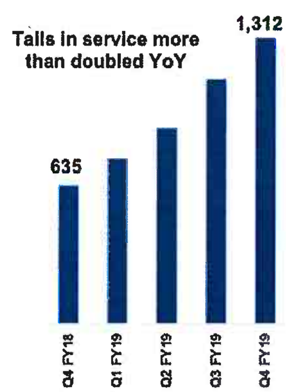
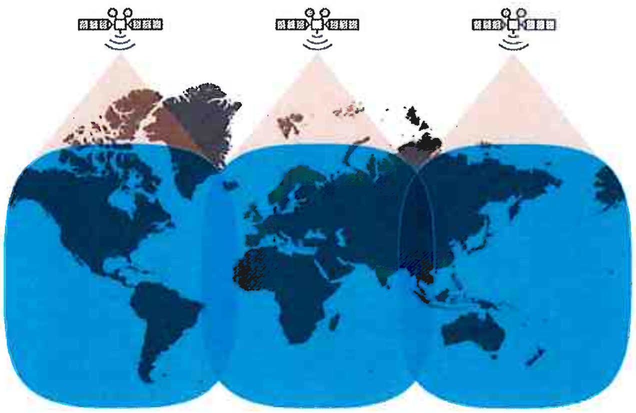


The ViaSat-3-class design provides far greater bandwidth economics than any other satellite in operation today and will enable the provision of services and the offer of service terms never before possible. These unparalleled capabilities are critical to bridging the digital divide and increasing the availability and affordability of high-quality, high-speed connectivity for unserved and underserved communities: areas without cost-effective alternatives or where services with only slower speeds are available. Moreover, the capacity of the satellite allows it to satisfy the demand for satellite-powered broadband services that are growing exponentially, as people increasingly demand high-speed service in mobile settings—on airplanes, trains, buses, cars, trucks, helicopters, ambulances, and ships alike. Today, Viasat provides over 150 million connections annually to personal electronic devices on just 1,312 commercial aircraft, a number that has more than doubled in the past year.



Viasat expects to install in-flight connectivity systems on an additional 490 aircraft under existing contracts, which, once completed, will put Viasat closer to the mark of 2,000 in-service aircraft. Projections indicate that there will be hundreds of millions of personal electronic device connections per year on airplanes served by the ViaSat-3-class satellites. Viasat's success in North America is helping the company engage with airlines on a global basis, commensurate with the expansion of Viasat's global satellite fleet. For example, Viasat recently partnered with China Satcom to provide in-flight connectivity to airlines over China.[5]



For these reasons, the capabilities and capacity afforded by the ViaSat-3-class design are truly transformative and will revolutionize the availability and coverage of broadband services delivered to homes and businesses in metropolitan urban and rural areas alike, and for both fixed and mobile applications.

Moreover, the ViaSat-3-class design includes a number of features that enable extremely secure and reliable service for the most demanding needs of government users. Viasat's current broadband services support a variety of military and national security initiatives, and provide reliable communications for first responders. Viasat has developed and enhanced security and encryption capabilities for military users and has been recognized for its forward-looking approach to cybersecurity services for government and military customers. The ViaSat-3-class design extends these types of features. Significantly, these features of the satellite network design will offer new resiliency and reliability capabilities for Government customers.

[5] Viasat, China Satcom Partner to Bring In-Flight Connectivity Service to Airlines over China (23 April 2019), http://investors.viasat.com/news-releases/news-release-details/viasat-china-satcom-partner-bring-flight-connectivity-service.

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ANNEX C

Satellite in the 5G Ecosystem

ASIA-PACIFIC TELECOMMUNITY **The 4th Meeting of the APT Conference Preparatory Group for WRC-19 (APG19-4)** 7 – 12 January 2019, Busan, Republic of Korea	**Document No: APG19-4/INF-15** **31 December 2018**

VIASAT, INC.

INFORMATION DOCUMENT ON SATELLITE IN THE 5G ECOSYSTEM

Introduction

5G has been conceived as an ecosystem of many technologies – a network of networks – in which satellite plays a vital role in accelerating opportunity, maximizing network potential, and extending network reach.

