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**PLENARY MEETING**

**Addendum 6 to  
Document 6331-E  
5 September 2019  
Original: English**

**Member States of the Inter-American Telecommunication Commission (CITEL)**

**PROPOSALS FOR THE WORK OF THE CONFERENCE**

**Agenda item 1.6**

1.6 to consider the development of a regulatory framework for non-GSO FSS satellite systems that may operate in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space), in accordance with Resolution **159 (WRC-15)**;

**BACKGROUND INFORMATION:**

Article **22** of the Radio Regulations contains provisions to ensure compatibility of non-GSO FSS operations with GSO networks for the 14/11 GHz and 30/20 GHz bands. Among these provisions are uplink and downlink equivalent power flux density (epfd<sub>↑</sub> and epfd<sub>↓</sub>) limits to protect GSO networks from unacceptable interference pursuant to RR No. **22.2**. There are currently no defined technical provisions for sharing between non-GSO systems and GSO networks in the 50/40 GHz frequency bands. Moreover, there are no existing mechanisms in the RR establishing coordination procedures applicable to non-GSO systems operating within the FSS allocations in frequency bands in the 37.5 to 51.4 GHz range, such as application of RR No. **9.12**.

To address these issues, and the uncertainty they create among potential operators of non-GSO FSS satellite systems in this 50/40 GHz range, WRC-15 established agenda item 1.6 and associated Resolution **159 (WRC-15)** for WRC-19.

Resolution **159 (WRC-15)** discusses the development of new technologies in the Fixed Satellite Service (FSS) in frequency bands above 30 GHz that would allow for the provision of high-capacity and low-cost communications in all parts of the world, especially in remote and isolated areas. This Resolution considers that satellite constellations in both geostationary-satellite orbits (GSO) and non-geostationary-satellite orbits (NGSO) would allow for the implementation of these new technologies in the FSS bands and that the Radio Regulations should enable the introduction of such technologies to ensure efficient use of the radio spectrum.

Resolution **159 (WRC-15)** resolves to invite the ITU-R to conduct and complete in time for WRC-19 studies on the regulatory provisions to enable the operation of NGSO FSS satellite systems in the above mentioned frequency bands, including sharing studies with GSO, EESS, and RAS.

The proposals below present a regulatory solution for providing certainty and technical provisions to allow for sharing between non-GSO FSS systems and for protection of co-frequency GSO networks and adjacent-band EESS (passive) systems under WRC-19 AI 1.6. The proposals have been developed based on the results of ITU-R studies called for in Resolution **159 (WRC-15)**, and identify a methodology to allow for maximum spectrum efficiency for non-GSO FSS systems, while protecting operations of GSO networks from operations of non-GSO FSS systems. This proposal also provides a regulatory solution to ensure that aggregate emissions from operating non-GSO FSS systems do not exceed aggregate protection requirements of GSO networks.

**For sharing between GSO and non-GSO systems:**

Regarding the protection of GSO systems, CITELE supports the following approach of defining in the Radio Regulations:

- a) a maximum value for the time allowance for degradation exceeding the minimum short-term performance objectives, in terms of C/N, of a set of GSO reference links due to the interference caused by a single non-geostationary system, as well as the aggregate value for all NGSO FSS systems; and
- b) a maximum value for the decrease in the time-averaged spectral efficiency (throughput) caused by a single non-GSO system, as well as the aggregate value for all NGSO FSS systems, into a set of GSO reference links using adaptive coding and modulation to satisfy the long-term performance objectives

This proposal is similar to Method A of Issue 1 in the CPM Report, with new Resolutions that contain both the calculation procedures and GSO reference links for sharing between non-GSO systems and GSO networks.

**For sharing between NGSO systems:**

Studies on sharing conditions between non-GSO FSS systems operating in the frequency bands 37.5-42.5 GHz (space-to-Earth) and 47.2-48.9 GHz (limited to feeder links only), 48.9-50.2 GHz and 50.4-51.4 GHz (all Earth-to-space) have shown the possible effectiveness of mitigation techniques such as orbital angle avoidance and earth station site diversity in assisting NGSO operators to achieve compatibility between the non-GSO FSS systems studied.

To address sharing considerations between NGSO systems, that the use of the bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) by non-GSO FSS systems should be subject to coordination procedures under No. **9.12**.

**For the protection of EESS (passive) systems and modifications to Resolution 750 (Rev. WRC15):**

For the band 36-37 GHz, based on the results of studies, EESS (passive) systems operating in the 36- 37 GHz band and non-GSO FSS systems are compatible and no regulatory measures are required to address the compatibility between these two services.

For the frequency band 50.2-50.4, it is proposed to modify Resolution **750 (Rev. WRC-15)** to introduce new out of band emission limits for both GSO and non-GSO FSS stations. Studies have shown that GSO FSS systems alone cause exceedance to the EESS (passive) protection criteria and

that in order to allow the aggregate interference from both GSO and non-GSO FSS stations emission to meet these criteria, modifications to both limits are needed.

The proposed limits are independent of the type of earth station antenna. It is recognized that small ubiquitously-deployed user terminals greatly outnumber larger gateway-type stations. Further consideration of whether additional limits to address the effect of aggregate interference from such FSS user terminals may be required. Additionally, FSS user terminals generally operate with lower transmit power into their antennas, and as such may be able to accommodate a reduction in out-of-band emissions.

With respect to non-GSO FSS systems, the use of mitigation techniques in the bands adjacent to the 50.2-50.4 GHz band would obviate the need for stringent levels of unwanted emissions. These methods include angular avoidance, uplink power control and other operational means. Less stringent out of band emission limits could be considered if such mitigation techniques are shown to reduce the interference into EESS and can be mandatory. This can be studied in time for WRC-19 and could lead to additional proposals.

## ARTICLE 5

### Frequency allocations

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

**MOD IAP/6331A6/1**

**34.2-40 GHz**

Allocation to services		
Region 1	Region 2	Region 3
<b>37.5-38</b>	FIXED FIXED-SATELLITE (space-to-Earth) <a href="#">ADD 5.A16</a> MOBILE except aeronautical mobile SPACE RESEARCH (space-to-Earth) Earth exploration-satellite (space-to-Earth) 5.547	
<b>38-39.5</b>	FIXED FIXED-SATELLITE (space-to-Earth) <a href="#">ADD 5.A16</a> MOBILE Earth exploration-satellite (space-to-Earth) 5.547	
<b>39.5-40</b>	FIXED FIXED-SATELLITE (space-to-Earth) 5.516B MOBILE MOBILE-SATELLITE (space-to-Earth) Earth exploration-satellite (space-to-Earth) 5.547 <a href="#">ADD 5.A16</a>	

**Reasons:** To insert provisions for coordination among non-GSO satellite services

**MOD IAP/6331A6/2**

**40-47.5 GHz**

Allocation to services		
Region 1	Region 2	Region 3
<b>40-40.5</b>	EARTH EXPLORATION-SATELLITE (Earth-to-space) FIXED FIXED-SATELLITE (space-to-Earth) 5.516B MOBILE MOBILE-SATELLITE (space-to-Earth) SPACE RESEARCH (Earth-to-space) Earth exploration-satellite (space-to-Earth) <a href="#">ADD 5.A16</a>	

<b>40.5-41</b> FIXED FIXED-SATELLITE (space-to-Earth) <u>ADD 5.A16</u> BROADCASTING BROADCASTING-SATELLITE Mobile  5.547	<b>40.5-41</b> FIXED FIXED-SATELLITE (space-to-Earth) 5.516B <u>ADD 5.A16</u> BROADCASTING BROADCASTING-SATELLITE Mobile Mobile-satellite (space-to-Earth) 5.547	<b>40.5-41</b> FIXED FIXED-SATELLITE (space-to-Earth) <u>ADD 5.A16</u> BROADCASTING BROADCASTING-SATELLITE Mobile  5.547
<b>41-42.5</b>	FIXED FIXED-SATELLITE (space-to-Earth) 5.516B <u>ADD 5.A16</u> BROADCASTING BROADCASTING-SATELLITE Mobile 5.547 5.551F 5.551H 5.551I	
<b>47.2-47.5</b>	FIXED FIXED-SATELLITE (Earth-to-space) 5.552 <u>ADD 5.A16</u> MOBILE 5.552A	

