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Results and implications of World Radiocommunication Conference, 2015

Radiocommunication Bureau
International Telecommunication Union

World Radiocommunication Conference, 2015 took place from 2 to 27 November 2015 in Geneva

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Purpose of ITU WRCs

- Create regulatory certainty for a multi-trillion dollars industry which plays a increasingly important role in the development of our societies
- For fixed, mobile, satellites and broadcasting industries, global spectrum harmonization is essential to create economies of scale, roaming and interoperability
- Creating certainty requires consensus in order to achieve stable results. This demands time, efforts and patience.

WRC-15 general information

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- **3275** participants attended WRC-15, including:
  - **2780** participants from **162** Member States, and
  - **495** participants representing **130** other entities, including industry, which also attended as observers

- **678** Documents including **2888** proposals were submitted before WRC-15. Two thirds (66%) of those were common proposals (either regional or multi-country).

- WRC-15 addressed over **40** topics related to frequency allocation and frequency sharing for the efficient use of spectrum and orbital resources.

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Mobile Broadband

(agenda items 1.1, 1.2)

Challenges

- Everybody is in favor of spectrum harmonization
- But
- Everybody wants it to be his own way
- The success of mobile broadband and its ubiquitous nature represents a threat of disruption to other services if IMT is identified in the same band, even though technical solutions may exist to share it between countries
- The main success of WRC-15 was to continue global harmonization for IMT and to secure future access to spectrum by other services

Spectrum for mobile broadband

agenda items 1.1 and 1.2

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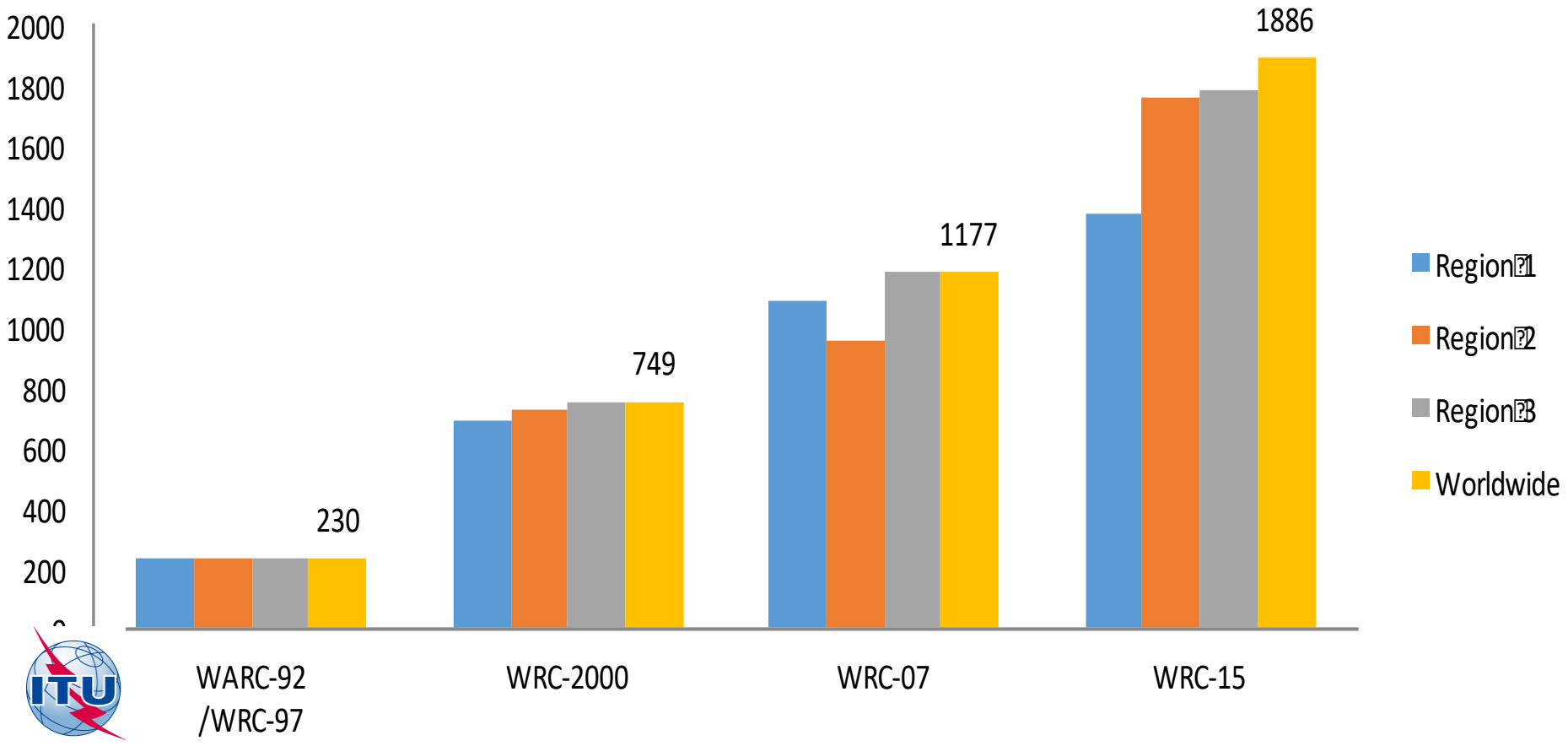
- **Background**
  - There is a need to satisfy rapidly growing traffic requirements for IMT (estimated IMT additional spectrum by 2020: from 159 to 1075 MHz depending on Region and user density)
  - Bands considered: 470 MHz - 6 425 MHz. Harmonized bands were highly desirable to facilitate global roaming and economies of scale
  - As for 700 MHz band in R1, WRC-15 had to specify conditions for mobile service in 694-790 MHz already allocated by WRC-12
- **WRC-15 results**
  - Allocations to mobile service and/or identifications for IMT in: 470-694/698 MHz, 694 – 790 MHz (Region 1),1427-1518 MHz, 3300-3400 MHz, 3400-3700 MHz, 4800 – 4990 MHz
  - Allocations are subject to various conditions, e.g. non-interference basis, pfd limits, 9.21 -> to secure protection of incumbent services
  - Action “Identification for IMT” was for the first time associated with regulatory/technical conditions imposed on this application in MS

