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| A close up of a sign  Description automatically generated | **World Radiocommunication Conference (WRC-23)Dubai, 20 November - 15 December 2023** |  |
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| PLENARY MEETING | **Addendum 16 toDocument 44-E** |
|  | **13 October 2023** |
|  | **Original: English** |
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| Member States of the Inter-American Telecommunication Commission (CITEL) |
| Proposals for the work of the Conference |
|  |
| Agenda item 1.16 |

1.16 to study and develop technical, operational and regulatory measures, as appropriate, to facilitate the use of the frequency bands 17.7‑18.6 GHz, 18.8‑19.3 GHz and 19.7‑20.2 GHz (space-to-Earth) and 27.5‑29.1 GHz and 29.5‑30 GHz (Earth-to-space) by non-geostationary fixed-satellite service earth stations in motion, while ensuring due protection of existing services in those frequency bands, in accordance with Resolution **173 (WRC‑19)**;

Background

Multiple non-GSO fixed-satellite service (FSS) systems are currently being planned and are designed to meet the constantly growing demand for broadband connectivity. Over the last few years, the development of broadband connectivity while on the move has been such that users are now expecting the same quality of service when they are travelling than at home, and non-GSO FSS systems are ideally positioned to serve this growing market with low latency.

The last two WRCs have adopted regulatory frameworks for the operations of earth stations in motion (ESIM) communicating with GSO networks (“GSO ESIM”) in the Ka-band. WRC‑15 adopted Resolution **156** **(WRC‑15)** allowing the use of GSO ESIM in the frequency bands 19.7‑20.2 GHz and 29.5‑30.0 GHz, and WRC‑19 adopted Resolution **169 (WRC‑19)** allowing the use of GSO ESIM in the frequency bands 17.7‑19.7 GHz and 27.5‑29.5 GHz.

The development of a harmonized technical and regulatory framework for the use of ESIMs communicating with non-GSO FSS systems (“non-GSO ESIM”) would facilitate the development of and access to affordable broadband connectivity for all regardless of location while ensuring that no harmful interference is caused to other services.

Proposals

ARTICLE 5

Frequency allocations

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

MOD IAP/44A16/1#1880

15.4-18.4 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 17.7-18.1FIXEDFIXED-SATELLITE(space-to-Earth) 5.484A 5.517A ADD 5.A116(Earth-to-space) 5.516MOBILE | 17.7-17.8FIXEDFIXED-SATELLITE(space-to-Earth) 5.517 5.517A ADD 5.A116(Earth-to-space) 5.516BROADCASTING-SATELLITEMobile5.515 | 17.7-18.1FIXEDFIXED-SATELLITE(space-to-Earth) 5.484A 5.517A ADD 5.A116(Earth-to-space) 5.516MOBILE |
|  | 17.8-18.1FIXEDFIXED-SATELLITE(space-to-Earth) 5.484A 5.517A ADD 5.A116(Earth-to-space) 5.516MOBILE5.519 |  |
| 18.1-18.4 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B 5.517A ADD 5.A116(Earth-to-space) 5.520 MOBILE 5.519 5.521 |

MOD IAP/44A16/2#1881

18.4-22 GHz

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| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 18.4-18.6 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B 5.517A ADD 5.A116 MOBILE |
| … |  |  |
| 18.8-19.3 FIXED FIXED-SATELLITE (space-to-Earth) 5.516B 5.517A 5.523A ADD 5.A116 MOBILE |
| … |
| 19.7-20.1FIXED-SATELLITE(space-to-Earth) 5.484A 5.484B 5.516B 5.527A ADD 5.A116Mobile-satellite (space-to-Earth) | 19.7-20.1FIXED-SATELLITE(space-to-Earth) 5.484A 5.484B 5.516B 5.527A ADD 5.A116MOBILE-SATELLITE(space-to-Earth) | 19.7-20.1FIXED-SATELLITE(space-to-Earth) 5.484A 5.484B 5.516B 5.527A ADD 5.A116Mobile-satellite (space-to-Earth) |
| 5.524 | 5.524 5.525 5.526 5.527 5.528 5.529 | 5.524 |
| 20.1-20.2FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.516B 5.527A ADD 5.A116 MOBILE-SATELLITE (space-to-Earth) 5.524 5.525 5.526 5.527 5.528 |

MOD IAP/44A16/3#1882

24.75-29.9 GHz

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| --- |
| 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 5.517A 5.539 ADD 5.A116 MOBILE 5.538 5.540 |
| 28.5-29.1 FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.517A 5.523A 5.539 ADD 5.A116 MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540 |
| … |
| 29.5-29.9FIXED-SATELLITE(Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 ADD 5.A116Earth exploration-satellite(Earth-to-space) 5.541Mobile-satellite (Earth-to-space) | 29.5-29.9FIXED-SATELLITE(Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 ADD 5.A116MOBILE-SATELLITE(Earth-to-space)Earth exploration-satellite(Earth-to-space) 5.541 | 29.5-29.9FIXED-SATELLITE(Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 ADD 5.A116Earth exploration-satellite(Earth-to-space) 5.541Mobile-satellite (Earth-to-space)  |
| 5.540 5.542 | 5.525 5.526 5.527 5.529 5.540  | 5.540 5.542 |

MOD IAP/44A16/4#1883

29.9-34.2 GHz

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| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 29.9-30 FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 ADD 5.A116 MOBILE-SATELLITE (Earth-to-space) Earth exploration-satellite (Earth-to-space) 5.541 5.543 5.525 5.526 5.527 5.538 5.540 5.542 |

