Key Outcomes of WRC-15

and Agenda Items of WRC-19

Related to Space Services

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WRC-15 Outcomes (space)

New Allocation

- FSS
- MMSS
- EESS

New Application

- UAS
- ESV
- ESIM

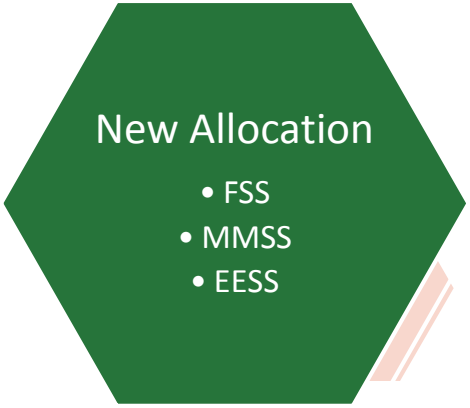
Satellite Regulatory Procedure

- Agenda item 7
- Agenda item 1.9.2
- Nano Picosatellite

GFT

- satellite reception ADS-B messages

Fixed-Satellite Service in 10 – 17 GHz (agenda item 1.6)



- in the space-to-Earth direction (Downlink)
  - ***13.4-13.65 GHz*** *in Region 1*

- in the Earth-to-space direction (Uplink)
  - ***14.5-14.75 GHz****, limited to 30 countries in Regions 1 and 2 (Resolution 163)*
  - ***14.5-14.8 GHz****, limited to 9 countries in Region 3 (Resolution 164)*

Implications

Development of various applications e.g. VSAT, video distribution, broadband networks, internet service, satellite news gathering, backhaul link etc.

Fixed-Satellite Service in 10 – 17 GHz (agenda item 1.6)

- **Conditions of utilization (to protect incumbent services)**
  - Downlink: 13.4 – 13.65 GHz
    - Limited to GSO
    - power flux density limits specified in No.**21.16**
    - Coordination procedures under Nos.**9.7** and **9.21**
  - Uplink: 14.5-14.8 GHz in Region 3, 14.5-14.75 GHz in Regions 1 and 2
    - Limited to GSO
    - Limited to specific countries, subject to several limitations, e.g.:
    - minimum earth station antenna diameter, power spectral density limits, power flux density limits towards the coast, power flux density limits towards the geostationary-satellite orbit, minimum separation distance of earth stations from the borders of other countries.
    - Coordination procedures under No.**9.7** and Article 7 of **AP30A**

Table of Allocation

13.4-14 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
13.4-13.65 EARTH EXPLORATION-SATELLITE (active) FIXED-SATELLITE (space-to-Earth) 5.499A 5.499B RADIOLOCATION SPACE RESEARCH 5.499C 5.499D Standard frequency and time signal-satellite (Earth-to-space) 5.499 5.499E 5.500 5.501 5.501B	**13.4-13.65** EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH 5.499C 5.499D Standard frequency and time signal-satellite (Earth-to-space) 5.499 5.500 5.501 5.501B	

Footnote

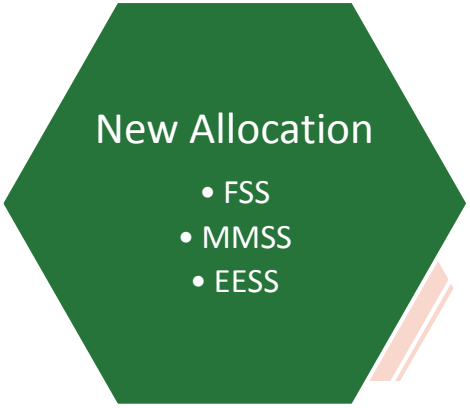
5.499A The use of the frequency band 13.4-13.65 GHz by the fixed-satellite service (space-to-Earth) is limited to **geostationary-satellite systems** and is subject to agreement obtained under **No. 9.21** with respect to satellite systems operating in the space research service (space-to-space) to relay data from space stations in the geostationary-satellite orbit to associated space stations in non-geostationary satellite orbits for which advance publication information has been received by the Bureau by 27 November 2015. (WRC-15)

