NATIONAL PREPARATORY COMMITTEE TOWARDS WRC-27 AGENDA ITEM BRIEF

Chapter: *3*
Service: *Mobile-satellite issues*
Agenda Item : *1.11*

Description of Agenda Item: *to consider the technical and operational issues, and regulatory provisions, for space-to-space links among non-geostationary and geostationary satellites in the frequency bands 1 518-1 544 MHz, 1 545-1 559 MHz, 1 610-1 645.5 MHz, 1 646.5-1 660 MHz, 1 670-1 675 MHz and 2 483.5-2 500 MHz allocated to the mobile-satellite service, in accordance with*

Focus: is to evaluate the technical and operational issues and establish regulatory provisions for **space-to-space** links between non-geostationary (non-GSO) and geostationary (GSO) satellites

Status of Studies

Studies supporting WRC-27 Agenda Item 1.12 are still in progress and have not yet been finalized. Technical and regulatory analyses across the candidate frequency bands are advancing at different levels of maturity, and several important issues remain under examination.
Key developments at this stage include:

i. Three potential methods for addressing the agenda item have been identified, although they remain under discussion.
ii. Given the complexity of the subject, a new draft **Resolution** is expected to provide the technical and operational framework.
iii. Discussions are continuing on specific parameter values, including e.i.r.p. and traffic limits.

Objective of the Studies

The study of this AI seeks to establish a robust technical and regulatory framework for space-to-space mobile-satellite service (MSS) links. The primary objective is to identify the technical challenges associated with these systems, define their operational characteristics, and develop the necessary regulatory provisions to enable their safe, reliable, and efficient deployment.

Conventionally, satellite communications rely on direct links between satellites and ground stations. However, many non-geostationary (non-GSO) satellite systems do not currently benefit from continuous real-time connectivity. Enabling these satellites to relay communications through higher-altitude satellite systems would significantly enhance the speed, resilience, and reliability of data transmission, particularly for latency-sensitive applications requiring near real-time communication.

The study further proposes an operational architecture in which lower-altitude non-GSO satellites, known as user space stations, communicate with MSS service provider space stations. These provider satellites operating in either geostationary (GSO) or non-geostationary orbits serve as relay platforms, forwarding communications and data to Earth stations.

A central element of the agenda item is the establishment of a stable and enduring international regulatory framework. At present, many of these operations are conducted under interim or provisional regulatory arrangements. The intention is therefore to transition toward harmonized and internationally recognized regulatory provisions that support long-term operational certainty.

The study also places significant emphasis on spectrum protection and interference management. Any new space-to-space MSS operations must ensure the protection of existing mobile-satellite services, terrestrial services, and other critical radio services, including radio astronomy and aeronautical radionavigation systems. Accordingly, detailed compatibility and sharing studies are essential to ensure prevention of harmful interference and preserve the integrity of incumbent services.

Studied Frequency Bands

The table presents the frequency bands under study for this agenda item. Important to note its all these bands are currently allocated to the mobile-satellite service (MSS) on a primary basis

Frequency band (MHz)	Existing MSS Allocation Direction
1 518 – 1 544 MHz	space-to-Earth
1 545 – 1 559 MHz	space-to-Earth
1 610 – 1 645.5 MHz	Earth-to-space
1 646.5 - 1 660 MHz	Earth-to-space
1 670 - 1 675 MHz	Earth-to-space
2 483.5 - 2 500 MHz	Space-to-Earth

Key noting's:

i. Directionality: The studies consider limiting space-to-space link transmissions to the same directions as the existing MSS allocations in these bands.
ii. User space stations (lower altitude) transmit in the Earth-to-space bands to the relay satellite and receive in the space-to-Earth bands from the relay satellite.
iii. MSS service provider space stations (higher altitude) receive in the Earth-to-space bands from the user station and transmit in the space-to-Earth bands toward the user station.

i. Regulatory Context: These bands are being studied to develop technical conditions that ensure space-to-space operations do not cause harmful interference to incumbent services, such as the fixed and mobile services, radio astronomy, and aeronautical radionavigation

Methods to Satisfy the Agenda Item

Several methods have currently been identified to satisfy the agenda item, ranging from making no changes to the Radio Regulations to developing complex new regulatory frameworks. These are however still under discussion and none has been agreed upon to date

