Radiocommunication Study Groups

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Annex 4.15 to
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IAFI

FURTHER UPDATES TO WORKING DOCUMENT ON SHARING AND COMPATIBILITY STUDIES OF IMT SYSTEMS IN THE FREQUENCY BANDs 6 425-7 025 and 7 025-7 125 MHz

Introduction:

41st WP5D meeting continued the development of various sharing and compatibility studies of IMT systems with Fixed Satellite Service (FSS) (Earth to Space), FSS (Space-to-Earth), Space Research Service (SRS), SOS and the Fixed Service (like Microwave system working as backhaul). This main document provides a link to all these studies.

Proposal:

This contribution proposes to update section 4 of the main document with a summary table of each of the studies that were submitted to WP5D for ease of understanding. Towards this, following sections have been added into the main document.

Section Added	Title	Table with the summary of Studies
Section 4.5	Sharing and compatibility of the SRS operating in the frequency band 7 145-7 190 MHz and IMT operating in the frequency band 6 425-7 125 MHz	Table E
Section 4.4	Sharing and compatibility of the SOS operating in the frequency band 7 100-7 155 and IMT operating in the frequency band 6 425-7 125 MHz	Table D
Section 4.3	Sharing and compatibility of the fixed service and IMT operating in the frequency band 6 425-7 125 MHz	Table C
Sections 4.2	Sharing and compatibility of the fixed-satellite service (FSS) (Earth-to-space) operating in the frequency band 6 425-7 025 MHz and IMT operating in the frequency band 6 425-7 125 MHz	Table B

Sections 4.1	Sharing and compatibility of the fixed-satellite service (FSS) (space-to-Earth) operating in the frequency band 6 700-7 075 MHz and IMT operating in the frequency band 6 425-7 125 MHz	Table A

This proposal makes it easy for the reader to get a quick view of all the study results and for further details attachments contains the full studies.

Enclosed: Updated Main Document

Annex 4.15 to Document 5D/1361-E

WORKING DOCUMENT ON SHARING AND COMPATIBILITY STUDIES OF IMT SYSTEMS IN THE FREQUENCY BANDs 6 425-7 025 and 7 025-7 125 MHz

1 Introduction

The studies contained in this working document are part of the studies carried under WRC-23 agenda item 1.2 and Resolution **245 (WRC-19)**, specifically for the potential identification to IMT of the bands 6 425-7 025 MHz (Region 1) and 7 025-7 125 MHz (globally).

2 Allocation information in 6 425-7 025 MHz and 7 025-7 125 MHzand in adjacent frequency bands, as appropriate

*[Editor's note: Resolution **245 (WRC-19)** calls for studies with respect to services in adjacent band, as appropriate, and these need to be considered on a case-by-case basis.]*

5 925-7 145 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
5 925-6 700	FIXED 5.457 FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B MOBILE 5.457C 5.149 5.440 5.458	
6 700-7 075	FIXED FIXED-SATELLITE (Earth-to-space) (space-to-Earth) 5.441 MOBILE 5.458 5.458A 5.458B	
7 075-7 145	FIXED MOBILE 5.458 5.459	
7 145-7 190	FIXED MOBILE SPACE RESEARCH (deep space) (Earth-to-space) 5.458 5.459	

For allocation details and footnotes text, please refer to the Radio Regulations, Edition of 2020.

3 Technical characteristics

3.1 Technical and operational characteristics of services and systems operating in 6 425-7 125 MHz and in adjacent frequency bands, as appropriate

[Editor's note: This section provides the sources of technical and operational characteristics of IMT from WP 5D and other services from other expert groups.]

WP 5D #	Source	Services / Application / Models
245, 722	WPs 3K and 3M	Propagation models
734, 897	WP 4A	Fixed-satellite service (FSS) Broadcasting-satellite service (BSS)
377	WP 4C	Mobile-satellite service
227, 398	WP 5B	Aeronautical mobile (AMS) Radiodetermination (RDS) Radiolocation (RLS)
233, 583	WP 5C	Fixed (FS)
5D/716 Annex 4.4	WP 5D	IMT parameters (MS)
150, 559	WP 7B	Space operation (SOS) Space research (SRS) Earth exploration-satellite (EESS) Inter-satellite (ISS)
151, 353, 573	WP 7C	Earth exploration-satellite (passive) (EESS (passive)) Space research (passive) (SRS (passive))
561	WP 7D	Radio astronomy

3.2 Propagation models for sharing and compatibility studies for IMT operating in 6 425-7 125 MHz

[Editor's note: This section provides the propagation models for sharing and compatibility studies from SG 3.]

