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Consideration on A.I. 1.5, 9.1/Issue 9.1.1 and 9.1.7

ITU-APT Foundation of India
3RD NATIONAL WORKSHOP ON WRC-19 PREPARATION

New Delhi, 15 December 2018

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Inmarsat use of spectrum

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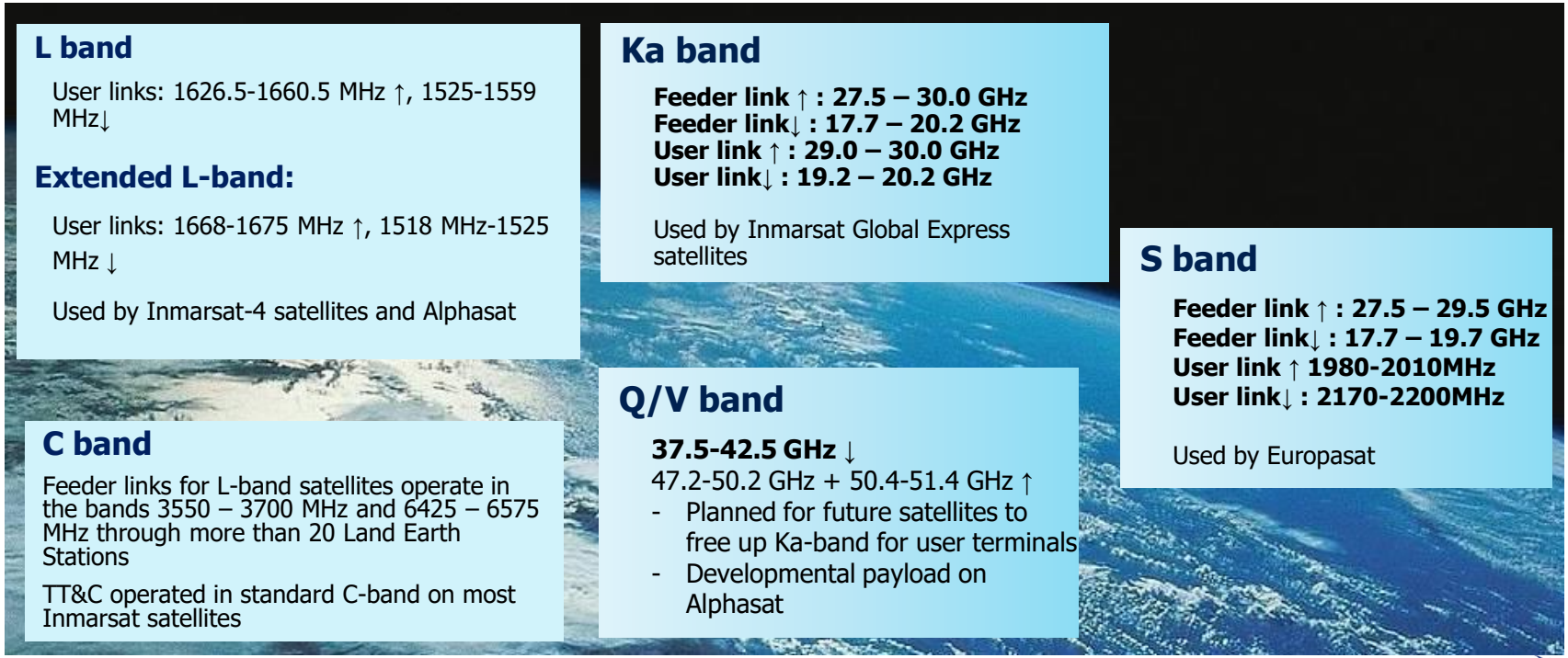

L band

User links: 1626.5-1660.5 MHz ↑, 1525-1559 MHz↓

Extended L-band:

User links: 1668-1675 MHz ↑, 1518 MHz-1525 MHz ↓

Used by Inmarsat-4 satellites and Alphasat

Ka band

Feeder link ↑ : 27.5 – 30.0 GHz
Feeder link↓ : 17.7 – 20.2 GHz
User link ↑ : 29.0 – 30.0 GHz
User link↓ : 19.2 – 20.2 GHz

Used by Inmarsat Global Express satellites

S band

Feeder link ↑ : 27.5 – 29.5 GHz
Feeder link↓ : 17.7 – 19.7 GHz
User link ↑ 1980-2010MHz
User link↓ : 2170-2200MHz

Used by Europasat

C band

Feeder links for L-band satellites operate in the bands 3550 – 3700 MHz and 6425 – 6575 MHz through more than 20 Land Earth Stations

TT&C operated in standard C-band on most Inmarsat satellites

Q/V band

37.5-42.5 GHz ↓
47.2-50.2 GHz + 50.4-51.4 GHz ↑

- Planned for future satellites to free up Ka-band for user terminals
- Developmental payload on Alphasat

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WRC-19 A.I. 1.5 - ESIM in 27.5-29.5GHz

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WRC-19 Agenda Item 1.5

to consider the use of the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) by earth stations in motion communicating with geostationary space stations in the fixed-satellite service and take appropriate action, in accordance with Resolution 158 (WRC-15)

- Resolution 158 (WRC-15) resolves to invite ITU-R:

  1. to study the technical and operational characteristics and user requirements of different types of earth stations in motion that operate or plan to operate within geostationary FSS allocations in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz, including the use of spectrum to provide the envisioned services to various types of earth station in motion and the degree to which flexible access to spectrum can facilitate sharing with services identified in recognizing further a) to n);