**Reasons:** To insert provisions for coordination among non-GSO satellite services

**MOD IAP/6331A6/3**

**47.5-51.4 GHz**

Allocation to services		
Region 1	Region 2	Region 3
<b>47.5-47.9</b> FIXED FIXED-SATELLITE (Earth-to-space) 5.552 <u>ADD 5.A16</u> (space-to-Earth) 5.516B 5.554A MOBILE	<b>47.5-47.9</b> FIXED FIXED-SATELLITE (Earth-to-space) 5.552 <u>ADD 5.A16</u> MOBILE	
<b>47.9-48.2</b>	FIXED FIXED-SATELLITE (Earth-to-space) 5.552 <u>ADD 5.A16</u> MOBILE 5.552A	
<b>48.2-48.54</b> FIXED FIXED-SATELLITE (Earth-to-space) 5.552 <u>ADD 5.A16</u> (space-to-Earth) 5.516B 5.554A 5.555B MOBILE	<b>48.2-50.2</b> FIXED FIXED-SATELLITE (Earth-to-space) 5.516B 5.338A 5.552 <u>ADD 5.A16</u> MOBILE	

<p><b>48.54-49.44</b> FIXED FIXED-SATELLITE (Earth-to-space) 5.552 <b>ADD</b> <b>5.A16</b> MOBILE 5.149 5.340 5.555</p>	
<p><b>49.44-50.2</b> FIXED FIXED-SATELLITE (Earth-to-space) <b>MOD</b> 5.338A 5.552 <b>ADD 5.A16</b> (space-to-Earth) 5.516B 5.554A 5.555B MOBILE</p>	<p>5.149 5.340 5.555</p>
<p><b>50.2-50.4</b></p>	<p>EARTH EXPLORATION-SATELLITE (passive) SPACE RESEARCH (passive) 5.340</p>
<p><b>50.4-51.4</b></p>	<p>FIXED FIXED-SATELLITE (Earth-to-space) 5.338A <b>ADD 5.A16</b> MOBILE Mobile-satellite (Earth-to-space)</p>

**Reasons:** To insert provisions for coordination among non-GSO satellite services

**ADD IAP/6331A6/4**

**5.A16** The use of the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) by a non-GSO-satellite system in the fixed-satellite service or mobile satellite-service is subject to the application of the provisions of No. **9.12** for coordination with other non-GSO-satellite systems in the fixed-satellite service and/or non-GSO satellite systems in the mobile satellite service, but not with non-GSO systems in other services. Draft new Resolution **[IAP/A16] (WRC-19)** shall also apply, and No. **22.2** shall continue to apply. (WRC-19)

**Reasons:** To address coordination among non-GSO FSS systems in the 50/40 GHz bands and to indicate that the provisions in the Draft New Resolution **[IAP/A16] (WRC-19)** shall apply to regulate the protection of GSO networks from the interference caused by non-GSO systems operating co-frequency.

**MOD IAP/6331A6/5**

**5.338A** In the frequency bands 1 350-1 400 MHz, 1 427-1 452 MHz, 22.55-23.55 GHz, 30-31.3 GHz, 49.7-50.2 GHz, 50.4-50.9 GHz, 51.4-52.6 GHz, 81-86 GHz and 92-94 GHz, Resolution 750 (Rev.WRC-19~~5~~) applies. (WRC-19)

**Reasons:** Consequential change

## ARTICLE 9

### Procedure for effecting coordination with or obtaining agreement of other administrations<sup>1, 2, 3, 4, 5, 6, 7, 8, 9</sup> (WRC-15)

#### Section II – Procedure for effecting coordination<sup>12, 13</sup>

##### Sub-Section IIA – Requirement and request for coordination

###### MOD IAP/6331A6/6

**9.35** a) examine that information with respect to its conformity with No. **11.31** <sup>MOD19</sup>;

**Reasons:** To address the publication of the Bureau's examination of the non-GSO single entry limits.

###### MOD IAP/6331A6/7

<sup>19</sup> **9.35.1** The Bureau shall include the detailed results of its examination under No. **11.31** of compliance with the limits in Tables **22-1** to **22-3** or the single entry limits in No. **22.5L** of Article **22**, as appropriate, in the publication under No. **9.38**. (WRC-2019)

**Reasons:** To address the publication of the Bureau's examination of the non-GSO single entry limits.

## ARTICLE 22

### Space services<sup>1</sup>

###### ADD IAP/6331A6/8

**22.5L** A non-GSO satellite system in either the fixed-satellite or mobile-satellite service in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz shall not exceed:

- a single-entry increase of 3% of time allowance for the C/N values associated with the shortest percentage of time specified in the short-term performance objectives of the generic<sup>1</sup> GSO reference links; and
- a single-entry permissible allowance of at most 3% reduction in time-averaged throughput (spectral efficiency) calculated on an annual basis for the generic GSO reference link using adaptive coding and modulation. The procedures and methodologies specified in Resolution

<sup>1</sup> 22.5L.1 Generic links are comprised of parametric link budget parameters and are used for the purpose of determining the compliance of a non-GSO system with respect to 22.5L. The generic link parameters are found in Table 1 of Annex 1 to Resolution [IAP/A16] (WRC-19).

[IAP/A16-A] shall be used for the calculations. The epfd levels from the non-GSO FSS system should be derived using the most recent version of Recommendation ITU-R S.1503.

**ADD IAP/6331A6/9**

**22.5M** 10) Administrations operating or planning to operate non-GSO-satellite systems in either the fixed-satellite or mobile-satellite service in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz shall ensure that the aggregate interference to GSO FSS, MSS, and BSS networks caused by all non-GSO FSS and non-GSO MSS systems operating in these frequency bands does not exceed 10% of the short-term and long-term performance objectives of GSO satellite networks by applying the provisions of draft new Resolution **[IAP/A16] (WRC-19)**.

**Reasons:** Based on ITU-R studies, the detailed technical regulatory provisions presented above will introduce technical regulatory provisions into the Radio Regulations that will enable the introduction of non-GSO satellite systems that will protect GSO networks and provide for maximum spectral efficiency for simultaneous operations of non-GSO system and GSO network operations in the 50/40 GHz bands.

**Reasons:** Based on ITU-R studies, the detailed technical regulatory provisions presented above will introduce technical regulatory provisions into the Radio Regulations that will enable the introduction of non-GSO satellite systems that will protect GSO networks and provide for maximum spectral efficiency for simultaneous operations of non-GSO system and GSO network operations in the 50/40 GHz bands.