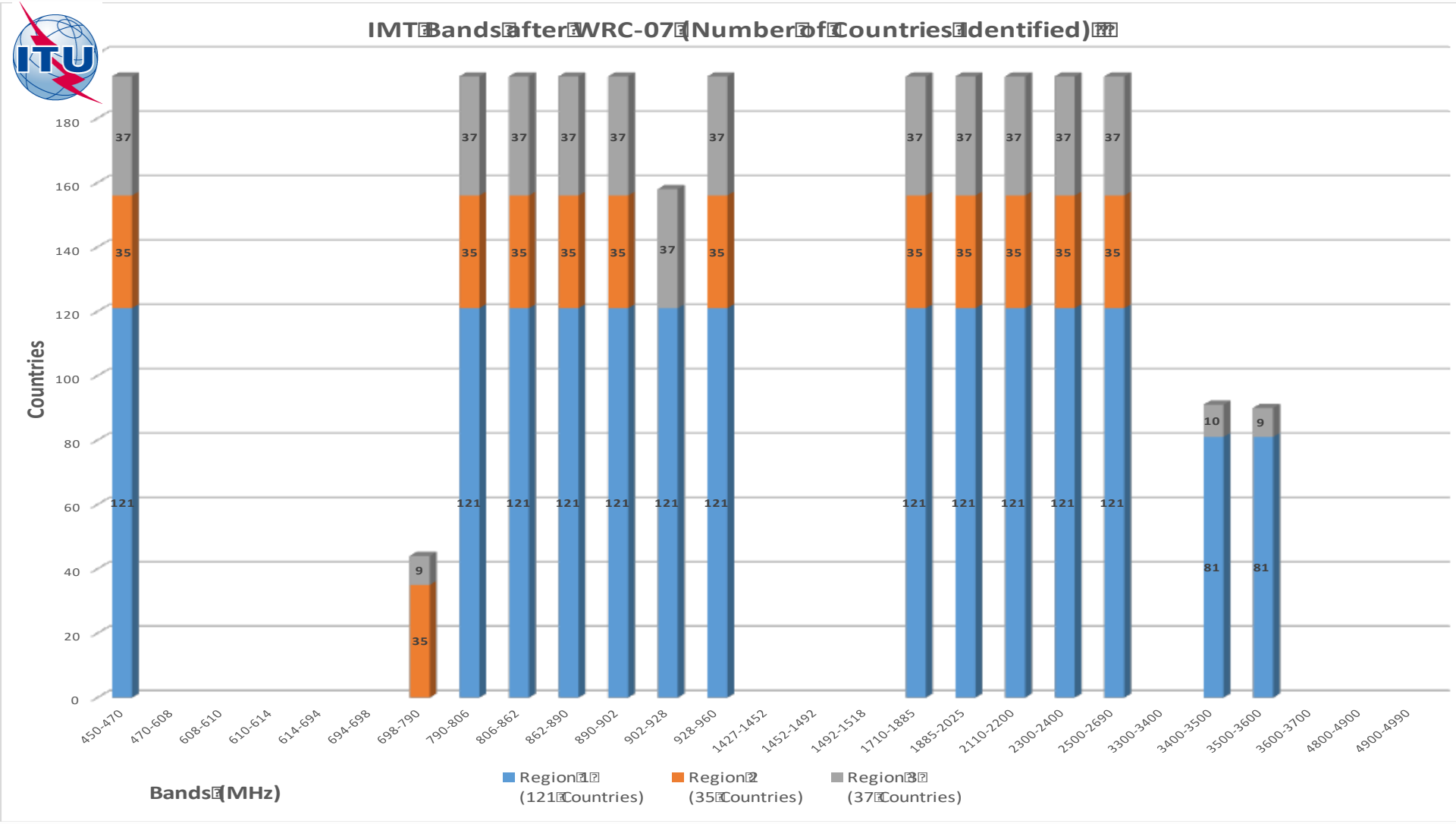
WRC-15 results for specific bands

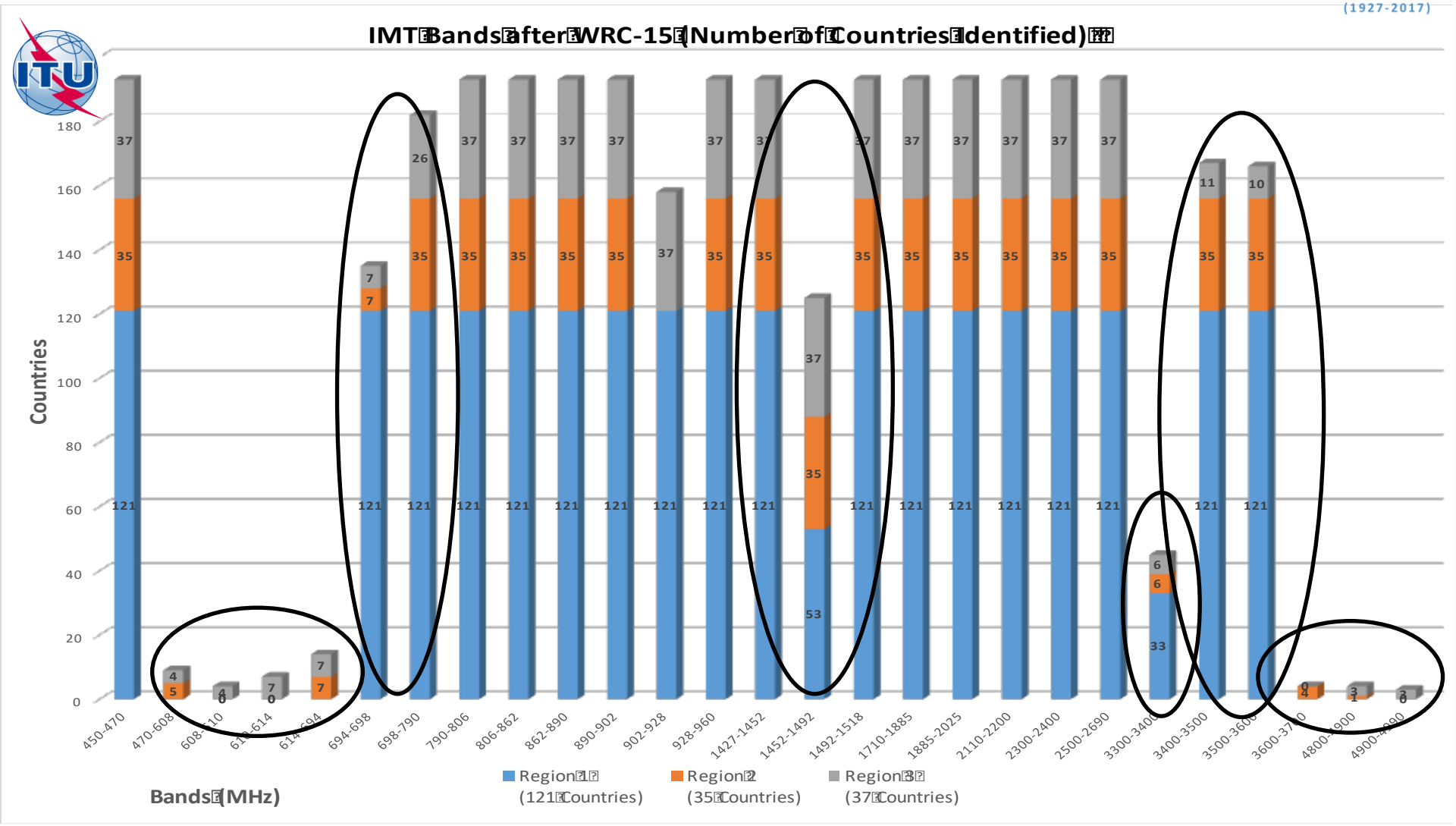
agenda items 1.1 and 1.2

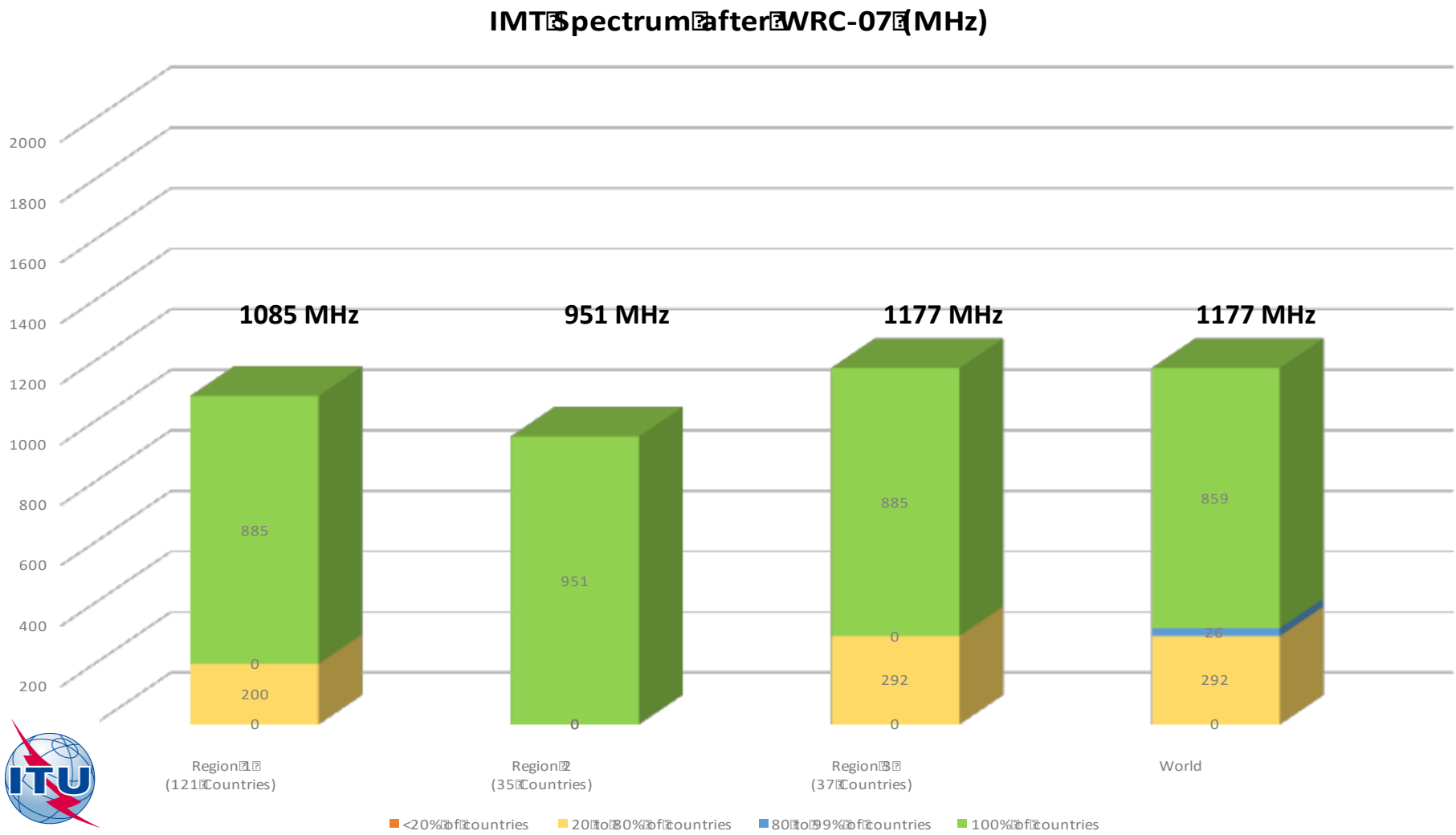
- **470–698 MHz**: IMT identification of parts of this band for 14 Regions 2, 3 countries (9.21, non-interference basis). For R1: consideration at WRC-23
- **1 427 – 1 518 MHz**: IMT identification in R2 and 3. Also in R1, except 1452–1492 MHz that identified only in 54 R1 countries (9.21 for R.1, 3)
- **3 300 – 3 400 MHz**: allocation to, or upgrade of MS in 36 countries worldwide. IMT identification in 33 R1, 6 R2 and 6 R3 countries
