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| U.S. Radiocommunications SectorFact Sheet |
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| **Document Title:** WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R SA.[LUNAR 1.15 STUDIES] |
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| **Purpose/Objective:** The purpose of this contribution is to initiate the working document in WP7B, with the framework of the sharing studies and spectrum needs of space research service (SRS) stations on the lunar surface, and SRS systems in lunar orbit communicating with systems on the lunar surface, consistent with *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 World Radiocommunication Conference* 1, 2, and 4 of Resolution 680 (WRC-23) under WRC-27 agenda item 1.15. |
| **Abstract:** Under Agenda item 1.15 (WRC-27), possible new or modified space research service allocations, in the frequency ranges identified in Resolution 680 (WRC-23) resolves to invite 1, are under study to ensure sharing and compatibility between SRS links on the lunar surface/between lunar orbit and lunar surface and incumbent services in Res 680 (WRC-23) *recognizings* g) to n) and RAS in adjacent and nearby bands. This input contribution proposes a document framework which includes the preliminary sharing studies matrix, lunar SRS spectrum needs and preliminary study results. |

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| **Radiocommunication Study Groups** |  |
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|  |  |
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|  |
| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R SA.[LUNAR 1.15 STUDIES]  |

Based on the results of CPM27-1, Working Party 7B is responsible for conducting studies and preparation of draft CPM text under WRC-27 agenda item 1.15 on lunar communications related to systems in the space research service which may operate on the lunar surface, or systems in lunar orbit communicating with systems on the lunar surface in specific frequency ranges called out in Resolution **680 (WRC-23)**.

This contribution proposes, as outlined in the attachment, a method for summarizing the information received from the contributing groups, along with a proposed structure for the document related to sharing studies and spectrum needs under WRC-27 agenda item 1.15.

**Attachment: 1**

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| --- |
| ATTACHMENTWORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R SA.[LUNAR 1.15 STUDIES] |
| Working document on sharing studies of space research systems for lunar operations under WRC-27 agenda item 1.15 |

# 1 Introduction

This document provides the sharing studies and spectrum needs related to systems in the space research service planned for operations on the lunar surface, or systems in lunar orbit communicating with systems on the lunar surface, in the following frequency ranges or portions thereof:

* 390-406.1 MHz, 420-430 MHz and 440-450 MHz, limited to outside the SZM
* 2 400-2 690 MHz, 3 500-3 800 MHz, 5 150-5 570 MHz, 5 570-5 725 MHz, 5 775-5 925 MHz, 7 190-7 235 MHz, 8 450-8 500 MHz and 25.25-28.35 GHz

and taking into account protection of incumbent services in **Res 680 (WRC-23)** *recognizing g)* to *n)* and RAS on the Earth and in the shielded zone of the Moon (SZM) in the same, adjacent or nearby bands.

The objective of this document is to respond to *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* *1) and 4)* of Resolution **680 (WRC-23)** under WRC-27 agenda item 1.15.

# 2 Spectrum needs

Figure 1 shows a conceptual diagram of the envisioned elements [1] used for space research operations on the lunar surface, and the associated communication network architecture in the vicinity of the Moon. The communication links between the lunar elements will be used to support scientific discovery and human/robotic exploration of the Moon, and may leverage technology and frequency ranges originally developed for wireless communication networks on Earth. A detailed description of the technical and operating characteristics of systems in the space research service planned for operations on the lunar surface, or systems in lunar orbit communicating with systems on the lunar surface, are provided in PDN Report ITU-R SA.[LUNAR.SRS STATIONS CHAR]. This section provides a description of the amount of spectrum needed within each frequency range needed to support the envisioned concept of operations as described in the aforementioned Report and summarized below.



Figure 1. Envisioned Lunar Surface Communication Architecture

In this lunar communication network architecture, it is assumed that the initial human exploration activities will centered around the lunar landers, and eventually around permanent habitation modules. The lunar landers will be considered as a stationary surface platform for the duration of the landed mission phase, which may last up to several months. There will likely be multiple landers present on the lunar surface at any one time, some which may be crewed and others which are for robotic exploration only. There may also be multiple habitation modules, each with their own local area communication networks and high rate point-to-point links between habitation modules.

The lander and the habitation module are expected to provide a wireless local area network (WLAN) service for crew and rovers in the near vicinity of the lander (< 300 meters). The data rate for each device is expected to be between 1-30 Mbps including file transfers and high definition video, with up to 15-20 connected devices per WLAN. The frequency ranges for this application are expected to in the 2 400 – 2 480 MHz and 5 150 – 5 725 MHz bands using Wi-Fi technology. In addition, lunar terrain vehicles and pressurized rovers may also provide WLAN coverage in their immediate vicinity for crewed exploration of the Moon away from the lander/habitation modules.

