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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 | | **Document 101-E** | |
|  | | **27 October 2023** | |
|  | | **Original: English** | |
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| Japan/New Zealand | | | |
| PROPOSALS FOR THE WORK OF THE CONFERENCE | | | |
|  | | | |
| Agenda item 1.2 | | | |

1.2 to consider identification of the frequency bands 3 300-3 400 MHz, 3 600‑3 800 MHz, 6 425-7 025 MHz, 7 025-7 125 MHz and 10.0-10.5 GHz for International Mobile Telecommunications (IMT), including possible additional allocations to the mobile service on a primary basis, in accordance with Resolution **245 (WRC‑19)**;

Introduction

The Asia-Pacific Telecommunity (APT) Common Proposal (ACP) on WRC‑23 agenda item 1.2 is provided in Addendum 2, [Document 62](https://www.itu.int/dms_pub/itu-r/md/23/wrc23/c/R23-WRC23-C-0062!A2!MSW-E.docx) as part of the proposals for the work of WRC‑23. The ACP outlines that APT Members support identification of the frequency band 7 025-7 125 MHz for IMT globally under Method 5C. APT Members are considering whether the proposed new Resolution **[ACP-A12-7 GHz] (WRC‑23)** could be combined with a potential new WRC Resolution **[A12-6 GHz] (WRC‑23)** for the frequency band 6 425-7 125 MHz in Region 1, if agreed.

The ACP also proposes changes to the Radio Regulations (RR) to satisfy the requirements of Method 5C, in particular, the development of specific technical conditions required for the protection of incumbent services, e.g., fixed-satellite service (FSS), Earth-to-space links between 7 025 MHz and 7 075 MHz.

This document presents a proposal from the co-signing Administrations to complement the ACP for the frequency band 7 025-7 125 MHz and provides specific technical conditions required for the protection of incumbent services within the aforementioned frequency band. The co-signing Administrations also provide additional details for precise clarification of the proposed technical conditions, in order to avoid misinterpretation of any potential modifications to the Radio Regulations motivated by Method 5C.

Background

For the protection of incumbent services, e.g., FSS Earth-to-space links (a.k.a. uplinks), between 7 025 MHz and 7 075 MHz, the ACP contains three examples for specific technical conditions under “*resolves* 2” of the proposed new Resolution **[ACP-A12-7 GHz] (WRC‑23)**. Namely, “*resolves* 2” contains “*Example 1*”: antenna pointing restrictions; “*Example 2*”: expected equivalent isotropically radiated power (e.i.r.p) mask; and “*Example* 3”: maximum e.i.r.p. mask, respectively.

Proposal

The co-signing Administrations propose technical conditions for “*resolves* 2” of the draft new WRC Resolution, for the frequency band 7 025-7 125 MHz. In accordance with the concept presented in *Example 2*, the co-signing Administrations propose an expected (average) e.i.r.p. mask for IMT base stations to protect FSS uplinks (Earth-to-space) in the geostationary orbit from potential aggregate interference resulting from IMT stations operating on the Earth’s surface. The expected e.i.r.p. mask sets a regulatory limit[[1]](#footnote-1) on the expected e.i.r.p. within each vertical (elevation) angle window[[2]](#footnote-2) at or above the horizon . The proposed expected e.i.r.p. mask is accompanied with specific “*Notes*” which clearly define the statistical expectation (averaging) process and state the stochastic parameters involved in the expectation process. The “*Notes*” are used to define explicit conditions required for verification of the derived expected e.i.r.p. limits, ensuring that the defined limits are clear and cannot be misinterpreted.

The co-signing Administrations are also of the view that the proposed new Resolution **[ACP‑A12‑7 GHz] (WRC‑23)** from the ACP could be combined with a potential new WRC Resolution **[A12-6 GHz]** for the frequency band 6 425-7 125 MHz in Region 1, if agreed. However, if during the discussions of WRC-23, more stringent technical conditions than those described in this proposal are enforced, e.g., much *lower* limits on the expected e.i.r.p. of an IMT base station relative to the proposed limits in this contribution within the frequency band 6 425-7 125 MHz in Region 1, the co-signing Administrations will advocate for a separate new Resolution for the frequency band 7 025-7 125 MHz, applicable only to Region 3, specifying the technical conditions supported by the co-signing Administrations as proposed in this contribution.