- **3 400 – 3 600 MHz**: upgrade of MS and identification for entire R.1, 2 and for 11 R3 countries (subject to 9.17, 9.18, 9.21 and pfd limit)
- **3 600 – 3 700 MHz**: IMT identification in 4 Region 2 countries subject to coordination under 9.17, 9.18, 9.21 and a pfd limit
- **4800–4990 MHz** IMT identification in 1 Region 2 and 3 Region 3 countries
- **694 – 790 MHz in Region 1**: allocation to MS and identification for IMT. **In force from 28.11.2015**. Provides harmonized worldwide allocation of this band. Ensures compatibility with broadcasting and ARNS (Res. 224, 760). Accommodates applications ancillary to broadcasting in 470 – 694 MHz

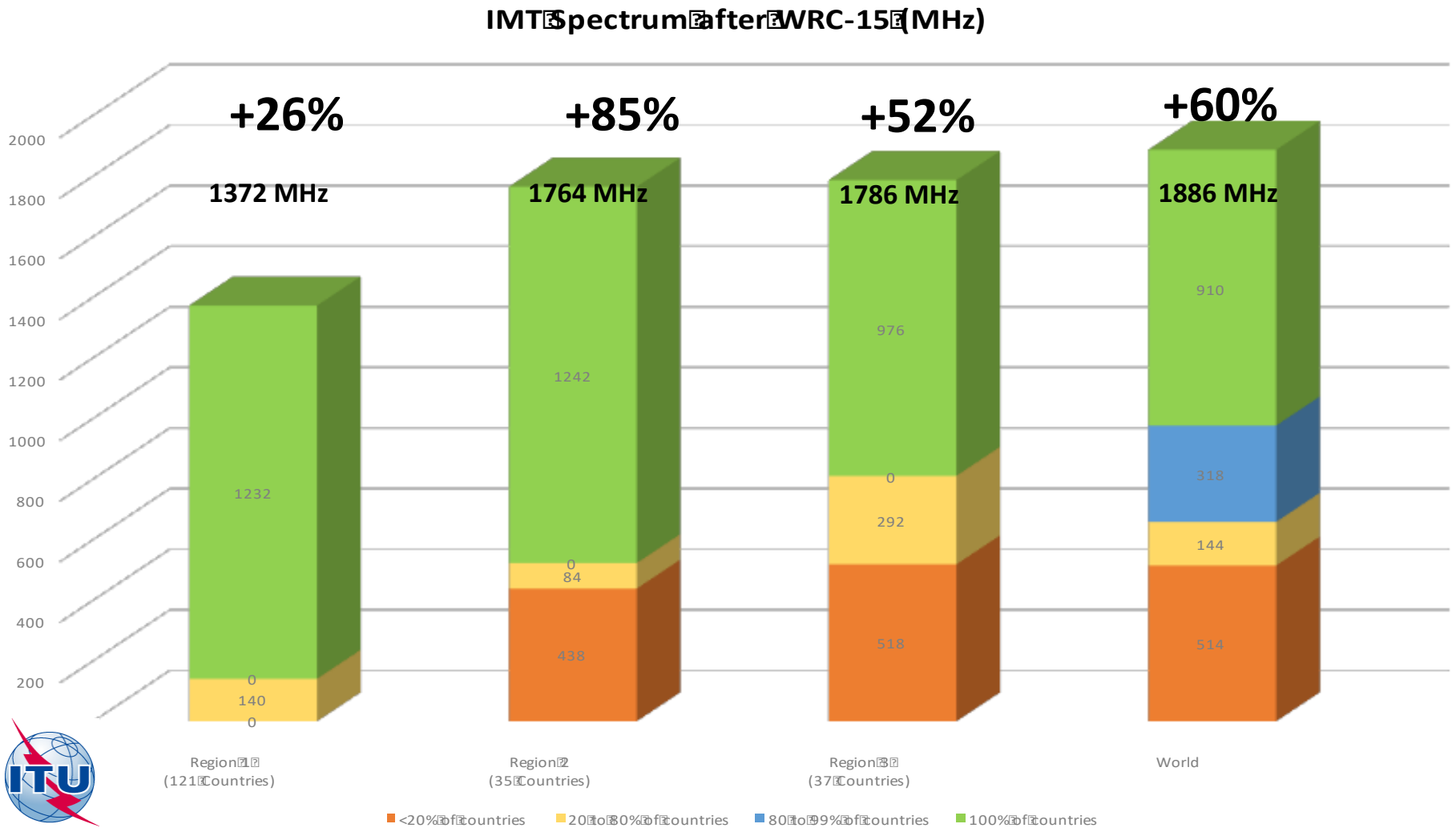
Total amount of spectrum identified for IMT (MHz)