Method	Brief description
A	This method proposes **no changes to the Radio Regulations** (NOC)
Method B[1] (this has several subvariants)	
B1	Proposes **no changes** for specific bands (1525-1559 MHz and 1626.5-1660 MHz), while the status for other bands is still to be determined

[1] **General Regulatory Framework:** This is a general method that proposes developing technical conditions and regulatory provisions for space-to-space links. It requires that these links **not cause harmful interference** to, or claim protection from, existing mobile-satellite services (MSS) or other incumbent services

B2	Proposes adding a **space-to-space directional indicator** to existing MSS allocations in the frequency bands 1518-1559 MHz, 1616-1675 MHz, and others. It includes a draft resolution (Resolution **[A111-B2]**) defining technical conditions like off-nadir angle limits and EIRP spectral density masks
B3	Similar to B2, but applies to slightly different frequency ranges (e.g., beginning at **1617.775 MHz** instead of 1616 MHz). It is associated with a similar draft resolution (Resolution **[A111-B3]**)
B4	ocuses on the **1610-1626.5 MHz** and **2483.5-2500 MHz** bands. For the 1610 MHz band, it proposes adding a space-to-space indicator with specific **aggregate interference limits** (e.g., time percentages for I/N thresholds) to protect co-frequency MSS systems
Issue-Specific Methods	
C1	No change to the Radio Regulations for the **1610-1626.5 MHz** band.
D1	No change to the Radio Regulations for the **2483.5-2500 MHz** band

Common Element for All Methods

For the methods that propose regulatory changes (like B2 and B3), several common technical conditions are outlined:

i. **Directionality:** Space-to-space transmissions must follow the same direction as existing MSS allocations. For example, a user space station transmits to a relay satellite in an Earth-to-space band.

ii. **Altitude Restrictions:** Communication is generally limited to cases where the user space station's apogee is below the relaying MSS provider satellite's minimum operational altitude.

iii. **Non-Interference:** New space-to-space links must neither cause harmful interference to nor claim protection from incumbent terrestrial and satellite services.

Interference Protection Mechanisms

The proposed interference protection mechanisms are designed to ensure that new space-to-space links do not cause harmful interference to, or claim protection from, incumbent satellite and terrestrial services.

1. Geometric and Operational Constraints

i. Directionality Alignment: Space-to-space transmissions must follow the same directionality as existing mobile-satellite service (MSS) allocations. For example, lower-altitude "user space stations" transmit in "Earth-to-space" bands, while higher-altitude "service provider" satellites transmit in "space-to-Earth" bands.

ii. Altitude Separation: A user space station's apogee altitude must be lower than the minimum operational altitude of the MSS service provider satellite it communicates with.

iii. Cone of Operation: Transmissions are restricted to a specific off-nadir angle (θMax). The user space station must only transmit when it is within a cone whose apex is the receiving service provider satellite. Specific formulas are used to determine this angle based on the altitudes of the satellites and the notified service area.

2. Technical and Emission Limits

i. Earth Station Envelope Compliance: Emissions from user space stations must remain within the envelope of the recorded characteristics of typical earth stations for the associated MSS network.

ii. Power Flux-Density (PFD) Limits:

- GSO Arc Protection: User space stations must not produce a power flux density (PFD) at any point in the geostationary-satellite orbit (GSO) arc greater than that produced by the earth stations of the satellite network they are communicating with.
- Terrestrial Protection: Limits on PFD from space stations are established to protect terrestrial services like meteorological and fixed services.

iii. Radio Astronomy Protection: In the 1 610.6-1 613.8 MHz band, space stations must comply with equivalent power flux-density (epfd) protection criteria to prevent harmful interference to the radio astronomy service.
iv. Aggregate Interference Limits: Under Method B4, the time percentage of aggregate interference from all user space stations into co-frequency MSS systems must be less than 1% for I/N=−12.2 dB and 0.5% for I/N=−6 dB.

