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**English only**

## ITU-APT Foundation of India (IAFI<sup>1</sup>)

**STUDIES ON POSSIBLE REVISIONS OF SHARING CONDITIONS IN THE FREQUENCY BAND 13.75-14 GHz TO ALLOW THE USE OF UPLINK FIXED-SATELLITE SERVICE EARTH STATIONS WITH SMALLER ANTENNA SIZES**

### Introduction

As per the Resolution -129 adopted by the World Radiocommunication Conference -2023 (WRC-23, held at Dubai), the ITU Radiocommunication Sector (ITU-R) is invited to conduct and complete the studies on the following issues, in time for the 2027 world radiocommunication conference.

1. studies on the technical and operational limitations regarding the minimum antenna size and associated power limitations of GSO and non-GSO FSS earth stations in the frequency band 13.75-14 GHz (Earth-to-space), while ensuring the protection of the services stipulated in Nos. 5.502 and 5.503.
2. studies on possible changes to Nos. 5.502 and 5.503 and possible associated regulatory measures.

First session of the Conference Preparatory Meeting (CPM 27-1) convened soon after WRC-23, allocated the tasks for further study amongst the various Working Parties (WPs) under the ITU-R, to timely submit the report and decisions to ITU-R for onward submission to WRC-27.

As per the CPM 27-1 report, Agenda Item 1.2 is allocated the following task to the Working Party 4A (WP-4A) as main responsible group and WP-3M, WP-5A, WP-5B, WP-5C, WP-7A, WP-7B and WP-7C as contributing group.

- a. Study the technical and operational limitations regarding the minimum antenna size and associated power limitations for GSO and non-GSO FSS earth stations in frequency band 13.75-14 GHz (Earth-to-space), ensuring the protection of the services stipulated in Nos. 5.502 and 5.503.
- b. Based on the study results, consider minimum antenna size and associated power limitations and propose possible changes to Radio Regulations No. 5.502 and 5.503, along with any consequential regulatory measures.

Resolution -129 and Agenda Item 1.2 are attached as **Annexure-I and II** respectively.

### Radio Regulation -5.502:

In the band 13.75-14 GHz, an earth station of a geostationary fixed-satellite service network shall have a minimum antenna diameter of 1.2 m and an earth station of a non-geostationary fixed-satellite service

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<sup>1</sup> IAFI is a sector Member of ITU-R. For more details please see <https://iafi.in>

system shall have a minimum antenna diameter of 4.5 m. In addition, the e.i.r.p., averaged over one second, radiated by a station in the radiolocation or radio-navigation services shall not exceed 59 dBW for elevation angles above 2° and 65 dBW at lower angles. Before an administration brings into use an earth station in a geostationary-satellite network in the fixed-satellite service in this band with an antenna diameter smaller than 4.5 m, it shall ensure that the power flux-density produced by this earth station does not exceed:

- 115 dB (W/(m<sup>2</sup> · 10 MHz)) for more than 1% of the time produced at 36 m above sea level at the low water mark, as officially recognized by the coastal State;
- 115 dB (W/(m<sup>2</sup> · 10 MHz)) for more than 1% of the time produced 3 m above ground at the border of the territory of an administration deploying or planning to deploy land mobile radars in this band, unless prior agreement has been obtained.

For earth stations within the fixed-satellite service having an antenna diameter greater than or equal to 4.5 m, the e.i.r.p. of any emission should be at least 68 dBW and should not exceed 85 dBW. (WRC-03)

### **Radio Regulation -5.503:**

In the band 13.75-14 GHz, geostationary space stations in the space research service for which information for advance publication has been received by the Bureau prior to 31 January 1992 shall operate on an equal basis with stations in the fixed-satellite service; after that date, new geostationary space stations in the space research service will operate on a secondary basis. Until those geostationary space stations in the space research service for which information for advance publication has been received by the Bureau prior to 31 January 1992 cease to operate in this band:

- in the band 13.77-13.78 GHz, the e.i.r.p. density of emissions from any earth station in the fixed-satellite service operating with a space station in geostationary-satellite orbit shall not exceed:
  - i)  $4.7D + 28$  dB(W/40 kHz), where  $D$  is the fixed-satellite service earth station antenna diameter (m) for antenna diameters equal to or greater than 1.2 m and less than 4.5 m;
  - ii)  $49.2 + 20 \log(D/4.5)$  dB(W/40 kHz), where  $D$  is the fixed-satellite service earth station antenna diameter (m) for antenna diameters equal to or greater than 4.5 m and less than 31.9 m;
  - iii) 66.2 dB(W/40 kHz) for any fixed-satellite service earth station for antenna diameters (m) equal to or greater than 31.9 m;
  - iv) 56.2 dB(W/4 kHz) for narrow-band (less than 40 kHz of necessary bandwidth) fixed-satellite service earth station emissions from any fixed-satellite service earth station having an antenna diameter of 4.5 m or greater;
- the e.i.r.p. density of emissions from any earth station in the fixed-satellite service operating with a space station in **non**-geostationary-satellite orbit shall not exceed 51 dBW in the 6 MHz band from 13.772 to 13.778 GHz.

Automatic power control may be used to increase the e.i.r.p. density in these frequency ranges to compensate for rain attenuation, to the extent that the power flux-density at the fixed-satellite service space station does not exceed the value resulting from use by an earth station of an e.i.r.p. meeting the above limits in clear-sky conditions. (WRC-03)

## **Proposal**

IAFI through this contribution suggested to begin the work on a new report or recommendation on the following points.

- a. Study the technical and operational limitations regarding the minimum antenna size and associated power limitations for GSO and non-GSO FSS earth stations in frequency band 13.75-14 GHz (Earth-to-space), ensuring the protection of the services stipulated in Nos. 5.502 and 5.503.
- b. Based on the study results, consider minimum antenna size and associated power limitations and propose possible changes to Radio Regulations No. 5.502 and 5.503, along with any consequential regulatory measures.

Detailed work-plan to complete the study is also attached **Annexure-III**.

**WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT  
NEW REPORT REGARDING STUDIES ON POSSIBLE REVISIONS OF SHARING  
CONDITIONS IN THE FREQUENCY BAND 13.75-14 GHz TO ALLOW THE USE OF UPLINK  
FIXED-SATELLITE SERVICE EARTH STATIONS WITH SMALLER ANTENNA SIZES**