The global Internet approach has been a powerful driver in providing world-changing economic opportunities. By integrating the unique benefits of every kind of network – copper, fiber, terrestrial wireless, and satellite – the Internet has become a global force that has created as much economic growth in 15 years as the industrial age created in 50 years.[i] This network of networks approach has been instrumental not only because it takes advantage of the unique capability of every available technology at the *core* of the network to extend its reach (fiber, copper, and satellite), but also through the variety of access technologies at the *edge* of the network – Wi-Fi, cable, DSL, LTE, and satellite to name a few.

This ecosystem approach has proven to be essential for leveraging the unique benefits of each type of network technology to expand the reach and capability of the Internet. The combination of cellular, Wi-Fi, satellite and other advances are enabling this same kind of ecosystem approach to be extended to the wireless world – both in the core of the network and at its edges – to expand the capabilities of mobile and fixed end user devices and the locations they operate.

At the dawn of the 5G world, advancing this 5G ecosystem architecture is even more vital. Too often, however, the only aspect of next generation wireless technology that is focused on is the last 100 meter access link to the end user device. A myopic view of 5G – especially when it comes to spectrum – can limit its potential. Only through a holistic view of 5G, and a broad understanding of the comprehensive nature of the entire 5G ecosystem, can the full power and potential of next-generation wireless opportunity be realized. That's because 5G is not a step change from 4G, nor is it just a technological shift. It's a paradigm shift in the way we think about high speed mobile broadband networks. Today's 5G vision encompasses a broad technology ecosystem – with multiple network technologies supporting a global infrastructure including traditional mobile wireless networks, satellite, Wi-Fi, and small cells.

The 5G network is envisioned as an access network-agnostic architecture that includes new cellular wireless access technologies (for the last 100 meter access), but also existing fixed wireless networks, Wi-Fi and satellite networks.[ii] These multiple access technologies are critical for optimizing the many different use cases envisioned for next generation networks. With advanced concepts of a unified user identity, users can be authenticated regardless of access technology enabling a seamless experience. The access technology and network technology are not inextricably linked but are decoupled to provide more flexibility for users and applications regardless, for example, if they are on a cellular network or Wi-Fi network. This multi-access capability can, for example, enable traffic to be offloaded from the mobile access network to other networks (for example to a satellite enabled Wi-Fi endpoint).

This 5G ecosystem approach is also essential for expanding the reach of 5G networks. By taking advantage of satellite's geographically independent cost structure to extend connectivity, for example in underserved and unserved areas, satellite systems can accelerate the commercially viable deployment of 5G networks and extend scalable and efficient 5G network solutions globally. This is especially critical in areas that may not be economically or otherwise connected via terrestrial networks. Network diversity is also essential for ensuring network resiliency and continuity of service across geographies and enabling 5G devices to connect on truly mobile platforms including onboard aircraft, high-speed trains, sea-going vessels, and land-based vehicles that are beyond the reach of a cell site.

In order to fundamentally expand what networks are capable of achieving, and the places they are capable of reaching, a holistic approach is necessary to advance the entire 5G ecosystem of technologies. Harnessing the capabilities of satellite technology maximizes the reach and capabilities of 5G networks. Doing so also maximizes the ability of the 5G ecosystem to solve bigger problems – like extending high speed access to the next billion people, improving network resiliency, and enabling ubiquitous connectivity in the air, across the seas, and around the globe.

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Nowhere is this more critical than in spectrum policy decisions. Having a holistic approach to spectrum policy that takes into account the unique capabilities of each technology is essential. This paper outlines the key spectrum decisions that enable the 5G opportunity to be maximized by embracing a holistic approach to the 5G ecosystem, and a holistic approach to the spectrum policy that accompanies this network of networks.

Next Gen Wireless Networks

It is important to be clear on the goals for the 5G ecosystem: To enable a connected world with ubiquitous access to the Internet by providing hyper mobility on land, sea and air for *all* people *everywhere*. This is more than just about the edge devices or the radio access; it is about providing a complete global network infrastructure.

Figure 1: The Connected World [iii]

Clearly, this cannot be done with one wireless access technology or with one network. There will continue to be extensive use of multiple wireless technologies such as Wi-Fi, point-to-multipoint links, satellites and, of course, cellular. They all play an essential role in building an infrastructure that is adaptable to the ever-expanding new applications and environments.