For longer range connectivity around the lander and habitation modules, it is expected that network coverage will be provided by technology similar to 3GPP developed for terrestrial networks. The data rates per lunar device is expected to between 3-12 Mbps for voice, data, and video. Initial deployments on the Moon will likely involve a base station installed on the lunar lander supporting EVA communications for up to 6 lunar elements (crew and/or rovers) in a 2 km radius around the lander. This can be supported using a FDD network in the 2 500 – 2 690 MHz band, assuming a 50 MHz guard band between the FDD uplink and downlink bands. For crew contingency walk-back scenarios where coverage is limited or the range is large (up to 10 km), the data rate using this network may limited to 100 kbps.

Eventual deployment around the habitation module will involve multiple base stations for a larger coverage area and more lunar elements (up to approximately 30 – 50 devices). These networks may utilize the 3 500 - 3 800 MHz frequency range in order to provide a higher data rates (up to 100 Mbps per device) and increased network capacity. The lunar terrain vehicle and pressurized rover may also carry a base station to provide connectivity during long range crewed exploration missions away from the lander/habitation module.

During crewed exploration missions, short range crew suit-to-suit communications up to 200 meters distance is need for voice and data. The data rate for this application is expected to be around 100 kbps, and will use the 420 – 430 MHz frequency range. For higher rate suit-to-suit communications involving high definition video (~12 Mbps), technology based on the Sidelink device-to-device communications in the 5 855 – 5 925 frequency band may also be used. Furthermore, the astronauts will carry a distress beacon in the 406 – 406.1 MHz band. This beacon will be used to notify a lunar orbiting satellite in the event of an emergency. The crew EVA suits and rovers will also carry devices to receive signals transmitted by lunar orbiting satellites for position determination and time synchronization in the 2 483.5 – 2 500 MHz band. Outside of the SZM, relay communications between elements on the lunar surface and lunar orbiting satellites may also take place in the 390 – 405 MHz and 440 – 450 MHz bands.

For high rate point-to-point links between the habitation module and remote experimental platforms involving science observations and/or data collection, the 27.5 – 28.35 GHz frequency range is expected be used. These links may involve data rates up to 1 Gbps using highly directional antennas. This frequency band may also be used for high rate communications between two habitation modules, or for relay communications between a lander and a habitation module.

Table 2 shows a calculation of the spectrum needs for different envisioned lunar SRS applications.

Table 1

Envisaged Concept of Operations of Spectrum Use for SRS Systems in the Lunar Environment

| Frequency Band | Lunar Surface to Lunar Surface | Lunar Orbit to Lunar Surface | Lunar Surface to Lunar Orbit |
| --- | --- | --- | --- |
| 390-405 MHz |  | X |  |
| 406-406.1 MHz |  |  | X |
| 420-430 MHz | X |  |  |
| 440-450 MHz |  |  | X |
| 2400-2480 MHz | X |  |  |
| 2483.5-2500 MHz |  | X |  |
| 2500-2690 MHz | X |  |  |
| 3500-3800 MHz | X |  |  |
| 5150-5570 MHz | X |  |  |
| 5570-5725 MHz | X |  |  |
| 5725-5855 MHz | X |  |  |
| 5855-5925 MHz | X |  |  |
| [7190-7235 MHz] |  | [X] |  |
| [8450-8500 MHz] |  |  | [X] |
| 27.0-27.5 GHz |  |  | X |
| 27.5-28.35 GHz | X |  |  |

Table 2

Lunar SRS Spectrum Needs

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | EVA Comms | HAB module | Point-to-point Surface Comms | Orbiter relay comms (proximity link) | Remote Science Instruments | Exploration Vehicle(LTV, pressurized rover) |
| Data Type | Voice, Data, Video | High rate data transfer, file upload, high definition video | Backhaul data | Relay data | Scientific measurement data | Voice, Data, Video |
| Data Rate (Mbps) | 12  | 30  | 1000 | 100  | 30 | 30 |
| # of Devices/ Links per Site | 6-12 | TBD | TBD | 6(forward and return) | 20 | 4 |
| Total capacity (Mbps) | 144 | TBD | TBD | 600  | 600 | 120 |
| Spectral efficiency (bits/s/Hz) | 1 | TBD | TBD | 2 | 2 | 1 |
| Spectrum needs (MHz) | 144 | TBD | TBD | 300 | 300 | 120 |
| Total Spectrum needs (MHz)1 | TBD |

1 Not including bandwidth for backup communications and guard bands

# 3 Services identified for sharing and compatibility studies with space research systems for lunar communications

This section provides a summary of the services identified for sharing and compatibility studies with lunar surface SRS systems, or systems in lunar orbit communicating with systems on the lunar surface, in the frequencies ranges listed for study in Resolution **680 (WRC-23)**. The following tables provide a summary of the services identified for sharing and compatibility studies in each frequency range, along with the regions and relevant footnotes from Article 5 in the Radio Regulations.