Article 21

TABLE 21-4 (*continued*) (Rev.WRC-15)

Frequency band	Service*	Limit in dB(W/m²) for angles of arrival (δ) above the horizontal plane				Reference bandwidth
		0°-5°	5°-25°		25°-90°	
13.4-13.65 GHz (Region 1)	Fixed-satellite (space-to-Earth) (geostationary-satellite orbit)	0°-25°	25°-80°	80°-84°	84°-90°	4 kHz
		−159 + 0.4δ [19]	−149 [19]	−149 − 0.5(δ − 80) [19]	−151 [19]	

Maritime Mobile Satellite Service in 7/8 GHz (agenda item 1.9.2)



- in the space-to-Earth direction (Downlink)
  - ***7 375 – 7 750 MHz***

- No allocation for uplink in 8025-8400 MHz (traffic demand in uplink is much less and sharing with incumbent services is difficult)

Implications

Additional bandwidth for downlink data transmissions of the next-generation satellites in the MMSS (introduction of new broadband services on ships).

Earth Exploration Satellite Service in 7/8 GHz (agenda item 1.11)

- New primary EESS up link allocation limited to tracking, telemetry and command (TT&C) in the **7 190-7 250MHz** band
- Provision to protect existing and future stations in the fixed, mobile and space research services from the new allocation

Implications

In combination with existing EESS downlink allocation in 8 025-8 400 MHz this new allocation will lead to simplified on-board architecture and operational concepts for future missions of EESS

Earth Exploratin Satellite Service in 8/9 GHz (agenda item 1.12)

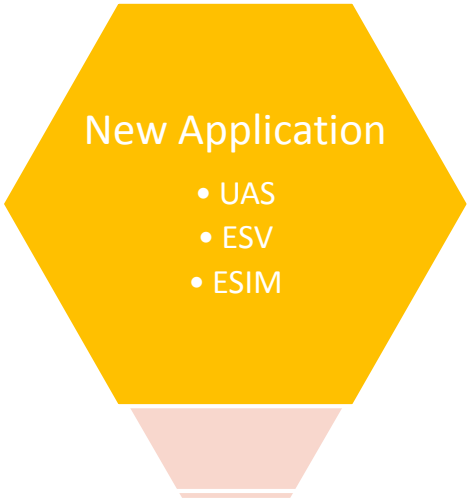
- New primary EESS(active) allocations totally of 600 MHz in the 9200 - 9300 MHz, 9900 – 10000 MHz and 10-10.4 GHz bands

- Provision to protect existing and future fixed and mobile stations

Implications

Development of modern broadband sensing technologies and space-borne radars on active sensing EESS that provides high quality measurements in all weather conditions with enhanced applications for disaster relief and humanitarian aid, large-area coastal surveillance

Use of Fixed-Satellite Service for Unmanned Aircraft Systems (UAS) (agenda item 1.5)



11.45-11.7 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B (Earth-to-space) 5.484 MOBILE except aeronautical mobile	**11.45-11.7** FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B MOBILE except aeronautical mobile

5.484B Resolution **155 (WRC-15)** shall apply. (WRC-15)

Designation of 8 bands for such usage.
Total pectrum: Ku band: 70 MHz globally, 1050 MHz regionally,
Ka band: 1000 MHz globally