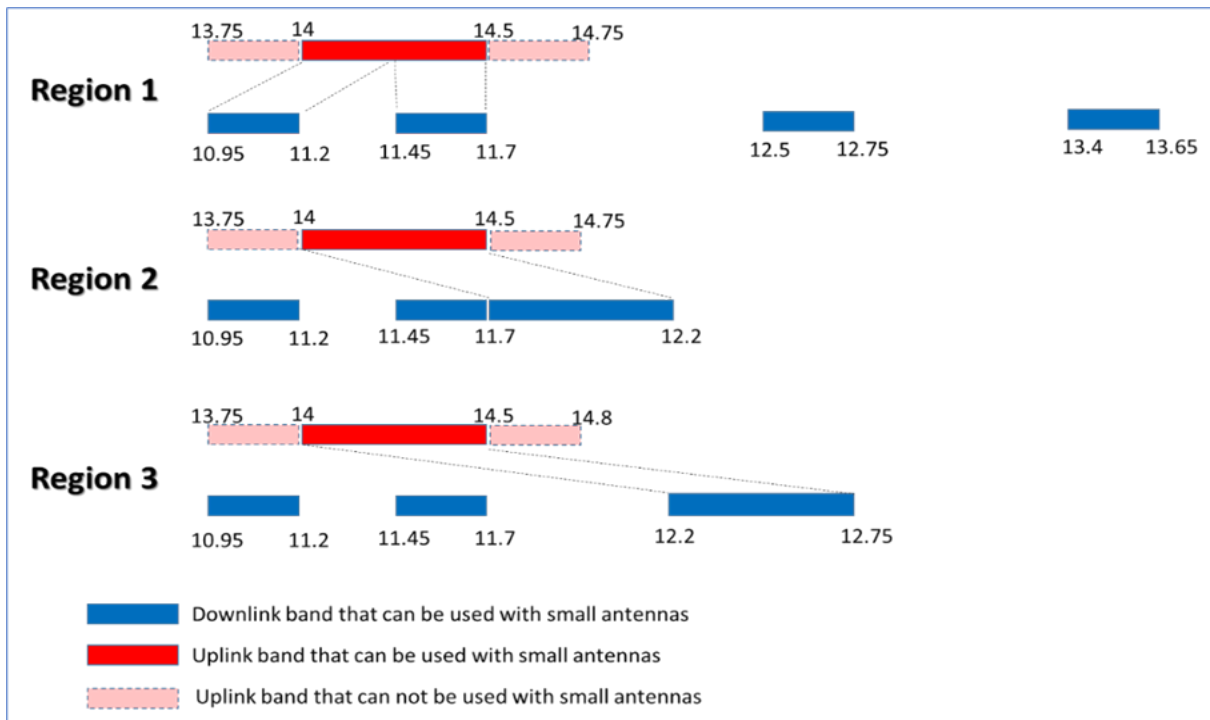
**ITU-R S.[FSS 13.75-14.00 GHz USING SMALLER ANTENNA]**

**1 Introduction**

Unprecedented growth has been observed in the Fixed Satellite Service (FSS), both in terms of number of satellites launched, involvement of more industry players, creation of new applications and the increasing data rate demands and better performances. This general growth of the FSS created pressure on the available limited spectrum resources required for providing services in particular within Ku band 10-15 GHz, as the Ku-band remains one of the most common resource for FSS.

The satellite industry is witnessing remarkable transformation in the user terminals. These user terminals are becoming smaller, more flexible, and more user-friendly, due to technological advancements. Employing active antenna technology, they can seamlessly operate across multiple orbits and frequency bands, enhancing efficiency and user experience.

This figure highlights Ku-band satellite frequencies without limitations from Appendices 30, 30A, or 30B, and identifies frequencies where user terminal size restrictions apply. So, there is a restriction not to use smaller size antenna for uplink in 13.75 -14.00 GHz band, in the entire region -1, 2 and 3.



## **2 Reason for the study:**

In 1992, the World Administrative Radio Conference (WARC-92) designated the 13.75-14 GHz band for primary use by fixed-satellite services (FSS) and FSS earth stations were restricted to use maximum antenna of 4.5 meters diameter. In addition, there was no limitations on power flux density (PFD).

The World Radiocommunication Conference of 2003 (WRC-2003) introduced significant changes for fixed-satellite service (FSS) earth stations. The minimum antenna size requirement for geostationary FSS stations was reduced to a more manageable 1.2 meters. But, to address potential interference concerns, power flux density (PFD) limitations were introduced for stations utilizing antennas smaller than the previous standard of 4.5 meters. These adjustments aimed to strike a balance between technological advancement in FSS and ensuring minimal disruption to other radiocommunication services.

Since 2003, Satellite Communication has undergone a significant leap forward, especially in the last decade, especially due to development and widespread adoption of multi-spot beam technology. VHTS (Very High Throughput Satellites) unlocked a new level of capacity to multi-spot beam technology. This innovation allows to reuse frequencies across numerous, tightly focused beams, maximizing data transmission. While Ka-band traditionally dominated high-throughput satellites, recent years have seen a surge in Ku-band VHTS projects, offering a wider range of options for communication needs.