The technical and operating characteristics of systems in the space research service planned for operations on the lunar surface, or systems in lunar orbit communicating with systems on the lunar surface, are provided in PDN Report ITU-R SA.[LUNAR.SRS STATIONS CHAR]. All the lunar communications described in this report are between or among types of space stations on the lunar surface or in lunar orbit.

## 3.1 390-406.1 MHz

TABLE 1

**Services identified for sharing studies with lunar communications (390-406.1 MHz)**

|  |  |  |
| --- | --- | --- |
| **Service** | **Frequencies** | **Footnotes** |
| FIXED | 390.0 – 399.9 MHz |  |
| 400.15 – 401 MHz | 5.262 |
| MOBILE | 390.0 – 399.9 MHz |  |
| 400.15 – 401 MHz | 5.262 |
| MOBILE-SATELLITE(Earth-to-space) | 399.9 – 400.05 MHz | 5.209, 5.220, 5.260A, 5.260B |
| 406.00 – 406.10 MHz | 5.265, 5.266, 5.267 |
| MOBILE-SATELLITE (space-to-Earth) | 400.15 – 401.00 MHz | 5.208A, 5.208B, 5.209 |
| Fixed(1) | 401 – 406 MHz |  |

1. Service allocated on a secondary basis as per Radio Regulations, but identified for study by WP 5C

## 3.2 420-430 MHz

TABLE 2

**Services identified for sharing studies with lunar communications (420-430 MHz)**

|  |  |  |
| --- | --- | --- |
| **Service** | **Frequencies** | **Footnotes** |
| FIXED | 420 – 430 MHz |  |
| MOBILE except aeronautical mobile | 420 – 430 MHz |  |
| RADIOLOCATION | 420 – 430 MHz | 5.269 |

## 3.3 440-450 MHz

TABLE 3

**Services identified for sharing studies with lunar communications (440-450 MHz)**

|  |  |  |
| --- | --- | --- |
| **Service** | **Frequencies** | **Footnotes** |
| FIXED | 440 – 450 MHz |  |
| MOBILE except aeronautical mobile | 440 – 450 MHz |  |
| RADIOLOCATION | 440 – 450 MHz | 5.269, 5.285 |

## 3.4 2400-2690 MHz

TABLE 4

**Services identified for sharing studies with lunar communications (2400-2690 MHz)**

|  |  |  |
| --- | --- | --- |
| **Service** | **Frequencies** | **Footnotes** |
| FIXED | 2400 – 2690 MHz |  |
| MOBILE | 2400 – 2500 MHz |  |
| RADIOLOCATION | 2450 – 2500 MHz |  |
| RADIODETERMINATION-SATELLITE(space-to-Earth) | 2483.5 – 2500 MHz | 5.398, 5.399 (Region 1), 5.401 (Regions 1&3), 5.402 |
| MOBILE-SATELLITE (space-to-Earth) | 2483.5 – 2500 MHz | 5.351A, 5.401 (Regions 1&3), 5.402 |
| 2500 – 2520 MHz |  |
| MOBILE-SATELLITE(Earth-to-space) | 2655 – 2670 MHz | 5.420 |
| 2670 – 2690 MHz | 5.351A |
| FIXED-SATELLITE(space-to-Earth) | 2500 – 2535 MHz | 5.415 |
| 2535 – 2655 MHz | 5.415 |
| 2655 – 2690 MHz | 5.415 |
| FIXED-SATELLITE(Earth-to-space) | 2655 – 2690 MHz | 5.415 |
| MOBILE except aeronautical mobile  | 2500 – 2690 MHz | 5.384A, 5.409A (Regions 1&2) |
| MOBILE (identified for IMT) | 2500 – 2690 MHz | 5.384A |
| MOBILE (identified for HIBS) | 2500 – 2690 MHz | 5.409A |
| BROADCASTING-SATELLITE | 2520 – 2655 MHz | 5.413, 5.416, 5.418B, 5.418C |
| 2520 – 2535 MHz | 5.413, 5.416 |
| 2535 – 2655 MHz | 5.413, 5.416, 5.418, 5.418A, 5.418B, 5.418C |
| 2655 – 2670 MHz | 5.413, 5.416 |
| AERONAUTICAL RADIONAVIGATION (1) | 2700 -2900 MHz | 5.423 |

NOTE: The frequency range from 2 400 to 2 500 MHz is also designated for industrial, scientific and medical (ISM) applications according RR No. **5.415A**. Radiocommunication services operating within these bands must accept harmful interference which may be caused by these applications. ISM equipment operating in these bands is subject to the provisions of No. **15.13**.

