Document WRC-15-IRWSP-13/10(Rev.1)-E
4 December 2013
English only

1st ITU INTER-REGIONAL WORKSHOP ON WRC-15 PREPARATION (Geneva, 4 – 5 December 2013)

Science Issues

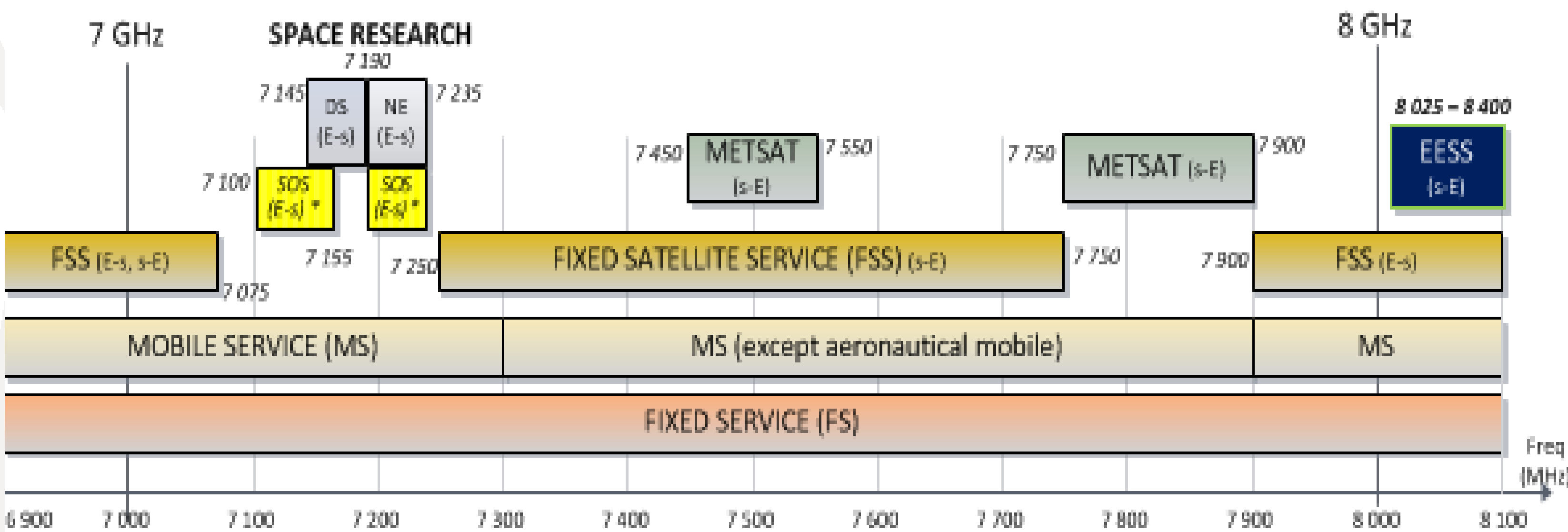
Panel-3 Discussions on WRC-15 Agenda items 1.11, 1.12, 1.13, 1.14 & 9.1.8

Vincent Meens
Chairman of ITU-R SG 7

Agenda Item 1.11

to consider a primary allocation for the Earth exploration-satellite service (Earth-to-space) in the 7-8 GHz range, in accordance with Resolution 650 (WRC-12)

- ✓ **Additional spectrum is needed for EESS missions requiring uplink of large amount of data for operation plan and dynamic software modifications;**
- ✓ **Resolution 650 invites ITU-R to conduct studies preferably in the band 7 145-7 235 MHz.**