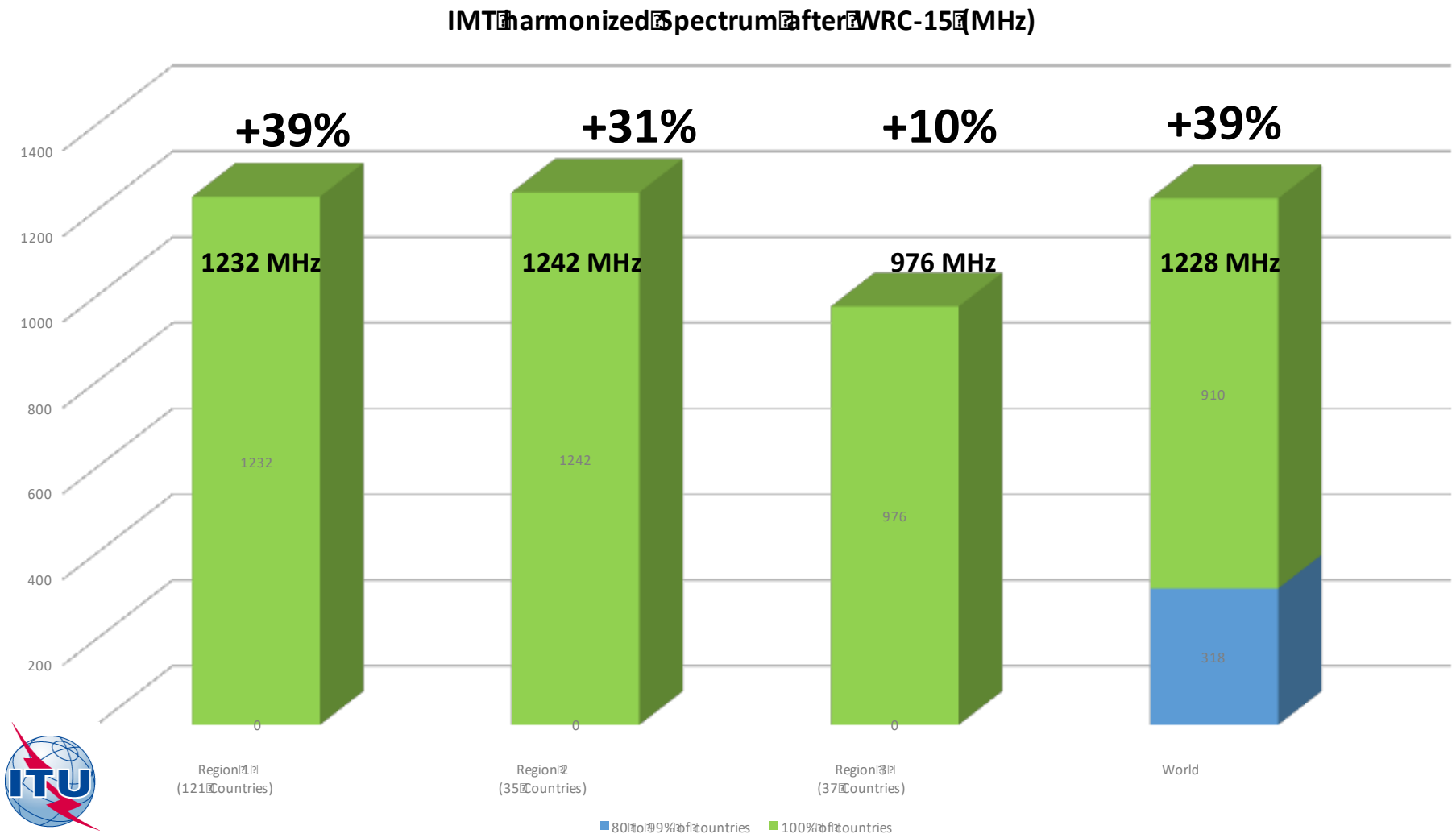



IMT Bands after WRC-07 (Number of Countries Identified)
Countries
0
20
40
60
80
100
120
140
160
180
450-470
470-608
608-610
610-614
614-694
694-698
698-790
790-806
806-862
862-890
890-902
902-928
928-960
1427-1452
1452-1492
1492-1518
1710-1885
1885-2025
2110-2200
2300-2400
2500-2690
3300-3400
3400-3500
3500-3600
3600-3700
4800-4900
4900-4990
Bands (MHz)
Region 1 (121 Countries)
Region 2 (35 Countries)
Region 3 (37 Countries)


IMT Bands after WRC-15 (Number of Countries Identified)
Countries
Bands (MHz)
Region 1 (121 Countries)
Region 2 (35 Countries)
Region 3 (37 Countries)
450-470
470-608
608-614
614-694
694-698
698-790
790-806
806-862
862-890
890-902
902-928
928-960
1427-1452
1452-1492
1492-1518
1710-1885
1885-2025
2110-2200
2300-2400
2500-2690
3300-3400
3400-3500
3500-3600
3600-3700
4800-4900
4900-4990


IMT Spectrum after WRC-07 (MHz)
2000
1800
1600
1400
1200
1000
800
600
400
200
1085 MHz
951 MHz
1177 MHz
1177 MHz
885
0
200
0
951
0
885
0
292
0
859
26
292
0
Region 1
(121 Countries)
Region 2
(35 Countries)
Region 3
(37 Countries)
World
<20% of countries
20 to 80% of countries
80 to 99% of countries
100% of countries


IMT Spectrum after WRC-15 (MHz)
+26%
+85%
+52%
+60%
1372 MHz
1764 MHz
1786 MHz
1886 MHz
2000
1800
1600
1400
1200
1000
800
600
400
200
1232
0
140
0
1242
0
84
438
976
0
292
518
910
318
144
514
Region 1
(121 Countries)
Region 2
(35 Countries)
Region 3
(37 Countries)
World
<20% of countries
20 to 80% of countries
80 to 99% of countries
100% of countries


IMT harmonized Spectrum after WRC-15 (MHz)
+39%
+31%
+10%
+39%
1232 MHz
1242 MHz
976 MHz
1228 MHz
1400
1200
1000
800
600
400
200
1232
1242
976
910
318
0
0
0
Region 1
(121 Countries)
Region 2
(35 Countries)
Region 3
(37 Countries)
World
80 to 99% of countries
100% of countries

Importance of WRC-15 decisions

agenda items 1.1 and 1.2

- Satisfy growing IMT broadband spectrum requirements:
  - 60% increase in IMT bands after WRC-15
  - total IMT spectrum of 1886 MHz
- Provide harmonization of IMT bands:
  - 39% increase in globally harmonized spectrum after WRC-15
    318 MHz of harmonized bands in more than 80% of countries:
- Secures future of other services through coordination procedures, technical restrictions, in some cases operation on a non-interference basis

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Public Protection and Disaster Relief (PPDR)

(agenda item 9.1.1)

Public protection and disaster relief

agenda items 9.1.1

- **Background:** there were requirements to
  - ensure better protection of 406 – 406.1 MHz (Cospas-Sarsat)
- **WRC-15 results**

- **Protection of 406-406.1 MHz** (MSS reception of Cospas-Sarsat) via review Res. **205** to reinforce protection from out-of-band emissions:
  - request not to assign frequencies to FS and MS in adjacent bands
  - BR to organize monitoring programs on impact from systems in 405.9-406 MHz, 406.1-406.2 MHz (in addition to the current program in the band)
  - administrations to take into account frequency drift of radiosondes above 405 MHz to avoid transmitting in the 406-406.1 MHz.