1. Service identified for compatibility analysis by WP 5B

## 3.5 3500-3800 MHz

TABLE 5

**Services identified for sharing studies with lunar communications (3500-3800 MHz)**

|  |  |  |
| --- | --- | --- |
| **Service** | **Frequencies** | **Footnotes** |
| FIXED | 3500 – 3800 MHz |  |
| FIXED SATELLITE (space-to-Earth) | 3500 – 3800 MHz |  |
| MOBILE except aeronautical mobile | 3500 – 3600 MHz | 5.430A (Region 1), 5.431B (Region 2), 5.433A (Region 3) |
| 3600 – 3800 MHz | 5.434A (Region 1), 5.435A (Region 1), 5.433B(Region 1), 5.434B (Region 1), 5.434 (Region 2) |
| MOBILE (identified for IMT) | 3500 – 3600 MHz | 5.430A, 5.431B, 5.433A |
| 3600 – 3700 MHz | 5.434 |
| 3700 – 3800 MHz | 5.434B |
| 3700 – 3800 MHz | 5.435B |

## 3.6 5150-5570 MHz

TABLE 6

**Services identified for sharing studies with lunar communications (5150-5570 MHz)**

|  |  |  |
| --- | --- | --- |
| **Service** | **Frequencies** | **Footnotes** |
| FIXED SATELLITE (Earth-to-space) | 5150 – 5250 MHz | 5.447A, 5.447C |
| FIXED SATELLITE (1) (space-to-Earth) | 5150 – 5216 MHz | 5.447B |
| MOBILE except aeronautical mobile | 5150 – 5250 MHz | 5.446A, 5.446B, 5.447 |
| 5250 – 5350 MHz | 5.446A, 5.447F |
| 5470 – 5570 MHz | 5.446A, 5.450A |
| AERONAUTICAL MOBILE | 5150 -5250 MHz | 5.446C, 5.446D |
| AERONAUTICAL RADIONAVIGATION | 5150 – 5250 MHz |  |
| 5350 – 5460 MHz | 5.449 |
| 5470 – 5650 MHz | 5.450 |
| FIXED | 5250 – 5350 MHz | 5.447E |
| RADIOLOCATION | 5250 – 5350 MHz | 5.448A |
| 5350 – 5470 MHz | 5.448D |
| 5470 – 5570 MHz | 5.450B |
| SPACE RESEARCH (active) | 5250 – 5255 MHz | 5.447D |
| 5255 – 5350 MHz | 5.448A |
| 5350 – 5460 MHz | 5.448C |
| 5460 – 5570 MHz | 5.448B |
| RADIONAVIGATION | 5250 – 5350 MHz | 5.448 |
| 5460 – 5470 MHz | 5.448B, 5.449 |
| MARITIME RADIONAVIGATION | 5470 – 5570 MHz | 5.448B |

(1) This allocation is limited to feeder links of non-geostationary-satellite systems in the mobile satellite service and is subject to provisions of No. **9.11A**.

## 3.7 5570-5725 MHz

TABLE 7

**Services identified for sharing studies with lunar communications (5570-5725 MHz)**

|  |  |  |
| --- | --- | --- |
| **Service** | **Frequencies** | **Footnotes** |
| RADIOLOCATION | 5570 – 5650 MHz | 5.450B |
| 5650 – 5725 MHz |  |
| FIXED | 5650 – 5725 MHz | 5.453, 5.455 |
| MOBILE | 5650 – 5725 MHz | 5.453 |
| MOBILE except aeronautical mobile | 5570 – 5 725 MHz | 5.450A |

## 3.8 5775-5925 MHz

TABLE 8

**Services identified for sharing studies with lunar communications (5775-5925 MHz)**

|  |  |  |
| --- | --- | --- |
| **Service** | **Frequencies** | **Footnotes** |
| FIXED SATELLITE(Earth-to-space) | 5775 – 5850 MHz |  |
| 5850 – 5925 MHz |  |
| RADIOLOCATION | 5775 – 5850 MHz |  |
| FIXED | 5775 – 5850 MHz | 5.453 |
| 5850 – 5925 MHz |  |
| MOBILE | 5775 – 5850 MHz | 5.453 |

NOTE: The frequency range from 5 725 to 5 875 MHz is also designated for industrial, scientific and medical (ISM) applications according RR No. **5.415A**. Radiocommunication services operating within these bands must accept harmful interference which may be caused by these applications. ISM equipment operating in these bands is subject to the provisions of No. **15.13**.

