WRC-27 AGENDA ITEM 1.11

SPACE-TO-SPACE LINKS IN THE MOBILE-SATELLITE SERVICES

15th- 16th JUNE 2026

UGANDA COMMUNICATIONS COMMISSION

Executive Summary

The Catalyst

Non-GSO small satellites currently rely on limited, non-real-time Earth station connectivity. **Utilizing space-to-space links via higher-altitude GSO/non-GSO MSS** networks enables continuous, low-latency data relay.

The Conflict

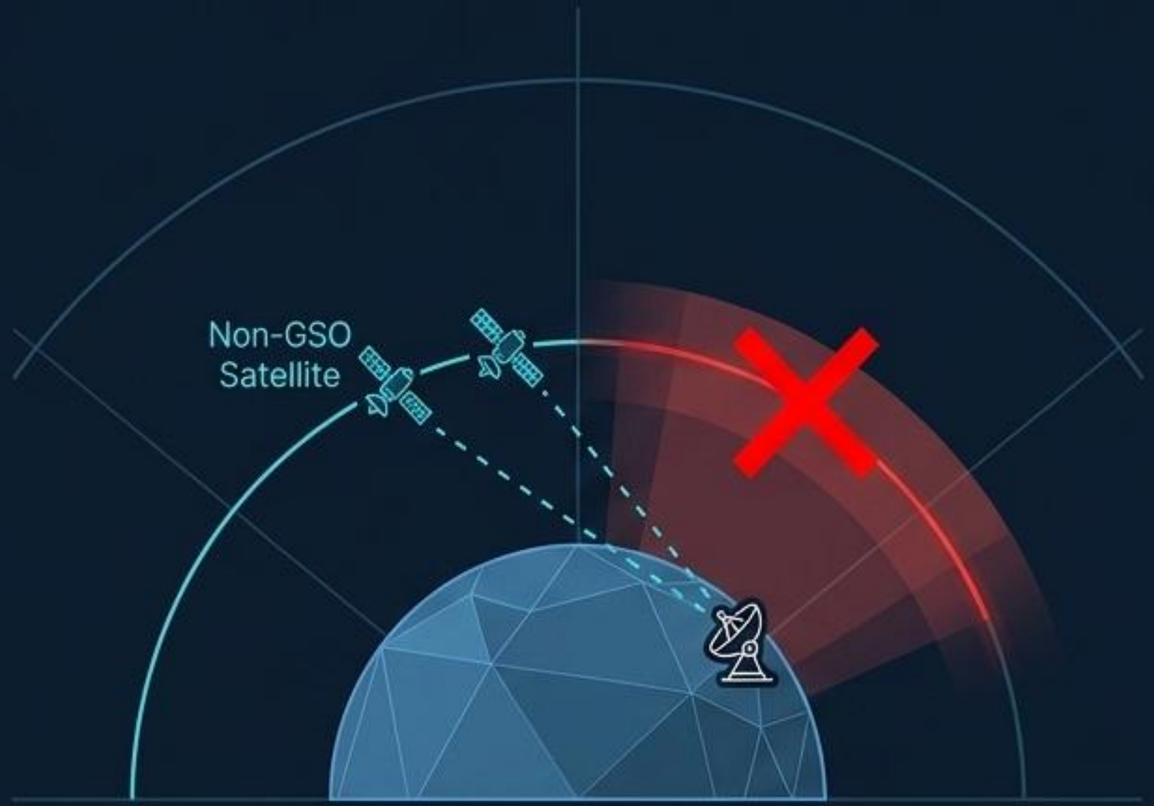
Accommodating new links risks unacceptable interference to incumbent terrestrial, aeronautical, and radio astronomy services. In the 1.6 GHz band, uncoordinated models show interference exceedances of up to 50 dB.

The Pathway

WRC-27 must decide between the status quo (Method A) or new regulatory frameworks (Method B) introducing strict directional indicators, altitude constraints, and off-nadir angle limits (Draft Resolution [A111]) to govern coexistence.