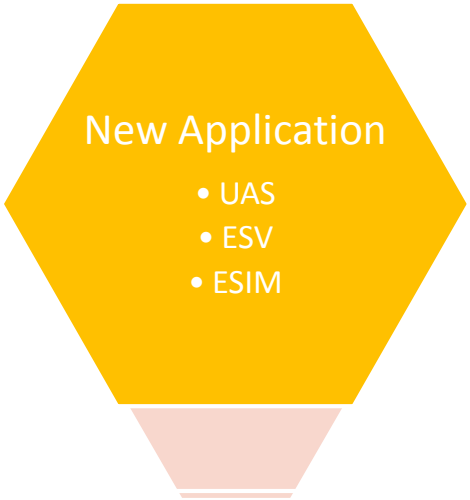
RES155-2

resolves

1 that assignments to stations of geostationary FSS satellite networks operating in the frequency bands 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) in Region 2, 12.2-12.5 GHz (space-to-Earth) in Region 3, 12.5-12.75 GHz (space-to-Earth) in Regions 1 and 3 and 19.7-20.2 GHz (space-to-Earth), and in the frequency bands 14-14.47 GHz (Earth-to-space) and 29.5-30.0 GHz (Earth-to-space), may be used for UAS CNPC links in non-segregated airspace*, provided that the conditions specified in *resolves* below are met;

- FSS can be used only after development of related ICAO aeronautical standards and recommended practices (SARPs);
- measures to avoid impact on terrestrial services and other FSS
- requirement to UA ES to operate in existing interference environment

Earth stations located on board vessels (ESVs) (agenda item 1.8)



Possibility to use smaller (1.2m) antenna for ESVs transmitting in the frequency band 5 925-6 425 MHz

→ Resolution **902 (WRC-03)** continues to apply

Implications

Increased use and further development of ESVs in the frequency band 5 925-6 425 MHz with sufficient protection to the terrestrial services

Earth Stations in Motion (ESIM)

New **5.527A** and new Res. **156** to set conditions for ESIM communication with GSO FSS space stations in 19.7-20.2, 29.5-30.0 GHz in all Regions

19.7-20.1 FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.516B 5.527A Mobile-satellite (space-to-Earth) 5.524	**19.7-20.1** FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.516B 5.527A MOBILE-SATELLITE (space-to-Earth) 5.524 5.525 5.526 5.527 5.528 5.529	**19.7-20.1** FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.516B 5.527A Mobile-satellite (space-to-Earth) 5.524
29.5-29.9 FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 Earth exploration-satellite (Earth-to-space) 5.541 Mobile-satellite (Earth-to-space) 5.540 5.542	**29.5-29.9** FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 MOBILE-SATELLITE (Earth-to-space) Earth exploration-satellite (Earth-to-space) 5.541 5.525 5.526 5.527 5.529 5.540	**29.5-29.9** FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 Earth exploration-satellite (Earth-to-space) 5.541 Mobile-satellite (Earth-to-space) 5.540 5.542

5.527A (WRC-15). The operation of earth stations in motion communicating with the FSS is subject to Resolution **156** (WRC-15)

New Application
- UAS
- ESV
- ESIM

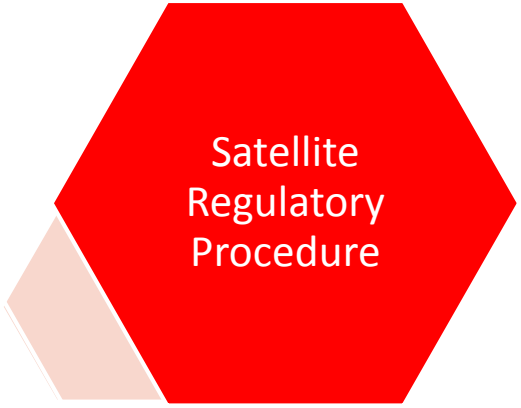
Implications

Increased use and further development of ESIM in the frequency bands 19.7-20.2 and 29.5-30.0 GHz in all Regions with sufficient protection to other GSO satellite networks and terrestrial services

Satellite Regulatory Procedures (agenda item 7)

Results of WRC-15: various improvements of the procedures, e.g.:

- Mod. 11.49 to reduce regulatory period of suspension day-by-day when the information of suspension is received beyond 6 month after suspension
- Sup. Requirement for submission of Advance Publication Information for networks subject to coordination
- New Res. 40 (WRC-15) to increase transparency when one space station is used to bring into use assignments to GSO networks at different orbital locations within a short period of time
- Mod. 13.6 to include reason for BR' query and specify period for BR to inform administration of its conclusion in response to administrations' replies



Implications

Facilitate the rational, efficient and economical use of radio frequencies and any associated orbits, including the geostationary-satellite orbit.