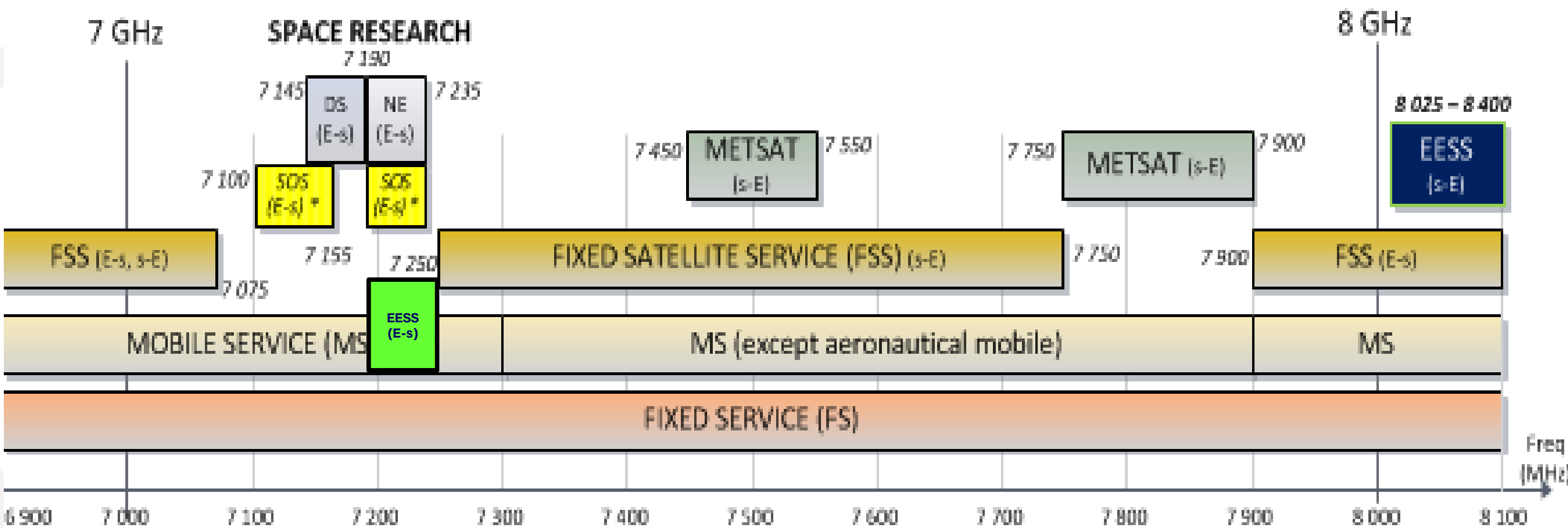
Agenda Item 1.11

Results of studies

- ✓ Bandwidth requirement for EESS systems dependent on sharing with other space services - between 38 MHz (not shared) and 56 MHz (fully shared);
- ✓ Sharing studies with the FS have shown:
  - ✓ Separation distance of about 150 km when the FS station is pointing directly towards the EESS station,
  - ✓ Distance drops to 3 km for an offset angle of 50°,
  - ✓ For 90 % of FS stations separation distance would be less than 10 km;
- ✓ The band is not used today by the mobile service but it is felt that separation distances derived from the FS would be sufficient to protect the MS;
- ✓ EESS uplink operations are compatible with near-Earth SRS operations except in the case of co-located stations where SRS uplinks would exceed the ITU-R criterion for protection of the EESS satellite;
- ✓ EESS uplink operations are not compatible with SRS (deep space) missions in 7 145-7 190 MHz band.

Agenda Item 1.11

How to satisfy the Agenda Item



- ✓ **Article 21 is modified to extend the range 7 145-7 235 MHz to 7 145-7 250 MHz;**
- ✓ **Appendix 7 is modified to include the new EESS allocation.**

Agenda Item 1.12

to consider an extension of the allocation to the EESS (active) in the frequency band 9 300-9 900 MHz by up to 600 MHz within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz, in accordance with Resolution 651 (WRC-12)

- ✓ **Spaceborne radars operating in the EESS (active) have an important contribution such as mapping, protection and disaster relief or environmental monitoring to name a few;**
- ✓ **The growing demand for higher resolution radar pictures raises the need to further increase the bandwidth used by the next generation of EESS synthetic aperture radars (SAR), since there is a direct ratio between the available bandwidth and the resulting SAR image resolution;**
- ✓ **The amount of estimated spectrum requirements for EESS (active) around 9 GHz is a contiguous 1 200 MHz.**