**Reasons:** Add a new footnote in RR Article **5** providing the conditions for the operation of non-GSO ESIM.

ADD IAP/44A16/5#1884

5.A116The operation of earth stations in motion communicating with non-geostationary space stations in the fixed-satellite service in the frequency bands 17.7-18.6 GHz (space-to-Earth), 18.8-19.3 GHz (space-to-Earth) and 19.7-20.2 GHz (space-to-Earth), 27.5-29.1 GHz (Earth-to-space) and 29.5-30 GHz (Earth-to-space) shall be subject to the application of Resolution **[IAP‑A116] (WRC‑23)**.     (WRC‑23)

**Reasons:** The objective of this footnote is to make draft new Resolution **[IAP-A116] (WRC-23)** mandatory.

ADD IAP/44A16/6#1885

draft new RESOLUTION [IAP-A116] (WRC‑23)

Use of the frequency bands 17.7‑18.6 GHz, 18.8‑19.3 GHz and 19.7‑20.2 GHz (space-to-Earth) and 27.5‑29.1 GHz and 29.5‑30 GHz (Earth-to-space) by earth stations in motion communicating with non-geostationary space stations in the fixed-satellite service

The World Radiocommunication Conference (Dubai, 2023),

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 (ESIMs) to communicate with space stations of non-geostationary-satellite orbit (non-GSO) fixed-satellite service (FSS) systems (“non-GSO ESIM”) operating in the frequency bands 17.7‑18.6 GHz, 18.8‑19.3 GHz and 19.7‑20.2 GHz (space-to-Earth), and 27.5‑29.1 GHz and 29.5‑30.0 GHz (Earth-to-space);

*b)* that the frequency bands 17.7‑18.6 GHz, 18.8‑19.3 GHz and 19.7‑20.2 GHz (space-to-Earth) and 27.5‑29.1 GHz and 29.5‑30 GHz (Earth-to-space) are allocated to space services and, the frequency bands 17.7‑18.6 GHz, 18.8‑19.3 GHz, and 27.5‑29.1 GHz are allocated to terrestrial services on a primary basis worldwide and, in the countries identified in No. **5.524** of the Radio Regulations, the frequency band 19.7‑20.2 GHz is allocated to the fixed and mobile services on a primary basis; and, in the countries identified in No. **5.542** of the Radio Regulations, the frequency band 29.5‑30 GHz is allocated to the fixed and mobile services on a secondary basis;

*c)* that the frequency bands in *considering b)* are used by a variety of different systems and these existing services and their future development need to be protected without any additional constraints from the operation of non-GSO ESIMs;

*d)* that the frequency band 18.6‑18.8 GHz is allocated to the Earth exploration-satellite service (EESS) (passive) and space research service (SRS) (passive) and that these services need to be protected from operation of non-GSO FSS in the space-to-Earth direction;

*e)* that appropriate regulatory and interference-management mechanisms, including necessary mitigation measures are required for the operation of non-GSO ESIMs to protect other space and terrestrial services which are allocated on a primary basis in the Radio Regulations in the frequency bands mentioned in *considering a)*,

considering further

*a)* that there is no publicly available information on the conditions for coordination agreements reached among administrations regarding non-GSO FSS satellite systems;

*b)* that administrations intending to authorize non-GSO ESIMs, when establishing national licensing rules, may consider adopting other interference management procedures and/or mitigation measures than those contained in this Resolution as long as the provisions in Annex 1 are complied with in cross-border applications;

*c)* that aeronautical and maritime ESIMs operating within the service area of the non-GSO FSS systems with which they communicate may provide service within the territories under the jurisdiction of multiple administrations/countries;

*d)* that this Resolution does not address any technical or regulatory provisions for the operation and use of land ESIMs communicating with non-GSO FSS space stations, and any authorization of land ESIMs remains strictly a national matter, also taking into account the need to avoid cross-border interference,

recognizing

*a)* that the administration authorizing non-GSO ESIMs on the territory under its jurisdiction has the right to require that non-GSO ESIMs referred to above only use those assignments associated with non-GSO FSS systems which have been successfully coordinated, notified, brought into use and recorded in the Master International Frequency Register (MIFR) with a favourable finding under Articles **9** and **11**, including Nos. **11.31**, **11.32** or **11.32A**, where applicable;

*b)* that for cases of incomplete coordination under No. **9.7B** of the non-GSO FSS system with which non-GSO ESIMs communicate, the operation of non-GSO ESIMs in the frequency bands 17.8-18.6 GHz and 19.7-20.2 GHz (space-to-Earth) 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 the provisions of No. **22.2** apply to non-GSO FSS systems with which ESIMs operate in the frequency band 17.7‑17.8 GHz (space-to-Earth) with respect to GSO FSS and GSO BSS networks;

*d)* that under the provisions of No. **22.2**, non-GSO ESIMs in the frequency bands 17.8‑18.6 GHz and 19.7‑20.2 GHz, shall not claim protection from GSO FSS and GSO BSS networks operating in accordance with the Radio Regulations, and non-GSO ESIMs in the frequency bands 27.5‑28.6 GHz and 29.5‑30 GHz shall not cause unacceptable interference to GSO FSS and GSO BSS networks operating in accordance with the Radio Regulations; and No. **5.43A** does not apply in this case;

*e)* that there is no obligation for an administration to authorize/license any non‑GSO ESIMs to operate within the territory under its jurisdiction;

*f)* that a non-GSO FSS system operating in the frequency bands 17.8‑18.6 GHz and 19.7‑20.2 GHz (space-to-Earth) and 27.5‑28.6 GHz and 29.5‑30 GHz (Earth-to-space) in compliance with the epfd limits referred to in Nos. **22.5C**, **22.5D** and **22.5F** is considered as having fulfilled its obligations under No. **22.2** with respect to any geostationary-satellite network;