Ku-band satellites are undergoing a revolution with narrow, high-precision spot beams, transforming a shift towards more compact and affordable user terminals. These spot beams enable communication with significantly smaller antennas. Traditional wide beams offered a maximum G/T (gain-to-noise-temperature ratio) of 5-10 dBK, limiting the range for effective communication. Spot beams, however, offers a G/T range of 10-20 dBK. This dramatic increase allows for satellite links that previously required large user terminals to now function with much smaller and more affordable options. It may be noted that a 1.2m antenna offers a maximum gain of around 42.7 dBi in Ku-band, while a 0.75m antenna offers gain around 38.5 dBi. The 4 dB difference is effectively compensated for by the superior G/T of spot beam technology, driving a surge in demand for smaller user terminals.

The FSS allocation in Ku band for the user terminals is mainly limited to the frequency band 13.75 – 14.5 GHz with severe limitations are imposed by footnote 5.502, which specifies technical details governing fixed-satellite service (FSS) earth stations operating in the 13.75-14.00 GHz band of the Ku-band.

### **3. Effect of the restriction imposed due to Radio Regulations 5.502 & 5.503**

Current regulations restrict earth station antenna size in the 13.75-14 GHz band. A minimum diameter of 1.2 meters applies to Geostationary (GSO) satellites, while Non-Geostationary (NGSO) require antennas at least 4.5 meters dia. Furthermore, for GSO antennas between 1.2 and 4.5 meters, additional limitations exist on power density and power flux density (pfd) near sea and borders. These restrictions hinder the efficient use of the spectrum by preventing the deployment of smaller, more flexible user terminals.

The surge in demand for satellite internet, driven by the popularity of smaller user terminals, is straining the Ku-band spectrum. This pressure is particularly acute in the adjoining 14-14.5 GHz

uplink band, currently the only portion suitable for smaller terminals. Existing limitations on antenna size in this band (13.75-14 GHz) create a growing imbalance between uplink and downlink spectrum availability. This imbalance threatens to bottleneck data flow and hinder the full potential of smaller user terminals.

A critical challenge exists as a significant mismatch between the amount of uplink and downlink spectrum available for services using smaller satellite user terminals. Currently, there's a potential gap of up to 550 MHz (between 250 MHz and 550 MHz) that could be allocated for uplink to address this imbalance. This lack of dedicated uplink spectrum hinders the full potential of smaller user terminals and could lead to bottlenecks in data flow.

	Bandwidth (MHz) in the 10-15 GHz range, not subject to RR Appendices 30, 30A or 30B, that can be used by smaller antennas		
	Downlink (MHz)	Uplink (MHz)	Lack of uplink bandwidth to feed downlink bandwidth (MHz)
Region 1	750 (1000)	500	250 (500)
Region 2	1000	500	500
Region 3	1050	500	550

- Region 1:
  - Downlink: 750 MHz (or 1000 MHz with 13.4-13.65 GHz)
  - Uplink without limit on antenna size: 500 MHz
  - **Lack of uplink bandwidth to meet downlink bandwidth: 250 MHz (or 500 MHz)**
- Region 2:
  - Downlink: 1000 MHz
  - Uplink without limit on antenna size: 500 MHz
  - **Lack of uplink bandwidth to meet downlink bandwidth: 500 MHz**
- Region 3:
  - Downlink: 1050 MHz
  - Uplink without limit on antenna size: 500 MHz
  - **Lack of uplink bandwidth to meet downlink bandwidth: 550 MHz**

The above highlights needs to identify more uplink capacity that can be efficiently used by smaller antennas that can interact with GSO and NGSO satellites with fast switching

The current regulations governing antenna size and power density in the 13.75-14 GHz band (outlined in RR Nos. 5.502 and 5.503) were established over two decades ago during WRC-03. These restrictions, originally intended to protect radiolocation and space research services, are now proving overly constraining for the deployment of modern, smaller uplink antennas. Furthermore, limitations on power flux density (pfd) near sea areas restrict deployment locations, hindering wider utilization. This out-dated regulatory framework needs revision to accommodate the advancements in satellite technology and unlock the full potential of smaller user terminals.