3. Regulatory and Procedural Oversight

i. Bureau Examination: The Radiocommunication Bureau will perform technical examinations of notifications to verify compliance. This includes assessing whether the EIRP spectral density masks of user space stations exceed "reduced" levels (accounting for differences in free-space loss) compared to typical earth stations.
ii. Responsibility for Interference: The notifying administration for the MSS service provider system is responsible for eliminating any case of harmful interference to stations operating in accordance with the Radio Regulations.
iii. Non-Interference/Non-Protection: The framework explicitly mandates that space-to-space links shall not claim protection from, or cause harmful interference to, incumbent services, including existing MSS networks and terrestrial services.
iv. Coordination Integrity: Service providers must respect all existing coordination agreements and ensure space-to-space links do not exceed the interference envelope of those requirements

Technical and Regulatory Challenges

1. Technical Challenges

i. High Interference Levels: Multiple studies show that, without strict coordination or mitigation, space-to-space links could exceed protection criteria by as much as 40 to 50 dB.

ii. Feasibility Concerns: In the 1 610-1 626.5 MHz band, some studies find coexistence between space-to-space links and existing non-GSO MSS systems not feasible. One analysis found that even with a low duty cycle, interference would exceed protection thresholds for significant periods.

iii. Impact on Specialized Services: Simulations show that user space stations could cause unacceptable interference to the Aeronautical Radionavigation Service (ARNS) and Aeronautical Radionavigation-Satellite Service (ARNSS), exceeding limits by 8.5 to 12.8 dB. Protecting the Radio Astronomy Service (RAS) from aggregate emissions also remains a critical requirement.

iv. Mitigation Uncertainty: There is ongoing debate over whether current interference suppression methods can eliminate the large excesses identified in studies, some of which exceed 50 dB. Some experts consider these mitigation assumptions unsubstantiated.

2. Regulatory Challenges

i. Transition from RR No. 4.4: Currently, many space-to-space links operate under Radio Regulations No. 4.4, meaning they must not cause interference and cannot claim protection. The challenge is moving these into a stable, primary regulatory framework without disrupting existing services.

ii. Exclusion from Existing Agreements: Space-to-space links are not currently covered by established Memorandums of Understanding (MoU) that govern GSO network compatibility.

Because these MoUs are reviewed annually and frequency of use may change, there is a risk that uncoordinated space-to-space links could become incompatible with future terrestrial or satellite configurations.

iii. Administrative Complexity: The administration notifying a "user space station" (the lower-altitude satellite) may not be the same administration that notified the "service provider" relay satellite, complicating oversight and enforcement.

iv. Protection of Priority Services: Regulatory provisions must ensure that new links do not impose additional constraints on, or claim protection from, critical safety services and priority services like the aeronautical mobile-satellite (R) service.

v. Absence of Data: For some allocated services, such as civil ARNSS, a lack of developed standards (ICAO SARPs) and deployed systems means there are no technical characteristics available to perform the required sharing studies

Conclusion

In light of the above, we have sharply divided conclusions, particularly for Earth-to-space (user-to-provider) satellite links and their impact on existing services.

For space-to-Earth links, where higher-altitude provider satellites transmit to lower-altitude user satellites, there is broad agreement that the interference environment would remain largely unchanged. This is because these signals are similar to already coordinated transmissions used for conventional mobile earth stations. The consensus mainly applies to the 1 518 - 1 525 MHz and 2 483.5 - 2 500 MHz bands, with studies in the 2.4 GHz range also finding strong protection margins.

In contrast, findings for Earth-to-space links are highly inconsistent. Some studies suggest that space-to-space operations in the 1 616 - 1 626.5 MHz and 1 626.5 - 1 660 MHz bands could operate within existing coordination frameworks with limited short-term interference exceedances. However, several other studies conclude that coexistence is technically unfeasible, showing interference levels exceeding protection criteria by 40 - 50 dB. One analysis further warns that these links may create serious and underestimated harmful interference risks to incumbent MSS systems, potentially far greater than interference from traditional ground-based stations.

The studies also identify significant risks to safety-critical and specialized services. Planned space-to-space transmissions could interfere with Aeronautical Radionavigation (ARNS) and Radionavigation-Satellite (ARNSS) systems, exceeding protection thresholds by 8.5 - 12.8 dB. In addition, strict compliance with equivalent power flux-density (epfd) limits is considered necessary to protect radio astronomy operations in the 1 610.6 - 1 613.8 MHz band.

Finally, the studies highlight important regulatory and operational gaps. There is no demonstrated evidence of successful coexistence between these proposed space-to-space links and existing systems in the 1.5/1.6 GHz bands. The links are also outside current GSO coordination Memorandums of Understanding, leaving unresolved compatibility concerns. In some cases, studies could not even be completed due to missing technical data or the absence of deployed systems for analysis.