Similarly, network infrastructure will continue to rely upon fiber, cable, microwave, satellite, HAPS (High Altitude Platforms) and mm-wave technologies to deliver on the ubiquitous and robustness promise. These hybrid networks must now enable greater capabilities to ensure security and accessibility and adaptive performance with simple hand-offs between peer networks.

With this more complete perspective of 5G we can now put in context a balanced roadmap to future wireless technologies which will include satellite, microwave, mm-wave, cellular and Wi-Fi networks that will collectively compete for the broadening demand for new applications. Each of these networks provides its unique value in user management, security and capabilities, yet each also connects to the global Internet in a consistent way to exchange data using compatible user authentication models.

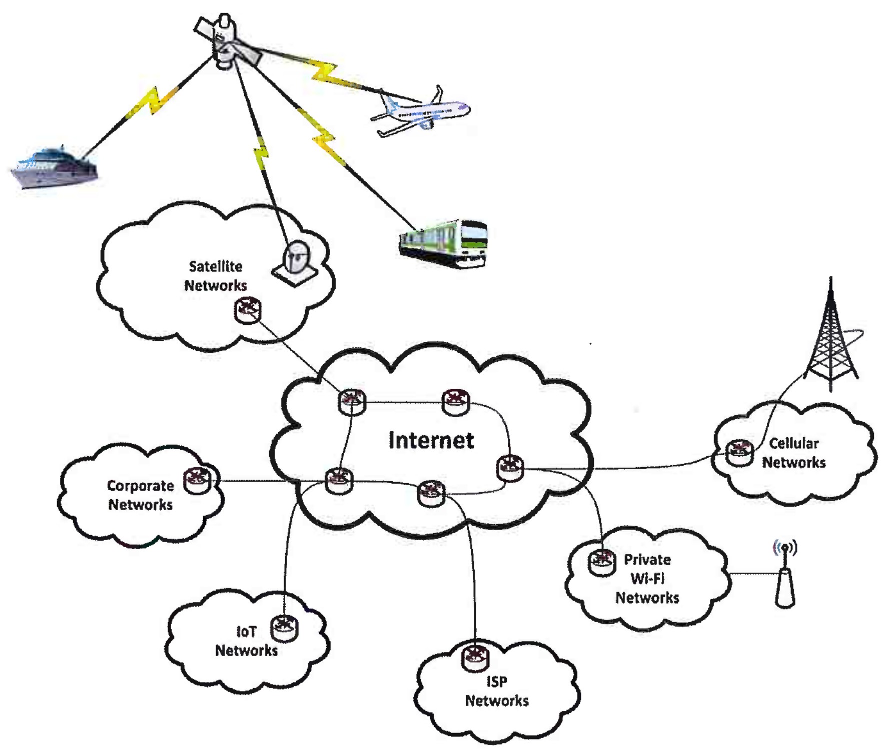

Figure 2: 5G Ecosystem – Network of Networks

This network infrastructure is invisible to most users but plays a critical role in delivering performance, security, value-added features, and authentication for the user. While most users rely heavily on their mobile devices, few realize that 63% of all mobile data actually is 'offloaded' to Wi-Fi and the Internet using unlicensed spectrum. As mobile data demand increases so will this offload to unlicensed spectrum. By 2021, Cisco predicts that 5G cellular devices will represent only 0.2% of all connected devices in the world and will account for only 1.5% of network traffic. Cisco also predicts that by 2021 the total of all IP Internet traffic will exceed 84 exabytes of data, 50% will be Wi-Fi, 30% will be fixed and only 20% will be mobile data. [iv]

It is this diversity of wireless access technologies as well as the inter-connectivity of network topologies that ensures a robust and resilient network ecosystem.

Current Satellite Capabilities

Both geostationary (GSO) and non-geostationary (NGSO) satellite networks have their specific benefits for the 5G ecosystem. Innovation is driven by development of High Throughput Satellite (HTS) systems in various types of orbits (GSO, MEO, LEO). HTS systems today deliver substantial improvements in throughput, capacity and cost, as well as provide flexible, global and high-performance services. This is done by utilizing concentrated spot beams, wideband payloads, increased frequency re-use and higher frequency bands to significantly increase capacity and speeds over wide areas. HTS networks are operating on a global basis and can provide broadband service with speeds in excess of 100 Mbit/s to the end user.