*g)* that, with respect to GSO FSS networks, in the frequency bands 18.8‑19.3 GHz (space-to-Earth) and 28.6‑29.1 GHz (Earth-to-space) Nos. **9.12A** and **9.13** apply, and No. **22.2** does not apply;

*h)* that, for the use of the frequency bands 17.7‑18.6 GHz, 18.8‑19.3 GHz and 19.7‑20.2 GHz (space-to-Earth) and 27.5‑29.1 GHz and 29.5‑30 GHz (Earth-to-space) by non-GSO FSS systems, No. **9.12** applies,

recognizing further

*a)* that frequency assignments to non-GSO ESIMs need to be notified to the Radiocommunication Bureau (BR);

*b)* that the notification by different administrations of frequency assignments to be used by the same non‑GSO satellite system may create difficulties to identify the responsible administration in case of unacceptable interference;

*c)* that, an administration authorizing the operation of ESIMs within the territory under its jurisdiction may modify or withdraw that authorization at any time,

resolves

1 that, for any aeronautical and/or maritime ESIMs communicating with non-GSO FSS systems within the frequency bands 17.7‑18.6 GHz, 18.8‑19.3 GHz and 19.7‑20.2 GHz (space-to-Earth) and 27.5‑29.1 GHz and 29.5‑30 GHz (Earth-to-space), or parts thereof, the following conditions shall apply:

1.1 with respect to the protection of space services in the frequency bands 17.7‑18.6 GHz, 18.8‑19.3 GHz, 19.7‑20.2 GHz (space-to-Earth), 27.5‑29.1 GHz and 29.5‑30 GHz (Earth-to-space) and in the adjacent frequency band 18.6‑18.8 GHz, non‑GSO ESIMs shall comply with the following conditions:

1.1.1 to prevent potential interference with respect to satellite networks or systems, non-GSO ESIMs characteristics shall remain within the envelope characteristics of typical earth stations associated with the non-GSO FSS system with which ESIMs communicate;

1.1.1.1 for the implementation of *resolves* 1.1.1 above, the notifying administration for the non-GSO FSS system with which the non-GSO ESIMs communicate shall, in accordance with this Resolution, send to the BR Appendix **4** notification information related to the characteristics of the non-GSO ESIMs intended to communicate with that non-GSO FSS system;

1.1.1.2 upon receipt of the notification information referred to in *resolves* 1.1.1.1 above, the Bureau shall examine it with respect to the provisions referred to in *resolves* 1.1.1 above, and publish the result of such examination in the International Frequency Information Circular (BR IFIC);

1.1.2 the notifying administration of the non-GSO FSS system with which the ESIMs communicate shall ensure that the operation of ESIMs complies with the coordination agreements for the frequency assignments of the typical earth station of this non-GSO FSS system obtained under the provisions of Article **9**, taking into account *recognizing a)* above;

1.1.3 taking into account *recognizing f)* above the notifying administrations of the non-GSO FSS system with which the ESIMs communicate shall ensure that non-GSO ESIMs comply with the limits referred to in Nos. **22.5C**, **22.5D** and **22.5F** for the protection of GSO FSS networks operating in the frequency bands 17.8‑18.6 GHz, 19.7‑20.2 GHz (space-to-Earth), 27.5‑28.6 GHz and 29.5‑30 GHz (Earth-to-space);

1.1.4 non-GSO ESIMs shall not claim protection from broadcasting-satellite service feeder-link earth stations operating in accordance with the Radio Regulations in the frequency band 17.7‑18.4 GHz;

1.1.5 with respect to the protection of EESS (passive) operating in the frequency band 18.6‑18.8 GHz, any non-GSO FSS system with an orbital apogee of less than 20,000 km operating in the frequency bands 18.3‑18.6 GHz and 18.8‑19.1 GHz with which aeronautical and/or maritime ESIMs communicate and for which the complete notification information has been received by the Radiocommunication Bureau after 1 January 2025 shall comply with the provisions indicated in Annex 3 to this Resolution;

1.1.5.1 for the implementation of *resolves*1.1.5 above, the notifying administration for the non-GSO FSS system with which the non-GSO ESIMs communicate shall send to the BR the relevant Appendix **4** notification information including the commitment that the operation shall be in conformity with *resolves*1.1.5;

1.2 with respect to the protection of terrestrial services to which the frequency bands 17.7‑18.6 GHz, 18.8‑19.3 GHz, 19.7‑20.2 GHz, 27.5‑29.1 GHz and 29.5‑30 GHz are allocated and that operate in accordance with the Radio Regulations, non-GSO ESIMs shall comply with the following conditions:

1.2.1 receiving non-GSO ESIMs in the frequency bands 17.7‑18.6 GHz and 18.8‑19.3 GHz and 19.7‑20.2 GHz (see No. **5.524**) shall not claim protection from terrestrial services to which those frequency bands are allocated and operate in accordance with the Radio Regulations;

1.2.2 transmitting non-GSO ESIMs in the frequency band 27.5‑29.1 GHz shall not cause unacceptable interference to terrestrial services to which the frequency band is allocated and that operate in accordance with the Radio Regulations, and Annex 1 to this Resolution shall apply;

1.2.3 transmitting non-GSO ESIMs in the frequency band 29.5‑30.0 GHz shall not adversely affect the operations of terrestrial services to which this frequency band is allocated on a secondary basis and that operate in accordance with the Radio Regulations, and limits in Annex 1 to this Resolution shall apply with respect to administrations mentioned in No. **5.542**;

1.2.4 the provisions in this Resolution, including Annex 1, set the conditions for the purpose of protecting terrestrial services from unacceptable interference from aeronautical and maritime non-GSO ESIMs in neighbouring countries in accordance with the provisions included in *resolves* 1.2.2 and 1.2.3 above in the frequency band 27.5‑29.1 GHz and in the frequency band 29.5‑30.0 GHz; however, the requirement not to cause unacceptable interference to, or claim protection from, terrestrial services to which the frequency bands are allocated and operating in accordance with the Radio Regulations remains valid (see *resolves further*3);