Agenda Item 1.12

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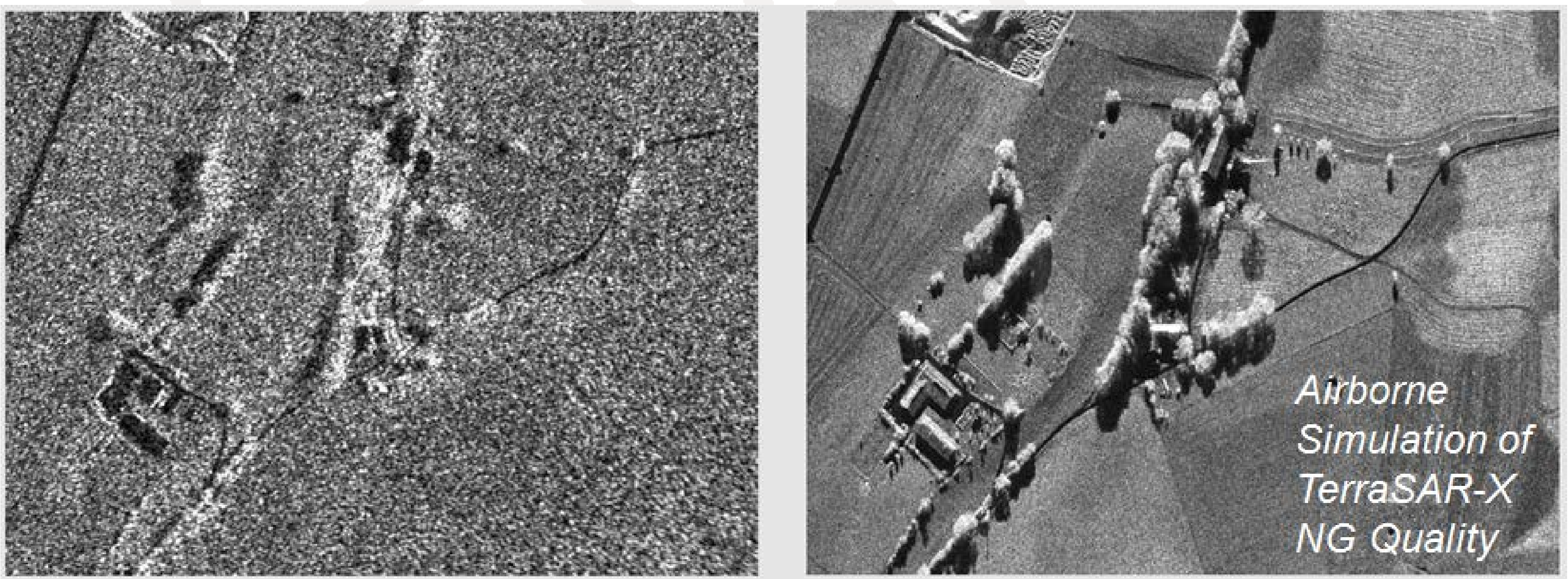
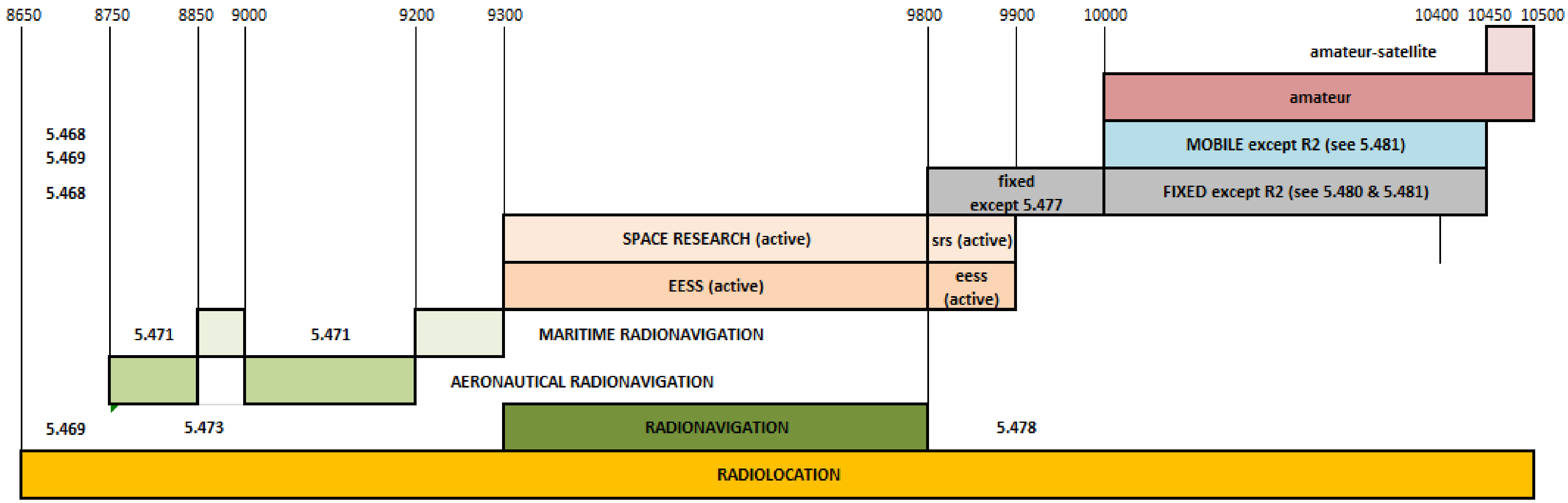