The proposed additions compared with the ACP are highlighted with bright green text. Any deletion of text is marked with ~~black strikethrough text.~~ The proposed additions and deletions are only marked as stated above for the modifications to the proposed new Resolution **[ACP-A12-7 GHz] (WRC‑23**).

In addition, Attachment 1 of this input contribution details the exact methodology employed to derive the expected e.i.r.p. mask, including the key assumptions used to compute the mask values.

Discussion

The proposal of the expected e.i.r.p. mask inherently captures the condition in “*Example 1*” which states: *“take practical measures to ensure the transmitting antennas of outdoor base stations are normally pointing below the horizon when deploying IMT base stations within the frequency band 7 025-7 075 MHz; the mechanical pointing needs to be at or below the horizon*”. By its nature, the expected e.i.r.p. mask ensures the restriction of the e.i.r.p. levels as a function of the vertical angle windows (defined later within the proposed new Resolution **[ACP-A12-7 GHz] (WRC‑23)** at or above the horizon to protect FSS satellite space stations quantitatively, which would be more appropriate than the qualitative condition in “*Example 1*”.

Within the sharing studies conducted in ITU‑R Working Party (WP) 5D, given the large area considered and modelled on the Earth’s surface, the orientation (with respect to the boresight) of the IMT base station in the horizontal (azimuthal) plane will vary depending on its physical location, including its relative location to the FSS space station receiver. As a result, while the instantaneous e.i.r.p. of an IMT base station above the horizon generating sidelobes towards the FSS space station receiver contributes to the overall interference at the FSS space station, the simultaneous contributions from different IMT base stations will not be the same due to the differences in the base station orientations and beamforming directions. Consequently, the aggregate interference at the FSS space station receiver is a mathematical summation of different instantaneous e.i.r.p.s from different IMT base stations. As a result, restricting the maximum e.i.r.p., as used in “*Example 3*”, of a single base station is not an appropriate metric when considering aggregate interference at the FSS space station, as it does not reflect the statistics of the aggregate interference. This is more appropriately captured by the expected e.i.r.p. of an IMT base station, with the expectation process over the horizontal angles, beamforming directions and vertical (elevation) angle windows.

ARTICLE 5

Frequency allocations

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

MOD J/NZL/101/1#1372

6 700-7 250 MHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 6 700-7 075 FIXED  FIXED-SATELLITE (Earth-to-space) (space-to-Earth) 5.441  MOBILE ADD 5.C12  5.458 5.458A 5.458B | | |
| 7 075-7 145 FIXED  MOBILE ADD 5.C12  5.458 5.459 | | |

**Reasons:** This is to identify the frequency band 7 025-7 125 MHz for IMT globally by creating a new RR footnote with conditions which are contained in a draft new WRC Resolution.

ADD J/NZL/101/2#1374

5.C12-5C The frequency band 7 025-7 125 MHz is identified for use by administrations wishing to implement the terrestrial component of International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. Resolution **[ACP-A12‑7 GHz] (WRC‑23)** applies.     (WRC‑23)

**Reasons:** This is to identify the frequency band 7 025-7 125 MHz for IMT globally by creating a new RR footnote with conditions which are contained in a draft new WRC Resolution.