1.2.5 the Bureau shall examine, in accordance with the provisions included in *resolves* 1.2.2 and 1.2.3, and with the methodology in Annex 2, the characteristics of aeronautical non-GSO ESIMs with respect to the conformity with the power flux density (pfd) limits on the Earth’s surface specified in Part 2 of Annex 1 and publish the results of such examination in the BR IFIC;

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

3 that the operation of non-GSO ESIMs within the territory, including territorial waters and airspace of an administration, shall be carried out only if authorized by that administration;

4 that the notifying administration of the non-GSO FSS system with which non-GSO ESIMs communicate shall ensure:

4.1 for the operation of A-ESIM and M-ESIM, techniques are employed to maintain adequate antenna pointing accuracy with the associated non-GSO FSS satellite;

4.2 that all necessary measures are taken so that non-GSO ESIMs are subject to permanent monitoring and control by a network control and monitoring centre (NCMC) or equivalent facility in order to comply with the provisions in this Resolution, and are capable of receiving and acting upon at least “enable transmission” and “disable transmission” commands from the NCMC or equivalent facility;

4.3 that measures, when required, are taken to limit the operation of non-GSO ESIMs in the territory, including territorial waters and territorial airspace, under the jurisdiction of the administrations authorizing non-GSO ESIMs;

4.4 that measures are taken so that the A‑ESIM and/or M‑ESIM do not transmit on the territory under the jurisdiction of an administration, including its territorial waters and its national airspace that has not authorized its use;

4.5 that a permanent point of contact shall be designated and provided in the Appendix **4** submission by the notifying administration of the non-GSO FSS satellite systems with which the above-mentioned non-GSO ESIMs communicate for the purpose of tracing any suspected cases of unacceptable interference from non-GSO ESIMs and to immediately respond to requests from the focal point of the authorizing administration;

5 that in case of unacceptable interference caused by any type of non-GSO ESIMs:

5.1 the administration of the country in which the non-GSO ESIM(s) is authorized shall cooperate with an investigation on the matter and provide , to the extent of its ability any required information on the operation of the ESIM(s) and a point of contact to provide such information;

5.2 the administration of the country in which the non-GSO ESIM(s) is authorized and the notifying administration of the non-GSO FSS system with which the aeronautical and maritime non-GSO ESIM(s) communicates shall, jointly or individually, as the case may be and to the extent of ability of the former administration, upon receipt of a report of unacceptable interference, take required action to eliminate or reduce interference to an acceptable level;

6 that the application of this Resolution does not provide regulatory status to non-GSO ESIMs different from that derived from the non-GSO FSS system with which they communicate,

resolves further

1 that the notifying administration for the ESIMs shall send to the BR, when submitting the relevant Appendix **4** data a commitment that, upon receiving a report of unacceptable interference, the notifying administration for the non-GSO system with which ESIMs communicate shall immediately act to eliminate or reduce the interference to an acceptable level upon receiving a report of unacceptable interference (see *resolves*5);

1.1 in case there is more than one administration involved in the notification of frequency assignments of the same non-GSO satellite system with which ESIMs communicate, all those administrations shall be responsible to eliminate any unacceptable interference cases;

2 that, in case of continued unacceptable interference despite the commitment referred to in *resolves further*1, the assignment causing interference shall be submitted to the Radio Regulations Board for review;

3 that compliance with the provisions contained in Annex 1 does not release the notifying administration of the non-GSO satellite system with which ESIMs communicate of its obligations to ensure that non-GSO ESIMs shall not cause unacceptable interference nor claim protection from other services referred to in this Resolution;

4 that, should an administration authorizing aeronautical and/or maritime non-GSO ESIMs agree to less stringent limits than those contained in Annex 1 within the territory under its jurisdiction, such agreement shall not affect other countries that are not party to that agreement,

5. that frequency assignments to non-GSO ESIMs shall be notified by the notifying administration of the non-GSO satellite system in the FSS with which ESIMs communicate;

6 that ESIMs shall be designed and operate so as to cease transmission over the territory of any administration/country from which authorization has not been obtained,

instructs the Director of the Radiocommunication Bureau

1 to take all necessary actions to facilitate the implementation of this Resolution, together with providing any assistance for the resolution of interference, when required;

2 to report to future world radiocommunication conferences any difficulties or inconsistencies encountered in the implementation of this Resolution, including whether or not the responsibilities relating to the operation of aeronautical and maritime non-GSO ESIMs have been properly addressed;

3 to report to future world radiocommunication conferences any difficulties or inconsistencies encountered in the implementation of Recommendation ITU‑R S.1503 for verifying that the non-GSO FSS systems under this Resolution comply with the limits specified in Article **22**,

invites administrations

to collaborate for the implementation of this Resolution, in particular for resolving interference, if any,

instructs the Secretary-General

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

Annex 1 to draft new Resolution [iap-A116] (WRC‑23)

Provisions for maritime and aeronautical non-GSO ESIMs to protect terrestrial services operating in the frequency band 27.5-29.1 GHz and for the frequency band 29.5-30.0 GHz on the territories of administrations mentioned in No. 5.542

The parts below contain provisions to ensure that maritime and aeronautical non-GSO ESIMs do not cause unacceptable interference in neighbouring countries to terrestrial service operations when non-GSO ESIMs operate in frequencies overlapping with those used by terrestrial services at any time to which the frequency band 27.5‑29.1 GHz is allocated and operating in accordance with the Radio Regulations.