**ADD IAP/6331A6/10**

**DRAFT NEW RESOLUTION [IAP/A16-A] (WRC-19)**

**Application of Article 22 of the Radio Regulations to the protection of geostationary fixed-satellite service and broadcasting-satellite service networks from non-geostationary fixed-satellite service systems in the 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz frequency bands**

The World Radiocommunication Conference (2019),

*Considering*

- a) that geostationary (GSO) and non-geostationary (non-GSO) fixed-satellite service (FSS) networks may operate in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz;
- b) that this conference adopted RR Nos. **22.5L** and **22.5M**, which contain single-entry and aggregate limits for non-GSO FSS systems in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz to protect GSO networks operating in the same frequency bands;
- c) that ITU-R has developed Recommendation ITU-R S.1503 to provide a methodology on how to compute the equivalent power flux density (epfd) for the calculation of interference from any one non-GSO system into potentially affected GSO earth stations and satellites;

*recognizing*

- a) that, in accordance with calculations utilizing Recommendation ITU-R S.1503, the verification of the worldwide epfd interference of any one non-GSO system can be carried out by a



set of generic link budgets having characteristics that encompass global GSO network deployments that are independent of any specific geographic locations;

b) that the aggregate interference levels from multiple non-GSO FSS systems will be related to the actual number of systems providing service to a particular region and sharing a frequency band based on the single-entry operational use of each system;

c) that Recommendation ITU-R S.1503 does not provide guidance on the modelling of interference from multiple non-GSO systems into GSO networks;d) that the calculation of the aggregate impact from multiple non-GSO systems to GSO networks would benefit from the modelling of non-GSO systems into operational GSO reference links,

*resolves*

that during the examination under Nos. **9.35** and **11.31**, the generic technical characteristics of GSO satellite networks contained in Annex 1 shall be used in conjunction with the methodology in Annex 2 to determine compliance with No. **22.5L**;

2 that notified frequency assignments to non-GSO FSS systems shall receive a favourable finding under No. **11.31** with respect to the single-entry provision given in No. **22.5L**, if *resolves 1* is satisfied, otherwise the non-GSO satellite system will receive an unfavourable finding under No. **11.36**;

3 that if the Bureau is unable to examine non-GSO FSS systems subject to the single-entry provision given in No. **22.5L** due to a lack of available software, the notifying administration shall send the Bureau a commitment that the non-GSO FSS system complies with the limits given in **22.5L**;

4 that notified frequency assignments to non-GSO FSS systems that cannot be assessed under *resolves 2* shall receive a qualified favourable finding under No. **9.35** with respect to No. **22.5L**, if *resolves 3* is satisfied, otherwise the non-GSO satellite system will receive an unfavourable finding under No. **11.36**;

5 that if an administration believes that a non-GSO FSS system, for which the commitment referred to in *resolves 3* was sent, has the potential to exceed the limits given in No. **22.5L**, it may request additional information from the notifying administration with regard to the compliance with these limits. Both administrations shall cooperate to resolve any difficulties, with the assistance of the Bureau, if so requested by either of the parties.

6 that *resolves 3, 4 and 5* shall no longer be applied after the Bureau has communicated to all administrations via a Circular Letter that validation software adequate to address is available and the Bureau is able to verify compliance with the limit in No. **22.5L**

*invites the ITU Radiocommunication Sector*

to study and, as appropriate, develop software for the procedures outlined in *resolves 1 to 6* above;

## ANNEX 1 TO RESOLUTION [IAP/A16-A] (WRC-19)

### **Generic GSO satellite system characteristics for evaluation of compliance with single-entry requirements for non-GSO systems**

The data in Annex 1 are to be regarded as a range of technical characteristics of generic worldwide GSO network links that are independent of any specific geographic location, to be used only for assessing non-GSO system impact to GSO networks and not as a basis for coordination between satellite networks.

Note: in order for the BR to do an evaluation of 22.5L, it is necessary to identify which GSO reference links use ACM.

**Table 1A: Generic parameters of GSO links to be used in examination of the downlink (space-Earth) impact from any one non-GSO system**

1	Generic Link Parameters = service					Parameters
	Link type	User #1	User #2	User #3	Gateway	
1.1	Frequency (GHz)	40	40	40	40	$f_{GHz}$
1.2	e.i.r.p. density (dBW/MHz)	44	44 /	44 /	44 /	
1.3	Equivalent Antenna Diameter (m)	.45	0.6	2	9	$D_m$
1.3	Bandwidth (MHz)	1	1	1	1	
1.4	ES antenna gain pattern	S.1428	S.1428	S.1428	S.1428	
1.5	ES antenna efficiency	0.65	0.65	0.6	0.55	$\eta$
1.6	Additional link losses (dB)	1	1	1	1	$L_a$
1.7	Additional link margin (dB)	3	3	3	3	
2	Generic Link Parameters - Parametric Analysis	Parametric Cases for Evaluation				
2.1	e.i.r.p. density variation	$\pm 3$ dB from value in 1.2				$EIRP$
2.2	Elevation angle (deg)	20	55	90		
	Additional link margin (dB)	9.1	5.4	5.0		
2.2 *	Latitude (deg)	0, 30, 61.8	0, 30	0		
2.3	0.01% Rain Rate (mm/hr)	10, 50, 100				
2.4	Height of ES (m)	0, 500, 1000,				
2.5	ES noise temperature (K)	250				$T$
2.6	Threshold C/N (dB)**	-2.5, 2.5, 5, 10 /				$\frac{C}{N}$

\* For item 2.2, these three groups of data are be considered as unique sets of data to be used in the larger, overall set of total possible permutations. For example, 20 degrees of elevation angle will consider three different latitudes of 0, 30 and 61.8 degrees while 90 degrees of elevation will only consider a latitude of 0 degrees in combination with two possible rain heights of 4.5 and 5 km. The above parameters are chosen as representative propagation parameters for purposes of calculations of rain fade statistics. These rain fades are representative of other geographic locations.

\*\* The above C/N values represent thresholds for

- -2.5 dB for links using QPSK R1/4 coding
- 2.5 dB for links using QPSK R1/2 coding

- 5 dB for links using QPSK R1/2 coding or 8-PSK R1/2 coding
- 10 dB for links using 8-PSK R3/4 coding or 16-QAM links with R1/2 coding
- Each of the above C/N threshold values shall be evaluated as part of the generic GSO links in a parametric analysis for fixed rate links. A link using ACM is capable of operating across all the above MOD-COD range but for the purposes of the BR's evaluation of No. **22.5L**, the lowest C/N value from the table above shall be used.

**Table 1-B – Example Implementation using generic link parameters (space-to-Earth)**

<b>3 Example Implementation – Link Calculation</b>		<b>First Case parametric taken for examples</b>				<b>Equations to Calculate Downlink Availability</b>
3,1	ES Peak gain (dBi)	34.7	46.1	56.2	68.9	$G_{max} = 20\log(4\pi R^2 / \lambda^2) + 20\log(P_t) + 10\log(G)$
3.2	Path length (km)	39554.4	39554.4	39554.4	39554.4	$D = R_e \left( \frac{R_{ES}}{R_E} - \cos^2(\epsilon) - \sin(\epsilon) \right)$
3.3	Path loss (dB)	216.4	216.4	216.4	216.4	$L_{sp} = 92.44 + 20\log(f_{MHz}) + 20\log(D_{km})$
3.4	Unfaded wanted single strength (dBW/MHz)	-138.8	-127,3	-117.2	-104.5	$C_u = EIRP - L_{fs} + G_{rx} - L_o$
3.5	Noise plus margin (dBW/MHz)	-141.6	-141.6	-141.6	-141.6	$N + M = 10\log_{10}(\sigma^2) + 60 + k + M_0$
<b>4 Validation Checks</b>						
4.1	Margin for rain fade (dB)	2.8	14.3	24.4	37.1	$A_{rain} = C_u - (N + M) - \frac{C}{N}$
4.2	$PF_{Dval}$ (dB(W/(m <sup>2</sup> · MHz)))	-118.9	-118.9	-118.9	-118.9	$PF_{D} = EIRP - 10\log_{10}(\pi D_e^2)$

The following checks are done to ensure the combination of Generic and Parametric Parameters are valid:

1. The rain margin should be greater than zero  $A_{rain} > 0$
2. The calculated availability, p, should be in the range  $1 - (0.001 \leq p \leq 10\%)$
3. The PFD should be below the limits in Article 21

**Table 2A: Generic link parameters of GSO links to be used in examination of the uplink (Earth-space) impact from any one non-GSO network**