## 3.9 7190-7235 MHz

TABLE 9

**Services identified for sharing studies with lunar communications (7190-7235 MHz)**

|  |  |  |
| --- | --- | --- |
| **Service** | **Frequencies** | **Footnotes** |
| FIXED | 7190 – 7235 MHz |  |
| MOBILE | 7190 – 7235 MHz |  |
| SPACE RESEARCH(Earth-to-space) | 7190 – 7235 MHz | 5.460, 5.459 |

## 3.10 8400-8500 MHz

TABLE 10

**Services identified for sharing studies with lunar communications (8450-8500 MHz)**

|  |  |  |
| --- | --- | --- |
| **Service** | **Frequencies** | **Footnotes** |
| FIXED | 8450 – 8500 MHz |  |
| MOBILE except aeronautical mobile | 8450 – 8500 MHz |  |
| SPACE RESEARCH (space-to-Earth) | 8450 – 8500 MHz |  |

## 3.11 25.25-28.35 GHz

TABLE 11

**Services identified for sharing studies with lunar communications (25.25-28.35 GHz)**

|  |  |  |
| --- | --- | --- |
| **Service** | **Frequencies** | **Footnotes** |
| FIXED | 25.25 – 27 GHz | 5.534A |
| 27 – 27.5 GHz | 5.534A (Regions 2&3) |
| 27.5 - 28.35 GHz | 5.537A |
| FIXED (identified for HAPS) | 25.25 – 27.5 GHz | 5.534A |
| INTER SATELLITE | 25.25 – 27.5 GHz | 5.536, 5.537 (Regions 2&3) |
| 27.5 – 28.35 GHz (1) | 5.521A |
| MOBILE | 25.25 – 27.5 GHz | 5.532AB |
| 27.5 – 28.35 GHz |  |
| FIXED SATELLITE (Earth-to-space) | 27 – 27.5 GHz |  |
| 27.5 – 28.35 GHz | 5.484A, 5.516B, 5.517A, 5.539, 5.538, 5.540, 5.517B |

(1) New intersatellite service allocation from WRC-23

# 4 Technical and operational characteristics for sharing and compatibility studies

Technical and operational characteristics to be considered in the sharing and compatibility studies are presented in the table below, as provided by WP 7B and the contributing groups to WRC-27 agenda item 1.15.

|  |  |  |
| --- | --- | --- |
| **Working Party 7B/** | **Contributing Group** | **Services/Parameters** |
| [35/Annex 2](https://www.itu.int/md/R23-WP7B-C-0035/en) | WP 7B | Lunar SRS  |
| [58](https://www.itu.int/md/R23-WP7B-C-0058/en) | WP 3J | Propagation models |
| - | WP 4A | Fixed-satellite serviceBroadcasting-satellite service |
| [41](https://www.itu.int/md/R23-WP7B-C-0041/en) | WP 4C | Mobile-satellite service |
| - | WP 5A | Land mobile service |
| - | WP 5B | Aeronautical mobile service Radiodetermination service |
| [56](https://www.itu.int/md/R23-WP7B-C-0056/en) | WP 5C | Fixed service |
| 64 | WP 5D | International Mobile Telecommunications (IMT) |
| - | WP 7B | Space research serviceEarth exploration-satellite service  |
| - | WP 7C | Space research service (active)Earth exploration-satellite service (passive)  |
| - | WP 7D | Radio astronomy service |

# 5 Sharing and compatibility studies

The sharing and compatibility studies are presented in the Annexes to this document.