ADD J/NZL/101/3

Draft New Resolution [ACP-A12-7 GHz] (wrc‑23)

Terrestrial component of International Mobile Telecommunications in the frequency band 7 025-7 125 MHz in all Regions

The World Radiocommunication Conference (Dubai, 2023),

considering

*a)* that International Mobile Telecommunications (IMT), including IMT‑2000, IMT‑Advanced and IMT‑2020, is the ITU vision of global mobile access, and is intended to provide telecommunication services on a worldwide scale, regardless of location and type of network or terminal;

*b)* that harmonized worldwide frequency bands for IMT are desirable in order to achieve global roaming and the benefits of economies of scale;

*c)* that identification of frequency bands allocated to the mobile service for IMT may change the sharing situation regarding applications of services to which the frequency band is already allocated, and may require regulatory actions;

*d)* that the ITU Radiocommunication Sector (ITU‑R) has studied, in preparation for WRC‑23, sharing and compatibility with services allocated in the frequency band 7 025-7 125 MHz and its adjacent band, as appropriate, based on characteristics available at that time, and results may change if these characteristics change;

*e)* that it is assumed that a very limited number of IMT base stations will be communicating with a positive elevation angle towards IMT indoor mobile stations;

*f)* that the frequency band 7 025-7 125 MHz, or part thereof, is allocated on a primary basis to the fixed, mobile, fixed-satellite (Earth-to-space and space-to-Earth) and space operation (Earth-to-space) services,

noting

*a)* Resolutions **223 (Rev.WRC‑19)**, **224 (Rev.WRC‑19)**, **225 (Rev.WRC‑12)**, **241 (WRC‑19)**, **242 (WRC‑19)** and **243 (WRC‑19)**, which also relate to IMT;

*b)* that the IMT terrestrial radio interfaces as defined in Recommendations ITU‑R M.1457, ITU‑R M.2012 and ITU‑R M.2150 are expected to evolve within the framework of ITU‑R beyond those initially specified, to provide enhanced services and services beyond those envisaged in the initial implementation;

*c)* that ITU‑R has developed its vision defining the framework and overall objectives of IMT towards 2030 and beyond to drive the future developments for IMT,

recognizing

*a)* that the identification of a frequency band for IMT does not establish priority in the Radio Regulations and does not preclude the use of the frequency band by any application of the services to which it is allocated;

*b)* that studies have shown that the protection of feeder links for the non-geostationary-satellite orbit (non-GSO) fixed-satellite service (FSS) (space-to-Earth) requires the determination of protection distances ranging between a few kilometres to tens of kilometres. These protection distances are site-specific and depend on several elements, such as the propagation parameters, local terrain topography, station and orbital parameters of the feeder links for non-GSO FSS (space‑to-Earth);

*c)* that some administrations are planning the frequency band 7 025-7 125 MHz or portions thereof for IMT;

*d)* that some administrations are using and planning the frequency band 7 025-7 125 MHz or portions thereof for other applications of the mobile service, including other wireless access systems,

resolves

1 that administrations wishing to implement IMT consider the use of the frequency band 7 025-7 125 MHz identified for IMT in all Regions in No. **5.C12-5C**, taking into account the latest relevant ITU‑R Recommendations;

2 that administrations wishing to implement IMT in the frequency band 7 025-7 075 MHz shall apply the following conditions to IMT to ensure the protection, continued use and future development of the fixed-satellite service (Earth-to-space):

*~~[Example 1]~~*

~~2.1 take practical measures to ensure the transmitting antennas of outdoor base stations are normally pointing below the horizon when deploying IMT base stations within the frequency band 7 025-7 075 MHz; the mechanical pointing needs to be at or below the horizon;~~

*~~[Example 2]~~*

2.1 the level of expected equivalent isotropically radiated power (e.i.r.p.) emitted by an IMT base station as a function of vertical angle above the horizon in the frequency band 7 025-7 075 MHz or part thereof shall not exceed the following values:

|  |  |
| --- | --- |
| Vertical angle ~~measurement~~ window θlow ≤ θ < θhigh (vertical angle θ above the horizon) | Expected e.i.r.p.  (dBm/MHz)  (See NOTES 1, 2, 3, 4, 5, 6 and 7) |
| 0° ≤ θ < 5° | 32 |
| 5° ≤ θ < 10° | 27 |
| 10° ≤ θ < 15° | 23 |
| 15° ≤ θ < 20° | 21 |
| 20° ≤ θ < 30° | 19 |
| 30° ≤ θ < 60° | 18 |
| 60° ≤ θ ≤ 90° | 18 |
| NOTE 1: The expected/average e.i.r.p. is defined as the statistical expectation (first moment) of a set of e.i.r.p. values ~~average value of the e.i.r.p.,~~ evaluated over: ~~with the averaging being performed:~~  – the ~~over~~ horizontal angles, *ϕ*, between −180° to +180°~~, and the IMT base station beamforming in~~ for a given ~~specific~~ beamforming direction within the ~~its~~ horizontal and vertical steering range of the IMT base station,  – the ~~over~~ different beamforming directions within the IMT base station steering range in both the horizontal and vertical domains, and  – ~~over~~ the specified vertical angle ~~measurement~~ windows θlow  ≤  θ  <  θhigh, at or above the horizon, where the horizon refers to θ = 0°. The vertical angleθis with respect to the zenith axis in the clockwise direction.  NOTE 2: As the e.i.r.p. of an IMT base station is a random variable, its statistical expectation should be based on a set of e.i.r.p. samples such that the confidence interval on the statistical expectation is at least 95%.  NOTE 3: IMT base stations must always comply with the defined expected e.i.r.p. limits irrespective of the mechanical downtilt angles which are considered in IMT base station deployments across different environments e.g., urban, sub-urban, and rural.  NOTE 4: For the verification of the expected e.i.r.p. for each vertical angle window, the horizontal angles *ϕ* between −180° to +180° covering the entire horizontal plane are to be selected from a uniform distribution with a closed interval for ϕ ∈ [−180°,180°].  NOTE 5: For the verification of expected e.i.r.p. at each vertical angle window, the beamforming directions used in the statistical expectation process are to be based on a uniform distribution across the horizontal and vertical domains within the steering range of an IMT base station for the frequency band range specified in this Resolution.  NOTE 6: Upon measurement, IMT base stations must always be compliant with the specified expected e.i.r.p. limits for all vertical angle ranges specified. A declaration must be issued by the IMT system manufacturer to the IMT operator specifying the expected e.i.r.p. levels are met for all vertical angle ranges, prior to the IMT base station transmitting beams.  NOTE 7: The set of e.i.r.p. values used to verify the expected e.i.r.p. for each vertical angular window must be a mathematical summation of both polarization states of the IMT base station antenna, with no polarization discrimination. | |

*~~[Example 3]~~*

~~2.1 The following limit to the e.i.r.p. radiated by each IMT base station for a given elevation angle above the horizon applies:~~

~~e.i.r.p. limits for IMT base stations~~

| ~~Elevation angle (θ) degrees~~ | ~~Maximum e.i.r.p.  dBW/100 MHz~~ |
| --- | --- |
| ~~0 ≤ θ ≤  TBD~~ | ~~TBD~~ |
| ~~TBD < θ ≤ TBD~~ | ~~TBD~~ |
| ~~TBD < θ ≤ 90~~ | ~~TBD~~ |

*~~[Example 1]~~*

3 that administrations wishing to implement IMT in the frequency band 7 025-7 075 MHz shall ensure the protection, continued use and future development of feeder links for the non-GSO fixed-satellite service (space-to-Earth) stations through the adoption of site-specific coordination, either on a national basis or through bilateral agreement(s);

3*bis* that IMT within the frequency range 7 025-7 075 MHz shall not be used by aeronautical applications,

*~~[Example 2]~~*

~~3 (not used)~~

~~3~~*~~bis~~* ~~(not used)~~

invites administrations

to take into account the benefits of harmonized utilization of the spectrum for the terrestrial component of IMT,

invites the ITU Radiocommunication Sector

1 to develop harmonized frequency arrangements to facilitate IMT deployment in the frequency band 7 025-7 125 MHz in all Regions;

2 to continue providing guidance to ensure that IMT can meet the telecommunication needs of developing countries;

3 to develop a recommendation to address methods for the determination of geographic zones for the coexistence between IMT base stations in the frequency band 7 025-7 125 MHz and non-GSO earth stations in the frequency band 6 700-7 075 MHz;

