## **Input Contribution to EACO**

Online, 28 February 2022

# SES

# Agenda Item 1.17

#### Part A: Description

**1.17** to determine and carry out, on the basis of the ITU-R studies, the appropriate regulatory actions for the provision of inter-satellite links in the 11.7-12.7 GHz, 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz bands or portions thereof, by adding an inter-satellite service allocation where appropriate (**Res. 773**)

#### Part B: Key Elements-the notables

#### Background

Space station operations in non-geostationary-satellite ("NGSO") orbits, mainly low-earth orbit ("LEO") are increasing at a rapid and unprecedented rate for commercial, scientific and academic purposes. All these systems need to downlink data generated on-board down to Earth in an efficient, fast and cost-effective manner. In many cases, downlink capacity is a bottleneck as well as a strong design driver. The payload data generation is normally limited by the downlink capacity. There is consequently a strong need for additional means to relay data to the ground, and, in some cases, relay them in real-time or quasi-real time. Telecommunications satellites offer a ready solution to fulfil this data-relay need and this agenda item may enable this application.

Both Small and Large satellite missions would benefit from satellite-to-satellite transmission services. Even nanosatellites (1-25 kg) may carry a satellite-to-satellite transmission payload.

By analysing forecasts for the next decade (2020-2028), it is possible to extrapolate the following for Earth observation and space science missions:

- 80 Small Satellite (100-500 kg) missions to be launched every year
- 15 Large Satellite (>500 kg) missions to be launched every year



Figure 1: Earth observation and space science missions forecast – launches per year and anticipated data downlink performance without data relay capabilities

The anticipated downlink performances build on the assumption that future earth-exploration satellite service (EESS) will benefit from Ka downlink spectrum, which is not heavily used today by these missions. On-board storage capacity is limited. As a result, satellite-to-satellite transmissions to access collected data is a viable solution to enhance data downlink capabilities and payload data collection.

Because of their size and power limitations, Small Satellites (< 500 kg) represent significant future potential to utilize satellite-to-satellite links. Moreover, African Nations are currently investing in Small Satellites for Earth observation missions. Consequently, the Africa-specific opportunities emerging from this AI are clear.

Examples of applications benefiting from sat2sat services include:

- Climate Change and Food Security monitoring
- Land use and forest monitoring
- Disaster and emergency management
- High accuracy mapping, location identification and urban intelligence
- Pipeline and illegal oil bunkering monitoring
- Illegal mining activities identification
- Illegal fishing monitoring
- Border security and control
- Coastal monitoring (fishing, oil pollution, transport of goods at sea, port activities etc.)

Working Party 4A (WP 4A) is the responsible group for conducting technical studies under this Agenda item and has developed two Working Documents with several annexes addressing technical studies and the Draft CPM text (link).

### Concept of operations

The satellite-to-satellite links being considered are:

- NGSO-to-GSO and GSO-to-NGSO (i.e. MEO-to-GSO or LEO-to-GSO)
- Lower-altitude NGSO to higher-altitude NGSO and higher-altitude NGSO to lower-altitude NGSO

Key assumptions:

- the non-GSO space station transmitting in the 27.5-30 GHz bands and receiving in the 18.1-18.6 GHz, 18.8-20.2 GHz bands, or parts thereof, shall only operate at an orbital altitude lower than the orbital altitude of the GSO or non-GSO FSS space station with which it communicates
- the GSO/non-GSO FSS space station receiving in the 27.5-30 GHz bands and transmitting in the 18.1-18.6 GHz, 18.8-20.2 GHz bands, or parts thereof, shall only operate at an orbital altitude higher than the orbital altitude of the non-GSO space station with which it communicates
- "Within the cone" concept of operations



Figure 2: satellite-to-satellite links operations according to "within the cone of coverage" concept

- with respect to emissions in the frequency bands 27.5-30 GHz, the following provisions shall apply:
  - transmitting non-GSO space stations shall not produce a power flux density at any point in the GSO arc greater than the power flux density produced by earth stations associated with the satellite network/system it communicates with;
  - the maximum pfd produced at any point of the GSO arc from a non-GSO space station transmitting in the 27.5-28.6 GHz and 29.5-30.0 GHz bands towards a Non-GSO space station shall not exceed -162 dBW/m2/40KHz
  - in the frequency band 27.5-29.5 GHz, the maximum pfd produced at the surface of the Earth by emissions from a non-GSO space station transmitting in the 27.5-30 GHz bands shall not exceed:

pfd(θ) = −115	(dB(W/(m <sup>2</sup> · 1 MHz)))	for	0°≤ θ ≤ 5°	
pfd(θ) = −115+0.5(θ-5)	(dB(W/(m <sup>2</sup> · 1 MHz)))	for	5°≤ θ ≤ 25°	
pfd(θ) = -105	(dB(W/(m <sup>2</sup> · 1 MHz)))	for	25°< θ ≤ 90°	

where  $\theta$  is the angle of arrival of the radio-frequency wave (degrees above the horizon)