### 3 Frequency Allocation Information as per Radio Regulation, 2020

Frequency Allocation details for frequency band 13.75 to 14.00 GHz and footnotes text, reference are taken from the Radio Regulations, Edition of 2020.

**Table of Frequency Allocations**  
13.75 to 14.00 GHz

Allocation to services						
Region 1	Region 2			Region 3		
13.75-14	FIXED-SATELLITE (Earth-to-space) 5.484A RADIOLOCATION Earth exploration-satellite Standard frequency and time signal-satellite (Earth-to-space) Space research 5.499 5.500 5.501 5.502 5.503					

#### Radio Regulation - 5.484A

The use of the bands 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) in Region 2, 12.2-12.75 GHz (space-to-Earth) in Region 3, 12.5-12.75 GHz (space-to-Earth) in Region 1, **13.75-14.5 GHz (Earth-to-space)**, 17.8-18.6 GHz (space-to-Earth), 19.7-20.2 GHz (space-to-Earth), 27.5-28.6 GHz (Earth-to-space), 29.5-30 GHz (Earth-to-space) by a non-geostationary-satellite system in the fixed-satellite service is subject to application of the provisions of No. 9.12 for coordination with other non-geostationary-satellite systems in the fixed-satellite service. Non-geostationary-satellite systems in the fixed-satellite service shall not claim protection from geostationary-satellite networks in the fixed-satellite service operating in accordance with the Radio Regulations, irrespective of the dates of receipt by the Bureau of the complete coordination or notification information, as appropriate, for the non-geostationary-satellite systems in the fixed-satellite service and of the complete coordination or notification information, as appropriate, for the geostationary-satellite networks, and No. 5.43A does not apply. Non-geostationary satellite systems in the fixed-satellite service in the above bands shall be operated in such a way that any unacceptable interference that may occur during their operation shall be rapidly eliminated. (WRC-2000)

#### 4. Technical Characteristics of FSS

TBD

#### 5 Operational Considerations

TBD

#### 6 Summary

TBD

## 8 Abbreviations and acronyms

TBD

**Annexure-I**

### **RESOLUTION 129 (WRC-23)**

#### **Studies on possible revisions of sharing conditions in the frequency band 13.75-14 GHz to allow the use of uplink fixed-satellite service earth stations with smaller antenna sizes**

The World Radiocommunication Conference (Dubai, 2023),

considering

- a) that WARC-92 added an allocation to the fixed-satellite service (FSS) (Earth-to-space) in the frequency band 13.75-14 GHz;
- b) that WRC-03 introduced changes to Nos. 5.502 and 5.503 that made it possible to use earth station antennas in the range of 1.2 to 4.5 metres for the geostationary fixed-satellite service (FSS) networks with limits on power flux-density (PFD) and equivalent isotropically radiated power (e.i.r.p.) density;
- c) that WRC-03 did not introduce any changes in Nos. 5.502 and 5.503 in regard to earth stations for non-geostationary-satellite orbit (non-GSO) systems;
- d) that there is congestion in the geostationary orbit (GSO);
- e) that many new satellite systems are being introduced into non-GSO;
- f) that it is necessary to guarantee that orbit and spectrum resources are used efficiently and rationally to facilitate the introduction of new satellite networks;
- g) that there is a requirement for more uplink spectrum in the frequency range 13-15 GHz, which could be used worldwide by smaller earth station antennas, to complement the downlink capacity in the frequency range 10-13 GHz;
- h) that the frequency band 13.75-14 GHz is allocated worldwide on a primary basis to the radiolocation service (RLS);
- i) that the frequency band 13.75-14 GHz is shared with the RLS on the basis of the conditions set forth in No. 5.502;



j) that the sharing conditions in No. 5.502 impose technical limitations on both the RLS and FSS to balance the operational needs of the two services;