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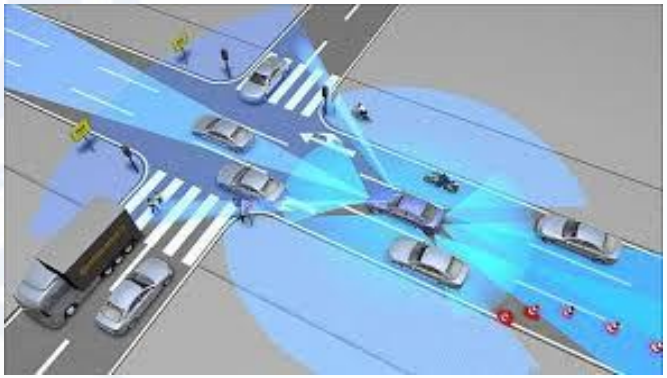
Aeronautical services and automotive applications

(agenda items 1.5 and Global Flight Tracking)



Use of fixed-satellite service for unmanned aircraft systems (UAS)

90th Anniversary CCIR/ITU-R Study Groups (1927-2017)

agenda item 1.5

- **Background**
  - rapid UAS development, future integration in conventional air traffic
  - reliable terrestrial and satellite links are critical for controlling UAS
  - WRC-12 made allocation to terrestrial component in 5 GHz, but satellite component still required frequencies due to limited AMSS spectrum and lack of operational AMSS systems
  - possible solution: to use FSS links for UAS, taking into account increasing requirement to utilize existing capacity of GSO FSS
- **Specific issues**
  - need for ensuring reliability of UAS links, given interference in FSS
  - need for protection of terrestrial services because placing FSS earth station on aircraft changes interference situation
  - need for taking decision in the absence of available ICAO standards

Use of fixed-satellite service for unmanned aircraft systems (2)

agenda item 1.5

- **WRC-15 results**
  - approval of No. 5.484B and Res. 155 allowing the use of FSS assignments for UAS
  - Designation of 8 bands for such usage. Total spectrum: Ku band: 970 MHz globally, 1520 MHz regionally, Ka band: 1000 MHz globally
  - 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
  - instructions to the Bureau: to identify a new class of stations for UAS, to examine Res. 155 to identify actions by administrations, not to process filings until all conditions are met, liaise with ICAO
- **Implications**
  - paves the way for commercial utilization of UAS after 2023

Global Flight Tracking (GFT)

agenda item GFT

90th Anniversary CCIR/ITU-R Study Groups (1927-2017)

- **Background**
  - need for continuous aircraft surveillance; satellite tracking could complement terrestrial tracking, e.g. radars, HF communications, etc.
  - the issue was urgent, following disappearance of MH370. PP-14 adopted Resolution 185 and established additional AI on GFT
  - By WRC-15 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

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Fixed satellite service (FSS)

(agenda items 1.6, 1.7, 1.8)

Allocations to the fixed-satellite service in 10 – 17 GHz

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agenda item 1.6

- **Background**
  - Before WRC-15, for unplanned FSS in the Ku band:
    - *Region 1: 750 MHz of spectrum both for uplink and downlink*
    - *Region 2: 1000 MHz of spectrum for downlink, only 800 MHz for uplink*
    - *Region 3: 1050 MHz of spectrum for downlink, only 750 MHz for uplink*
- **Results of WRC-15**
  - New allocations for the FSS
  - 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*
    - *14.5-14.8 GHz, limited to 9 countries in Region 3*

- **Better balance between uplink/downlink and between Regions**
  - *1000MHz (UP/Down) in **Region 1**; 1050MHz (UP), 1000MHz (Down) in **Region 2**; 1050MHz (UP/Down) in **Region 3***

Ku-band frequency allocation for unplanned FSS Downlink (R1)