Results of studies



Agenda Item 1.12

Results of studies

- ✓ Compatibility studies made previously for the band 9300-9900 MHz were considered appropriate for similar radiodetermination system operating below and above this frequency range;
- ✓ Studies focused on current radars not considered in previous studies;
- ✓ No impact from RLS into new SAR but in the case of main beam to main beam coupling, I/N for RLS can reach 60 dB for 0.00001% of the time;
- ✓ No impact from RNS into new SAR but interference can be found into RNS systems, however processing gain could alleviate such interference, further studies are continuing on the radar processing;
- ✓ The fixed service would be protected with large margins (16 to 20 dB) except for elevation angle higher than 35°. Statistics indicate that current FS systems do not exceed 24° elevation angles;
- ✓ The mobile service would be protected with a margin of about 22 dB;
- ✓ EESS (active) sensor into the amateur-satellite or amateur stations can create an I/N exceeding -6 to -10 dB for limited periods of time (in the order of 4s per day).

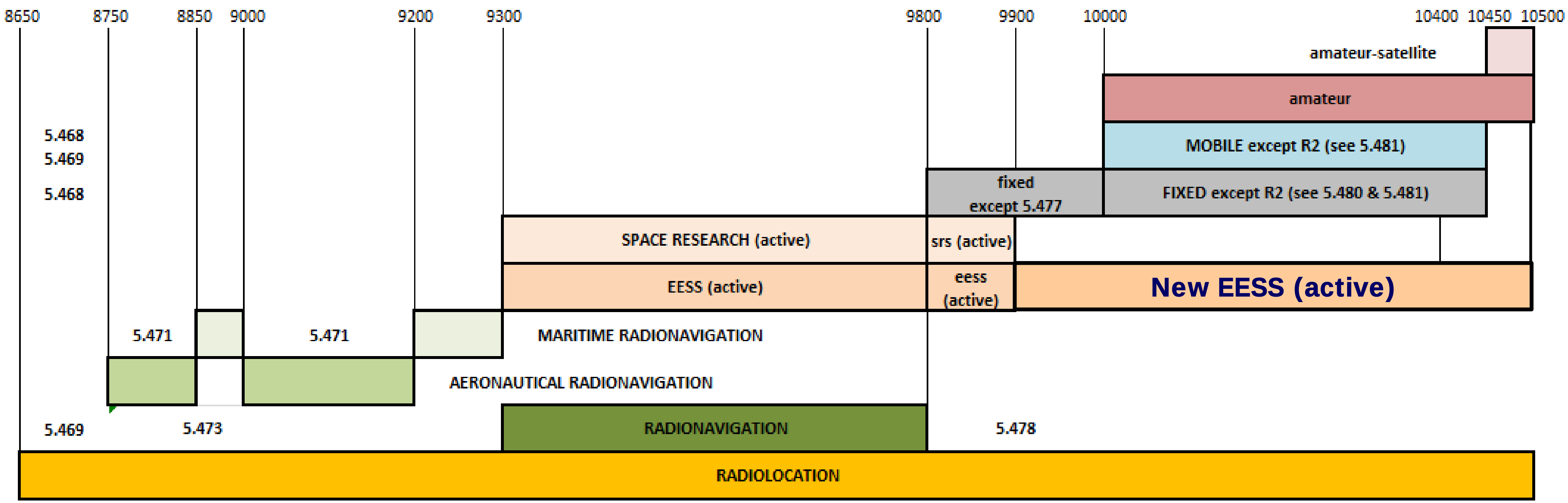
Agenda Item 1.12

Results of studies

- ✓ **Unwanted emissions into SRS deep space receivers is a serious concern, emission from from EESS (active) systems can exceed the SRS receiver damage threshold by :**
  - ✓ **71 dB if the extension is in the frequency range 8 700-9 300 MHz;**
  - ✓ **9 dB if the extension is in the frequency ranges 9 000-9 300 MHz and the 9.9-10.2 GHz;**
  - ✓ **2 dB if the extension in in the frequency range 9.9-10.5 GHz .**
- ✓ **Mitigation techniques are proposed in a new Recommendation, operational coordination could also be applied.**