4 to update existing ITU‑R Recommendations/Reports or develop new ITU‑R Recommendations, as appropriate, to provide information and assistance to the concerned administrations on possible coordination of FS stations with IMT stations in the frequency band 7 025-7 125 MHz;

5 to develop ITU‑R Recommendations and/or Reports, as appropriate, to assist administrations in ensuring the efficient use of the frequency band 7 025-7 125 MHz through coexistence mechanisms between IMT and other applications of the mobile service, including other wireless access systems,

instructs the Director of the Radiocommunication Bureau

to bring this Resolution to the attention of relevant international organizations.

**Reasons:** This is to identify the frequency band 7 025-7 125 MHz for IMT globally by creating a new RR footnote with conditions which are contained in a draft new WRC Resolution.

SUP J/NZL/101/4#1391

RESOLUTION 245 (WRC‑19)

Studies on frequency-related matters for the terrestrial component of International Mobile Telecommunications identification in the frequency bands 3 300-3 400 MHz, 3 600-3 800 MHz, 6 425-7 025 MHz,   
7 025-7 125 MHz and 10.0-10.5 GHz

**Reasons:** The work is now complete on WRC-23 agenda item 1.2.

ATTACHMENT 1

Methodology and key assumptions in the calculation of the expected e.i.r.p. limits of an IMT base station

# 1 Introduction

This attachment provides a detailed explanation on the proposed limits on the expected (average) e.i.r.p. of an IMT base station for draft new Resolution **[ACP-A12-7 GHz] (WRC‑23)**, in which the expected e.i.r.p. concept from the frequency band 6 425-7 025 MHz in section 1/1.2/5.5 of the CPM Report to WRC-23 (*“Regulatory and procedural considerations for IMT identification in 6 425-7 025 MHz”*) has been extended to the frequency band 7 025-7 125 MHz.

The expected e.i.r.p. of an IMT base station is governed by a statistical averaging process over the distribution of horizontal (azimuth) angles, distribution of the horizontal and vertical (elevation) beamforming directions within the steering range of the IMT base station, and vertical angle windows at or above the horizon, as conceptually demonstrated in Document [CPM23-2/229](https://www.itu.int/md/R19-CPM23.2-C-0229/en).

In the CPM23-2 Report, examples for the expected e.i.r.p. limits were derived based on multiple studies within “*resolves*2.1” in the draft new Resolution **[A12-6 GHz] (WRC‑23)**. Following the same technical assumptions (in accordance to the ITU‑R Working Party 5D baseline parameters as found in Document [5D/1776 Annex 4.17)](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-1776!H4-N4.17!MSW-E.docx), the co-signing Administrations have derived the expected e.i.r.p. limits of an IMT base station based on a specific study (Study B in ITU‑R Working Party 5D) using Ra\_suburban = 5%; Ra\_urban = 10%; and Rb = 1%.

Although the study used to derive the expected e.i.r.p. of an IMT base station was focused on sharing and compatibility between the FSS (Earth-to-space) allocation in the frequency band 7 025-7 075 MHz and the candidate band for IMT systems from 7 025 MHz to 7 125 MHz, it is also applicable to the frequency band 6 425-7 025 MHz, as the study assumed the same, typical, parameters of globally applicable FSS carriers (e.g., carrier 1) provided by ITU‑R Working Party 4A to Working Party 5D for the frequency band 6 425-7 025 MHz.

# 2 Expected e.i.r.p. limits of an IMT base station

## 2.1 Derivation methodology

The concept of the expected e.i.r.p. of an IMT base station as a function of a given vertical angle window was illustrated in Document [CPM23-2/229](https://www.itu.int/md/R19-CPM23.2-C-0229/en).

The proposed limits are derived by starting from the maximum permitted aggregate interference at the FSS space station receiver in order to satisfy the ITU‑R Working Party 4A specified long-term *I*/*N* protection criteria of ‒10.5 dB, and working backwards to account for the contribution of various technical parameters including the FSS space station antenna gain, radio propagation losses from the location of IMT base station to the FSS space station receiver (including the clutter loss), densities of IMT base stations for both urban macro and suburban macro environments, network loading and TDD activity factors. This yields a limit of the expected e.i.r.p. as a function for a vertical angle window at or above the horizon for each IMT base station.