<b>1</b>	<b>Generic Link Parameters = service</b>					
	Link type	Link #1	Link #2	Link #3		
1.1	Frequency (GHz)	48	48	48		$f_{GHz}$
1.2	ES EIRP (dBW/Hz)	0	-5	-10		

1.3	Spot beam size (deg)	0.3	0.3	0.3	
1.4	ITU-R S.672 sidelobe level (dB)	-25	-25	-25	
1.5	ES antenna efficiency	0.6	0.6	0.6	
1.6	Additional link losses (dB)	1	1	1	$L_0$
1.7	Additional link margin (dB)	3	3	3	
<b>2 Generic Link Parameters - Parametric Analysis</b>					
<b>2.1 e.i.r.p. density variation</b>		<b>± 3 dB from value in 1.2</b>			
2.2*	Elevation angle (deg)	20	55	90	$\epsilon$
	Additional link margin (dB)	9.1	5.4	5.0	$M_0$
	Latitude (deg)	0, 30, 61.8	0, 30	0	
2.3	0.01% Rain Rate (mm/hr)	10, 50, 100			
2.4	Height of ES (m)	0, 500, 1000			
2.5	Satellite noise temperature (K)	500			
2.6	Threshold C/N (dB)*	-2.5, 2.5, 5, 10			

\* For item 2.2, these three groups of data are be considered as unique sets of data to be used in the larger, overall set of total possible permutations. For example, 20 degrees of elevation angle will consider three different latitudes of 0, 30 and 61.8 degrees while 90 degrees of elevation will only consider a latitude of 0 degrees in combination with two possible rain heights of 4.5 and 5 km.

\*\*The above C/N values represent thresholds for

- -2.5 dB for links using QPSK R1/4 coding
- 2.5 dB for links using QPSK R1/2 coding
- 5 dB for links using QPSK R1/2 coding or 8-PSK R1/2 coding
- 10 dB for links using 8-PSK R3/4 coding or 16-QAM links with R1/2 coding
- Each of the above C/N threshold values shall be evaluated as part of the generic GSO links in a parametric analysis for fixed rate links. A link using ACM is capable of operating across all the above MOD-COD range but for the purposes of the BR's evaluation of No. **22.5L**, the lowest C/N value from the table above shall be used.

**Table 2-B:– Example Implementation using generic link parameters (Earth-to-space)**

<b>3</b>	<b>Example Implementation – Link Calculation</b>	<b>First Case parametric cases taken for examples</b>	<b>Equations to Calculate Uplink Availability</b>
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3,1	ES Peak gain (dBi)	55.1	55.1	55,1		
3.2	Path length (km)	39554.4	36780.4	39554.4		$\sigma = \sigma_0 \left( \frac{R_0}{R_1} - \cos^2(\theta) - \sin^2(\theta) \right)$
3.3	Path loss (dB)	216.4	215.8	216.4		$L_{p0} = 92.45 + 20 \log_{10}(d_{km}) + 20 \log_{10}(f_{MHz})$
3.4	Unfaded wanted single strength (dBW/MHz)	-118.4	-117.7	-118.4		$C_{u0} = EIRP - L_{p0} + G_{RX} - L_{c0}$
3.5	Noise plus margin (dBW/MHz)	-140.2	-141.6	-141.6		$N + M = 10 \log_{10}(T) + 60 + k + M_0$
<b>4 Validation Checks</b>						
4.1	Margin for rain fade (dB)	11.8	23.3	23.3		$A_{rain} = C_{u0} - (N + M) - \frac{C}{N}$

The following checks are done to ensure the combination of Generic and Parametric Parameters are valid:

1. The rain margin should be greater than zero  $A_{rain} > 0$
2. The calculated availability, p, should be in the range  $1 - (0.001 \leq p \leq 10\%)$

## ANNEX 2 TO RESOLUTION [IAP/A16-A] (WRC-19)

### Description of parameters and procedures for the evaluation of interference from any one non-GSO system into global set of GSO generic links

This Annex provides an overview of the process to validate compliance with the single-entry permissible interference of a non-GSO system into GSO networks using the generic link parameters in Annex 1 and the interference impact using the latest version of Recommendation ITU-R S.1503. The procedure to determine the compliance with the single-entry permissible interference relies on the following principles.

*Principle 1:* The two time-varying sources of link performance degradation considered in the verification are link fading (from rain, cloud, gas and scintillation attenuation) using the characteristics of the link and interference from non-GSO systems.

The total  $C/N$  in the reference bandwidth for a given carrier is:

$$C/N = C(N_T + I) \quad (1)$$

where:

- $C$ : wanted power (W) in the reference bandwidth, which varies as a function of fades and also as a function of transmission configuration.
- $N_T$ : total system noise (W) in the reference bandwidth (i.e. the thermal power)
- $I$ : time-varying interference power (W) in the reference bandwidth generated by other networks.

*Principle 2:* The calculation of spectral efficiency is focused on satellite systems utilizing adaptive coding and modulation (ACM) by calculating the throughput degradation as a function of  $C/N$ , which varies depending on the propagation and interference impacts on the satellite link.

*Principle 3:* This analysis assumes that during a fading even in the downlink direction the interfering carrier is attenuated by the same amount as the wanted carrier. This assumption results in some under-estimation of the total downlink degradation under circumstances where interference peaks and downlink fading occur simultaneously.

*Principle 4:* It is assumed that for a GSO network the internetwork interference caused by the earth and space station emissions of all other satellite networks operating in the same frequency band and that can potentially cause interference of time-varying nature, are responsible for at most 10% of the time allowance for the BER (or C/N value) specified in the short-term performance objectives of the desired network.

By applying the following steps, the single-entry interference impact from a non-GSO system on the availability and spectral efficiency of a GSO link is determined. The generic GSO link parameters of Annex 1 are used, considering all possible parametric permutations, in conjunction with the worst-case geometry (“WCG”) epdf outputs, of the latest version of Recommendation ITU-R S.1503. The output of Recommendation ITU-R S.1503 is a set of interference statistics that a non-GSO system creates into each generic GSO link. The generic link parameters of Annex 1 are then used in conjunction with the interference statistics from ITU-R S.1503 to evaluate the impact of a non-GSO system into GSO networks.

**For each generic GSO link from Annex 1:**

*Step 1:* Determine  $x_{fade}$ , the pdf of the propagation fading plus other time variations in the characteristics of the link. These statistics can be calculated using the procedures of the latest version of Recommendation ITU-R P.618.

*Step 2:* Determine  $y_{int}$ , the effect of epdf interference from the non-GSO system under examination using the procedures of Recommendation ITU-R S.1503

*Step 3:* Determine  $z_{conv}$ , the discrete convolution by combining each bin of the rain degradation, pdf ( $x_{fade}$ ), with each value of the interference degradation, pdf ( $y_{int}$ ). For each pair of degradation values, the combined degradation value is determined by the product of the  $x_{fade}$  and  $y_{int}$  degradation values (or equivalently, the sum of the log values in dB) and the combined probability, computed as the product of each of the individual probabilities, is added to the appropriate combined degradation pdf ( $z_{conv}$ ) bin.

For the downlink direction, a modified convolution is used This modified convolution is equivalent to a regular discrete convolution with the exception that the interference degradation values ( $y_i$ ) are first reduced by the applicable rain attenuation, i.e., the  $j^{th}$  rain loss value,  $(L_R)_j$ , from the rain degradation pdf bin ( $x_j$ ) for which it is being combined.