The Operational Catalyst

Current State

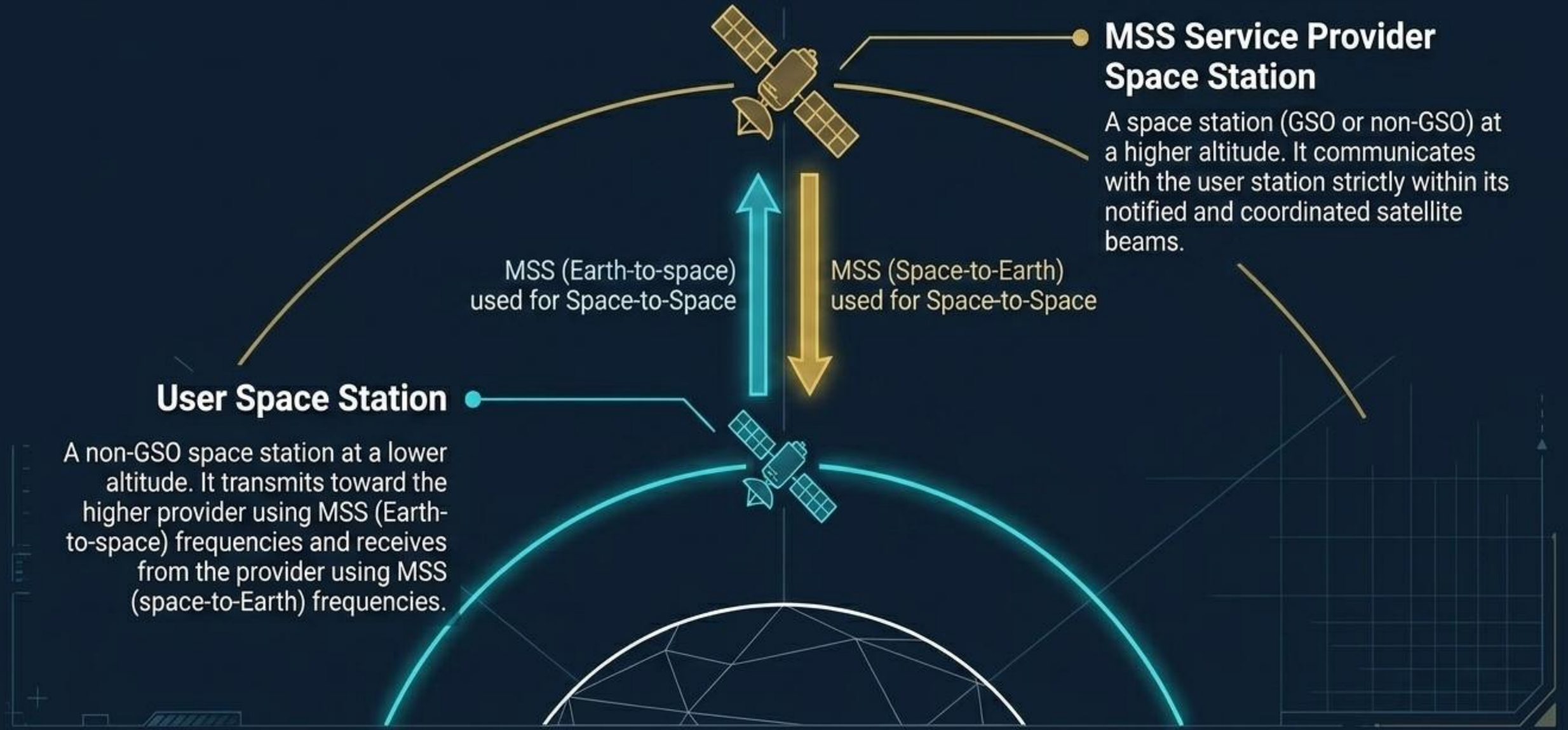


Non-GSO satellites face orbital and operational limitations, severely restricted by intermittent, non-real-time connectivity to direct-to-Earth stations.