4 Sharing and compatibility studies

[Editor's note: This section includes the sharing and compatibility studies for IMT operating in 6 425-7 125 MHz.]

The sharing and compatibility studies are contained in the Attachments to this Report. A summary of these studies are provided in the tables in sections 4.1 to 4.5 below:

Attache		
Attachment 1:	Sharing and compatibility of the SRS operating in the frequency band 7 145-7 190 MHz and IMT operating in the frequency band 6 425-7 125 MHz	Table E /Section 4.5
Attachment 2:	Sharing and compatibility of the SOS operating in the frequency band 7 100-7 155 and IMT operating in the frequency band 6 425-7 125 MHz	Table D/Section 4.4

Attachment 3:	Sharing and compatibility of the fixed service and IMT operating in the frequency band 6 425-7 125 MHz	Table C Section 4.3
Attachment 4:	Sharing and compatibility of the fixed-satellite service (FSS) (Earth-to-space) operating in the frequency band 6 425-7 025 MHz and IMT operating in the frequency band 6 425-7 125 MHz	Table B Sections 4.2
Attachment 5:	Sharing and compatibility of the fixed-satellite service (FSS) (space-to-Earth) operating in the frequency band 6 700-7 075 MHz and IMT operating in the frequency band 6 425-7 125 MHz	Table A Sections 4.1

4.1 Sharing and compatibility of the fixed-satellite service (FSS) (space-to-Earth) operating in the frequency band 6 700-7 075 MHz and IMT operating in the frequency band 6 425-7 125 MHz

A total of 18 studies were submitted to WP5D on sharing and compatibility of FSS (Earth to Space) operating in the frequency band 6 425 – 7 025 MHz and IMT operating in the frequency band 6 425 – 7 025 MHz.Table A below provides a summary of these 18 studies on sharing and compatibility of FSS (Earth to Space) operating in the frequency band 6 425 – 7 025 MHz and IMT operating in the frequency band 6 425 – 7 025 MHz. 10 studies indicate that the interreference criteria of I/N of -10.5 dB is satisfied, while 7 studies indicate that the interreference criteria of I/N of -10.5 is not satisfied or is marginally satisfied. One study was considered as not relevant.

Table A: Summary the 18 studies on sharing and compatibility of FSS (Earth to Space) operating in the frequency band 6 425 – 7 025 MHz and IMT operating in the frequency band 6 425 – 7 025 MHz. (Interference Protection Criteria I/N of -10.5 dB)

Study	Details of Countries /Institutions	Summary of the results submitted by Countries/Institutions
A.	Cameroon, Zimbabwe, SA and Nigeria	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N protection criteria, **satisfied** the sharing of band between IMT and FSS systems.
B.	Japan	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N protection criteria, **satisfied** the sharing of band between IMT and FSS systems.
C.	Saudi Arabia and Jordan	Study results show that aggregate interference from IMT stations to the Earth Station is well above the I/N protection criteria, so **not satisfying** the sharing of band between IMT and FSS systems.
D.	China	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N

		protection criteria, **satisfied** the sharing of band between IMT and FSS systems.
E.	Benin, Burkina, Ghana, Guinea, Niger, Mali, Togo and Cote d' Ivoire	Study results shows that aggregate interference from IMT stations to the Earth Station is well above the I/N protection criteria, so **not satisfying** the sharing of band between IMT and FSS systems.
F.	IAFI	Study results show that aggregate interference from IMT stations to the Earth Station is well above the I/N protection criteria, so **not satisfying** the sharing of band between IMT and FSS systems.
G.	GSOA (Global Satellite Operators' Association)	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N protection criteria, **satisfied** the sharing of band between IMT and FSS systems.
H.	Ericsson	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N protection criteria, **satisfied** the sharing of band between IMT and FSS systems.
I.	France	Study results show that aggregate interference from IMT stations to the Earth Station is well above the I/N protection criteria, so **not satisfying** the sharing of band between IMT and FSS systems.
J.	Russian Federation	Study results show that aggregate interference from IMT stations to the Earth Station is **marginally** below the I/N protection criteria in two scenario 1& 2, while scenario 3, satisfied the sharing of band between IMT and FSS systems.
K.	Nokia	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N protection criteria, **satisfied** the sharing of band between IMT and FSS systems.
L.	UAE, Kuwait	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N protection criteria, **satisfied** the sharing of band between IMT and FSS systems.
M.	Jio	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N protection criteria, **satisfied** the sharing of band between IMT and FSS systems.
N.	Mali and Guinea	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N protection criteria, **satisfied** the sharing of band between IMT and FSS systems.
O.	Russian Federation	This study is not relevant.