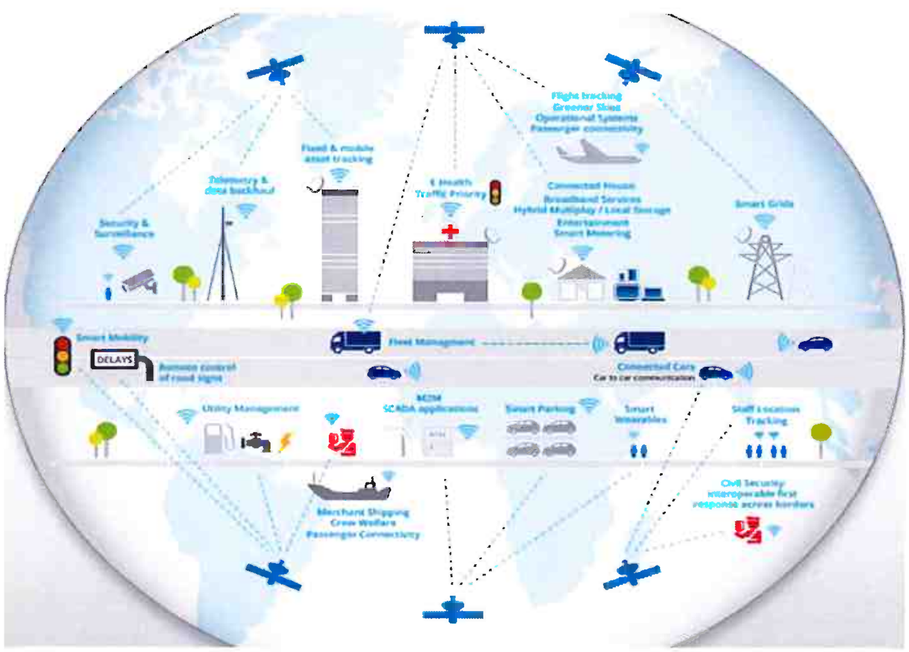

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Figure 3: Satellites in the 5G Ecosystem[v]

In addition to the developments in the space segment, there are technical developments in the satellite ground segment with evolutions both in the network platforms and satellite communication terminals and antennas. Satellite already has and will further adopt technologies and standards necessary to deliver the types of services needed in the 5G ecosystem, including in the areas of service delivery, network-slicing, orchestration, mobile edge computing, security, interoperability and resource virtualization in order to transparently support end-to-end service delivery to vertical applications. Furthermore, a new wave of flat panel antenna technology is emerging for satellite communications. These antennas have removed mechanical components, relying on software and electronics for steering, making them available for mobile platforms like cars, boats, planes and more.

Advanced Satellite Network Technology

Advanced satellite technology includes support for virtual network operators, traffic management, intelligent routing, quality of services, and other features. Some of these features are nearly unique to satellite communications, such as acceleration services to mitigate the impact of latency. Some, such as traffic enforcement, service accounting, and media services (including content rights management) are common among most access networks. Some, such as mobility services, are similar to those employed in cellular systems but are tailored to the much larger reach of satellites.