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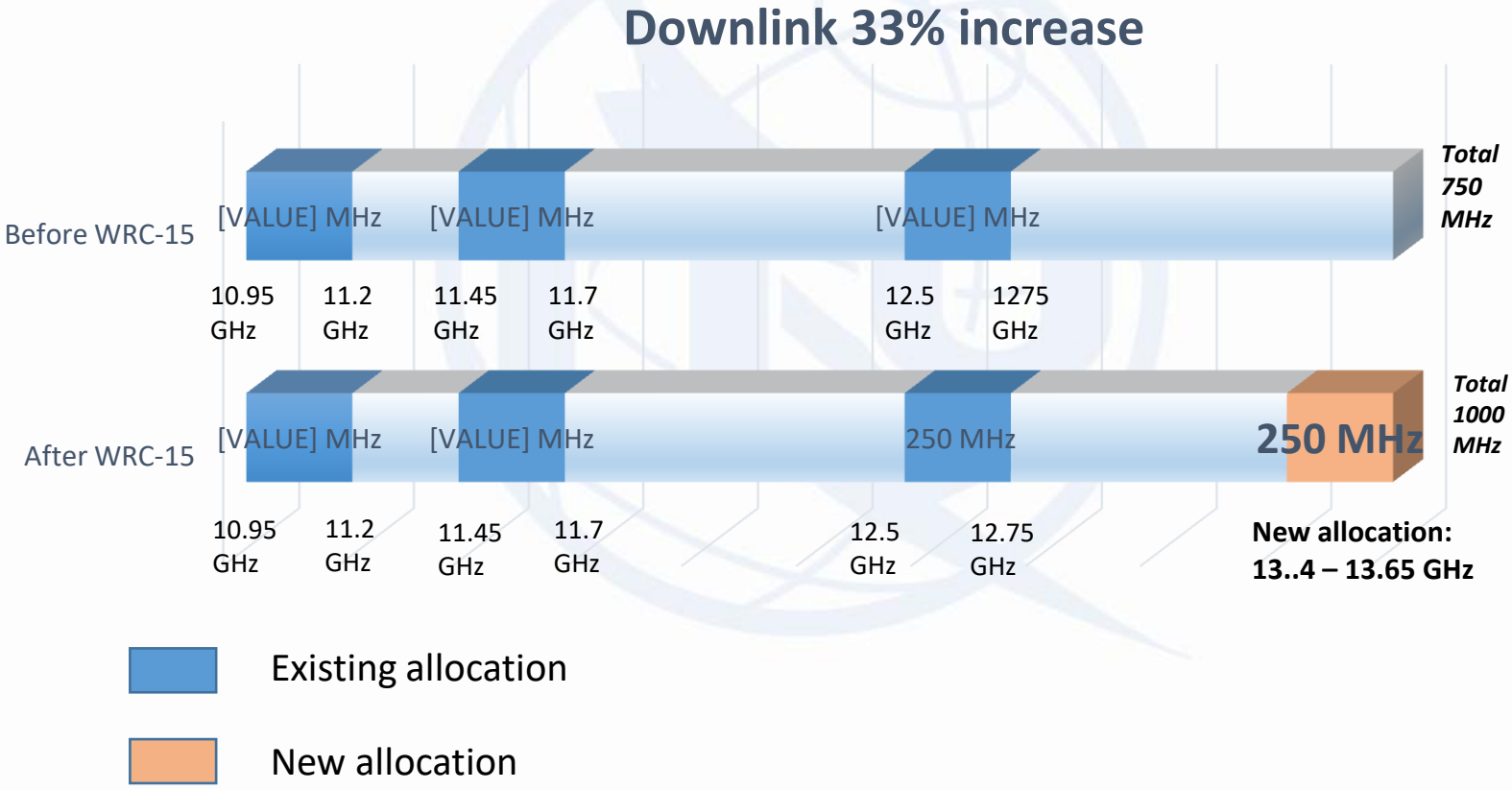
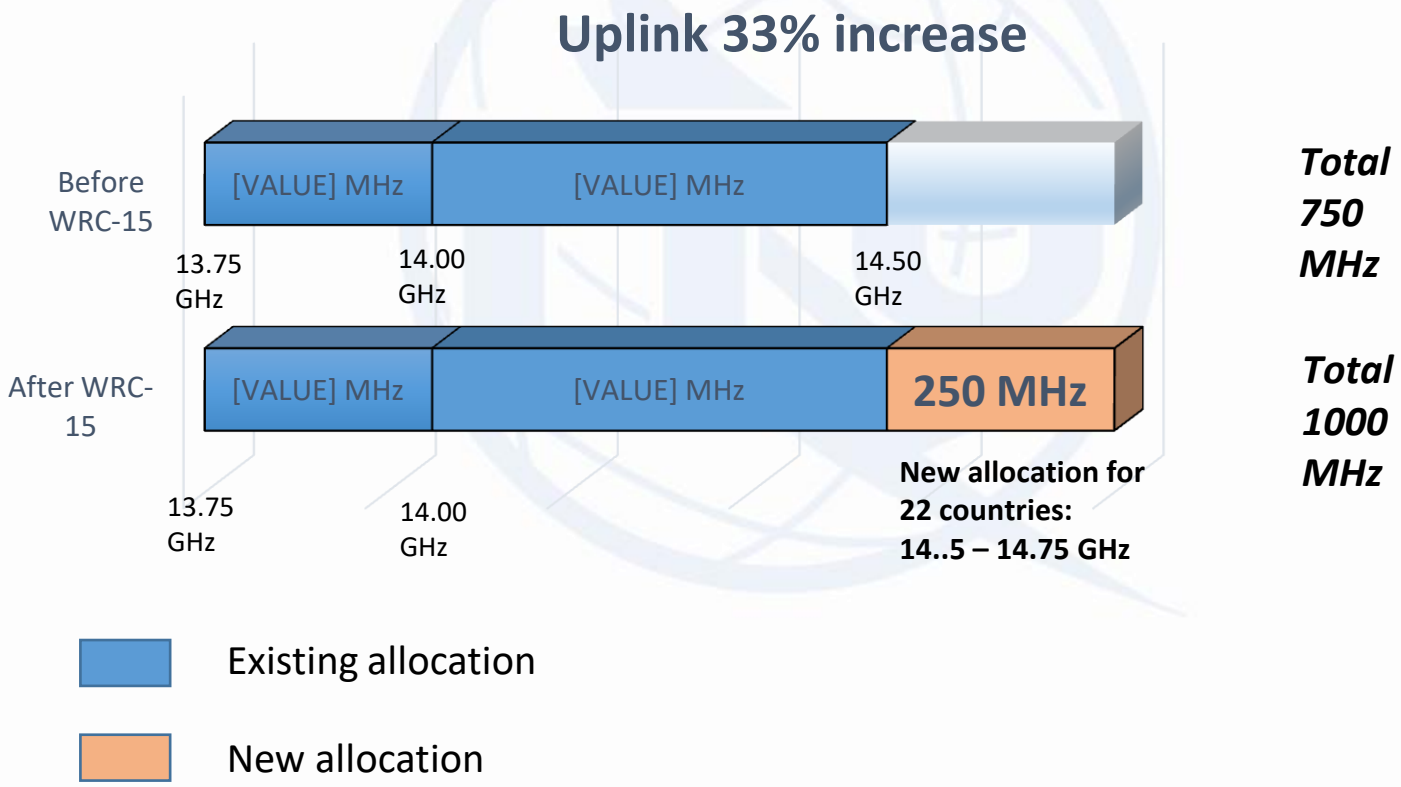
agenda item 1.6



Ku-band frequency allocation for unplanned FSS uplink (R1)

agenda item 1.6



Total 750 MHz

Total 1000 MHz

Ku-band frequency allocation for unplanned FSS (Region 2)

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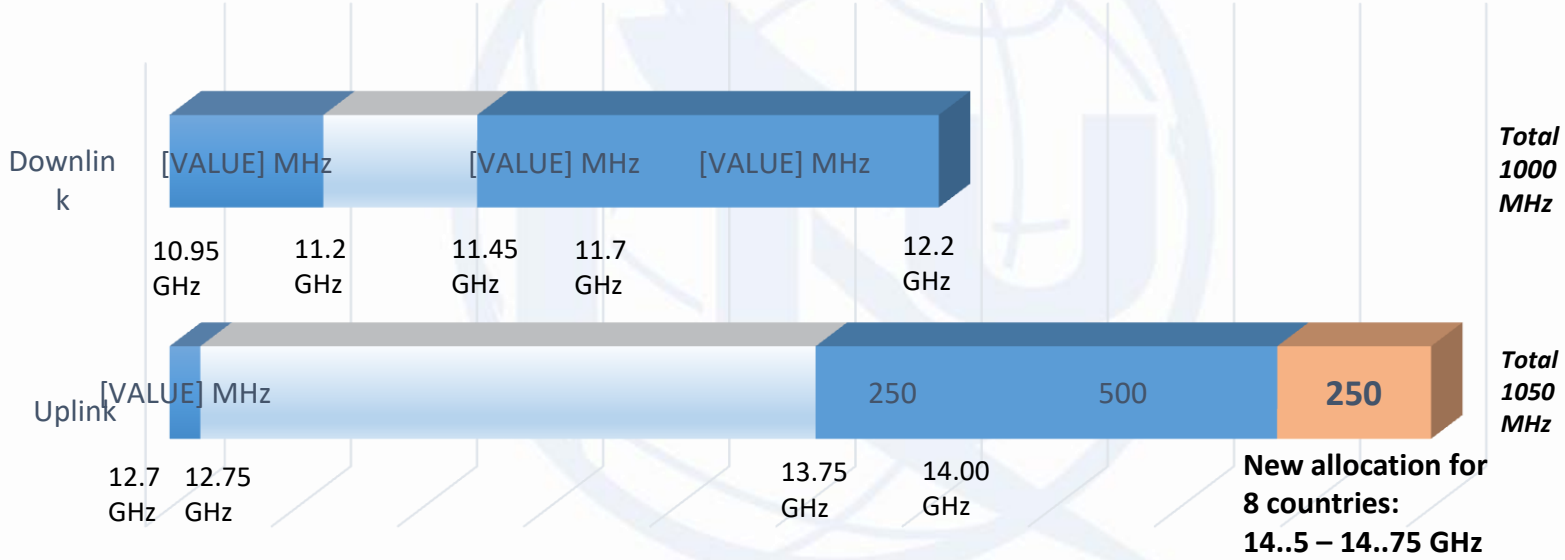
agenda item 1.6

Improved balance between uplink and downlink



Existing allocation

New allocation

Ku-band Frequency allocation for unplanned FSS (Region 3)