The probability density function (pdf) of  $z_{conv}$  is the modified convolution of the pdf of  $x_{fade}$  and  $y_{int}$  The total C/N degradation  $z_{conv}$  (dB) is therefore:

$$z_{conv} = x_{fade} * y_{int} \quad (2)$$

*Step 4:* Using the results of the convolution procedures to obtain the pdf  $p_z(z_{conv})$  described above for the total degradation for the propagation fade ( $x_{fade}$ ) of each variation of the generic GSO reference links given in Annex 1 and the WCG interference calculations of the non-GSO system ( $y_{int}$ ), the conditions for the single entry case can be verified:

$$p_z(z_{conv}) = p_{xfade} * p_{yint} \quad (3)$$

Conditions to be verified for compliance are:

- For the short term performance objectives of generic GSO reference links:

$$P(z \leq z_j) \leq 0.93 p_j / 100 \text{ for } j = 1, \dots, J \quad (4)$$

where

the constant is derived by noting that corresponding to principle 4, 90% (a 0.9 fraction) of the time allowance is allocated to propagation effects and non-time varying interference and that RR No. 22.5L allows for a single-entry increase of 3% (a 0.03 fraction) of time allowance due to non-GSO operations.

- For the long term performance objectives related to the spectrum efficiency (SE) of GSO reference links:

$$(SE_{xfade} - SE_{zconv})/SE_{xfade} \leq 0.03 \quad (5)$$

and

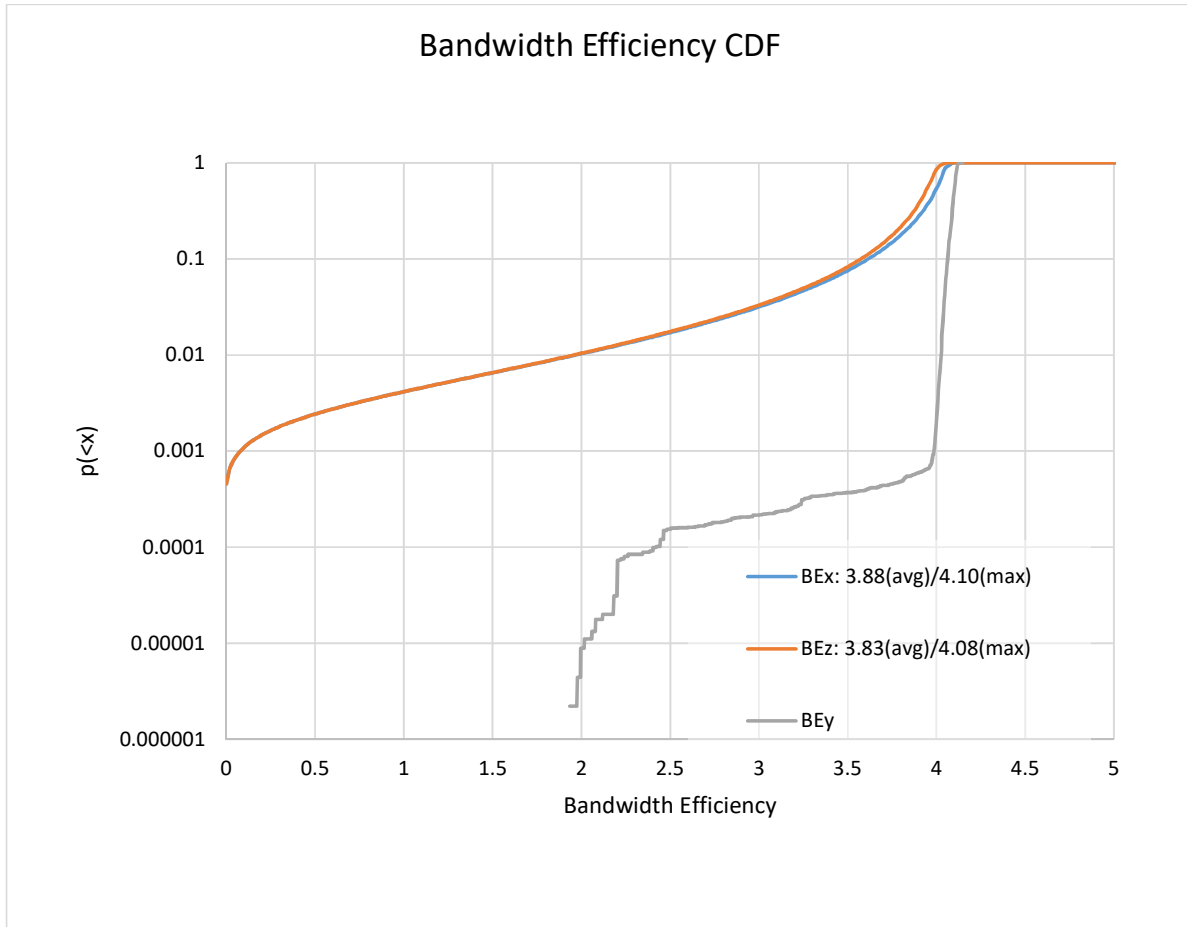
$$SE_i = \int \left( 1 - \frac{\eta(\gamma(\tau_i))}{\eta_{max}} \right) dT_{\%} \approx \sum SE_i(T_{\%}) \Delta T_{\%} \quad (6)$$

Where  $\eta_{max}$  is the maximum achievable spectral efficiency of the link and  $\eta(\gamma(T\%))$  is the spectral efficiency for an achievable C/N at a given percentage of time over one year,  $\gamma(T\%)$ .  $SE_{xfade}$  represents the operational capacity of the FSS link due to propagation fading over a time period of one year and  $SE_{zconv}$  represents the operational capacity of the FSS link due to the combined mechanism of propagation and interference over a period of one year. These equations represent the conditions to be checked to ensure that the percent degraded throughput caused by interference fades does not exceed a certain threshold, when compared to fades caused by propagation conditions over a long term period of operation.

This procedure is repeated for each generic GSO link from Annex 1, considering all parametric permutations and validation checks.

For an example of the use of percent degraded throughput, an analysis was conducted from a non-GSO system into a FSS GSO earth station located in New York operating at 40.0 GHz. The figure below presents the consideration of bandwidth efficiency for this analysis. In the figure, the blue curve ( $SE_{xfade}$ ) represents the spectrum efficiency CDF due to propagation fade, the green curve ( $SE_y$ ) represents the spectrum efficiency CDF resulting from non-GSO interference into the GSO earth station, and the brown curve represents spectrum efficiency ( $SE_{zconv}$ ) CDF resulting from the convolution of the propagation fades and the interference fades.

**Figure 1: Analysis of non-GSO interference into GSO ES**



In terms of determining the percent degraded throughput, the difference between the spectrum efficiency from the CDF curves of SEzconv and SExfade should not exceed 3% for single entry and 10% for aggregate contributions. For this particular example, the bandwidth efficiency for the long term operation of this system due to propagation alone is determined to be 3.88 bps and the spectrum efficiency for the long term operation of this system due to propagation and interference is determined to be 3.83 bps. Thus, in applying the concept of equation, this analysis produces:

$$(3.88-3.83)/3.88 * 100\% = 1.29\% \text{ percent degraded throughput}$$

Note: SE and BE (see Figure 1) are identical.