### Sharing and compatibility with stations of terrestrial and space services

- **Protection of terrestrial stations:** satellite-to-satellite transmissions shall ensure the same level of protection for terrestrial services as currently provided in the Radio Regulation, without imposing additional constraints on such services in order to protect satellite-to-satellite links
- Protection of space stations: satellite-to-satellite transmissions shall provide the same levels
  of protection for GSO and NGSO links as those currently provided in the Radio Regulations
  without imposing additional constraints on such links in order to protect the satellite-tosatellite links

#### Part C: Current Status of Band or Issue

- 11.7 12.7 GHz: Different parts of the band allocated to fixed, fixed-satellite, mobile, broadcasting, broadcasting-satellite
- 18.1 18.6 and 18.8-20.2 GHz: Different parts of the band allocated to fixed, fixed-satellite, mobile and mobile-satellite services
  - 18.6 18.8 GHz: adjacent primary EESS services
- 27.5 30.0 GHz: Different parts of the band allocated to fixed, fixed-satellite, mobile and mobile-satellite services

#### Part D: Conclusion of the results of studies, if any

- All studies for the "within the cone" concept have been finalized
  - All studies based on the "comparative I/N analysis" approach show compatibility, i.e. sat2sat links DO NOT produce greater interference wrt what is allowed today by the Radio Regs
- Studies on the "expanded cone" concept have started

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- Serious concerns were expressed regarding the LEO-to-LEO links in the expanded cone
  - The expanded cone concept of operations, as applied between LEO service providers and LEO users will result in geometries that are different than the ones corresponding to Earth-to-space or space-to-Earth directions, in terms of interference paths
  - These LEO-to-LEO links would greatly expand the service provider coverage, thus clearly exceeding a typical FSS envelope of operations
    - Consequence: allocation within FSS seems really inappropriate and unfeasible
- Several operators and Admins suggested removing LEO-to-LEO links from the expanded cone, i.e. idea of "augmented cone"
- It is realistic to assume that the full "expanded cone" concept has no chances of going forward, as there is general agreement on removing LEO-to-LEO links. It is expected that the "augmented cone" concept will gain traction at the next 4A, with the following two options:
  - The expanded cone will be modified by introducing altitude limitations for user and



Satellite-to-satellite transmissions represent a clear opportunity for African Nations, especially in light of Africa's significant investment in Small Satellites (< 500 kg) for Earth observation. For such missions, sat2sat services could represent a valuable mean to download higher volume of data and, in specific cases, have access to real-time or quasi-real-time data download.

As studies on the "within the cone" concept are completed, African Administrations could:

- Draft the Resolution text to allow sat2sat links within FSS for the "within the cone" concept of operations and submit it to the next 4A in May 2022
- Propose the modification of the definition of the "expanded cone" concept by imposing altitude limitations on service providers and users and thus excluding LEO-to-LEO links

• Conduct studies on the "augmented cone" concept (same exact studies as they were done for the "within the cone" one) and submit them at the next 4A in May 2022

Part H: Other Regional Groups and international organizations preliminary positions or positions

#### **CEPT** preliminary position (September 2021)

CEPT supports that the introduction of satellite-to-satellite transmissions must ensure the same level of protection for GSOs, non-GSOs and terrestrial services as currently provided in the RR and must not impose new constraints on GSOs, non-GSOs and terrestrial services to protect satellite-to-satellite links from interference.

- CEPT supports:
  - o operations within the cone of coverage of GSO or non-GSO service provider space stations
  - operations within the volume of space defined by the service provider space station and the visible service area defined in the ITU satellite network of the service provider space station;
- CEPT will further consider the possibility to allow operations outside the cone of coverage, within FSS, provided that no undue constraints are placed on other FSS use and services and that unacceptable interference is not caused to other FSS use and services. CEPT final support to a concept of operation will depend on the outcome of the studies.
- Satellite-to-satellite link transmissions will comply with the same directionality indicators as in the existing FSS allocations (Earth-to-space = from user space station to service provider space station, space-to-Earth = from service provider space station to user space station);
- Non-GSO user space stations will operate in a manner that should resemble typical user stations of the host FSS service provider system;
- Non-GSO user space stations should comply with applicable EPFD limits in the portions of the Ku- and Kabands where these limits apply when communicating with a non-GSO FSS service provider space station;
- The higher altitude to lower altitude link transmissions in 11.7-12.7 GHz, 18.1-18.6 GHz and 18.8-20.2 GHz from the GSO or non-GSO FSS service provider space station to the non-GSO user space station would be identical in technical characteristic to the transmissions from GSO or non-GSO service providers to any ground-based user in the service provider's network.
- Enabling the operation of Satellite-to-satellite links should not result in an increase of the interference to EESS (passive) sensors operating in the 18.6-18.8 GHz band. Any measure on non-GSO or GSO service provider space stations providing satellite-to-satellite links that may be needed to limit the interference to EESS (passive) sensors operating in the 18.6-18.8 GHz shall be applicable only to those non-GSO or GSO service provider systems notified/brought into use after the last day of WRC-23.