The provisions also apply in the frequency band 29.5‑30.0 GHz on the territories of administrations mentioned in No.**5.542**.

Part 1: Maritime non-GSO ESIMs

1 The notifying administration of the non-GSO FSS satellite system with which a maritime ESIMs communicates shall ensure compliance of the maritime ESIMs operating within the frequency band 27.5‑29.1 GHz, or parts thereof, with both of the following conditions for the protection of terrestrial services to which the frequency band is allocated within a coastal State:

1.1 The minimum distance from the low-water mark as officially recognized by the coastal State beyond which maritime ESIMs can operate without the prior agreement of any administration is 70 km within the 27.5-29.1 GHz and 29.5-30.0 GHz frequency band. Any transmissions from maritime ESIMs within the minimum distance shall be subject to the prior agreement of the coastal State(s) concerned.

1.2 The maximum maritime ESIMs e.i.r.p. spectral density towards the territory of any coastal State will be limited to 24.44 dBW in a reference bandwidth of 14 MHz. Transmissions from maritime ESIMs 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 coastal State(s) concerned.

Part 2: Aeronautical non-GSO ESIMs

2 The notifying administration of the non-GSO FSS satellite system with which an aeronautical ESIMs communicates shall ensure compliance of the aeronautical ESIMs operating within the frequency bands 27.5‑29.1 GHz, or parts thereof, with all of the following conditions for the protection of terrestrial services to which the frequency band is allocated:

2.1 When within line-of-sight of the territory of an administration, and above an altitude of 3 km, the maximum pfd produced at the surface of the Earth on the territory of an administration by emissions from a single aeronautical ESIM shall not exceed:

 pfd(θ) = −124.7 (dB(W/(m2 ∙ 14 MHz))) for 0° ≤ θ ≤ 0.01°

 pfd(θ) = −120.9 + 1.9 ∙ logθ (dB(W/(m2 ∙ 14 MHz))) for 0.01° < θ ≤ 0.3°

 pfd(θ) = −116.2 + 11 ∙ logθ (dB(W/(m2 ∙ 14 MHz))) for 0.3° < θ ≤ 1°

 pfd(θ) = −116.2 + 18 ∙ logθ (dB(W/(m2 ∙ 14 MHz))) for 1° < θ ≤ 2°

 pfd(θ) = −117.9 + 23.7 ∙ logθ (dB(W/(m2 ∙ 14 MHz))) for 2° < θ ≤ 8°

 pfd(θ) = −96.5 (dB(W/(m2 ∙ 14 MHz))) for 8° < θ ≤ 90.0°

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

2.2 When within line-of-sight of the territory of an administration, and up to an altitude of 3 km, the maximum pfd produced at the surface of the Earth on the territory of an administration by emissions from a single aeronautical ESIMs shall not exceed:

 pfd(θ) = −136.2 (dB(W/(m2 ∙ 1 MHz))) for 0° ≤ θ ≤ 0.01°

 pfd(θ) = −132.4 + 1.9 ∙ logθ (dB(W/(m2 ∙ 1 MHz))) for 0.01° < θ ≤ 0.3°

 pfd(θ) = −127.7 + 11 ∙ logθ (dB(W/(m2 ∙ 1 MHz))) for 0.3° < θ ≤ 1°

 pfd(θ) = −127.7 + 18 ∙ logθ (dB(W/(m2 ∙ 1 MHz))) for 1° < θ ≤ 12.4°

 pfd(θ) = −108 (dB(W/(m2 ∙ 1 MHz))) for 12.4° < θ ≤ 90°

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

2.3 The maximum power in the out-of-band domain should be attenuated below the maximum output power of the aeronautical ESIMs transmitter as described in Recommendation ITU‑R SM.1541.

2.4 Higher pfd levels than those provided in 2.1 and 2.2 above produced by aeronautical non-GSO ESIMs on the surface of the Earth within an administration shall be subject to the prior agreement of that administration. (see also *resolves further* 4 of this Resolution).

2.5 Aeronautical ESIMs operating in the 27.5‑29.5 GHz band, or parts thereof, within the territory of an administration that has authorized fixed-service and/or mobile-service operation in the same frequency bands shall not transmit in these frequency bands without prior agreement of that administration (see also *resolves* 3 of this Resolution).

Annex 2 to draft new Resolution [IAP-A116] (WRC‑23)

Methodology with respect to the examination referred to in *resolves* 1.2.5

# 1 A-ESIM parameters required for the examination

To conduct the relevant examination of A-ESIM and their conformity with respect to the pfd limits in Part 2 of Annex 1, the following parameters are required:

‒ Satellite system name;

‒ A-ESIM peak antenna gain;

‒ A-ESIM power density and bandwidth as given in Table 1;

‒ Fuselage attenuation mask expressed as a function of the angle below the horizon of the A-ESIM based on ITU‑R Reports or Recommendations.

# 2 Examination methodology

## 2.1 Introduction

An A-ESIM can operate at different locations defined by latitude, longitude and altitude. This methodology determines the maximum allowable power *Pj* for an A-ESIM transmitter communicating with a non-GSO FSS satellite system to ensure compliance with the pre-established pfd limits to protect terrestrial services, at all positions, for a defined set of altitude ranges. The methodology derives the *Pj*taking into account the relevant loss and attenuation in the geometry considered.

The methodology then compares the computed *Pj* with the range of notified power for the A-ESIM emission. The minimum and the maximum powers values of the emission  and  of the A-ESIM are calculated from the data included in the Appendix 4 Notification information of the non-GSO FSS satellite system with which the A-ESIM communicates and from the A‑ESIM characteristics.

A-ESIM are evaluated over a number of predefined altitude ranges in order to establish a number of *Pj*levels.