k) that WRC-03 decided that a reduction in the FSS earth station's antenna size required the application of a PFD limit applied at the low-water mark and at national land borders to ensure continued protection of the RLS;

l) that the enhancement of operating conditions of the earth stations in the frequency band 13.75-14 GHz would help to meet the evolving needs of FSS applications and facilitate an efficient and rational use of the Earth-to-space and space-to-Earth frequency bands corresponding to the frequency ranges 13-15 GHz and 10-13 GHz;

m) that space research service (SRS) systems continue to operate in the frequency band 13.75-14 GHz, including on a primary basis under No. 5.503,

noting

a) that the SRS is allocated to this band on a secondary basis;

b) that the geostationary space stations of the SRS for which the Bureau has received information for advance publication before 31 January 1992 shall be operating on an equal footing with the stations in the FSS; after that date, the new geostationary space stations of the SRS shall operate on a secondary basis;

c) that, until the geostationary space stations of the SRS for which the Bureau has received information for advance publication before 31 January 1992 stop operating in that frequency band, the frequency band 13.77-13.78 GHz shall be shared with the SRS under the conditions set forth in No. 5.503;

d) that, in the Master International Frequency Register, there is currently only a very limited number of earth stations and satellite networks of the SRS in the frequency band 13.77-13.78 GHz for which advance publication information was received before 31 January 1992;

e) that the usage of the FSS and other services that share this band may have evolved;

f) that the service objectives, geographical areas of operations, and protection requirements of the RLS are described in Recommendation ITU-R M.1644;

g) that, in some countries, the band is also allocated to the fixed service and the mobile service (Nos. 5.499 and 5.500) and to the radio-navigation service (RNS) (No. 5.501),

recognizing

a) that the possible use of the frequency band 13.75-14 GHz by uplink FSS earth stations with smaller antenna sizes requires studies to support possible regulatory changes while continuing to ensure the protection of the RLS and SRS, as addressed in Nos. 5.502 and 5.503;

b) that it is necessary to study possible revised coexistence conditions between the primary services that share this band with their current characteristics and applications and uplink FSS earth stations with smaller antenna sizes, in particular noting Nos. 5.502 and 5.503;

c) that these studies need to take into account that current SRS systems have been developed and operate in the current sharing environment in accordance with Nos. 5.502 and 5.503, and changes to these regulations may change this sharing environment;

d) that there is a need to ensure the continued operations of the RLS in the frequency band 13.75-14 GHz;

e) that the PFD limits at the low-water mark and at the border of national territories in No. 5.502 are critical to ensure the protection of the RLS;

f) that the power limitations applicable to stations in the RLS and RNS stated in No. 5.502 shall remain unchanged;

g) that frequency assignments to ship and mobile stations of the RLS cannot be notified under No. 11.14, and as such the coordination procedure as stipulated in Section II of Article 9 cannot apply as a method for resolving interference issues between FSS earth stations and mobile stations of the RLS;

h) that the protection of the RLS in the frequency band 13.75-14 GHz and SRS in the frequency band 13.77-13.78 GHz relies on the application of a combination of FSS antenna size limitation and of pfd limits at the low-water mark and at the border of national territories,

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1. studies on the technical and operational limitations regarding the minimum antenna size and associated power limitations of GSO and non-GSO FSS earth stations in the frequency band 13.75-14 GHz (Earth-to-space), while ensuring the protection of the services stipulated in Nos. 5.502 and 5.503;

2. studies on possible changes to Nos. 5.502 and 5.503 and possible associated regulatory measures,

invites administrations

to participate actively in the studies and provide the information required for the studies listed under resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference by submitting contributions to the ITU Radiocommunication Sector,

invites the 2027 world radiocommunication conference

to consider, based on the results of the above studies, the minimum antenna size and associated power limitations of GSO and non-GSO FSS earth stations in the frequency band 13.75-14 GHz (Earth-to-space), possible changes to Nos. 5.502 and 5.503, and consequential regulatory measures.