#### Arab Group preliminary position (October 2021)

- Support to develop a regulatory framework to ensure the protection of the in-band and adjacent bands services to which the frequency bands referred to in this agenda item, in particular, existing and future FSS services be guaranteed.
- Support the "within the cone of coverage" concept of operation, which allows satellite-to-satellite transmissions to be granted regulatory recognition under the current FSS allocation, without the need for a new inter-satellite service allocation.
- Support the allocation of satellite-to-satellite transmissions within current FSS allocation, with same directional designators as in FSS, i.e. Earth-to-space and space-to-Earth.
- The technical parameters shall be approved for uplink and downlink transmissions between two spacecraft with different altitude communicating with the earth stations

#### CITEL (November 2021)

Preliminary view provided by Mexico:

- The Administration of Mexico supports carrying out studies to consider appropriate regulatory measures for the provision of satellite-to-satellite links in the FSS in the frequency bands 11.7-12.7 GHz, 18.1-18.6 GHz, 18.8-20.2 GHz, and 27.5-30 GHz
- Satellite-to-satellite links in the FSS must protect existing services allocated on a primary basis in these frequency bands and in adjacent frequency bands, and likewise must not impose undue constraints on said services, including other FSS applications
- Mexico is also of the opinion that studies relative to satellite-to-satellite links in the framework of the present agenda item must be confined to links that operate in the same transmission direction provided for in the current allocations for the FSS in the frequency bands under consideration. It must be pointed out that the operations of these satellite-to-satellite links would only be permitted between satellites located on different orbits

Preliminary view provided by Brazil and Canada:

- Brazil and Canada support studies under Resolution 773 (WRC-19) to consider technical and regulatory provisions to allow satellite-to-satellite links in the frequency bands 11.7-12.7 GHz, 18.1-18.6 GHz, 18.8-20.2 GHz, and 27.5-30 GHz. Satellite-to-satellite links should be allowed provided undue constraints are not imposed on incumbent services, both in-band and adjacent band. These Administrations support confining studies to links that operate in the same direction of transmission as provided for in the current allocations and confined to satellites located on different orbits
- Currently there are two proposed concepts of operation being discussed in ITU Working Party (WP) 4A, one that allows communication links only within the cone of coverage (defined by the apex of the service provider satellite to the edge of the Earth) and the other that allows communication within the cone of coverage and outside the cone of coverage. In order to better understand the pros and cons of each of the aforementioned concepts, Brazil and Canada support the ITU-R WP 4A decision to study both proposed concepts of operation, as well as any newly proposed concepts as may be submitted. This approach facilitates the advancement of comprehensive sharing and compatibility studies, such that the spectrum considered under this agenda item is utilized in the most efficient manner

#### RCC (December 2021)

- The RCC Administrations consider that the use of inter-satellite links in the frequency bands 11.7-12.7 GHz, 18.1-18.6 GHz, 18.8-20.2 GHz, and 27.5-30 GHz in current concepts does not meet the definition of the FSS and imposes additional constraints on the use of the existing and future systems/networks of FSS, *inter alia*, over the national territories.
- The RCC Administrations believes that the conditions for the use of inter-satellite links in the abovementioned frequency bands should ensure the protection of existing primary services that have allocations in the same or neighboring frequency bands, including passive services, and should not impose additional constraints on the use of existing and future stations of these services.
- The RCC Administrations supports the development of technical and operational conditions, as well as regulatory provisions, including new allocations to inter-satellite service, for the operation of inter-satellite links in the frequency bands 11.7–12.7 GHz, 18.1–18.6 GHz, 18.8–20.2 GHz and 27.5–30 GHz or

parts thereof, taking into account the results of studies, including the development of a concept of operations that meets the above requirements.

#### SFCG (August 2020)

- SFCG supports the studies to develop the technical conditions and regulatory provisions for satellite-tosatellite operations in the frequency bands 11.7-12.7 GHz, 18.1-18.6 GHz, 18.8-20.2 GHz and 27.5-30 GHz, or portions thereof, including new ISS allocations, as appropriate
- SFCG supports that the space-to-space links should comply with the same directionality indicators as the existing FSS allocations (i.e., Earth-to-space = from lower altitude to higher altitude, space-to-Earth = from higher altitude to lower altitude)
- SFCG also supports that those studies should ensure that satellite-to-satellite operations in the 18.1-18.6 GHz and 18.8-20.2 GHz will not result in increased adjacent band interference to EESS (passive) operations in the 18.6-18.8 GHz band. Frequency overlap with agenda item 1.16 needs to be taken into account

#### ESA (October 2020)

• ESA supports the SFCG position on this WRC-23 agenda item

#### WMO and EUMETNET (February 2021)

• WMO supports studies, as necessary, to ensure satellite-to-satellite links will protect the co-frequency band MetSat allocation and that the operation of satellite-to-satellite links in the frequency bands adjacent to 18.6-18.8 GHz will not result in increased adjacent band interference to EESS (passive) operations