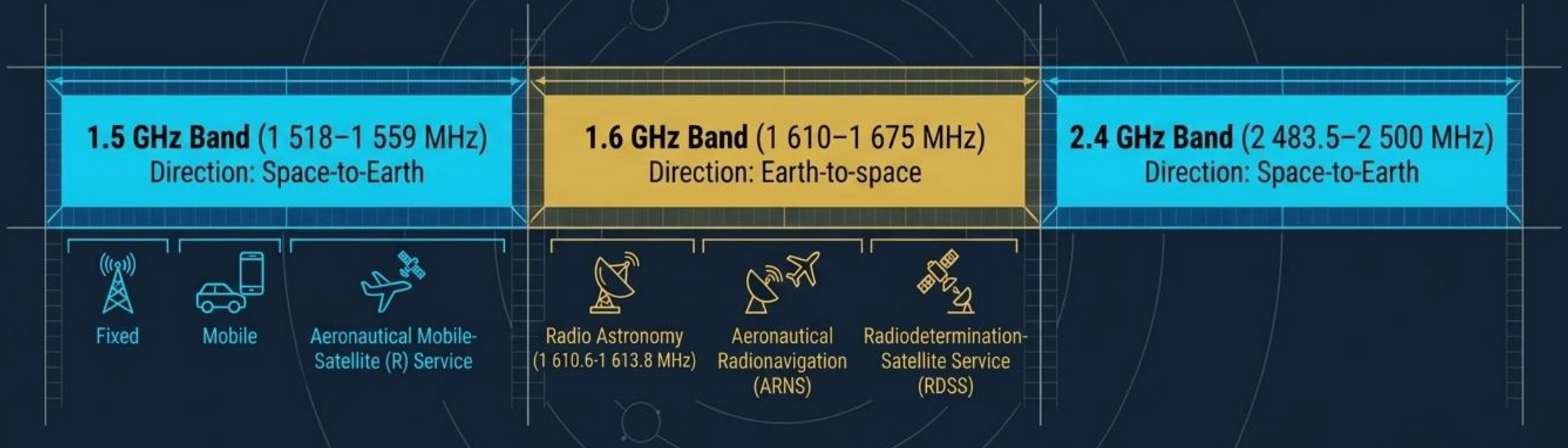
Proposed State

Space-to-space communication links between lower-altitude non-GSO satellites and higher-altitude MSS networks unlock continuous data relay, significantly enhancing the availability and value of instrument data requiring low latency.

System Architecture & Terminology



The Spectrum Landscape (In-Scope Bands)



Note: Studies by WP 4C and WP 7B concluded that overlap with Agenda Item 1.15 in the 2.4 GHz band features large positive margins; the items can be treated independently.

ITU-R Studies: Low Risk Bands

1.5 GHz Band (1 518–1 559 MHz)

Coexistence Verified

- Transmissions originate from higher-altitude Service Provider space stations.

- Emissions to lower-orbit User Space Stations are physically identical to emissions directed at existing Mobile Earth Stations (MESs).

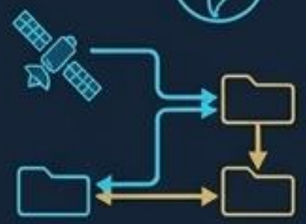
Conclusion: No change to the interference environment for incumbent services, provided GSO EIRP remains at or below current MES service levels.

2.4 GHz Band (2 483.5–2 500 MHz)

Coexistence Verified

- Operates in the Space-to-Earth direction.

- The introduction of User Space Stations will not change the notified characteristics of the MSS service provider network.



Conclusion: No additional interference will be introduced whether space-to-space links are established or not.