The methodology to derive the proposed limits on the expected e.i.r.p. taking into account the results of the sharing study follows the *stepwise procedure* outlined below:

1 **Averaging over horizontal angles and** **beamforming directions** – In the first step, the expected e.i.r.p. of an IMT base station, as defined in Equation (1), is computed. Note that the statistical expectation in this step is evaluated over the horizontal angles and beamforming directions, respectively. As shown in Figure 1 (on the following page), we consider an area on the Earth’s surface within a *mesh* given a specific longitude and latitude. This is demonstrated with a small (parallelogram-like) yellow highlighted area along the stripped belt-like curve across the Earth’s surface, as well as with an exploded view highlighting the longitude and latitude of the mesh. The mesh contains a multiplicity of IMT base stations in a cluster formation of 19 cells, 57 sectors (three sectors per-cell), as per the methodology in Recommendation ITU‑R M.2101. Given the area of the mesh, the aggregate interference from the cluster of 19 cells is *scaled* appropriately based on the land area in the mesh and the IMT deployment ratio governed by the Ra and Rb parameters (specified in Section 1 of Attachment 1) as well as the density of the IMT base stations for the urban macro and suburban macro environments, respectively. While doing this, we ensure that the *central* vertical angle of the mesh relative to the FSS space station receiver lies within the vertical angle window, θ*low*≤ θ < θ*high*, with respect to the horizon of the IMT base station.

Figure 1

Geometry for the uplink aggregate interface analysis from IMT systems to FSS space station receiver

A screenshot of a computer

Description automatically generated

For *each* Monte-Carlo realization of the IMT-FSS sharing and compatibility study, over a total of 10 000 independent realizations, the following computations are performed:

a) Each IMT base station within the mesh (part of a cluster of IMT base stations) is assumed to serve three IMT user equipments with its geographical positions relative to the IMT base station determined from the methodology in Recommendation ITU‑R M.2101;

b) Each IMT base station (each sector) within the mesh selects a uniformly distributed horizontal direction (orientation of the BS relative to boresight), ϕ*,* where −180° ≤ ϕ ≤ 180°. To this end, in total, 3 uniformly distributed horizontal directions are selected;

c) Each IMT base station (each sector) within the mesh selects three beamforming directions (within the steering range of the IMT base station) given the position of the IMT user equipments (i.e. three horizontal and vertical direction pairs);

d) The instantaneous values of e.i.r.p. for each IMT base stations are obtained.

The result obtained from d) (above) is summed 10 000 times for each mesh (corresponding to the total number of Monte-Carlo realizations) and the answer is divided by (10 000) × (total number of IMT base stations in the mesh) × (three IMT user equipments per-base station) to obtain the expected e.i.r.p. over beamforming directions and horizontal angles for a single IMT base station.

The above-mentioned process is repeated for *all* meshes across the Earth’s surface within visible area of the FSS beam footprint in the “belt-like curve” (see Figure 1). Therefore,

 (1)

where:

*i* is the index of a mesh (constant over the entire 10,000 realizations) of which the central vertical angle is contained within vertical angle window, θ*low*≤ θ < θ*high*;

 is the expected e.i.r.p. of an IMT base station in the *i*‑th mesh (in units of mW/MHz);

*Ni* is the total number of e.i.r.p. samples obtained from d) above of an IMT base station within the *i*‑th mesh (for all 10 000 realizations);

*n* is the index of the e.i.r.p. of an IMT base station in a mesh for all 10 000 realizations;

*P*(*n*) is the *n*‑th sample of e.i.r.p. of an IMT base station (where *n* is a part of all the e.i.r.p. samples) (in units of mW/MHz).