**Annex 1:** Sharing and compatibility studies of SRS for lunar operations in the frequency band 390-406.1 MHz

**Annex 2:** Sharing and compatibility studies of SRS or lunar operations in the frequency band 420-430 MHz

**Annex 3:** Sharing and compatibility studies of SRS for lunar operations in the frequency band 440-450 MHz

**Annex 4:** Sharing and compatibility studies of SRS for lunar operations in the frequency band 2 400-2 690 MHz

**Annex 5:** Sharing and compatibility studies of SRS for lunar operations in the frequency band 3 500-3 800 MHz

**Annex 6:** Sharing and compatibility studies of SRS for lunar operations in the frequency band 5 150-5 570 MHz

**Annex 7:** Sharing and compatibility studies of SRS for lunar operations in the frequency band 5 570-5 725 MHz

**Annex 8:** Sharing and compatibility studies of SRS for lunar operations in the frequency band 5 775-5 925 MHz

**Annex 9:** Sharing and compatibility studies of SRS for lunar operations in the frequency band 7 190-7 235 MHz

**Annex 10:** Sharing and compatibility studies of SRS for lunar operations in the frequency band 8 450-8 500 MHz

**Annex 11:** Sharing and compatibility studies of SRS for lunar operations in the frequency band 25.25-28.35 GHz

ANNEX 1

Sharing and compatibility studies of SRS for lunar operations in the frequency band 390-406.1 MHz

### A1.1 Sharing and compatibility of fixed service and SRS for lunar operations in the frequency band 390-406.1 MHz

### A1.1.1 Study A

[*Note: Insert relevant sharing and compatibility studies for each of the identified service.*]

### A1.1.2 Study B

### A1.1.3 Study C

## A1.2 Sharing and compatibility of [existing service XX] and SRS operating in the frequency band 390-406.1 MHz

## A1.3 …

## A1.[X] Summary and analysis of the results of studies

[*Note: The summary should offer an objective overview, encompassing the results of sharing and compatibility studies, alongside any pertinent information applicable for future comparisons among studies. Additionally, it should address any mitigation techniques or proposals employed to safeguard services operating within the same band or adjacent bands, where applicable, to SRS lunar systems.]*

ANNEX 2

Sharing and compatibility studies of SRS for lunar operations in the frequency band 420-430 MHz

## A2.1 Sharing studies between fixed service and SRS for lunar operations in the frequency band 420-430 MHz

### A2.1.1 Study A

[*Note: Insert relevant sharing and compatibility studies for each of the identified service.*]

### A2.1.2 Study B

### A2.1.3 Study C

## A2.2 Sharing and compatibility of [existing service XX] and SRS operating in the frequency band 420-430 MHz

## A2.3 …

## A2.[X] Summary and analysis of the results of studies

[*Note: The summary should offer an objective overview, encompassing the results of sharing and compatibility studies, alongside any pertinent information applicable for future comparisons among studies. Additionally, it should address any mitigation techniques or proposals employed to safeguard services operating within the same band or adjacent bands, where applicable, to SRS lunar systems.]*

ANNEX 3

Sharing and compatibility studies of SRS for lunar operations in the frequency band 440-450 MHz

 [*Note: Insert relevant sharing and compatibility studies for each of the identified service.*]

## A3.1 Sharing studies between fixed services and SRS operating in the frequency band 440-450 MHz

### A3.1.1 Study A

**A.3.1.1.1 Technical and operational characteristics of SRS operating in the 440 – 450 MHz frequency range**

**A.3.1.1.2 Technical and operational characteristics of fixed service operating in the 440– 450 MHz frequency range**

The characteristics for fixed service (FS) for point-to-point (PP) systems are based on the information contained in the draft revision of [Recommendation ITU-R F.758-7](https://www.itu.int/md/R23-WP7B-C-0056/en), Table 17, as summarized in Table A.3.1.1.2.

Table A.3.1.1.2

Characteristics of the FS (PP) systems

| Parameter | Value |
| --- | --- |
| Frequency range | 406.1- 450 MHz |
| Reference | Recommendation ITU-R F.1567 |
| Modulation format | 32-QAM |
| Receiver noise bandwidth | 3.5 MHz |
| Antenna height | 30 m |
| Antenna pattern | - |
| Antenna gain | 25 dBi |
| Receiver noise figure | 3.5 dB |
| Protection criteria (I/N) | -6 dB |

**A.3.1.1.3 Propagation model**

This sharing study includes the lunar SRS system on the surface of the Moon and fixed services operating on Earth's surface. Therefore, Working Party 3J in the document [7B/58](https://www.itu.int/md/R23-WP7B-C-0058/en) recommends using the propagation model based on [Recommendation ITU-R P.525](https://www.itu.int/rec/R-REC-P.525/en) for this scenario.