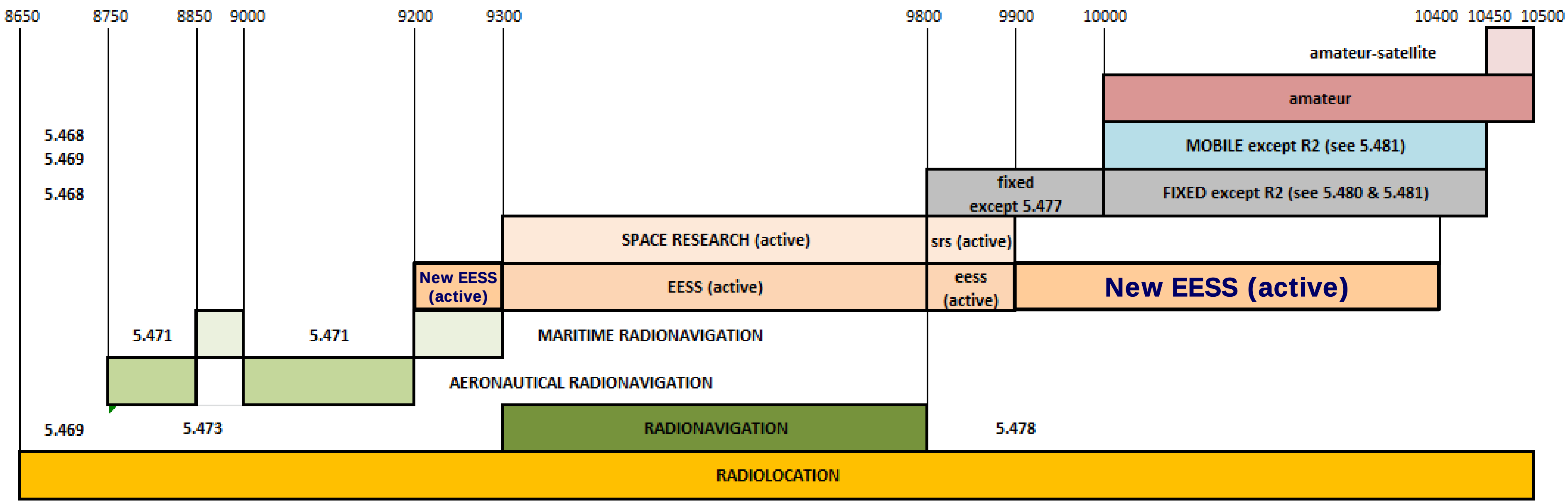
How to satisfy the Agenda Item

Method A



How to satisfy the Agenda Item

Method B



Agenda Item 1.13

to review No. 5.268 with a view to examining the possibility for increasing the 5 km distance limitation and allowing space research service (space-to-space) use for proximity operations by space vehicles communicating with an orbiting manned space vehicle, in accordance with Resolution 652 (WRC-12)

5.268 Use of the band 410-420 MHz by the space research service is limited to communications within 5 km of an orbiting, manned space vehicle. The power flux-density at the surface of the Earth produced by emissions from extra-vehicular activities shall not exceed

- *–153 dB(W/m 2) for 0° ≤ δ ≤ 5°,*
- *–153 + 0.077 (δ – 5) dB(W/m 2) for 5° ≤ δ ≤ 70° and*
- *–148 dB(W/m 2) for 70° ≤ δ ≤ 90°,*

where δ is the angle of arrival of the radio-frequency wave and the reference bandwidth is 4 kHz. No. 4.10 does not apply to extra-vehicular activities. In this frequency band the space research (space-to-space) service shall not claim protection from, nor constrain the use and development of, stations of the fixed and mobile services. (WRC-97) *to review No. 5.268 with a view to examining the possibility for increasing the 5 km distance limitation and allowing space research service (space-to-space) use for proximity operations by space vehicles communicating with an orbiting manned space vehicle, in accordance with Resolution 652 (WRC-12)*

- ✓ **The current 5 km distance limitation is adequate for Extra Vehicular Activities;**

NASA + Meens

to review No. 5.268 with a view to examining the possibility for increasing the 5 km distance limitation and allowing space research service (space-to-space) use for proximity operations by space vehicles communicating with an orbiting manned space vehicle, in accordance with Resolution 652 (WRC-12)

- ✓ **Rendezvous and docking manoeuvres require the use of the band over larger distances.**

Keith McNeill

Agenda Item 1.13

Results of studies

- ✓ The pfd limit specified in footnote 5.268 is adequate to protect terrestrial services;
- ✓ There is no need to modify that pfd limit if the operating distance is greater than 5 km;
- ✓ The physical construction of a manned space vehicle is typically of material and design optimize for the overall mission - not necessarily optimized for radio frequency communication (such as the ISS); hence the use of this band for proximity operations by vehicles approaching manned space vehicles would be advantageous as the propagation and physical properties of this frequency range enable comparable coverage performance in the highly multipath environment;