ITU-R Studies: The 1.6 GHz Interference Paradox

Focus Area: 1 610–1 626.5 MHz

The Feasibility View (Coordinated)	The Interference View (Uncoordinated)
	
• Operation within existing MSS frequency-territorial segmentation is viable. • Short-term protection exceedances are extremely brief (0.0005% to 0.2% of simulation steps). • Consistent with how current non-GSO MSS systems are successfully coordinated today.	• Victim network (e.g., HIBLEO-X) faces I/N exceedance over 30 dB. • With 200 user stations, interference exceeds the -12.2 dB protection criterion >55% of the time. • ARNSS (space-to-Earth) faces unacceptable interference (8.5 to 12.8 dB exceedance) even from a single non-GSO transmitting station. • Interference levels generally exceed 50 dB in theoretical unmitigated scenarios.

ITU-R Studies: Upper 1.6 GHz Bands

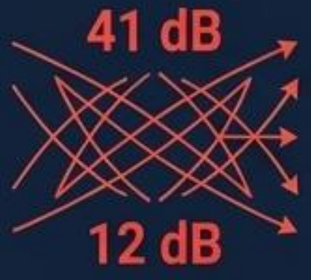
1 626.5–1 660 MHz Findings

Coordinated Approach

Interference to other GSO MSS satellites can be kept equal to or lower than interference caused by existing Mobile Earth Stations.

Uncoordinated Worst-Case

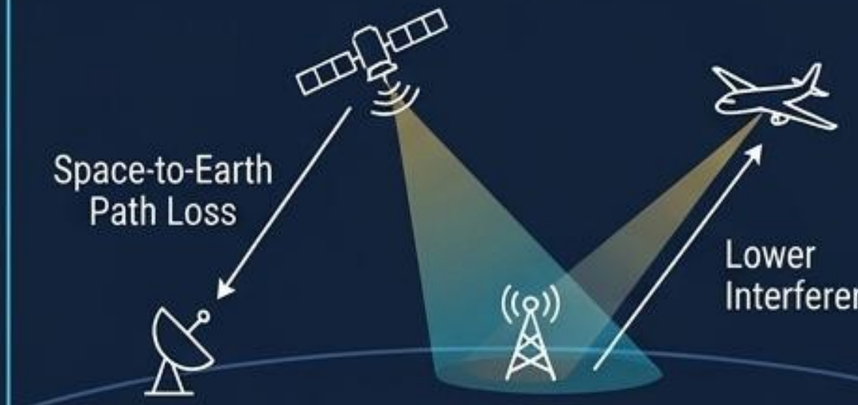
Theoretical models without mitigation show catastrophic exceedances—up to 41 dB for GSO networks and 12 dB for non-GSO systems.



2 1 670–1 675 MHz Findings

Path Loss

Interference to terrestrial stations from User Space Stations is lower than from comparable aeronautical MESs. This is driven by the increased path loss associated with space-to-Earth transmissions relative to terrestrial links.



Synthesis: The Core Regulatory Tension

Existing Multilateral MoUs
(Agile but Exclusionary)

Hardcoded ITU Regulations
(Rigid but Universal)

Proponents argue space-to-space links can safely operate within the constantly shifting agreements of existing MoUs.

Opponents argue theoretical coexistence is a false impression because new applicants operate entirely outside these closed MoUs.

The Imperative:

The technical viability of Agenda Item 1.11 does not hinge on physics alone, but on regulatory philosophy. A new space-to-space allocation is functionally impossible without distinct, hardcoded technical constraints and directional indicators to force coexistence.

Regulatory Pathways: Methods to Satisfy (Overview)

Method A (No Change)

Retain current Radio Regulations.

No space-to-space allocations permitted.

Method B (Develop Conditions)

Introduce technical conditions and directional indicators.