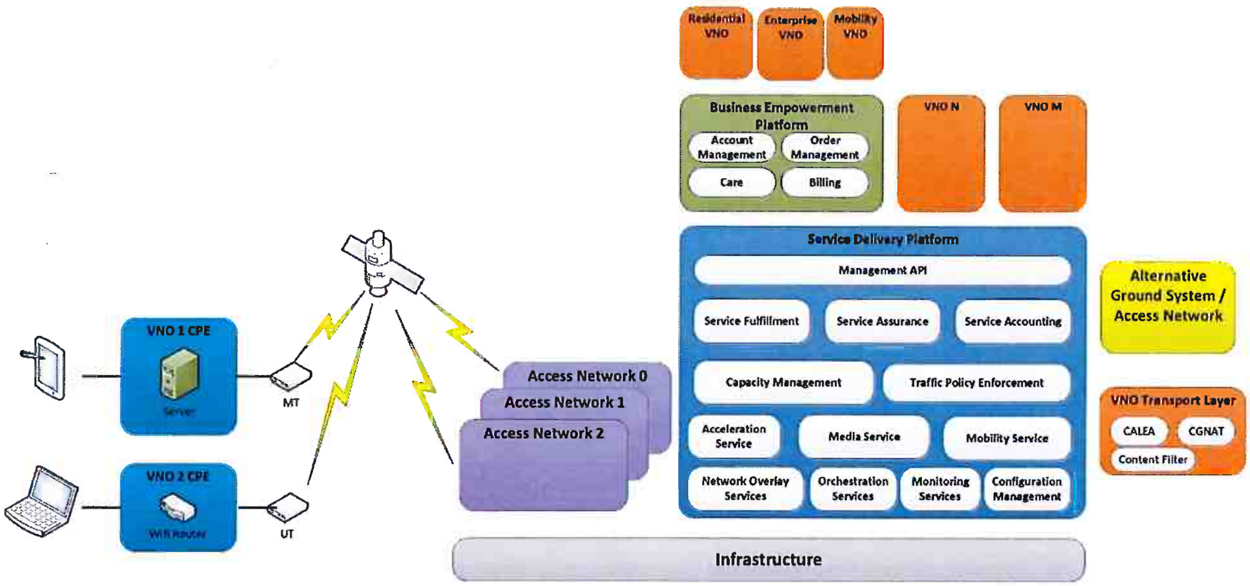

Figure 4: Satellite Ground System Components

Data can be routed between satellite beams within a satellite network, between satellite networks, and between satellite and terrestrial networks. This allows consistent, seamless connectivity for individual users whether they are in the air, on the water, in a vehicle or train, at home, in town, or in the office. The networks support multicast as well as unicast data efficiently.

Advanced satellite systems also include dynamic configuration management elements to enable flexible adaptation of device behavior suitable for operating across networks. This allows the networks to adapt over time and to change behavior as necessary to compensate for link dynamics.

Satellite Spectrum Technological Advancements

Commercial satellite networks have relied on access to the 27.5 – 30 GHz band (Ka Band) for over two decades to provide critical connectivity around the world. Today, over 130 GSO Ka band satellites are now in orbit, providing a wide range of services. Many more Ka band satellites (both GSO and NGSO) are under construction to meet the growing demand for service, and need to use the full 2.5 gigahertz of Ka band spectrum both to meet this demand,

and because the Ka band orbital arc is becoming increasingly congested. While satellite use of the Ka band has grown exponentially in the past few decades, the terrestrial mobile service simply did not develop in the Ka band, even though the ITU's Table of Frequency Allocations also provided an opportunity for that to occur.

For next generation satellites to provide high capacity connectivity, they need continued access to spectrum, and to employ the existing technologies that allow the spectrum to be used up to its technological limit. Modern satellite technology has developed to the point where it extensively employs frequency reuse technologies in which the same frequency band is used by one satellite to provide connectivity to many diverse locations at the same time by creating separate spatially isolated or orthogonal beams. Similarly, many different satellites use the same frequency band to provide connectivity to the same location. This is possible because each ground-to-satellite connection is from a different direction. The ground antenna can be a traditional parabolic dish, a horn array with mechanical steering, or an electrically-steered phased array.

In fact, satellite technology has advanced to the point that today's satellite broadband systems are approaching "Shannon's Limit" in terms of spectral efficiency.[vi] Access to adequate spectrum is now the primary limiting factor in extending satellite broadband networks to address all of the unserved and underserved around the world, no matter whether they live in metropolitan areas or remote communities.[vii]

Benefits for Consumers, Businesses, and Governments Provided by Satellite <u>Today</u>: Vertical Examples

As we enter a golden age of next gen satellite vast new opportunities come into view

Satellite is a vital part of the 5G ecosystem and is uniquely situated to solve key digital inclusion challenges, and expand global digital opportunity. As the world is blanketed with high speed broadband access, the opportunities become even greater, the technologies more transformative, and the impacts even more profound. Satellite systems already offer speeds today of up to 100 Mbit/s. Satellites currently under construction are capable of offering 1 Gbit/s, lightning-fast broadband speeds.