An examination by the Bureau should apply this methodology for the defined altitude range, to determine whether the A-ESIM operating under a given non-GSO satellite network complies with the pre-established pfd limits to protect terrestrial services.

## 2.2 Parameters and Geometry

Considering a hypothetical non-GSO FSS system, Table 1 below provides an example of emissions that are included in one Group associated to the A-ESIM non-GSO FSS class of earth station transmitting in the 27.5‑29.5 GHz band. Tables 2 to 4 provide additional assumptions and Figure 1 illustrates the geometry involved in the examination.

TABLE 1

Example of a Group of A-ESIM emissions
(with reference to relevant RR Appendix 4 data fields)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Emission n. | C7aDesignation of emission | ***BWemission***MHz | C8c3minimum power density dB(W/Hz) | C8a2/C8b2Maximum power density dB(W/Hz) |
| 1 | 6M00G7W-- | 6.0 | −69.7 | −66.0 |
| 2 | 6M00G7W-- | 6.0 | −64.7 | −61.0 |
| 3 | 6M00G7W-- | 6.0 | −59.7 | −56.0 |

TABLE 2

Additional example assumptions

| ID | Parameter | Notation | Value | Unit |
| --- | --- | --- | --- | --- |
| 1 | Frequency assignment | *f* | 29.1 | GHz |
| 2 | Reference bandwidth of pfd mask | *BWRef* | 1.0 or 14.0, depending on the altitude under examination | MHz |
| 6 | A-ESIM antenna peak gain | *Gmax* | 37.5 | dBi |
| 7 | A-ESIM antenna gain pattern | - | As per Recommendation ITU‑R S.580(see C.10.d.5.a) |

TABLE 3

Additional assumptions defined in the methodology

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ID | Parameter | Notation | Value | Unit |
| 8 | A-ESIM minimum elevation angle towards non-GSO FSS system | *ε* | Maximum of 10° and Min elev angle (A.4.b.7.cbis) | deg  |
| 9 | Atmospheric attenuation | *Latm* |  Computed with Rec. ITU‑R P.676 (see NOTE below) | dB |
| 10 | Angle of arrival of the incident wave on the Earth’s surface | $$δ$$ | Specified by the pre-established sets of pfd limits in Part 2 of Annex 1, variable from 0° to 90° | deg |
| 11 | Minimum examination altitude | *Hmin* | 0.01 | km |
| 12 | Maximum examination altitude | *Hmax* | 15.0 | km |
| 13 | Examination altitude spacing[[1]](#footnote-2)1 | *Hstep* | 1.0 | km |
| 14 | Fuselage attenuation | *Lf* | Computed based on ITU‑R Reports or Recommendations (see Table 4) | dB |

NOTE: The atmospheric attenuation is computed with Recommendation ITU‑R P.676, with the mean annual global reference atmosphere as defined in Recommendation ITU‑R P.835.

Figure 1

Geometry for the examination of compliance for two different A-ESIM altitudes



TABLE 4

Fuselage attenuation model

|  |  |  |  |
| --- | --- | --- | --- |
| *Lfuse*(γ) = 3.5 + 0.25 ⸱ γ | dB | for | 0°≤ γ ≤ 10° |
| *Lfuse*(γ) =−2 + 0.79 ⸱ γ | dB | for | 10°< γ ≤ 34° |
| *Lfuse*(γ) = 3.75 + 0.625 ⸱ γ | dB | for | 34°< γ ≤ 50° |
| *Lfuse*(γ) = 35  | dB | for | 50°< γ ≤ 90° |

Notes:

• This fuselage attenuation model is based on measurements made at 14.2 GHz (see Figure 3.6‑14 in Report ITU‑R M.2221‑0).

## 2.3 Calculation algorithm

This section includes a step-by-step description of how the examination methodology would be implemented.

**START**

i) For each A-ESIM altitude, it is necessary to generate as many δ*n* angles (angle of arrival of the incident wave) as required in order to test the full compliance with the applicable set of pfd limits. The *N* angles δ*n* must be comprised between 0° and 90° and have a resolution compatible with the granularity of the pre-established pfd limits. Each of the angles δ*n* will correspond to as many *N* points on the ground.

ii) For each altitude *Hj*= *Hmin*, *Hmin*+ *Hstep*, …, *Hmax*:

a) set the altitude of the *A\_ESIM* to *Hj*

b) compute the angles below the horizon γ*j,n* as seen from the A-ESIM for each of the *N* angles δ*n* generated in i) using the following equation:

  (1)

 where *Re* is the mean earth radius.

c) Compute the distance *Dj,n*, in km, for *n*= *1, …, N* between the A-ESIM and the tested point on the ground:

  (2)

d) Compute the fuselage attenuation *Lf j,n* (dB) with *n* = *1, …, N* applicable to each of the angles $γ\_{j,n}$ computed in b) above.

e) Compute the gaseous absorption *Latm\_j,n* (dB) with *n*= *1, …, N* applicable to each of the distances $D\_{j,n}$ computed in c) above, using the applicable sections of Recommendation ITU‑R P.676.

iii) a) For each altitude *Hj*= *Hmin*, *Hmin*+ *Hstep*, …, *Hmax*, and each angle below the horizon γ*j,n*, compute the maximum emission power in the reference bandwidth *Pj,n*(δ*n*, γ*j,n*) for which the pfd limits are met using the following algorithm:



With being the transmit antenna gain with the off-axis angle from the boresight, consisting of the summation of both angles γ*j,n* and minimum elevation angle ε as defined in Table 3.

b) Compute the minimum *Pj* across all values calculated at the previous step,

 

 The output of this step is the maximum power in the reference bandwidth that can be used by the A-ESIM to ensure it complies with the pfd limits in Part 2 of Annex 1, with respect to all angles *δn* at the altitude *Hj*, and the elevation indicated in Table 3. There will be one *Pj* for each of the *Hj* altitudes considered.