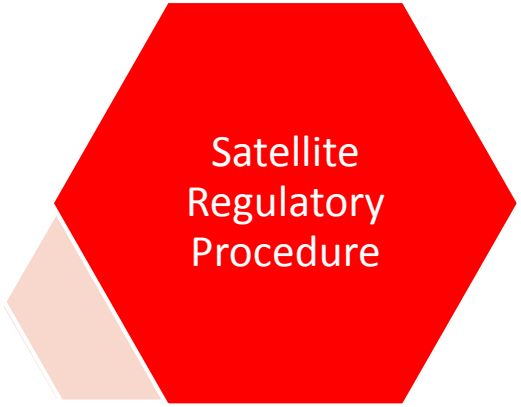
Satellite coordination (agenda 1.9.2)

Reduction of coordination arc in App. **5**

→ C band : from 8 to 7 degrees
→ Ku band : from 7 to 6 degrees

New Res. **762** with pfd criteria for uplink in C band and up/downlinks for Ku band outside coordination arc to consider no potential for harmful interference

→ No. **11.32A** examination



Implications

Facilitate the rational and efficient use of, as well as the access to, radio frequencies and associated geostationary-satellite orbit.

Regulatory aspects for nano- and picosatellites (agenda item 9.1.8)

WRC-12 adopted Resolution 757 (WRC-12) *Regulatory aspects for nanosatellites and picosatellites*.

This issue was studied in ITU-R WP-7B between 2012-2015, which came up with two reports:

ITU-R Report ITU-R SA.2312 - *Characteristics, definitions and spectrum requirements of nanosatellites and picosatellites, as well as systems composed of such satellites*; and

ITU-R Report ITU-R SA.2348 - *Current practice and procedures for notifying space networks currently applicable to nanosatellites and picosatellites*;

Satellite Regulatory Procedure

Conclusion was that there was no need for special regulatory arrangements for nano and picosatellites

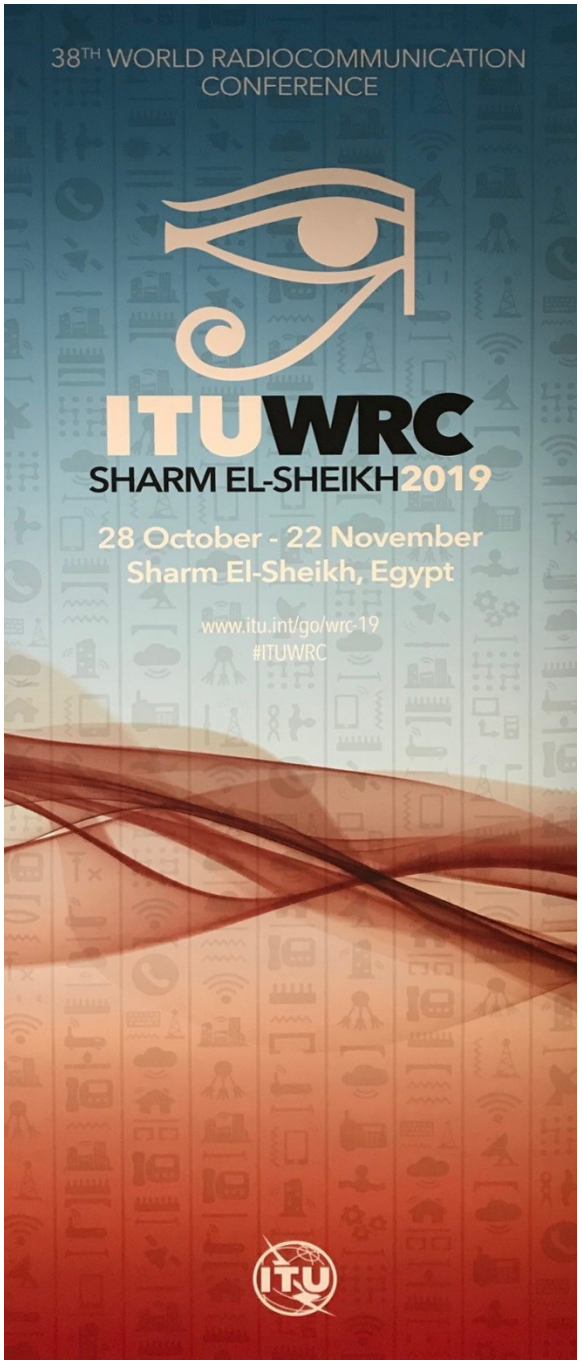
Terrestrial automatic dependent surveillance-broadcast (ADS-B) was available that could be extended to satellite reception