P.	Botswana, Eswatini, Malawi, SA, Zimbabwe	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N protection criteria, **satisfied** the sharing of band between IMT and FSS systems.
Q.	Huawei Technologies Sweden AB	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N protection criteria, satisfied the sharing of band between IMT and FSS systems, except the case of Niger, where the I/N protection criteria is **marginally below**.
R.	Senegal	Study results show that aggregate interference from IMT stations to the Earth Station is well below the I/N protection criteria, satisfied the sharing of band between IMT and FSS systems, where for the Hemi Beam, the I/N protection criteria is **marginally below**.

Remarks:" Study O" of Russian Federation in not relevant here.

4.2 Sharing and compatibility studies of Fixed Satellite Service (SPACE-TO-EARTH) operating in the frequency band 6 700-7 075 MHz

Nine studies have been submitted regarding sharing and compatibility of IMT systems operating in the frequency band 6 425 – 7 125 MHz and Fixed Satellite Services (FSS) operating in the frequency band 6 700 7075 MHz,

Table below provides a summary of the studies submitted to WP5D

TABLE B: Sharing and compatibility studies of Fixed Satellite Service (SPACE-TO-EARTH) operating in the frequency band 6 700-7 075 MHz

Study/ Document Ref.	**Country/ Institution**	**Recommendation/Views**
A	**Saudi Arabia, Jordan**	The results show that the operations of IMT BS and UE systems in this band would cause interference to incumbent fixed satellite service.
B	**Russia**	Studies shows that to achieve compatibility, between IMT-2020 networks and FSS earth stations (Space-to-Earth) operating in the 6700-7075 MHz frequency band, from 26 to 20 km separation is required for short-term interference and from 23 to 19 km for long-term interference.

C	**Russia**	Study shows that compatibility between one IMT BS 5G/IMT-2020 (Suburban macro) and ES FSS (Carrier 12) could be guaranteed, if the protection distance 23 km is taken for short-term criteria and 20 km for long-term is taken.
D	**Ericsson**	Study shows that coexistence between IMT-2020 using AASs and non-- GSO FSS (space-to-Earth) including LEO and MEO satellite constellations in the 6 700 -7 075 MHz band, is possible at a separation distance up to 18 km for a LEO FSS ES and at a separation distance up to 17 km for a MEO FSS ES, satisfying the long-term protection criterion.
E	**China**	Study observed that in case of Urban Scenario separation distance between IMT BS and FSS ES from 17 Km to 24 Km for Short-term and Long-term criteria is needed, lowest for HIBLEO and highest for SIRION-1 constellation is required. Study observed that in case of Sub-urban Scenario, separation distance between IMT BS and FSS ES from 20 Km to 28 Km for Short-term and Long-term criteria is needed, lowest for HIBLEO and highest for SIRION-1 constellation is required.
F	**France**	Study mentions that for an IMT to work in the frequency bands 6 725-7 025 MHz and 7 025-7 075 MHz, protection areas will be needed to keep FSS feeder link Earth stations, to avoid IMT harmful interference. The protection distances can range from few kilometres to tens of kilometres. Therefore, site specific mitigation measures should be considered by Administrations to maintain the protection of the current use of the FSS downlink.
G	**Nokia**	Study shows that a separation distance to the FSS earth station in the range of 5-17 km is required when IMT BS are in the urban environment with clutter loss applied to 65% of IMT base stations. When 100 % urban IMT base stations are within clutter, the separation distance to the FSS earth station is less than 1.2 km. This distance increases to a range of 11-21 km, when IMT BS are in the suburban environment, so only 15% are suffered with clutter loss.
H	**Globestar**	Study shows that the necessary protection distance to be applied around a NGSO ground station range between 40 and 180 km. It is mentioned that the results are site specific and depends on the orbital parameters of the constellation, and on the position /orientation of the IMT base stations towards the FSS Earth Station. Study also shows that the clutter loss is most determinant parameter influencing the results as it can multiply the protection distances by a factor of 3.
I	**Russia**	All sharing studies have shown that separation distances are required in order to protect the operation of non-GSO FSS Earth

		stations. These separation distances range between few Km to tens of Km. These protection distances are site specific and depend on several elements such as the propagation parameters, local terrain topography, surrounding clutter including vegetation losses, station and orbital parameters of the non-GSO system and satellite selection strategy.