**ADD IAP/6331A6/11**

**DRAFT NEW RESOLUTION [IAP/A16] (WRC-19)**

**Protection of geostationary satellite FSS, MSS, and BSS networks from unacceptable interference from non-GSO satellite FSS systems in the 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz frequency bands and from non-GSO MSS systems in the 39.5-40.0 GHz and 40.0-42.5 GHz frequency bands**

The World Radiocommunication Conference (2019),



*considering*

- a) that the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space), and 50.4-51.4 GHz (Earth-to-space) are allocated, *inter alia*, on a primary basis to the fixed-satellite service (FSS) in all Regions;
- b) that the frequency bands 40.5-41 GHz and 41-42.5 GHz are allocated, on a primary basis to the broadcasting-satellite service (BSS) in all regions;
- c) that the frequency bands 39.5-40 GHz and 40-40.5 GHz are allocated, on a primary basis to the mobile-satellite service (MSS) in all regions;
- d) that Article **22** contains regulatory and technical provisions on sharing between geostationary satellite orbit (GSO) satellite networks and non-geostationary satellite orbit (non-GSO) FSS systems in these bands in *considering a)*;
- e) that, in accordance with No. **22.2**, non-GSO systems shall not cause unacceptable interference to GSO FSS and broadcasting-satellite service (BSS) networks and, unless otherwise specified in the Radio Regulations, shall not claim protection from GSO FSS and BSS satellite networks;
- f) that non-GSO FSS systems would benefit from the certainty that would result from the quantification of technical regulatory provisions required for protection of GSO satellite networks operating in the bands referred to in *considering a)*, b), and c) above;
- g) that GSO FSS, MSS and BSS networks can be protected without placing undue constraints on non-GSO FSS systems in the bands in *considering a)*, b), and c) above;
- h) that WRC-19 modified Article **22** to limit single-entry and aggregate permissible time allowances for degradation in terms of C/N by non-GSO FSS systems to GSO satellite networks, in the bands in *considering a)*;
- i) that the operating parameters and orbital characteristics on non-GSO FSS systems are usually inhomogeneous;
- j) that, as a result of this inhomogeneity, the time allowance for the C/N value specified in the short-term performance objective associated with the shortest percentage of time (lowest C/N) or decrease of the long-term throughput (spectral efficiency) caused to reference GSO links by non-GSO FSS systems is likely to vary between such systems;
- k) that, the aggregate interference levels from multiple non-GSO FSS systems will be related to the actual number of systems sharing a frequency band based on the single-entry operational use of each system;
- l) that to protect GSO FSS, MSS, and BSS networks in the frequency bands listed in *considering a)* from unacceptable interference, the aggregate impact of interference caused by all co-frequency non-GSO FSS systems should not exceed the maximum aggregate impact specified in No. **22.5M** of the Radio Regulations;
- m) that the aggregate level of the time allowance for the C/N value specified in the short-term performance objective associated with the shortest percentage of time (lowest C/N) of GSO reference link is likely to be the summation of single-entry levels caused by non-GSO FSS systems,

*recognizing*

- a) that non-GSO FSS systems are likely to need to implement interference mitigation techniques, such as orbital avoidance angles, Earth station site diversity, and GSO arc avoidance, to facilitate sharing of frequencies and to protect GSO networks;
- b) that administrations operating or planning to operate non-GSO FSS systems will need to agree cooperatively through consultation meetings to share the aggregate interference impact allowance in a manner to achieve the level of protection for GSO FSS, MSS and BSS networks that is stated in No. **22.5M** of the Radio Regulations;
- c) that, taking into account the single-entry allowance in No. **22.5L**, the aggregated impact of all non-GSO FSS systems can be computed without the need for specialized software tools based on the results of the single-entry impact for each system;
- d) the need for administrations operating non-GSO FSS systems in the frequency bands listed in *considering a)* to agree cooperatively through consultation meetings takes on particular urgency whenever there could be aggregate interference at levels higher than the aggregate impact allowance from operational non-GSO FSS systems;
- e) that representatives of administrations operating or planning to operate GSO FSS, MSS and BSS networks are encouraged to be involved in the determinations made pursuant to *recognizing b)*;
- f) that in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space), signals experience high levels of attenuation due to atmospheric effects such as rain, cloud cover and gaseous absorption;
- g) that given these expected high levels of fading, it is desirable for GSO networks and non-GSO FSS systems to implement fade counter measures such as automatic level control, power control and adaptive coding and modulation,

*noting*

- a) that Resolution **[IAP/A16-A] (WRC-19)** contains the methodology for determining conformity to the single-entry and aggregate limits to protect the GSO networks;
- b) that Recommendation ITU-R S.1503 provides recommendations on how to compute the EPFD from a non-GSO FSS system into victim earth stations and satellites;
- c) that Resolution **[IAP/A16-A] (WRC-19)** contains GSO satellite system characteristics to be considered in non-GSO/GSO frequency sharing analyses in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz;

*resolves*

- 1 that administrations operating or planning to operate non-GSO FSS and non-GSO MSS systems in the frequency bands referred to in *considering a)* above, shall, in collaboration, take all necessary steps, including, if necessary, by means of appropriate modifications to their systems or networks, to ensure that the aggregate interference into GSO FSS, MSS and BSS satellite networks caused by such systems operating co-frequency in these frequency bands does not exceed the aggregate protection limits as determined pursuant to No. **22.5M** of the Radio Regulations;

2 that to carry out the obligations in *resolves* 1 above, administrations operating or planning to operate non-GSO FSS and non-GSO MSS systems shall agree cooperatively through regular consultation meetings referred to in recognizing b) to ensure that operations of all non-GSO networks do not exceed the aggregate level of protection for GSO satellite networks;

3 that to carry out the obligation of *resolves* 2, administrations shall use the generic GSO satellite characteristics listed in Resolution **[IAP/A16-A] (WRC-19)** to determine the aggregate impact to GSO networks;

4 that administrations operating or planning to operate non-GSO FSS and non-GSO MSS systems (including representatives of administrations operating GSO FSS, MSS and BSS networks) participating in a consultation meeting are allowed to use their own software in conjunction with any software tools used by the BR for the calculation and verification of the aggregate limits, subject to the agreement of the consultation meeting;

5 that *resolves* 2 and 3 above begin to apply when a second non-geostationary FSS systems with frequency assignments in the frequency bands referred to in *considering a)* meets the criteria listed in Annex 2 to this Resolution;

6 that administrations, in carrying out their obligations under *resolves* 1, shall take into account only those non-GSO FSS and non-GSO MSS systems with frequency assignments in the frequency bands referred to in *considering a)* above that have met the criteria listed in Annex 2 to this Resolution through appropriate information provided to consultation meetings referred to in *resolves* 2;

7 that administrations, in developing agreements to carry out their obligations under *resolves* 1, shall establish mechanisms to ensure that all potential FSS and MSS system and network notifying administrations and operators are given full visibility of, and the opportunity to participate in the consultation process;

8 that, taking into account *resolves* 2, failure by a responsible administration operating or planning to operate non-GSO FSS and non-GSO MSS systems to participate in the consultation process does not relieve that administration of obligations under *resolves* 1 above, nor does it remove their systems from consideration in any aggregate calculations by the consultation group;

9 that each administration, in the absence of an agreement reached at consultation meetings referred to in *resolves* 2, shall ensure that each of its non-GSO FSS and non-GSO MSS systems subject to this Resolution are operated in accordance with reduced single-entry interference impact allowances, calculated by the apportionment of the aggregate allowance commensurate to the number of simultaneously operating non-GSO systems, so as to ensure that the aggregate allowance in No. **22.5M** is not exceeded in operation;

10 that, in specific implementation of *resolves* 8 above, if the consultation discussions show that there would be an exceedance of the aggregate allowance from non-GSO FSS and non-GSO MSS systems in operation, every operational non-GSO FSS and non-GSO MSS system shall reduce its emissions by making appropriate modifications to their operations such that the amount of exceedance is eliminated, commensurate to the number of systems in operation and taking into account the stage of deployment of the systems in question;

11 that the administrations participating at the consultation meetings referred to in *resolves* 2 shall designate one convener to be responsible for communicating to the Bureau, such as shown in Annex 1, that the results of the aggregate non-GSO system operational calculation and sharing determinations made in application of *resolves* 1, 8 and 9 above, without regard to whether such determinations result in any modifications to the published characteristics of their respective systems,

providing a draft record of each Consultation meeting, and providing the approved record for posting by the Bureau on the ITU website;

*invites the Radiocommunication Bureau*

to participate in the consultation meetings mentioned in *resolves 2* as an observer and to provide advice as necessary of the aggregate interference impact calculation performed according to *resolves 1*;

*instructs the Radiocommunication Bureau*

1 to publish in the International Frequency Information Circular (BR IFIC), the information referred to in *resolves 7*;

2 to exclude the aggregate calculations given in No. **22.5M** as part of a satellite network examination under No. **11.31**,

## ANNEX 1 TO RESOLUTION [IAP/A16] (WRC-19)

### **List of GSO network characteristics and format of the result of the aggregate calculation to be provided to BR for publication for information**

#### **I GSO network characteristics to be used in the calculation of aggregate emissions from non-GSO FSS and MSS systems**

##### **I-1 GSO Network Characteristics**

Annex 1 of Resolution [IAP/A16-A] (WRC-19).