WRC-15 results

- primary allocation of **1087.7-1092.3 MHz** for satellite reception ADS-B messages (5.328AA)
- allocation conditions are in Resolution 425: not claiming protection from ARNS, ability operate in existing interference environment, compliance with ICAO standards

Implications

improves aircraft tracking through utilization of an existing technology; especially important for polar, oceanic, remote areas



WRC-19 Agenda Items (space)

Satellite Services
- AI 1.4
- AI 1.5
- AI 1.6

agenda item 9.1 (satellite):
- AI 9.1.2
- AI 9.1.3
- AI 9.1.9

Satellite Regulatory Procedure
- AI 7 (Issues A – M)

Wireless Broadband Connectivity:
- IMT (AI 1.13)
- HAPS (AI 1.14)
- RLAN (AI 1.16)

Science Issues
- AI 1.2
- AI 1.3
- AI 1.7

AI 1.4: Review Ku-band (BSS)

Consider results of studies on review, and possible revision if necessary, of RR App. 30 Annex 7 limitations, incl. orbital position limitations

→ Resolution 557 (WRC-15)

Improvement in the design of satellite antenna has triggered the need for review of Annex 7.

Studies under agenda item 1.4 need to take into account not only the technical improvements but also the current operational situation.

AI 1.5: ESIMs in Ka-band

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Studies to consider the use of the bands **17.7-19.7 GHz** (s-E) and **27.5 29.5 GHz** (E-s) by **earth stations in motion** communicating with GSO space stations in the FSS and take appropriate action

→ Resolution 158 (WRC-15)

Three types of ESIM:

– ESIM on aircraft (aeronautical ESIM);
– ESIM on ships (maritime ESIM), and
– ESIM on land vehicles (land ESIM).

Any of the three types of ESIM can be used to provide broadband communications, including Internet connectivity.

Sharing with:

- Terrestrial service
- Space Service (EESS, MetSat, FSS …)

AI 1.6: NGSOs in Q/V bands

Studies on development of a regulatory framework for non-GSO FSS systems that may operate in the bands **37.5-39.5 GHz** (s-E), **39.5-42.5 GHz** (s-E), **47.2-50.2 GHz** (E-s) and **50.4-51.4 GHz** (E-s)

→ Resolution 159 (WRC-15)

→ Sharing with GSO FSS/MSS/BSS
→ Sharing with Passive Services (EESS and SRS)
→ Sharing with Radio Astronomy

AI 9.1.2: Compatibility of IMT and BSS (sound) at **1452-1492 MHz** in R1&3

AI 9.1.3: N-GSO Satellite in “C-Band” allocated to the FSS

AI 9.1.9: Potential new FSS uplink allocation at **51.4-52.4 GHz**

Agenda item 9.1 (satellite):

- AI 9.1.2
- AI 9.1.3
- AI 9.1.9

Issue A - NGSO BIU and Consideration of a milestone-base deployment approach for non-GSO FSS systems in certain bands

A number of questions emerge concerning large non-geostationary constellations:

- What should be the conditions for bringing into use?
- How to monitor the deployment of constellations?
- Agreement of principle about a milestone approach
- How to allow for some adaptation of the orbital parameters?
- Should there be tolerances between the actual and notified orbital parameters? If yes, what level of tolerances can be acceptable?