How to satisfy the Agenda Item

5.268 Use of the band 410-420 MHz by the space research service is limited to communications within 5 km of an orbiting, manned space vehicle. The power flux-density at the surface of the Earth produced by emissions from extra-vehicular activities shall not exceed

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How to satisfy the Agenda Item

5.268 Use of the band 410-420 MHz by the space research service is limited to ***space-to-space*** *communications with~~in 5 km of~~ an orbiting, manned space vehicle. The power flux-density at the surface of the Earth produced by emissions from ~~extra-vehicular activities~~* ***stations of the space research service (space-to-space) in the band 410-420 MHz*** *shall not exceed*

- *–153 dB(W/m 2) for 0° ≤ δ ≤ 5°,*
- ***–153 + 0.077 (δ** – 5) dB(W/m 2) for 5° ≤ δ ≤ 70° and*
- *–148 dB(W/m 2) for 70° ≤ δ ≤ 90°,*

where δ is the angle of arrival of the radio-frequency wave and the reference bandwidth is 4 kHz. ~~No. 4.10 does not apply to extra-vehicular activities.~~ In this frequency band the space research (space-to-space) service shall not claim protection from, nor constrain the use and development of, stations of the fixed and mobile services. ***RR No. 4.10 does not apply.*** *(WRC-**15**~~97~~)*

to consider the feasibility of achieving a continuous reference time-scale, whether by the modification of coordinated universal time (UTC) or some other method, and take appropriate action, in accordance with Resolution 653 (WRC-12)

Since 1967, the second is defined as :

> **the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom;**

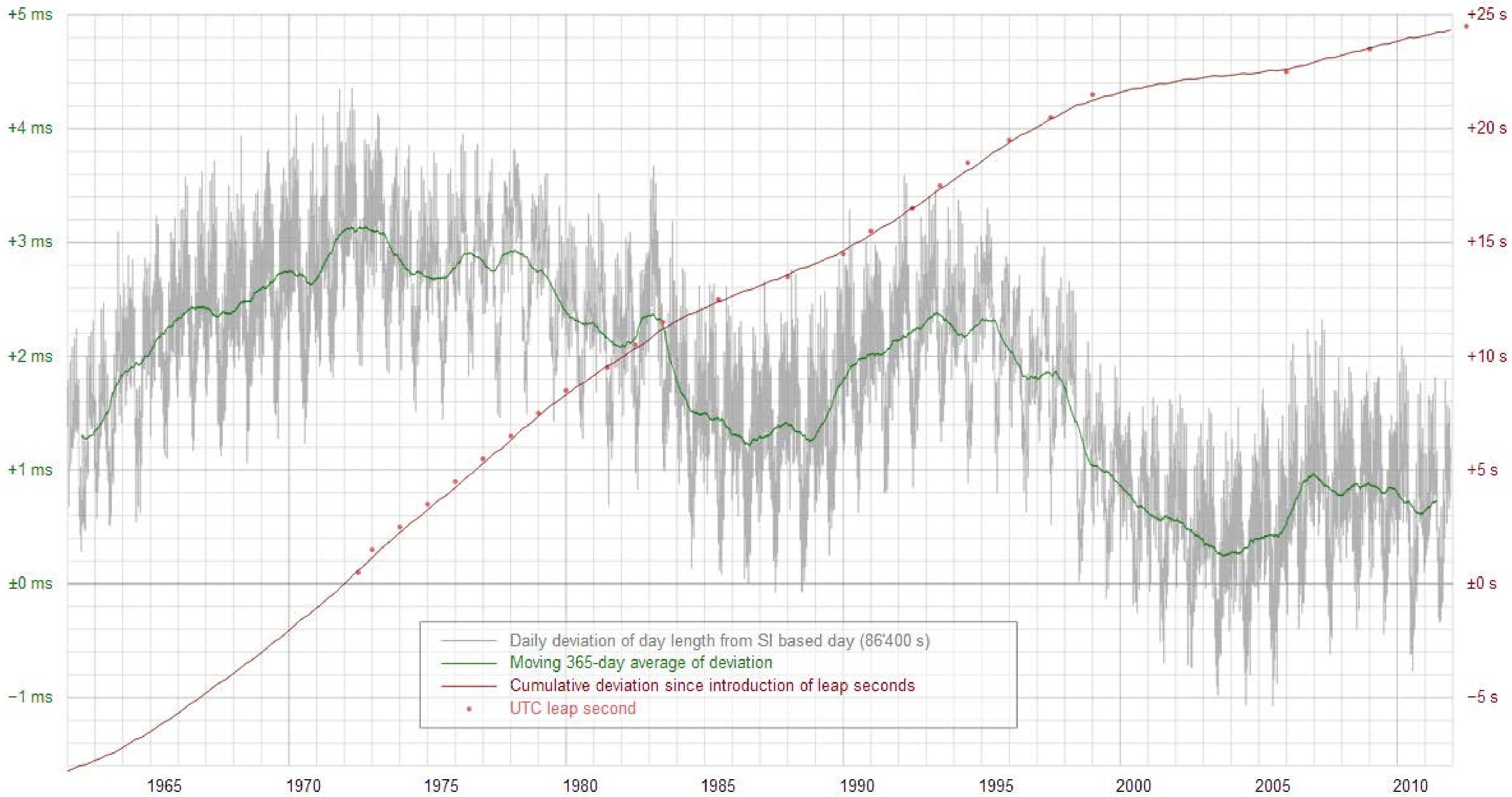
The SI second was based on the ephemeris second of 1952 and time is now based on the SI second as determined by atomic clocks;