Connecting the unconnected: Today, more than ever, access to high speed broadband is an opportunity equalizer and economic accelerator. What once was a luxury is a necessity today. However, 3.9 billion people around the globe still do not have access to the Internet, and around one-third of the world's inhabitants still do not own a personal mobile phone.[viii] High-quality and cost-effective satellite broadband is playing an increasingly important role in addressing this digital divide across the globe, for the unserved and underserved who exist everywhere, including in the most rural and remote areas of the world where it remains uneconomical for terrestrial or cellular services to build. The nature of satellite's wide coverage ensures that all communities within a satellite network's footprint receive the same quality of service, whether they are in metropolitan areas or remote communities.

- In many cases, the digitally disconnected are the ones who can benefit most when they gain access to the global Internet and are digitally included. Connecting these people is essential for supporting freedom of information and speech, accelerating developing economies, improving access to education, empowering women and minorities, and advancing democratic societies. This is why the UN's 2030 Agenda for Sustainable Development has recognized that "global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies,"[ix] and the UN's Human Rights Council has declared Internet access to be a basic human right.[x] Satellite technology helps meet these objectives by blanketing the globe with this digital opportunity, extending access beyond the reach of terrestrial networks, and transforming the economics of global broadband reach. Indeed, among the UN's Sustainable Development Goals, the achievement of 38 targets depends upon universal and affordable access to broadband and the technologies needed to access broadband.[xi] Satellite systems not only play an essential role in extending broadband connectivity globally, they also provide the connectivity for extending scalable and efficient network solutions globally. By taking advantage of satellite's geographically independent cost structure to extend connectivity, satellite today is helping provide connectivity to tens of millions of fixed and mobile end-user devices everywhere, including areas that are not adequately connected via terrestrial networks.

- It is also why the ITU's recently concluded Plenipotentiary Conference in Dubai, UAE, adopted modifications to Resolution 203 on Connectivity to broadband networks (Rev. Dubai, 2018) inviting Member States "to facilitate connectivity to satellite and terrestrial broadband networks, including enabling access to spectrum, as appropriate, as one important component of access to broadband services and applications, including to remote, underserved and unserved areas."

Enabling communications on the move. Satellite broadband is helping expand economic opportunity everywhere – on the ground, in the air, across the seas, and around the globe. Advances in technology make it possible today to deliver high-speed satellite broadband communications to consumers and businesses on the move – whether on an airplane (while waiting to take off, and at 35,000 feet), on a ship in the middle of the ocean, on a tractor in a remote and rural farm, on a bus or train in a city, or in an emergency vehicle speeding down the freeway on the way to a hospital. Already more than a thousand airplanes flying billions of air miles are accessing satellite-enabled high-speed Wi-Fi capable of streaming Internet and movies right to the seat. Wi-Fi on aircraft has become so popular that there are often more connected devices than passengers on planes. Well over 60 million electronic devices already connect every year to satellite-enabled Wi-Fi on airplanes and this number is expected to increase exponentially to hundreds of millions in just the next 3-5 years as more aircraft become connected. Satellite's unique ability to provide connectivity across moving platforms is essential for enabling people with 5G devices to connect while on the move.

Extending Wi-Fi service. Satellite-based Wi-Fi services today connect users in metropolitan areas as well as unserved and underserved markets within the satellite network's coverage area. Satellite-based Wi-Fi is extending high-speed broadband access in unique ways to urban city centers, community recreation centers, airports, stores and shops. At the same time, large numbers of towns and villages worldwide have little to no Internet access. To address these broadband-challenged locations, satellite-powered hotspot service connects people in small villages and towns to the online world – affordably and reliably. Many people in these villages and towns have mobile smartphones, yet many do not have Internet service. By bringing a satellite-powered community 5G Wi-Fi service to these villages, made available through a shared satellite terminal, the residents gain access to high-speed connectivity. For example, today nearly one million people in thousands of locations that don't have 3G or 4G services can now connect their smartphones thanks to satellite-powered community Wi-Fi hotspots.

Unlocking new digital health opportunities. With too many people living in areas with only sporadic and even diminishing access to quality health care, satellite broadband technologies that span distance *today* are extending connected care *everywhere*. What was once a dream is now becoming a reality, that is, no one should be forced to put their life at risk simply because they live too far from a doctor. Satellite technology is cost-effectively overcoming a rural physician shortage, extending experts to where they are needed most, and delivering services regardless of where the doctor or patient is physically located. For example, satellites today are being used to connect ambulances in transit to doctors in hospitals to improve patient outcomes.