Satellite Regulatory Procedure

- AI 7

Issues related with satellite coordination (unplanned)

- **Issue B** : Ka Band Coordination Arc
- **Issue D** : BR identification of coordination requirements

Issues related with AP4 data elements

- **Issue H -** NGSO AP4 data elements for systems not subject to Section II of Art. 9
- **Issue I** - NGSO AP4 data elements for systems with multiple orbital planes
- **Issue L** – AP4 data elements as a consequence of revising Rec ITU-R S.1503

Issues related with Planned Satellite Network (Appendix 30/30A/30B)

- **Issue E** – Resolution Appendix 30B
- **Issue F** – Measures to facilitate entering Appendix 30B
- **Issue G** - Updating the AP30/30A reference situation
- **Issue J** – Pfd limit in Section 1, Annex 1 of RR Appendix 30
- **Issue K** – Appendix 30B Part B examinations

Issue M - Simplified regulatory regime for short duration missions

Issue C – Issues (7) for which consensus was achieved in ITU-R and a single method has been identified

Agenda item 1.13 : identification of frequency bands for the future development of IMT

Agenda item 1.14: regulatory actions for high-altitude platform stations (HAPS),

Agenda Item 1.16 : Issues related to wireless access systems, including radio local area networks (WAS/RLAN), in the frequency bands between 5 150 MHz and 5 925 MHz

:

Wireless Broadband Connectivity:

- IMT (AI 1.13)
- HAPS (AI 1.14)
- RLAN (AI 1.16)

→ Some Frequency bands are used by Satellite service

→ Overlapping bands with other agenda items (1.6 and 9.1.9)

Overlapping frequency bands (GHz) between some WRC-19 agenda items

AI1.6 – NGSO FSS Res. 159 (WRC-15)	AI1.13 – IMT Res. 238 (WRC-15)	AI1.14 – HAPS Res. 160 (WRC-15)	AI9.1 (9.1.9) – FSS Res. 162 (WRC-15)
	24.25-27.5	24.25-27.5 (Reg. 2)	
37.5-39.5 (s-E*)	37-40.5	38-39.5 (globally)	
39.5-42.5 (s-E*)	40.5-42.5		
47.2-50.2 (E-s*)	47.2-50.2		
50.4-51.4 (E-s*)	50.4-52.6		51.4-52.4 (E-s*)
* E-s: Earth-to-space; s-E: space-to-Earth.			

Studies to **address mutual compatibility & sharing feasibility** among the **services/applications** for which **allocation/identification is envisaged** under the corresponding Res. relating to the AI in the overlapping bands

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Agenda item 1.2: Studies to consider in-band power limits for earth stations in MetSat & EESS at **401-403 MHz** for DCS* and in the MSS at **399.9-400.05 MHz (Res. 765 (WRC-15))**

Agenda item 1.3: Studies to consider possible upgrading of the **2ndary MetSat (s-E)** allocation **to 1mary** status & a possible **1mary EESS (s-E)** allocation @ **460-470 MHz** for DCS **(Res. 766 (WRC-15))**

Science Issues

- AI 1.2
- AI 1.3
- AI 1.7

* Data Collection Systems (DCS) are used to monitor and predict climate change, monitor oceans, weather and water resources, weather forecasting and assisting in protecting biodiversity, improving maritime security

Agenda Item 1.7: Study spectrum needs for **TT&C in the Space Operation Service (SOS)** for non-GSO satellites with short duration missions & consider, if necessary, new SOS allocations

Thank you!