Universal Coordinated Time (UTC) coordinates the difference between atomic time and ephemeris time by the insertion or deletion of leap seconds;

The differences are due to :

- Slowing down of the Earth rotation due to interactions with the Moon (about 2.3 ms/century),
- Irregularities in this value because of mantle convection and redistribution of mass,
- The ephemeris second of 1952 was chosen as the mean value over the 19th century.

Agenda Item 1.14



Agenda Item 1.14

Results of studies

- ✓ Digital systems are highly dependent on keeping very precise time synchronization and thus can be disrupted when a leap second is introduced. Internet timing, RNSS systems and financial transactions suffered serious disruptions during leap second insertions the last being in June 2012;

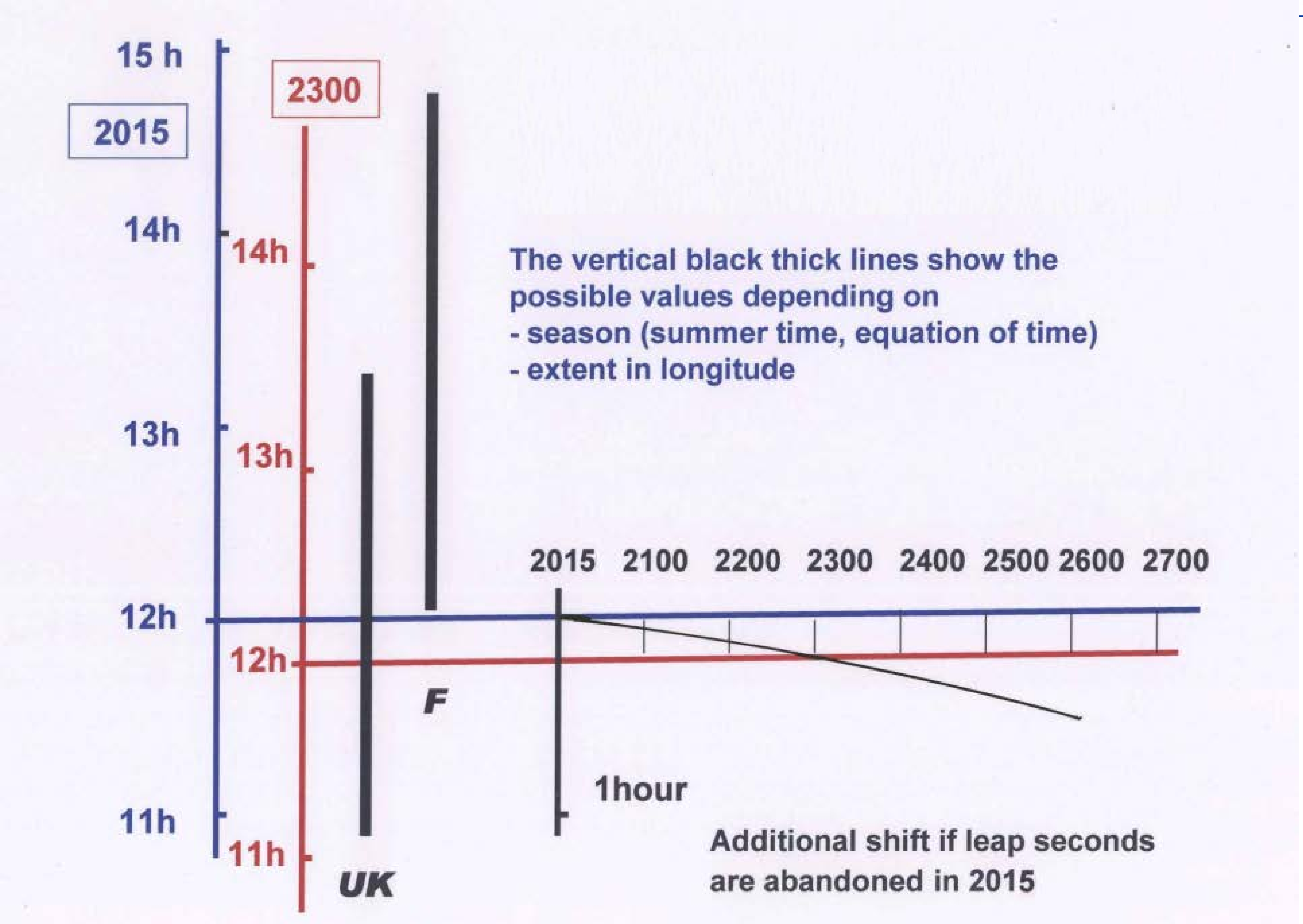
- ✓ Some systems requiring knowledge of the Earth's orientation which is closely related to mean solar time (UT1) will need to be updated;