2 **Averaging over the vertical angle windows** – The final expected e.i.r.p., , is then calculated by further averaging the results of Step (1) over vertical angle, θ, within vertical angle window, θ*low*≤ θ < θ*high*, considering the ratio of the number of IMT base stations in a mesh relative to the total number of IMT base stations across all the meshes considered, within a given vertical angle window. Therefore,

 (2)

where:

 is the expected e.i.r.p. of an IMT base station within a vertical angle window θ*low*≤ θ < θ*high* (in units of dBm/MHz);

*Nm* is the total number of e.i.r.p. samples of an IMT base station within the *m*‑th vertical angle window, θ*low*≤ θ < θ*high* (for all 10 000 realizations);

*Lm* is the total number of meshes of which the central vertical angle is contained within the *m*‑th vertical angle window, θ*low*≤ θ < θ*high*.

3 **Deriving the proposed limits on the expected e.i.r.p. with the compensation factor** – Interference margin of the results of the study is then distributed to the expected e.i.r.p. of Step (2) to derive the proposed limit of the expected e.i.r.p. by *adding* the compensation factor, , as defined in the following expression:

 (3)

Noting that:

is the limit on the expected e.i.r.p. of an IMT base station within vertical angle window θ*low*≤ θ < θ*high* (in units of dBm/MHz);

 is the compensation factor for vertical angle window θ*low*≤ θ < θ*high* (in units of dB).

It is noteworthy that the interference contribution of *each* vertical angle window relative to aggregate interference would depend on the e.i.r.p. levels of IMT base stations towards the FSS space station and the number of IMT base stations within a given vertical angle window. Thus, the compensation factor (), should be adjusted (weighted) so that aggregate interference from IMT base stations with the compensated e.i.r.p. toward the FSS space station can satisfy the FSS long-term protection criterion, considering the contribution of each vertical angle window relative to aggregate interference. Assuming that the aggregate interference from IMT base stations within the vertical angle window θ*low*≤ θ < θ*high*, is expressed as:

 (4)

where:

*Im* is the aggregate interference contributions received at the FSS space station receiver from contributing IMT base stations within the *m*-th vertical angle window, θ*low*≤ θ < θ*high* (in units of mW/MHz);

ω*m* are weighting factors within the *m*‑th vertical angle window θ*low*≤ θ < θ*high*;

*I*0 is constant value.

Considering the above, the aggregate interference received at the FSS space station receiver can be written as

 (5)

Note that in Equation (5):

*Iagg* is the aggregate interference received at the FSS space station receiver from IMT base stations within the FSS visible area (in units of mW/MHz);

*m* is the index of vertical angle window θ*low*≤ θ < θ*high*,;

*M* is the total number of vertical angle windows covering the desired vertical angular range.

Further assuming that the summation of the compensated aggregate interference from contributing IMT base stations within each vertical angle window equals to the maximum permitted aggregate interference corresponding to the long-term protection criterion of the FSS satellite space station as expressed in the following equation:

 (5)

where:

*Iʹagg* is the maximum permitted aggregate interference received at the FSS space station receiver from IMT base stations, corresponding to the long-term protection criterion of the FSS satellite space station (in units of mW/MHz);

*Km* is the compensation factor for the *m*-th vertical angle window θ*low*≤ θ < θ*high* which contains the real scalar value of .

From equations (4), (5) and (6), *the interference margin* can be expressed as:

 (7)

The compensation factor can be selected either *equal (uniform)* or *unequal (non‑uniform)* (i.e. weighted) over vertical angle windows depending on the desired limits on the expected e.i.r.p.:

a) Assuming equal (uniform) distribution of the interference margin over vertical angle windows, the compensation factor is identical to the interference margin of the results of the study and is uniform over vertical angle windows. It is the case that the compensation factor, *Km*, is constant value in equation (7), and equals to the interference margin.

b) Assuming unequal (non-uniform) distribution, the compensation factor of each vertical angle window could be weighted among the vertical angle windows, so that the weighted (non-uniform) compensation factor could be selected given the contribution of the vertical angle window. To this end, the compensation factors, *Km*, are selected considering weighting factors,ω*m*, so that equation (7) is satisfied.