- **B1** → Define Specific Bands
- **B2** → Aggregate Interference Limits (e.g., 1% for I/N = -12.2 dB)
- **B3** → New Draft Resolutions
- **B4** → Directional Indicators

Method C (Issue-Specific)

Band: 1 610–1 626.5 MHz

Issue C1 proposes **No Change** for this highly contested frequency.

Method D (Issue-Specific)

Band: 2 483.5–2 500 MHz

Issue D1 proposes **No Change** for this band.

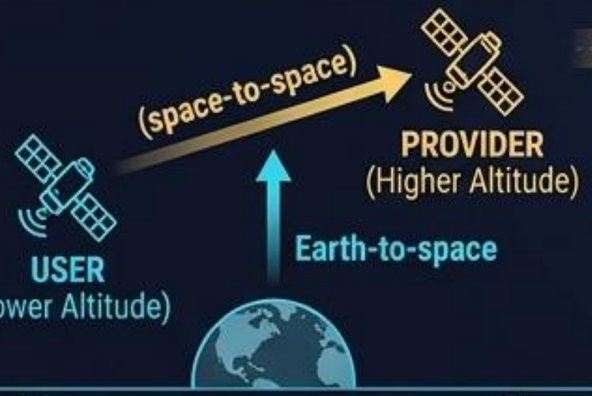
Deep Dive: The Mechanics of Method B

ITU Article 5 Table

MOBILE-SATELLITE → **(space-to-space)**

1. Directional Indicators

Explicitly adding a **"(space-to-space)" directional indicator** to primary MSS allocations (e.g., Earth-to-space = from lower altitude user to higher altitude provider).