- ✓ With leap seconds the UTC and UT1 difference is kept less than 0.9 s, without leap seconds UTC will gradually diverge from UT1, but the accuracy is known far better than 0.9 s;

- ✓ Today many systems use continuous GNSS system times to prevent discontinuities, however they are not time scales and can lead to serious consequences in case of time maintenance or failure;

- ✓ When a leap second is inserted, repeating the last second of the day can lead to time tagging confusion;

- ✓ In case of broadcasting the current UTC time scale and a new continuous time scale, operational considerations on differentiating the two time scales still need to be assessed.


15 h
2015
2300
14h
14h
13h
13h
12h
12h
11h
11h
UK
F
The vertical black thick lines show the
possible values depending on
- season (summer time, equation of time)
- extent in longitude
2015 2100 2200 2300 2400 2500 2600 2700
1hour
Additional shift if leap seconds
are abandoned in 2015

Agenda Item 1.14

How to satisfy the Agenda Item

Method A

Stop the insertion of leap seconds in UTC no less than five years after the date of entry into force of the Final Acts of the WRC-15.

This should allow for an adequate period of time for those legacy systems reliant on the use of leap seconds to adapt to the change in UTC.

Method B

Retain UTC as currently defined and introduce a continuous atomic time-scale based on TAI (Temps Atomique International) and broadcast these two reference time-scales (Current UTC and Continuous atomic time scale).

Agenda Item 9.1.8

on the activities of the Radiocommunication Sector since WRC-12;
9.1.8 Regulatory aspects for nanosatellites and picosatellites;

- ✓ Resolution 757 (WRC-12) called for studies by ITU-R "to examine the procedures for notifying space networks and consider possible modifications to enable the deployment and operation of nanosatellites and picosatellites, taking into account the short development time, short mission time and unique orbital characteristics";
- ✓ to report to WRC-15 on the results of these studies;
- ✓ to invite WRC-18 to consider whether modifications to the regulatory procedures for notifying satellite networks are needed to facilitate the deployment and operation of nanosatellites and picosatellites, and to take the appropriate actions.

Agenda Item 9.1.8

Results of studies

- ✓ the following specifications for small satellites are typical:
  - ✓ *Nanosatellite* : with a mass of 1 to 10 kg,
  - ✓ *Picosatellite* : with a mass between 0.1 and less than 1 kg;

- ✓ being used for a wide variety of missions and applications such as remote sensing, technology demonstration and education, as well as commercial applications;

- ✓ many projects can be developed quickly and deployed with lower cost than with traditional satellites;

- ✓ development, deployment and launch timelines for nanosatellite and picosatellite systems may be much shorter than for traditional satellite systems thus creating a challenge to enable timely filing of information required for international coordination;

- ✓ some nanosatellites and picosatellites currently use spectrum allocated to the amateur satellite service, EESS or MetSat service although their missions are potentially inconsistent with these services.

Agenda Item 9.1.8

Results of studies

✓ Two reports are being drafted :

- DN Report ITU-R SA.[NANO/PICOSAT CHARACTERISTICS] addresses the characteristics of nanosatellites and picosatellites and indicates both the differences and commonalities with traditional satellites,

- DN Report ITU-R SA.[NANO/PICOSAT CURRENT PRACTICE] addresses the current regulatory practice for nanosatellites and picosatellites, and identifies the difficulties encountered in applying the Radio Regulations.

Thanks for your attention