4 **Confirmation of the proposed limits on the expected e.i.r.p.** – For simplicity, the proposed limits on the expected e.i.r.p. of Step (3) is verified by simulation. Specifically, we confirm that the aggregate interference from the IMT base stations with the e.i.r.p. compensated by  for vertical angle window, θ*low*≤ θ < θ*high*, toward the FSS space station still satisfies the FSS long-term protection criterion.

## 2.2 Proposed limits on the expected e.i.r.p. of an IMT base station

The limits on the expected e.i.r.p. of an IMT base station for each vertical angle window is proposed based on the results of the study underlying the following assumptions (as presented for details in section 2.2 of Document [5D/1776 Annex 4.17](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-1776!H4-N4.17!MSW-E.docx)):

IMT deployment

‒ The deployment density values for large area based on the area-based Ra-Rb method as used in ITU‑R Working Party 5D, assuming Ra\_suburban = 5%; Ra\_urban = 10%; and Rb = 1%.

‒ The deployment density of IMT base stations being 10 BSs/km2 / 2.4 BSs/km2 for urban macro / suburban macro cells, respectively, where the definition of the base station is as in [5D/1776 Annex 4.17](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-1776!H4-N4.17!MSW-E.docx).

‒ The deployment ratio of IMT base stations being 89% / 11% for urban / suburban, respectively.

Clutter loss model

‒ Clutter loss model as described in Document [3K/178](https://www.itu.int/md/R19-WP3K-C-0178/en) was used.

FSS characteristics

‒ Global beam of carrier #1, assuming Total Integrated Gain (TIG) correction factor for the FSS space station receiver antenna of ‒2.7 dB. The FSS properties are as specified in Document [5D/734](https://www.itu.int/md/R19-WP5D-C-0734/en).

‒ Orbital position: We consider the FSS geostationary orbit of 128°E.

The results of the study showed no exceedance of the FSS long-term protection criterion, with an interference margin of 11.44 dB below this criterion for carrier 1 (global beam). Therefore, based on the methodology in section 2.1 of this attachment and the results of study for the global beam case, the proposed expected e.i.r.p. limits, as a function of vertical angle windows at or above the horizon are illustrated in Table 1.

Table 1

Proposed limits on the expected e.i.r.p. of an IMT base station   
as a function of vertical angle *θ* above horizon.

|  |  |
| --- | --- |
| Vertical angle window  θlow*≤* θ *<* θhigh (vertical angle θ at or above the horizon) | Expected e.i.r.p. (dBm/MHz) |
| 0° ≤ θ < 5° | 32 |
| 5° ≤ θ < 10° | 27 |
| 10° ≤ θ < 15° | 23 |
| 15° ≤ θ < 20° | 21 |
| 20° ≤ θ < 30° | 19 |
| 30° ≤ θ < 60° | 18 |
| 60° ≤ θ ≤ 90° | 18 |

Noting that *Example 3* of *resolves*2.1 in the draft new Resolution in CPM Report (shown in Figure 2) of the limits on the expected e.i.r.p. is included in some other proposals, the co-signing Administrations have also verified IMT base stations with *Example 3* of the limits on the expected e.i.r.p. still satisfies the FSS uplink protection criteria under the assumption of the study.

Figure 2

Comparison of proposed limits on the expected e.i.r.p. of an IMT base station with   
Example 3 in the draft new Resolution of [A12-6GHz] (WRC-23)

A graph with blue and orange lines

Description automatically generated

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1. When appropriate, the expected (average) e.i.r.p. mask for a given vertical angle window (at or above the horizon) is also referred to as the “limit” on the expected e.i.r.p for the vertical angle window under consideration. As a result, the terms “*expected e.i.r.p mask*” and “*limit* *on the expected e.i.r.p.”* are used interchangeably. [↑](#footnote-ref-1)
2. Note that a “*vertical angle* *window*” refers to a discrete set of vertical angles confined within a particular angular range. [↑](#footnote-ref-2)