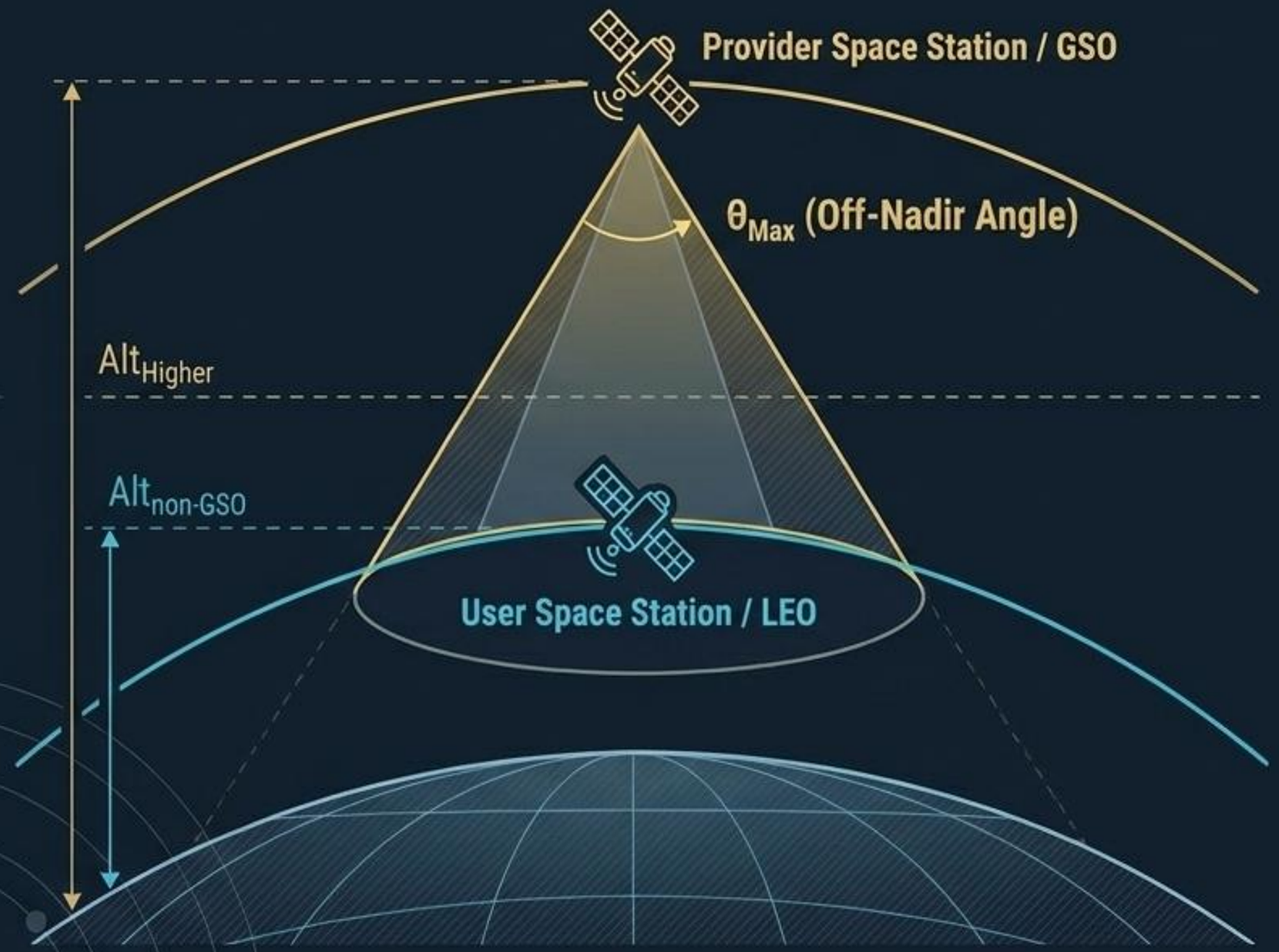
2. Regulatory Cleanup

Suppressing Resolution 249 (WRC-23), as the agenda item's study requirements would be entirely satisfied.

3. Draft Resolution [A111]

Introducing **Draft New Resolution [A111-B2/B3]** to enforce **strict operational altitude constraints** and **geographical geometries** on all new satellite filings.

Draft Resolution [A111]: Technical Constraints



The Altitude Rule

A User Space Station can only operate links when its apogee is strictly lower than the minimum operational altitude of the Provider station.

The Cone of Operation (θ_{Max})

Transmissions are physically constrained to a cone whose apex is the receiving Provider station. The off-nadir angle between the User and Provider must be less than or equal to the mathematically defined θ_{Max}.

Result

Emissions cannot spill over and produce a power flux-density (pfd) at any point in the GSO arc greater than existing associated earth stations.

Procedural Considerations: Modifying RR Appendix 4

Item No.	Description
A.1.a	User Station Identifier
A.2.b	Mask Identifier
A.41.c	Spectral sensity mask
A.41.a	e.i.r.p. spectral density mask function (4 or 40 kHz bandwidth)
A.41.b	Max e.i.r.p. density
A.42.a	Off-nadir angle limit
A.42.d	Offf-nadir angle limit

ITU Radio Regulations Appendix 4 (Table A)

New Requirement (A.41.a):

Administrations must provide an e.i.r.p. spectral density mask (defined in a 4 or 40 kHz bandwidth) as a function of the off-axis angle between the User station boresight and the GSO arc, factoring in Free Space Loss reduction (ΔFSL).

To verify compliance with the new θ_{Max} cone of operation, the ITU Radiocommunication Bureau will use this submitted mask to mathematically assess whether emissions remain within the established interference envelope of typical GSO earth stations.

Final Synthesis & WRC-27 Outlook

1. **The Promise:** Space-to-space links offer a massive leap in **low-latency, continuous data relay** for **non-GSO small satellites**.

2. **The Regulatory Delta:** The path forward requires resolving the massive gap between **agile, coordinated coexistence models** and worst-case, **uncoordinated interference simulations**—particularly in the 1.6 GHz band.

3. **The Policy Choice:** WRC-27 must decide whether to rely on existing **MoU frameworks** or embed strict spatial geometries (Method B / Res [A111]) directly into the Radio Regulations to guarantee incumbent protection.

Thank You!

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