##### **I-2 Non-GSO satellite system constellation parameters**

For each non-GSO satellite system, the following parameters should be provided to BR for publication in the aggregate calculation:

- Notifying administration;
- Number of space stations used in aggregate calculation;
- Single entry contribution to the aggregate value of each non-GSO FSS and each non-GSO MSS systems.

#### **II. Results of the aggregate calculation**

Results of aggregate calculation including systems studied and assessment results

## ANNEX 2 TO RESOLUTION [IAP/A16] (WRC-19)

### **List of criteria for the application of *resolves 5***

1 Submission of Notification Publication Information.

2 Entry into satellite manufacturing or procurement agreement, and entry into satellite launch agreement.

The non-GSO FSS system operator should possess:

- i) evidence of a binding agreement for the manufacture or procurement of its satellites;  
and

- ii) evidence of a binding agreement to launch its satellites.

The manufacturing or procurement agreement should identify the contract milestones leading to the completion of manufacture or procurement of satellites required for the service provision, and the launch agreement should identify the launch date, launch site and launch service provider. The notifying administration is responsible for authenticating the evidence of agreement.

The information required under this criterion may be submitted in the form of a written commitment by the responsible administration.

3 As an alternative to satellite manufacturing or procurement and launch agreements, clear evidence of guaranteed funding arrangements for the implementation of the project would be accepted. The notifying administration is responsible for authenticating the evidence of these arrangements and for providing such evidence to other interested administrations in furtherance of its obligations under this Resolution.

**Reasons:** A mechanism is required to ensure that only those administrations operating or planning to operate non-GSO FSS or MSS systems in the frequency bands under study individually or in collaboration through consultation meetings take all possible steps to ensure that the aggregate long-term interference does not exceed the performance criteria of GSO reference links.

**MOD IAP/6331A6/12**

## RESOLUTION 750 (REV.WRC-15)

### **Compatibility between the Earth exploration-satellite service (passive) and relevant active services**

The World Radiocommunication Conference ([Sharm el-Sheikh Geneva, 201519](#)),

*considering*

*a)* that primary allocations have been made to various space services such as the fixed-satellite service (Earth-to-space), the space operation service (Earth-to-space) and the inter-satellite service and/or to terrestrial services such as the fixed service, the mobile service and the radiolocation service, hereinafter referred to as “active services”, in frequency bands adjacent or nearby to frequency bands allocated to the Earth exploration-satellite service (EESS) (passive) subject to No. **5.340**;

*b)* that unwanted emissions from active services have the potential to cause unacceptable interference to EESS (passive) sensors;

*c)* that, for technical or operational reasons, the general limits in Appendix 3 may be insufficient in protecting the EESS (passive) in specific frequency bands;

*d)* that, in many cases, the frequencies used by EESS (passive) sensors are chosen to study natural phenomena producing radio emissions at frequencies fixed by the laws of nature, and therefore shifting frequency to avoid or mitigate interference problems is not possible;

*e)* that the frequency band 1 400-1 427 MHz is used for measuring soil moisture, and also for measuring sea-surface salinity and vegetation biomass;

*f)* that long-term protection of the EESS in the frequency bands 23.6-24 GHz, 31.3-31.5 GHz, 50.2-50.4 GHz, 52.6-54.25 GHz and 86-92 GHz is vital to weather prediction and

disaster management, and measurements at several frequencies must be made simultaneously in order to isolate and retrieve each individual contribution;

g) that, in many cases, the frequency bands adjacent or nearby to passive service frequency bands are used and will continue to be used for various active service applications;

h) that it is necessary to ensure equitable burden sharing for achieving compatibility between active and passive services operating in adjacent or nearby frequency bands,

*noting*

a) that the compatibility studies between relevant active and passive services operating in adjacent and nearby frequency bands are documented in Report ITU-R SM.2092;

b) that the compatibility studies between IMT systems in the frequency bands 1 375-1 400 MHz and 1 427-1 452 MHz and EESS (passive) systems in the frequency band 1 400-1 427 MHz are documented in Report ITU-R RS.2336;

c) that Report ITU-R F.2239 provides the results of studies covering various scenarios between the fixed service, operating in the frequency band 81-86 GHz and/or 92-94 GHz, and the Earth exploration-satellite service (passive), operating in the frequency band 86-92 GHz;

d) that Recommendation ITU-R RS.1029 provides the interference criteria for satellite passive remote sensing,

*noting further*

that, for the purpose of this Resolution:

- point-to-point communication is defined as radiocommunication provided by a link, for example a radio-relay link, between two stations located at specified fixed points;
- point-to-multipoint communication is defined as radiocommunication provided by links between a single station located at a specified fixed point (also called “hub station”) and a number of stations located at specified fixed points (also called “customer stations”),

*recognizing*

a) that studies documented in Report ITU-R SM.2092 do not consider point-to-multipoint communication links in the fixed service in the frequency bands 1 350-1 400 MHz and 1 427-1 452 MHz;

b) that, in the frequency band 1 427-1 452 MHz, mitigation measures, such as channel arrangements, improved filters and/or guardbands, may be necessary in order to meet the limits of unwanted emission for IMT stations in the mobile service specified in Table 1-1 of this Resolution;

c) that, in the frequency band 1 427-1 452 MHz, IMT mobile stations typically perform better than the equipment specifications as stated by relevant standards organizations, which may be taken into account in meeting the limits specified in Table 1-1 (see also sections 4 and 5 of Report ITU-R RS.2336),

*resolves*

1 that unwanted emissions of stations brought into use in the frequency bands and services listed in Table 1-1 below shall not exceed the corresponding limits in that table, subject to the specified conditions;

2 to urge administrations to take all reasonable steps to ensure that unwanted emissions of active service stations in the frequency bands and services listed in Table 1-2 below do not exceed the recommended maximum levels contained in that table, noting that EESS (passive) sensors

provide worldwide measurements that benefit all countries, even if these sensors are not operated by their country;

3 that the Radiocommunication Bureau shall not make any examination or finding with respect to compliance with this Resolution under either Article 9 or 11.