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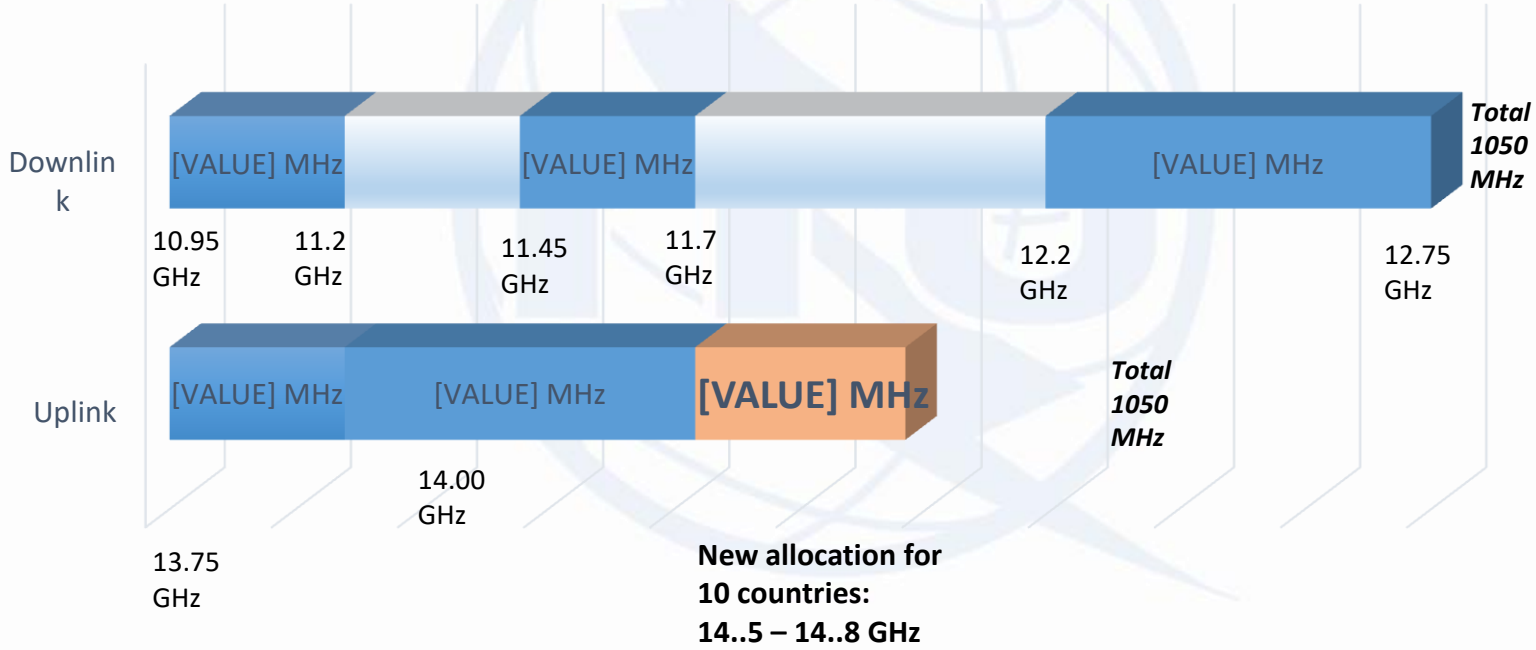
agenda item 1.6

Improved balance between uplink and downlink



Existing allocation

New allocation

Allocations to FSS in 10 – 17 GHz

agenda item 1.6

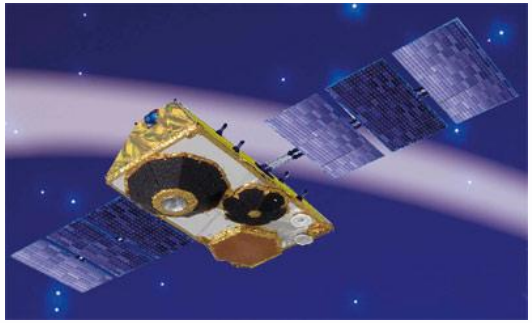
- **Conditions of utilization (to protect incumbent services)**
  - Downlink: 13.4 – 13.65 GHz
    - *Limited to GSO*
    - *power flux density limits specified in No.**21.16***
    - *Coordination procedures under Nos.**9.7** and **9.21***
  - Uplink: 14.5-14.8 GHz in Region 3, 14.5-14.75 GHz in Regions 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***
- **Implications**
  - Increased and balanced allocations will facilitate development of various applications e.g. VSAT, video distribution, broadband networks, internet service, satellite news gathering, backhaul link etc.

Use of the band 5 091-5 150 MHz by FSS

agenda item 1.7

Background

- 5 091-5 150 MHz was allocated to FSS (uplink) for feeder links of MSS non-GSO systems on a primary basis up to 1.1.2018 with the conditions:
  - *it becomes secondary to ARNS after 1 Jan 2018*
  - *no new assignments shall be made to earth stations providing these feeder-links after 1 Jan 2016.*



Results of WRC-15

- From 28.11.2015 this allocation is primary without any time limitation.
- Subject to Resolution **114 (Rev.WRC-15)**
- New coordination requirement for FSS earth stations within 450 km from the territory of an administration operating ARNS ground stations

Implications

- The long term availability of the spectrum for feeder links of non-GSO systems in MSS with sufficient protection to existing ARNS stations

Earth stations located on board vessels (ESVs)

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agenda item 1.8

➢ *Background*

- **5.457A** and Res. **902 (WRC-03)** provide technical, regulatory and operational conditions under which ESVs may communicate with space stations of FSS in bands 5 925-6 425 MHz and 14-14.5 GHz

➢ Results of WRC-15

- 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

	Before WRC-15		After WRC-15		
Frequency band	5 925-6 425 MHz	14-14.5 GHz	5 925-6 425 MHz		14-14.5 GHz
Minimum diameter of ESV antenna	2.4 m	0.6 m	2.4 m	1.2 m	0.6 m
Minimum distance from the low-water mark as officially recognized by the coastal State beyond which ESVs can operate without the prior agreement of any administration	300 km	125 km	300 km	330 km	125 km

➢ Implications

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

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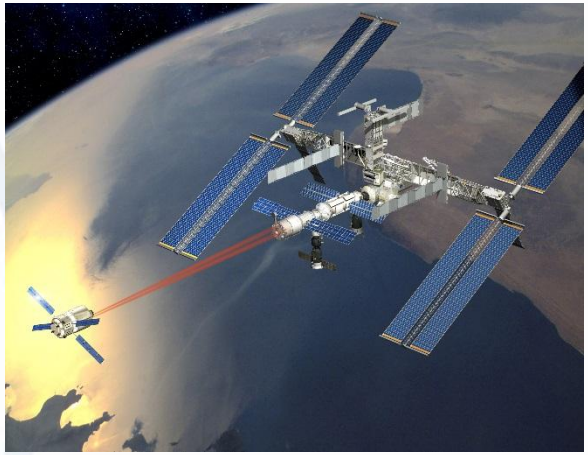
Maritime-mobile satellite and science services
(agenda items 1.9.2, 1.11, 1.12, 1.13)



7375-7750/8025-8400 MHz for maritime-mobile satellite

90th Anniversary CCIR/ITU-R Study Groups (1927-2017)

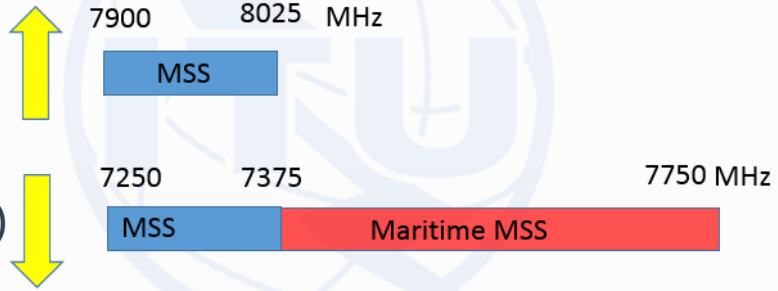
agenda item 1.9.2

Background

- spectrum shortfall for current and future applications in 7/8GHz

Results of WRC-15

- New allocation to MMSS in 7 375 – 7 750 MHz in the space-to-Earth direction
- No allocation for uplink in 8025-8400 MHz (traffic demand in uplink is much less and sharing with incumbent services is difficult)



Increase of 400% of spectrum in the downlink!