4.3 Sharing and compatibility studies of of IMT systems operating in the frequency band 6 425 – 7 125 MHz and Fixed Satellite Services (FSS) operating in the frequency band 6 700 7075 MHz,

Nine studies have been submitted regarding sharing and compatibility of IMT systems operating in the frequency band 6 425 – 7 125 MHz and Fixed Satellite Services (FSS) operating in the frequency band 6 700 7075 MHz,

Table C below provides a summary of the studies submitted to WP5D

Table C: Summary of 6 studies on sharing and compatibility studies FS (Fixed Service) and IMT operating in the frequency band 6 425-7 125 MHz

Study Ref.	Country/ Institution	Results and recommendations
A	**Russia**	In-band sharing studies between the FS and IMT shows that separation distances between FS receivers and IMT-2020 networks should be from 10 to 64 km depending on the FS station antenna height and IMT-2020 deployment scenario for the main lobe interference. Similarly, study shows that separation distance from >1 to 10 km between FS receivers and IMT-2020 networks is required depending on the FS antenna height and IMT-2020 deployment scenario for the side lobe interference.
B	**Cameroon, Nigeria, South Africa and Zimbabwe**	Study shows that if IMT deployed in Urban area and FS Antenna height is 60 Meter, so to avoid interference from main lobe separation distance minimum 55 Km is required and for FS Antenna Height is 20 Meter (deployed in Urban area), separation distance required is 17 Km. Similarly, if IMT deployed in Sub-urban area and FS Antenna height is 60 Meter, so to avoid interference from main lobe separation distance minimum 56 Km is required and if FS Antenna Height is 20 Meter and deployed in Urban area, separation distance required is 16 Km.
C	**Germany**	The study shows that to avoid interference from IMT BS to FS, separation distances 59 km is required, when the IMT BS is placed inside the clutter.

		In worst case scenario, if IMT BS are placed above the clutter, separation distance up to 122 km is required to avoid interference.
D	**China**	Considering protection criteria, I/N ≤ -10 dB, the co-channel sharing studies between the FS and IMT shows that separation distances of the FS receivers from the IMT-2020 networks should be from 24 to 58 km depending on the FS station antenna height and IMT-2020 deployment scenario. For the Side Lobe Interference Scenario, separation distances of the FS receivers from the IMT-2020 networks should be from and from 1.5 to 4 km depending on the FS antenna height and IMT-2020 deployment scenario for the side lobe interference scenario.
E	**Germany**	Interference analysis for the main lobe shows that the separation distance of 40 km being not enough. It is also concluded that whatever assumptions used, the side lobe separation distance would be much smaller due to the gap between maximum antenna gain and the minimum antenna gain of FS receiver (50 dB).
F	**Ericsson**	It is concluded that when IMT BS is facing the FS Main Lobe, separation distance for co-channel sharing to the tune of 44 to 70 km is required as interference from the IMT falls within the main beam of the FS. But if IMT is facing the FS Side Lobe, the separation distances for co-channel sharing requires only a few km.

4.4. Sharing and compatibility of the SOS operating in the frequency band 7 100 7 155 and IMT operating in the frequency band 6 425-7 125 MHz

3 studies on sharing and compatibility studies the SOS operating in the frequency band 7 100 7 155 MHz and IMT operating in the frequency band 6 425-7 125 MHz were submitted to WP5D. Table D below provides a summary result of Sharing and compatibility of the SOS operating in the frequency band 7 100 7 155 and IMT operating in the frequency band 6 425-7 125 MHz

Table D: Sharing and compatibility of the SOS operating in the frequency band 7 100 7 155 and IMT operating in the frequency band 6 425-7 125 MHz

Study Ref.	Submitted by	Recommendations
A	**Russia**	Two Modes of study are used. **Mode-1**: Satellite is at Apogee (450 Km) and 3 dB beam width area, approximately 2,00,000 Sq Km is taken and all IMT BSs falling in urban, sub-urban and rural of the above area are take in the study. **Mode -2:** Entire visible area of the satellite from apogee i.e., 16,844,877 Sq Km and all IMT BSs falling in urban, sub-urban and rural of the above area are taken in the study.