Improving disaster recovery and relief. Satellites networks provide high capacity and instantaneous connection to any place within their wide coverage areas. They are less vulnerable to physical attacks and natural disasters than terrestrial systems and satellite terminals can be rapidly deployed. Satellite networks can be especially important for improving 5G service resiliency, and for rapid deployments of high-speed wireless connectivity in emergencies and for disaster relief.

Advancing a new era of precision agriculture. Satellite broadband is helping enable a whole new generation of precision agriculture opportunities driven by broadband that enables remote farms –especially with livestock sensors, soil monitors, and autonomous farming equipment – far beyond where cell sites are likely to ever be deployed. Autonomous farm equipment, already enabled by satellite positioning technology, often needs connectivity far beyond the line of site of a cell site.

Enabling competition. Just as it has with radio and television services in the past, Ka-band enabled satellite broadband services today are providing market-based competition to terrestrial broadband services. Satellite broadband brings additional service package options, greater capacity for video downloads and streaming, competitive pricing per gigabit, and innovative services to consumers who often have few choices from terrestrial providers. It is essential that satellite networks have secured access to sufficient spectrum to meet consumer demand, without having terrestrial competitors as a gatekeeper for spectrum access.

A holistic approach to 5G users access needs is essential

In order to maximize 5G high-speed broadband opportunities for everyone, it is critical that a holistic approach to the 5G future be considered. This means taking a comprehensive view of spectrum policy across the 5G ecosystem to ensure secure access to the spectrum needed by all technologies to enable universally-available advanced broadband services, including to densely populated cities and underserved and unserved areas, wherever located.

1. **5G solutions must ensure global digital inclusion.** As noted above, today some 3.9 billion people do not have access to the Internet, and around one-third of the world's inhabitants still do not own a personal mobile phone.[xii] This lack of access has created a growing digital chasm between urban and rural, the wealthier and the less well off, and between developed and developing countries.[xiii] It's one of the reasons that embracing a holistic network of networks approach to 5G is essential – enabling the whole panoply of network technologies to work together to extend the reach of broadband connectivity. As satellite systems with over one terabit per second of capacity now under construction are deployed and provide affordable broadband service to everyone, they will play an even more important role in extending digital connectivity to all communities and all citizens, wherever they are located, and wherever they may travel. **Thus, to extend and project the reach of 5G broadband access, both vital satellite technologies and reliable spectrum access for satellites are essential.**

2. **A global spectrum strategy (that preserves critical Ka band spectrum for satellite) is essential for advancing digital opportunities.** Taking a holistic and harmonized approach to spectrum access is critical for ensuring that ubiquitous and consistently high-quality connectivity is spread in the broadest possible ways. At the last ITU World Radiocommunication Conference in 2015 (WRC-15), global leaders took the critical step of providing certainty for existing satellite uses in the Ka-band by declining to study the possible introduction of 5G into the 27.5-29.5 GHz portion of the Ka band (28 GHz). The WRC-15's foundational decisions to preserve the 28 GHz band for satellite growth was based on the recognition that the 28 GHz band is essential for delivering high-speed satellite broadband to end users; and the demand for this spectrum is only increasing. European leaders have built upon this framework and harmonized the 28 GHz band for broadband satellite, which makes the band unavailable for 5G terrestrial access. In the wake of the WRC-15 decision, the satellite industry has invested billions in deploying many new networks that operate in the 28 GHz band (as well as the adjacent 29.5-30 GHz band segment), the benefits of which are described above. Technical studies from both 5G and satellite interests show that the 5G terrestrial access being proposed is incompatible with existing satellite operations in the 28 GHz band. Nevertheless, terrestrial wireless network manufacturers and carriers have suggested reopening the debate and repurposing the 28 GHz band for 5G terrestrial access. Continued certainty on use of the Ka band, including the 28 GHz band, is essential both for the continued operation of existing satellite broadband, and enabling the continued provision of satellite services as a part of the 5G network of networks, to extend the 5G opportunity. **Thus, satellite broadband must be allowed to flourish and innovate in the Ka band with the certainty that the spectrum will not be opened for incompatible services.**