TABLE 1-1

EESS (passive) band	Active service band	Active service	Limits of unwanted emission power from active service stations in a specified bandwidth within the EESS (passive) band <sup>1</sup>
1 400-1 427 MHz	1 427-1 452 MHz	Mobile	-72 dBW in the 27 MHz of the EESS (passive) band for IMT base stations -62 dBW in the 27 MHz of the EESS (passive) band for IMT mobile stations <sup>2, 3</sup>
23.6-24.0 GHz	22.55-23.55 GHz	Inter-satellite	-36 dBW in any 200 MHz of the EESS (passive) band for non-geostationary (non-GSO) inter-satellite service (ISS) systems for which complete advance publication information is received by the Bureau before 1 January 2020, and -46 dBW in any 200 MHz of the EESS (passive) band for non-GSO ISS systems for which complete advance publication information is received by the Bureau on or after 1 January 2020
31.3-31.5 GHz	31-31.3 GHz	Fixed (excluding HAPS)	For stations brought into use after 1 January 2012: -38 dBW in any 100 MHz of the EESS (passive) band. This limit does not apply to stations that have been authorized prior to 1 January 2012
50.2-50.4 GHz	49.7-50.2 GHz	Fixed-satellite <u>GSO</u> (E-to-s) <sup>4</sup>	<p>For <u>GSO</u> stations brought into use after the date of entry into force of the Final Acts of WRC-07 <u>and brought into use prior to 1 January 2024</u>:</p> <p>-10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi</p> <p>-20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBi</p> <p><u>For GSO stations brought into use on or after 1 January 2024</u>:</p> <p><u>-25 dBW into the 200 MHz of the EESS (passive) band for stations with elevations angles less than 80°</u></p> <p><u>-45 dBW into the 200 MHz of the EESS (passive) band for stations with elevations angles greater than or equal to 80°</u></p>

EESS (passive) band	Active service band	Active service	Limits of unwanted emission power from active service stations in a specified bandwidth within the EESS (passive) band <sup>1</sup>
<u>50.2-50.4 GHz</u>	<u>49.7-50.2 GHz</u>	<u>Fixed-satellite non-GSO (E-to-s)<sup>4</sup></u>	<p><u>For non-GSO stations brought into use after the date of entry into force of the Final Acts of WRC-07 and brought into use before the date of entry into force of the Final Acts of WRC-19:</u></p> <p><u>-10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi</u></p> <p><u>-20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBi</u></p> <p><u>For non-GSO stations brought into use on or after the date of entry into force of the Final Acts of WRC-19:</u></p> <p><u>-35 dBW into the 200 MHz of the EESS (passive) band for stations</u></p>
50.2-50.4 GHz	50.4-50.9 GHz	<u>Fixed-satellite GSO (E-to-s)<sup>4</sup></u>	<p><u>For GSO stations brought into use after the date of entry into force of the Final Acts of WRC-07 and brought into use prior to 1 January 2024:</u></p> <p><u>-10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi</u></p> <p><u>-20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBi</u></p> <p><u>For GSO stations brought into use on or after 1 January 2024:</u></p> <p><u>-25 dBW into the 200 MHz of the EESS (passive) band for stations with elevations angles less than 80°</u></p> <p><u>-45 dBW into the 200 MHz of the EESS (passive) band for stations with elevations angles greater than or equal to 80°</u></p>



EESS (passive) band	Active service band	Active service	Limits of unwanted emission power from active service stations in a specified bandwidth within the EESS (passive) band <sup>1</sup>
<u>50.2-50.4 GHz</u>	<u>50.4-50.9 GHz</u>	<u>Fixed-satellite non-GSO (E-to-s)<sup>4</sup></u>	<p><u>For non-GSO stations brought into use after the date of entry into force of the Final Acts of WRC-07 and brought into use before the date of entry into force of the Final Acts of WRC-19:</u></p> <p><u>-10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi</u></p> <p><u>-20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBi</u></p> <p><u>For non-GSO stations brought into use on or after the date of entry into force of the Final Acts of WRC-19:</u></p> <p><u>-35 dBW into the 200 MHz of the EESS (passive) band for stations</u></p>
52.6-54.25 GHz	51.4-52.6 GHz	Fixed	<p>For stations brought into use after the date of entry into force of the Final Acts of WRC-07:</p> <p>-33 dBW in any 100 MHz of the EESS (passive) band</p>

<sup>1</sup> The unwanted emission power level is to be understood here as the level measured at the antenna port.

<sup>2</sup> This limit does not apply to mobile stations in the IMT systems for which the notification information has been received by the Radiocommunication Bureau by 28 November 2015. For those systems, -60 dBW/27 MHz applies as the recommended value.

<sup>3</sup> The unwanted emission power level is to be understood here as the level measured with the mobile station transmitting at an average output power of 15 dBm.

<sup>4</sup> The limits apply under clear-sky conditions. During fading conditions, the limits may be exceeded by earth stations when using uplink power control.

TABLE 1-2

EESS (passive) band	Active service band	Active service	Recommended maximum level of unwanted emission power from active service stations in a specified bandwidth within the EESS (passive) band <sup>1</sup>
1 400-1 427 MHz	1 350-1 400 MHz	Radiolocation <sup>2</sup>	-29 dBW in the 27 MHz of the EESS (passive) band
		Fixed	-45 dBW in the 27 MHz of the EESS (passive) band for point-to-point
		Mobile	-60 dBW in the 27 MHz of the EESS (passive) band for mobile service stations except transportable radio-relay stations -45 dBW in the 27 MHz of the EESS (passive) band for transportable radio-relay stations
	1 427-1 429 MHz	Space operation (E-to-s)	-36 dBW in the 27 MHz of the EESS (passive) band
	1 427-1 429 MHz	Mobile except aeronautical mobile	-60 dBW in the 27 MHz of the EESS (passive) band for mobile service stations except IMT stations and transportable radio-relay stations <sup>3</sup> -45 dBW in the 27 MHz of the EESS (passive) band for transportable radio-relay stations
		Fixed	-45 dBW in the 27 MHz of the EESS (passive) band for point-to-point
	1 429-1 452 MHz	Mobile	-60 dBW in the 27 MHz of the EESS (passive) band for mobile service stations except IMT stations, transportable radio-relay stations and aeronautical telemetry stations -45 dBW in the 27 MHz of the EESS (passive) band for transportable radio-relay stations -28 dBW in the 27 MHz of the EESS (passive) band for aeronautical telemetry stations <sup>3</sup>
		Fixed	-45 dBW in the 27 MHz of the EESS (passive) band for point-to-point
31.3-31.5 GHz	30.0-31.0 GHz	Fixed-satellite (E-to-s) <sup>4</sup>	-9 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 56 dBi -20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 56 dBi
86-92 GHz <sup>5</sup>	81-86 GHz	Fixed	-41 - 14( $f$ - 86) dBW/100 MHz for 86.05 ≤ $f$ ≤ 87 GHz -55 dBW/100 MHz for 87 ≤ $f$ ≤ 91.95 GHz where $f$ is the centre frequency of the 100 MHz reference bandwidth expressed in GHz
	92-94 GHz	Fixed	-41 - 14(92 - $f$ ) dBW/100 MHz for 91 ≤ $f$ ≤ 91.95 GHz -55 dBW/100 MHz for 86.05 ≤ $f$ ≤ 91 GHz where $f$ is the centre frequency of the 100 MHz reference bandwidth expressed in GHz

*Notes to Table 1-2:*

- <sup>1</sup> The unwanted emission power level is to be understood here as the level measured at the antenna port.
- <sup>2</sup> The mean power is to be understood here as the total power measured at the antenna port (or an equivalent thereof) in the frequency band 1 400-1 427 MHz, averaged over a period of the order of 5 s.
- <sup>3</sup> The frequency band 1 429-1 435 MHz is also allocated to the aeronautical mobile service in eight Region 1 administrations on a primary basis exclusively for the purposes of aeronautical telemetry within their national territory (No. **5.342**).
- <sup>4</sup> The recommended maximum levels apply under clear-sky conditions. During fading conditions, these levels may be exceeded by earth stations when using uplink power control.
- <sup>5</sup> Other maximum unwanted emission levels may be developed based on different scenarios provided in Report ITU-R F.2239 for the frequency band 86-92 GHz.

**Reasons:** Studies have shown that GSO FSS systems alone cause exceedance the EESS (passive) protection criteria and that in order to allow the aggregate interference from both GSO and NGSO FSS stations emission to meet this criteria modifications to the unwanted emission limits for both GSO and NGSO FSS systems are needed. Since it will be impractical to apply changes to GSO FSS networks that are operational, planned for near term operation or filed, the proposed changes would not apply to any GSO systems whose complete notification information was received by the bureau before January 1, 2024.