**A.3.1.1.4 Methodology**

**A.3.1.1.5 Scenarios and results of the study**

**A.3.1.1.6 Conclusion of Study A**

### A3.1.2 Study B

### A3.1.3 Study C

## A3.2 Sharing and compatibility of [existing service XX] and SRS operating in the frequency band 440-450 MHz

## A3.3 …

## A3.[X] Summary and analysis of the results of studies

[*Note: The summary should offer an objective overview, encompassing the results of sharing and compatibility studies, alongside any pertinent information applicable for future comparisons among studies. Additionally, it should address any mitigation techniques or proposals employed to safeguard services operating within the same band or adjacent bands, where applicable, to SRS lunar systems.]*

ANNEX 4

Sharing and compatibility studies of SRS for lunar operations in the frequency band 2 400-2 690 MHz

[*Note: Insert relevant sharing and compatibility studies for each of the identified service.*]

## A4.1 Sharing studies between fixed services and SRS for lunar operations in the frequency band 2 400-2 690 MHz

### A4.1.1 Study A

**A.4.1.1.1 Technical and operational characteristics of SRS operating in the 2 400-2 690 MHz frequency range**

**A.4.1.1.2 Technical and operational characteristics of fixed service operating in the 2 400-2 690 MHz frequency range**

The characteristics for fixed service (FS), for both point-to-point (PP) and point-to-multipoint(PmP) systems are based on the information contained in the draft revision of [Recommendation ITU-R F.758-7](https://www.itu.int/md/R23-WP7B-C-0056/en), especially those contained in Tables 17 and 20, as summarized in Table A.4.1.1.2.

Table A.4.1.1.2

Characteristics of the FS systems

| Parameter | Point-to-point (PP) | Point-to-multipoint (PmP) |
| --- | --- | --- |
| Frequency range | 2290 - 2670 MHz | 1350 - 2690 MHz |
| Reference | Recommendation ITU-R F.1243 | Recommendation ITU-R F.701 |
| Modulation format | MSK | QPSK |
| Receiver noise bandwidth | 14 MHz | 3.5 MHz |
| Antenna height | 30 m | 30 m |
| Antenna pattern | - | - |
| Antenna gain | 25 dBi | 27 dBi |
| Receiver noise figure | 4 dB | 4 dB |
| Protection criteria (I/N) | -6 dB |

**A.4.1.1.3 Propagation model**

This study includes the lunar SRS system orbiting the Moon and fixed services operating on Earth's surface. Therefore, Working Party 3J in the document [7B/58](https://www.itu.int/md/R23-WP7B-C-0058/en) recommends using the propagation model based on [Recommendation ITU-R P.525](https://www.itu.int/rec/R-REC-P.525/en) for this scenario.

**A.4.1.1.4 Methodology**

**A.4.1.1.5 Scenarios and results of the study**

**A.4.1.1.6 Conclusion of Study A**

### A4.1.2 Study B

### A4.1.3 Study C

## A4.2 Sharing and compatibility of [existing service XX] and SRS operating in the frequency band 2 400-2 690 MHz

## A4.3 …

## A4.[X] Summary and analysis of the results of studies

[*Note: The summary should offer an objective overview, encompassing the results of sharing and compatibility studies, alongside any pertinent information applicable for future comparisons among studies. Additionally, it should address any mitigation techniques or proposals employed to safeguard services operating within the same band or adjacent bands, where applicable, to SRS lunar systems.]*

ANNEX 5

Sharing and compatibility studies of SRS for lunar operations in the frequency band 3 500-3 800 MHz

## A5.1 Sharing and compatibility of fixed service and SRS for lunar operations in the frequency band 3 500-3 800 MHz

[*Note: Insert relevant sharing and compatibility studies for each of the identified service.*]

### A5.1.1 Study A

### A5.1.2 Study B

### A5.1.3 Study C

## A5.2 Sharing and compatibility of [existing service XX] and SRS operating in the frequency band 3 500-3 800 MHz

## A5.3 …

## A5.[X] Summary and analysis of the results of studies

[*Note: The summary should offer an objective overview, encompassing the results of sharing and compatibility studies, alongside any pertinent information applicable for future comparisons among studies. Additionally, it should address any mitigation techniques or proposals employed to safeguard services operating within the same band or adjacent bands, where applicable, to SRS lunar systems.]*

ANNEX 6

Sharing and compatibility studies of SRS for lunar operations in the frequency band 5 150-5 570 MHz

## A6.1 Sharing and compatibility of [existing service XX] and SRS operating in the frequency band 5 150-5 570 MHz

[*Note: Insert relevant sharing and compatibility studies for each of the identified service.*]

### A6.1.1 Study A

### A6.1.2 Study B

### A6.1.3 Study C

## A6.2 Sharing and compatibility of [existing service YY] and SRS operating in the frequency band 5 150-5 570 MHz

## A6.3 …

## A6.[X] Summary and analysis of the results of studies

[*Note: The summary should offer an objective overview, encompassing the results of sharing and compatibility studies, alongside any pertinent information applicable for future comparisons among studies. Additionally, it should address any mitigation techniques or proposals employed to safeguard services operating within the same band or adjacent bands, where applicable, to SRS lunar systems.]*