3. **This is not a choice between terrestrial 5G and satellite-enabled broadband.** There is more than enough spectrum for terrestrial 5G services in other bands being explored as a part of the WRC-19 agenda without denying satellite broadband the 28 GHz band spectrum that it currently uses. In fact, as a variety of 5G interests have indicated, the low and mid-band spectrum, beyond the 33+ gigahertz that the WRC-19 will consider, is much more attractive for 5G terrestrial access. 5G can be accommodated in 33 gigahertz of spectrum that the ITU is studying for use in 5G that doesn't include the 28 GHz band or the adjacent 29.5-30 GHz part of the Ka band.[xiv]

4. **Satellite access to the 28 GHz band is essential to prevent a balkanization of digital opportunity.** Sterilizing the 28 GHz band with unilateral national 5G spectrum strategies could severely impede opportunities everywhere – particularly in neighboring countries. The coverage areas and economies of scale necessary to bridge the digital divide require satellite broadband to have a broad footprint. One of the major advantages of satellite communications is that their beams can cover large areas, across borders. The only logical solution is for countries to continue to embrace satellite broadband use of the 28 GHz band and not make it available for incompatible 5G cellular use. Failure to do so would mean that true 5G – and the broad benefits of its network of networks approach – could not be delivered to all the world's population, and the vast satellite-enabled broadband opportunity would be balkanized and curtailed.

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[i] McKinsey, The great Transformer: The impact of the Internet on economic growth and prosperity. https://www.mckinsey.com/~/media/McKinsey/Industries/High%20Tech/Our%20Insights/The%20great%20transformer/MGI_Impact_of_Internet_on_economic_growth.ashx

[ii] Wireless Broadband Alliance, 5G networks. https://www.wballiance.com/wireless-broadband-alliance-calls-for-industry-cooperation-to-harmonize-the-integration-approaches-of-wi-fi-with-5g/

[iii] ECC Report 280, Satellite Solutions for 5G, at 11, https://www.ecodocdb.dk/download/e1f5f839-ba17/ECCRep280.pdf.

[iv] CISCO: Global Mobile Data Traffic Forecast Update, 2016–2021 White Paper

[v] ECC Report 280, Satellite Solutions for 5G, at 13, https://www.ecodocdb.dk/download/e1f5f839-ba17/ECCRep280.pdf.

Viasat

vi See https://www.gaussianwaves.com/2008/04/channel-capacity/. Today's satellite systems provide actual transmissions at near the maximum capacity that theoretically can be achieved over a given amount of spectrum. This means that making more spectrum available is the only way to increase satellite capacity and serve more end users.

vii These points were recently highlighted by Dr. Pace, the Executive Secretary of the White House National Space Council: "The United States has a strong and entrepreneurial satellite communications industry, available to engage in global competition.... The United States has a strong and entrepreneurial satellite communications industry, available to engage in global competition... There's an urgent need to provide reasonable protections for satellite gateway earth stations in certain frequency bands, as well as protection for satellite end user terminals in core satellite bands ... It's for those these reasons that the National Space Council is examining how the Department of State, Commerce and the FCC can better coordinate to ensure the protection and stewardship of spectrum necessary for space commerce. https://spacenews.com/space-council-seeking-to-protect-satellite-spectrum/.

viii https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.18-2017-PDF-E.pdf

ix https://sustainabledevelopment.un.org/post2015/transformingourworld

x https://www.article19.org/data/files/Internet_Statement_Adopted.pdf

xi Among the UN's Sustainable Development Goals (SDGs) there are no fewer than 38 targets whose achievement will depend upon universal and affordable access to ICT and Broadband. https://www.broadbandcommission.org/about/Pages/default.aspx

xii https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.18-2017-PDF-E.pdf

xiii https://news.itu.int/broadband-sustainable-development/

xiv The current WRC Agenda for the 2019 Conference has identified several bands under WRC 2018 Agenda Item 1.13 for possible identification for terrestrial IMT-2020 (also known as 5G). These bands include: 24.25-27.5 GHz, 37-40.5 GHz, 42.5-43.5 GHz, 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz and 81-86 GHz (Proposed IMT Bands). Other bands (31.8-33.4 GHz, 40.5-42.5 GHz and 47-47.2 GHz) are being considered for co-primary allocation to the mobile service and identification as well to the terrestrial component of IMT.