The output of step b) is summarized in Table 5 below:

TABLE 5

Computed *Pj* values

|  |  |
| --- | --- |
| *Hj* (Altitude) | *Pj*(Maximum power in the reference bandwidth that can be used at minimum elevation) |
| (km) | dB(W/BW) |
| 0.01 | TBD |
| 1.0 | TBD |
| 2.0 | TBD |
| 2.99 | TBD |
| 4.0 | TBD |
| 5.0 | TBD |
| 6.0 | TBD |
| 7.0 | TBD |
| 8.0 | TBD |
| 9.0 | TBD |
| 10.0 | TBD |
| 11.0 | TBD |
| 12.0 | TBD |
| 13.0 | TBD |
| 14.0 | TBD |
| 15.0 | TBD |

c) For each altitude *Hj*= *Hmin*, *Hmin*+ *Hstep*, …, *Hmax*, and each of the emissions of the groups of emissions under examination, compute the minimum and the maximum powers of the emission in the reference bandwidth:





BW in Hz is:

*BWRef* if *BWRef* =1 MHz

*BWRef* if *BWRef* =14 MHz & *BWemission* >= *BWRef*

*BWemission* if *BWRef* =14 MHz & *BWemission* < *BWRef*

For the operation of emission bandwidth smaller than the reference bandwidth, this methodology is applicable provided that the notifying administration confirms that A-ESIM operates only one emission within the reference bandwidth. If there is no such confirmation, this methodology is not applicable.

d) For each of the emission of the groups of emissions under examination check if there is at least one altitude *Hj* for which:

 *P*max\_*emission,j* > *Pj* > *P*min\_*emission,j*

 The results of this check are illustrated in Table 6below.

TABLE 6

Example comparison between *Pj* and (*P*min\_*emission,j*; *P*max\_*emission,j*)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Emission n. | C7aDesignation of emission | *BWemission*MHz | C8c3minimum power density dB(W/Hz) | C8a2/C8b2Maximum power density dB(W/Hz) | Lowest altitude *Hj* (km) for which *P*max\_*emission,j >Pj* > *P*min\_*emission,j* |
| 1 | 6M00G7W-- | 6.0 | −69.7 | −66.0 | TBD |
| 2 | 6M00G7W-- | 6.0 | −64.7 | −61.0 | TBD |
| 3 | 6M00G7W-- | 6.0 | −59.7 | −56.0 | TBD |

e) Based on the test detailed in iii)d) above applied to all emissions of the group under examination, the results of the Bureau’s examination for that group is favourable, after removing emissions that have failed the examination, otherwise it is unfavourable (i.e. all emissions have failed).

iv) The output of this methodology should, at a minimum, include:

– those resulting parameters as contained in Table 5;

– the examination results for each group;

– for those cases when some emissions successfully pass and some do not, the examination results for resulting new group that includes only those emission(s) which successfully passed the examination;

**END**

Annex 3 to draft new Resolution [IAP-A116] (WRC‑23)

Provisions for non-GSO FSS systems[[2]](#footnote-3)2 transmitting to aeronautical and/or maritime ESIMs operating in or over an ocean in the frequency bands 18.3‑18.6 GHz and 18.8‑19.1 GHz with respect to EESS (passive) operating in the frequency band 18.6‑18.8 GHz (in accordance with *resolves* 1.1.5)

Non-GSO space stations operating with an orbit apogee of more than 2 000 km and less than 20 000 km in the frequency bands 18.3‑18.6 GHz and 18.8‑19.1 GHz when communicating with aeronautical or maritime ESIM shall not exceed a power flux-density produced at the surface of the oceans across the 200 MHz of the 18.6‑18.8 GHz band, of −118 dB(W/(m² · 200 MHz)).

Non-GSO space stations operating with an orbit apogee less than or equal to 2 000 km in the frequency bands 18.3‑18.6 GHz and 18.8‑19.1 GHz when communicating with aeronautical or maritime ESIM shall not exceed a power flux-density produced at the surface of the oceans across the 200 MHz of the 18.6‑18.8 GHz band, of −110 dB(W/(m² · 200 MHz)).

**Reasons:** Align the methodology in Annex 2 with the recently approved new Recommendation ITU‑R S.[METHOD] - Methodology for examining the compliance of an aeronautical earth station in motion (A-ESIM) communicating with geostationary space stations in the fixed-satellite service in the 27.5‑29.5 GHz band with a set of pre-established pfd limits on the Earth’s surface. Align Annex 3 with outcome of WRC‑23 agenda item 1.17 using the same frequency band and simplify the limit

*Note*: The Bureau shall not examine, under RR No. **11.31**, the conformity of non-GSO FSS systems with the provisions of *resolves*1.1.5 of this Resolution,

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RESOLUTION 173 (WRC‑19)

Use of the frequency bands 17.7‑18.6 GHz, 18.8‑19.3 GHz and 19.7‑20.2 GHz (space-to-Earth) and 27.5‑29.1 GHz and 29.5‑30 GHz (Earth-to-space) by
earth stations in motion communicating with non-geostationary space stations
in the fixed-satellite service

**Reasons:** With the implementation of a new WRC Resolution by the WRC‑23 on non-GSO ESIM, Resolution **173 (WRC‑19)** can be suppressed.