Conditions of utilization

- Limited to GSO
- Earth stations in MMSS shall not claim protection, nor constrain use of fixed and mobile stations, except aeronautical mobile. **5.43A** does not apply.

Implications

- Additional bandwidth for downlink data transmissions of the next-generation satellites in the MMSS

Earth exploration-satellite service (EESS) in 7-8 GHz

agenda item 1.11

Background

- The need for uplink large amounts of data for operations plans and dynamic spacecraft software modifications, which might not be accommodated by heavily used 2 025-2 110 MHz and 2 200-2 290 MHz TT&C bands

Results of WRC-15

- New primary EESS up link allocation limited to tracking, telemetry and command (TT&C) in the 7 190-7 250MHz band (34% increase)
- 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 exploration-satellite service (active) in 8-9 GHz

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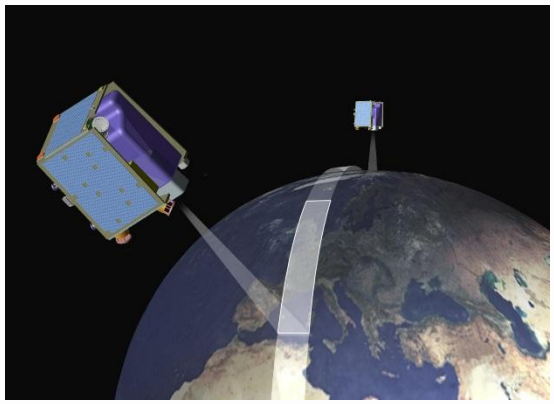
agenda item 1.12



Background

- EESS (active) bandwidth in 8-9 GHz was 600MHz. Growing demand for higher resolution to satisfy global environmental monitoring raised the need to increase the bandwidth up to 1200 MHz in total.

Results of WRC-15

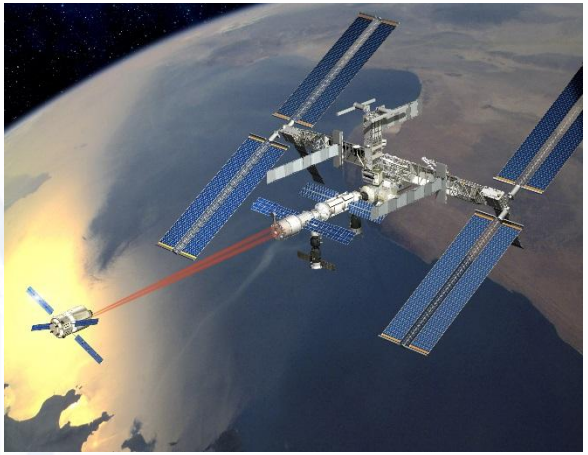
- New primary EESS(active) allocations totally of 600 MHz in the 9 200-9300MHz, 9 900-10 000MHz and 10.-10.4GHz bands (100% increase)
- Provision to protect existing and future fixed and mobile stations

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

5 km distance limitation in space research service

agenda item 1.13



- **Background**
  - Use of 410-420MHz band for Extra Vehicular Activities was limited to communication within 5 km of an orbiting, manned space vehicle. Rendezvous and docking maneuvers required the use of the band over larger distances.
- **Results of WRC-15**
  - Removal of the 5 km distance limitation in No. **5.268**
- **Implications**
  - Facilitation rendezvous and docking maneuvers which leads to safety of human life in a manned vehicle

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Satellite regulatory procedures

(agenda item 7)

Satellite regulatory procedures

agenda item 7

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Background

Articles **9**, **11** and **13** provide the regulatory procedures for advance publication, coordination, notification and recording of frequency assignments pertaining to satellite networks

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.

Reduction of the coordination arc

agenda item 9.1.2

90th Anniversary CCIR/ITU-R Study Groups (1927-2017)

- **Background**
  - Appendix **5** provides technical conditions for identification of administrations to coordinate with under Article **9**.

- **Results of WRC-15**
  - Reduction of coordination arc in App. **5** from 8 to 7 degrees in C band and from 7 to 6 degrees in the Ku band
  - New Res. **762** with pfd for uplink in C band and up/downlinks for Ku band outside coordination arc to consider no potential for harmful interference
  - These pfd criteria in the Resolution shall be used in No. **11.32A** examination. A new footnote was added to No. **11.32A**
- **Implications**
  - The reduction of the coordination arc and new Resolution **762 (WRC-15)** will facilitate the rational and efficient use of, as well as the access to, radio frequencies and associated geostationary-satellite orbit.

Earth Stations in Motion (ESIM)

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Background

- **5.526** provides conditions for ESIM communications with GSO FSS space stations in 19.7-20.2 GHz and 29.5-30 GHz in Region 2 as well as 20.1-20.2 GHz and 29.9-30 GHz in Regions 1 and 3.

Results of WRC-15

- 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
- This Res. extends the possibility offered for ESIM by **5.526** in the bands 19.7-20.2 GHz and 29.5-30 GHz in Region 2 and in bands 20.1-20.2 GHz and 29.9-30 GHz in Regions 1 and 3.

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

agenda item 10

WRC-19 Agenda

17 specific & 6 standing items, Res.809 (WRC-15)

90th Anniversary CCIR/ITU-R Study Groups (1927-2017)

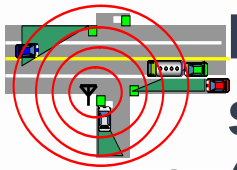
Fix. & Mob. BB Apps
(24.25 < IMT < 86 GHz, WAS/RLAN @ 5 GHz, HAPS, others>275 GHz)

Maritime (GMDSS modernization (+Sat.), VDES Sat component)

Amateur in R1 @ 50-54 MHz
(4WW allocation)

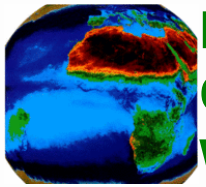
WRC 2019

Aeronautical
(GADSS needs)



New Transport systems
(harmonized bands for ITS, railways)

Satellite issues
(ES in motion, RR for N-GSO FSS @ 37.5 up to 51.4 GHz)

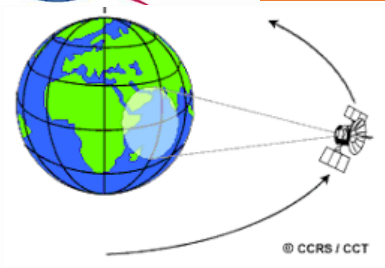


Earth resources & Climate monitoring Weather forecast, DCS improvement, TT&C for N-GSO Sat. of short duration

Regulatory issues
(Sat. regulations, harmonization of spectrum use, etc.)

Satellite issues
(WRC-19 agenda items 1.4, 1.5, 1.6 & 7)

90th Anniversary
CCIR/ITU-R Study Groups
(1927-2017)



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

► **Res. 557 (WRC-15)**

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

► **Res. 158 (WRC-15)**

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)**

► **Res. 159 (WRC-15)**

Satellite Regulatory issues

► **Res. 86 (Rev.WRC-07)**