ANNEX 7

Sharing and compatibility studies of SRS for lunar operations in the frequency band 5 570-5 725 MHz

## A7.1 Sharing and compatibility of [existing service XX] and SRS operating in the frequency band 5 570-5 725 MHz

[*Note: Insert relevant sharing and compatibility studies for each of the identified service.*]

### A7.1.1 Study A

### A7.1.2 Study B

### A7.1.3 Study C

## A7.2 Sharing and compatibility of [existing service YY] and SRS operating in the frequency band 5 570-5 725 MHz

## A7.3 …

## A7.[X] Summary and analysis of the results of studies

[*Note: The summary should offer an objective overview, encompassing the results of sharing and compatibility studies, alongside any pertinent information applicable for future comparisons among studies. Additionally, it should address any mitigation techniques or proposals employed to safeguard services operating within the same band or adjacent bands, where applicable, to SRS lunar systems.]*

ANNEX 8

Sharing and compatibility studies of SRS for lunar operations in the frequency band 5 775-5 925 MHz

## A8.1 Sharing and compatibility of [existing service XX] and SRS operating in the frequency band 5 775-5 925 MHz

[*Note: Insert relevant sharing and compatibility studies for each of the identified service.*]

### A8.1.1 Study A

### A8.1.2 Study B

### A8.1.3 Study C

## A8.2 Sharing and compatibility of [existing service YY] and SRS operating in the frequency band 5 775-5 925 MHz

## A8.3 …

## A8.[X] Summary and analysis of the results of studies

[*Note: The summary should offer an objective overview, encompassing the results of sharing and compatibility studies, alongside any pertinent information applicable for future comparisons among studies. Additionally, it should address any mitigation techniques or proposals employed to safeguard services operating within the same band or adjacent bands, where applicable, to SRS lunar systems.]*

ANNEX 9

Sharing and compatibility studies of SRS for lunar operations in the frequency band 7 190-7 235

## A9.1 Sharing and compatibility of [existing service XX] and SRS operating in the frequency band 7 190-7 235 MHz

[*Note: Insert relevant sharing and compatibility studies for each of the identified service.*]

### A9.1.1 Study A

### A9.1.2 Study B

### A9.1.3 Study C

## A9.2 Sharing and compatibility of [existing service YY] and SRS operating in the frequency band 7 190-7 235 MHz

## A9.3 …

## A9.[X] Summary and analysis of the results of studies

[*Note: The summary should offer an objective overview, encompassing the results of sharing and compatibility studies, alongside any pertinent information applicable for future comparisons among studies. Additionally, it should address any mitigation techniques or proposals employed to safeguard services operating within the same band or adjacent bands, where applicable, to SRS lunar systems.]*

ANNEX 10

Sharing and compatibility studies of SRS for lunar operations in the frequency band 8 450-8 500 MHz

## A10.1 Sharing and compatibility of [existing service XX] and SRS operating in the frequency band 8 450-8 500 MHz

[*Note: Insert relevant sharing and compatibility studies for each of the identified service.*]

### A10.1.1 Study A

### A10.1.2 Study B

### A10.1.3 Study C

## A10.2 Sharing and compatibility of [existing service YY] and SRS operating in the frequency band 8 450-8 500 MHz

## A10.3 …

## A10.[X] Summary and analysis of the results of studies

[*Note: The summary should offer an objective overview, encompassing the results of sharing and compatibility studies, alongside any pertinent information applicable for future comparisons among studies. Additionally, it should address any mitigation techniques or proposals employed to safeguard services operating within the same band or adjacent bands, where applicable, to SRS lunar systems.]*

ANNEX 11

Sharing and compatibility studies of SRS for lunar operations in the frequency band 25.25-28.35 GHz

## A11.1 Sharing and compatibility of [existing service XX] and SRS operating in the frequency band 25.25-28.35 GHz

[*Note: Insert relevant sharing and compatibility studies for each of the identified service.*]

### A11.1.1 Study A

### A11.1.2 Study B

### A11.1.3 Study C

## A11.2 Sharing and compatibility of [existing service YY] and SRS operating in the frequency band 25.25-28.35 GHz

## A11.3 …

## A11.[X] Summary and analysis of the results of studies

[*Note: The summary should offer an objective overview, encompassing the results of sharing and compatibility studies, alongside any pertinent information applicable for future comparisons among studies. Additionally, it should address any mitigation techniques or proposals employed to safeguard services operating within the same band or adjacent bands, where applicable, to SRS lunar systems.]*