APPENDIX 4 (REV.WRC‑19)

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[[3]](#footnote-4)2    (Rev.WRC‑12)

Footnotes to Tables A, B, C and D

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**TABLE A**

GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM,
EARTH STATION OR RADIO ASTRONOMY STATION     (Rev.WRC‑23)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Items in Appendix** | ***A \_ GENERAL CHARACTERISTICS OF THE SATELLITE NETWORK OR SYSTEM, EARTH STATION OR RADIO ASTRONOMY STATION*** | **Advance publication of a geostationary-satellite network** | **Advance publication of a non-geostationary-satellite network or system subject to coordination under Section II of Article 9** | **Advance publication of a non-geostationary-satellite network or system 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 or system** | **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.20** | **COMPLIANCE WITH *resolves* 1.1.4 OF RESOLUTION 169 (WRC-19)** |  | **A.20** |  |
| A.20.a | a commitment that the ESIM operation would be in conformity with the Radio Regulations and Resolution **169** **(WRC‑19)**Required only for the notification of earth stations in motion submitted in accordance with Resolution **169 (WRC‑19)** |  |  |  | **+** |  |  |  |  |  | A.20.a |  |
| **A.21** | **COMPLIANCE WITH *resolves* 1.2.6 OF RESOLUTION 169** **(WRC**‑**19)** |  | **A.21** |  |
| A.21.a | a commitment that, upon receiving a report of unacceptable interference, the notifying administration for the GSO FSS network with which ESIMs communicate shall follow the procedures in *resolves*4 of Resolution **169 (WRC‑19)**Required only for the notification of earth stations in motion submitted in accordance with Resolution **169 (WRC‑19)** |  |  |  | **+** |  |  |  |  |  | A.21.a |  |
| **A.22** | **COMPLIANCE WITH *resolves* 7 OF RESOLUTION 169** **(WRC‑19)** |  | **A.22** |  |
| A.22.a | a commitment that aeronautical ESIMs would be in conformity with the pfd limits on the Earth’s surface specified in Part II of Annex 3 to Resolution **169 (WRC‑19)**Required only for the notification of earth stations in motion submitted in accordance with Resolution **169 (WRC‑19)** |  |  |  | **+** |  |  |  |  |  | A.22.a |  |
| **A.23** | **COMPLIANCE WITH RESOLUTION 35 (WRC‑19)** |  | **A.23** |  |
| A.23.a | a commitment stating that the characteristics as modified will not cause more interference or require more protection than the characteristics provided in the latest notification information published in Part I‑S of the BR IFIC for the frequency assignments to the non-geostationary-satellite system |  |  |  |  | **O** |  |  |  |  | A.23.a |  |
| **A.24** | **COMPLIANCE WITH NOTIFICATION OF A NON-GSO SHORT DURATION MISSION** |  | **A.24** |  |
| A.24.a | a commitment by the administration that, in the case that unacceptable interference caused by a non-GSO satellite network or system identified as short-duration mission in accordance with Resolution **32 (WRC‑19)** is not resolved, the administration shall undertake steps to eliminate the interference or reduce it to an acceptable levelRequired only for notification |  |  |  |  | **+** |  |  |  |  | A.24a |  |
| **A.25** | **COMPLIANCE WITH *resolves* 1.1.1.1 OF RESOLUTION [IAP-A116] (WRC-23)** |  | **A.25** |  |
| A.25.a | a commitment that the ESIM operation would be in conformity with the Radio Regulations and Resolution **[IAP-A116] (WRC-23)**Required only for the notification of earth stations in motion submitted in accordance with Resolution **[IAP-A116] (WRC‑23)** |  |  |  |  | **+** |  |  |  |  | A.25.a |  |
| **A.26** | **COMPLIANCE WITH *resolves* 1.1.5 OF RESOLUTION [IAP-A116] (WRC-23)** |  | **A.26** |  |
| A.26.a | a commitment that the ESIM operation would be in conformity with *resolves*1.1.5 of Resolution **[IAP‑A116] (WRC‑23)**Required only for the notification of earth stations in motion submitted in accordance with Resolution **[IAP-A116] (WRC‑23)** |  |  |  |  | **+** |  |  |  |  | A.26.a |  |
| **A.27** | **COMPLIANCE WITH *resolves* 4 OF RESOLUTION [IAP-A116] (WRC-23)** |  | **A.27** |  |
| A.27.a | a commitment that, upon receiving a report of unacceptable interference, the notifying administration for the GSO FSS network with which ESIMs communicate shall follow the procedures in *resolves* 5 of Resolution **[IAP-A116] (WRC-23)**Required only for the notification of earth stations in motion submitted in accordance with Resolution **[IAP-A116] (WRC-23)** |  |  |  |  | **+** |  |  |  |  | A.27.a |  |
| **A.28** | **COMPLIANCE WITH *resolves* 1.2.2 OF RESOLUTION [IAP-A116] (WRC-23)** |  | **A.28** |  |
| A.28.a | a commitment that aeronautical ESIMs would be in conformity with the pfd limits on the Earth’s surface specified in Part II of Annex 1 to Resolution **[IAP-A116] (WRC-23)**Required only for the notification of earth stations in motion submitted in accordance with Resolution **[IAP-A116] (WRC-23)** |  |  |  |  | **+** |  |  |  |  | A.28.a |  |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. 1 The fourth altitude value (*H4*) computed in accordance with this *Hstep* is adjusted to 2.99 km to facilitate the examination of compliance with the two sets of pfd values indicated in Part 2 of Annex 1. [↑](#footnote-ref-2)
2. 2 These provisions do not apply to non-GSO systems using orbits with an apogee less than 2000 km that employ a frequency reuse factor of at least three. [↑](#footnote-ref-3)
3. 2 The Radiocommunication Bureau shall develop and keep up-to-date forms of notice to meet fully the statutory provisions of this Appendix and related decisions of future conferences. Additional information on the items listed in this Annex together with an explanation of the symbols is to be found in the Preface to the BR IFIC (Space Services).    (WRC‑12) [↑](#footnote-ref-4)