		Aggregate Interference observed by the SOS satellite comes as C/I = 11 dB for Mode-1 and = 12.3 dB for Mode 2. As *C/I* in both the cases do not meet 20 dB criteria, sharing and compatibility of SOS Satellites (NGSO) with IMT operating in the same band **is not feasible**.
B	**Russia**	Study shows that the aggregate interference C/I into GSO SOS satellite system (System D) from IMT urban/suburban/rural macro-BS deployment comes as = 22 dB for antenna gain as 45 dBi and 27 dB for antenna gain, so always meeting the 20 dB criteria. As *C/I* in both the cases are within 20 dB criteria, sharing and compatibility of SOS Satellites (NGSO) with IMT operating in the same band **is feasible**.
C	**Huawei Technology Sweden AB**	Two Modes of study are used. **Mode-1**: Satellite is at Apogee (450 Km) and 3 dB beam width area, approximately 2,00,000 Sq Km is taken and all IMT BSs falling in urban, sub-urban and rural of the above area are take in the study. **Mode -2: E**ntire visible area of the satellite from apogee i.e., 16,844,877 Sq Km and all IMT BSs falling in urban, sub-urban and rural of the above area are taken in the study. In the study, 20% Loading Factor is taken. Clutter loss has been applied to all IMT BSs in the urban and suburban area. Aggregate Interference observed by the SOS satellite comes as C/I = 29.3 dB for Mode-1 and = 29.1 dB for Mode 2, so always meeting the 20 dB criteria. As *C/I* in both the cases are within 20 dB criteria, sharing and compatibility of SOS Satellites (NGSO) with IMT operating in the same band **is feasible**.

4.5 Sharing and compatibility of the SRS operating in the frequency band 7 145 - 7190 and IMT operating in the frequency band 6 425-7 125 MHz

3 studies on sharing and compatibility studies on SRS operating in the frequency band 7 145 - 7190 and IMT operating in the frequency band 6 425-7 125 MHz were submitted to WP5D. Table E below provides a summary result of Sharing and compatibility of the SRS operating in the frequency band 7 145 7 190 and IMT operating in the frequency band 6 425-7 125 MHz

Table E: Summary of Sharing and compatibility of the SRS operating in the frequency band 7 145 7 190 and IMT operating in the frequency band 6 425-7 125 MHz

Study Ref.	Country	Recommendations
A	**GSMA**	We can see from the results that this initial model delivers a very large margin of around 47.9 dB. This provides a clear indication that there is no interference problem for this compatibility scenario. Furthermore, the study is conservative in some aspects and includes some simplifications in the modelling. Additional refinements seem

		unnecessary to close this case, even though the model could be improved by including factors such as network loading and TDD activity factor, and clutter loss at base station locations. This initial study is sufficient to show that there is no compatibility problem in this case; however, for compatibility scenarios where the margin may be smaller, such simplifications may not be appropriate and all such factors need to be included in the modelling.
B	**GSMA**	The calculation in this study is based on a snapshot analysis of instantaneous interference that may potentially occur for SRS satellites in LEO, LEOP or in the mission return phase. The study assumes an orbit height of 200 km, 0 dB SRS antenna gain and 330K receiver noise temperature and that the satellite footprint is completely filled with IMT base stations. The simulation returns a single, instantaneous value of aggregate interference I in 20 Hz of -233.8 dBW/20 Hz, or 43.8dB below the threshold. This value is the sum of contributions from urban (-234.25 dBW/20 Hz) and suburban (-244.04 dBW/20 Hz) base stations. This result provides a clear indication that there is no interference problem for this compatibility scenario.
C	**ESA**	The study results show that coordination distances, ranging from tens of kilometres up to 400 km, may be required to ensure the protection of IMT BS receivers below 7 125 MHz from unwanted emissions of SRS (deep space) earth station transmitters operating above 7 145 MHz. This study assumes an unwanted emissions attenuation of 60 dBc (in a 4 kHz reference bandwidth) for the SRS transmitters It is envisaged that SRS earth stations actually deployed may offer better performance for the unwanted emissions attenuation, consequently leading to lower separation distances. The exact value of the required separation distances would have to be assessed, on a case-by-case basis, taking into account the specific parameters of the SRS earth station

5 Abbreviations and acronyms

Attachments:

Attachment 1: Sharing and compatibility of the SRS operating in the frequency band 7 145-7 190 MHz and IMT operating in the frequency band 6 425-7 125 MHz

Attachment 2: Sharing and compatibility of the SOS operating in the frequency band 7 100-7 155 and IMT operating in the frequency band 6 425-7 125 MHz

Attachment 3: Sharing and compatibility of the fixed service and IMT operating in the frequency band 6 425-7 125 MHz

Attachment 4: Sharing and compatibility of the fixed-satellite service (FSS) (Earth-to-space) operating in the frequency band 6 425-7 025 MHz and IMT operating in the frequency band 6 425-7 125 MHz

Attachment 5: Sharing and compatibility of the fixed-satellite service (FSS) (space-to-Earth) operating in the frequency band 6 700-7 075 MHz and IMT operating in the frequency band 6 425-7 125 MHz

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