## **Annexure-II**

1.2 to consider possible revisions of sharing conditions in the frequency band 13.75-14 GHz to allow the use of uplink fixed-satellite service earth stations with smaller antenna sizes, in accordance with Resolution 129 (WRC-23);
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<p><b>Resolution 129 (WRC-23)</b> Studies on possible revisions of sharing conditions in the frequency band 13.75-14 GHz to allow the use of uplink fixed-satellite service earth stations with smaller antenna sizes</p>	<p><b>WP 4A</b> <b>2*</b></p>	<p><i>resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference</i></p> <p>1 studies on the technical and operational limitations regarding the minimum antenna size and associated power limitations of GSO and non-GSO FSS earth stations in the frequency band 13.75-14 GHz (Earth-to-space), while ensuring the protection of the services stipulated in Nos. <b>5.502</b> and <b>5.503</b>;</p> <p>2 studies on possible changes to Nos. <b>5.502</b> and <b>5.503</b> and possible associated regulatory measures,</p> <p>...</p> <p><i>invites the 2027 world radiocommunication conference</i></p> <p>to consider, based on the results of the above studies, the minimum antenna size and associated power limitations of GSO and non-GSO FSS earth stations in the frequency band 13.75-14 GHz (Earth-to-space), possible changes to Nos. <b>5.502</b> and <b>5.503</b>, and consequential regulatory measures.</p>	<p><b>WP 3M</b> <b>WP 5A</b> <b>WP 5B*</b> <b>WP 5C</b> <b>WP 7A</b> <b>WP 7B</b> <b>WP 7C</b></p>
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**Studies on possible revisions of sharing conditions in the frequency band 13.75-14 GHz to allow the use of uplink fixed-satellite service earth stations with smaller antenna sizes**

<b>Title</b>	Studies on possible revisions of sharing conditions in the frequency band 13.75-14 GHz to allow the use of uplink fixed-satellite service earth stations with smaller antenna sizes
<b>Identifier</b>	<b>ITU-R S.[FSS 13.75-14.00 GHz USING SMALLER ANTENNA]</b>
<b>Document type</b>	Technical Report
<b>ITU-T Lead Group</b>	SG-4 (study period 2024-27) (Satellite services) Systems and networks for the fixed-satellite service, mobile-satellite service, broadcasting-satellite service and radio-determination-satellite service.
<b>Document related to Working Party</b>	WP-4A
<b>Focus for scope and work</b>	Studies on possible revisions of sharing conditions in the frequency band 13.75-14 GHz to allow the use of uplink fixed-satellite service earth stations with smaller antenna sizes
<b>Related documents</b>	Related ITU references are mentioned at Annexure-I and II

<b>Milestones</b>	<p><b><u>Meeting No.54 at Geneva, Switzerland (01-09 May, 2024)</u></b></p> <ol style="list-style-type: none"><li>1 Consider received contributions.</li><li>2 Consider detailed work-plan</li><li>3 Create initial draft with structure of Document.</li></ol> <p><b><u>Meeting No. 55 at Geneva, Switzerland (23-31 Oct, 2024)</u></b></p> <ol style="list-style-type: none"><li>1 Consider received contributions</li><li>2 Continue work on the draft technical report</li></ol> <p><b><u>Meeting No. 56 (xx – xx, xx-xx-2025, TBD)</u></b></p> <ol style="list-style-type: none"><li>1 Consider received contributions</li><li>2 Continue work on the draft technical report</li></ol> <p><b><u>Meeting No. 57 (xx – xx, xx-xx-2025, TBD)</u></b></p> <ol style="list-style-type: none"><li>1. Consider received contributions</li><li>2. Continue work on the draft technical report</li></ol> <p><b><u>Meeting No. 58 (xx – xx, xx-xx-2026, TBD)</u></b></p> <ol style="list-style-type: none"><li>1. Consider received contributions</li><li>2. Continue work on the draft technical report</li><li>3. Finalize the report.</li></ol>
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