  2. to study sharing and compatibility between earth stations in motion operating with geostationary FSS networks and current and planned stations of existing services allocated in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz to ensure protection of, and not impose undue constraints on, services allocated in those frequency bands, and taking into account recognizing further a) to n)

  3. to develop, for different types of earth stations in motion and different portions of the frequency bands studied, technical conditions and regulatory provisions for their operation, taking into account the results of the studies above

- resolves to further invite the 2019 World Radiocommunication Conference

  to consider the results of the above studies and take necessary actions, as appropriate, provided that the results of the studies referred to in resolves to invite ITU-R are complete and agreed by ITU-R study groups

- **Current studies within ITU-R are heading toward a solution for Agenda item 1.5 similar to the one adopted by WRC-15 for the bands 29.7-20.2 / 29.5-30 GHz, with additional regulations to address sharing with terrestrial services**

Methods to satisfy Agenda Item 1.5

- **Method A**

No change

- **Method B**

addresses the different technical, regulatory and operational requirements that would need to be applied to ESIMs, as well as the limits required to protect other services operating in the bands

The draft CPM Report includes an example Resolution to address these matters

The main principles of the example Resolution

- ESIMs should operate within the envelope of the earth station characteristics in the FSS network filing. This will generally ensure that ESIMs do not cause more interference to other space services than other earth station types that are already able to operate in these bands;
- In the downlink band (17.7-19.7 GHz) ESIMs only receive and hence cannot cause interference to other services. ESIMs should therefore be allowed to operate on a non-protected basis in this band;
- Limits should apply to ensure that ESIMs operate compatibly with other services in the uplink band (27.5-29.5 GHz);
- In order to meet the above operational limitations, ESIM shall employ techniques to track the associated GSO FSS station and be subject to permanent network monitoring and control with the possibility to cease emissions as necessary; and
- Guidance is provided to administrations for the authorization of ESIM operations.

WP 4A agreements on the protection of terrestrial fixed and mobile service stations in the band 27.5-29.5 GHz

- Maritime ESIM (M-ESIM) should comply with a minimum distance from the low-water mark of a coastal state and an associated maximum e.i.r.p spectral density limit towards that coastal state. The same principle for the protection of terrestrial service stations is applied to operation of Earth Stations on Vessels (ESV) in the bands 5 925-6 425 GHz and 14.0-14.5 GHz. **Distances in the range 60 to 120 km have been proposed by different administrations**.
- Aeronautical ESIM (A-ESIM) should comply with PFD limits at the surface of the Earth, when in line-of-sight of a territory of an administration. The same principle for the protection of terrestrial service stations is applied to aircraft earth station operation in the band 14-14.5 GHz. **Different PFD masks have been proposed**. **An altitude limit has also been proposed**.
- Land ESIM (L-ESIM) should operate under the condition of no interference into terrestrial stations in neighbouring countries until coordination between concerned administrations is complete.
- The limits defined for a) and b) above can only be exceeded with prior agreement from the concerned administrations.

Protection of terrestrial services from M-ESIM

- The calculation of minimum protection distances should be based on the methodology used for Earth Stations on Vessels operating in the bands 5 925-6 425 MHz and 14-14.5 GHz as documented in Resolution 902 (WRC-03) and ITU-R Recommendation SF.1650
- The 120 km distance proposed by Korea and New Zealand is overly conservative due to the following assumptions used in the study:
  - The Resolution 902 (WRC-03) methodology is not considered and the study assumes that M-ESIMs are stationary in front of the MS antenna, which is in conflict with the mobile nature of ESIM operation;
  - A mobile service protection criteria of I/N=-6 dB is associated with the percentage of time of 1%. I/N=-6 dB is a long-term criterion and should be associated with at least 20% of time for such interference scenarios, which was the assumption in all the other studies provided to WP4A on M-ESIM;
  - An M-ESIM channel bandwidth of 100 MHz is used without any use of duty cycle, which translates into an unfeasible assumption of one satellite being able to serve only about 20 vessels in the band 27.5-29.5 GHz.
- The remaining studies, which all conclude on distances in the range 60-70 km, are based on the Resolution 902 (WRC-03) methodology and use appropriate assumptions on the FS and MS protection criteria and ESIM channel bandwidth

Protection of terrestrial services from A-ESIM (1)

- **Option 1 in Annex 2, Part 2 of the example Resolution was proposed by the CEPT and corresponds to the PFD mask that was adopted for ESIM operation in Europe in 2013 (see ECC Decision ECC/DEC(13)01).**
- Several studies have been submitted to WP4A showing that this PFD mask provides ample protection of terrestrial services. In particular, a CEPT study provided an analysis that takes into consideration the dynamic nature of interference and indicates that the PFD mask provided in Option 1 adequately protects both fixed and mobile services.
- A similar methodology was used to establish the PFD values in Recommendation ITU-R M.1643 for the operation of AES in the band 14-14.5 GHz.
- The PFD mask provided in Option 2 was proposed by the USA. The PFD mask is solely based on the characteristics of the victim receiver and applies a single protection criterion of I/N=-6 dB without any separate consideration for short term and long-term protection nor probability of interference, which makes the study very conservative.
- In addition, the mask is calculated based on the assumption that the MS base station is pointing towards the horizon. According to the characteristics provided by WP 5A, MS base station beam can be electronically steered in a range of -6 degrees to -60 degrees for 20m high BS and -3 degrees to -60 degrees for 10m high BS with respect to the horizontal plane. Hence, the beam cannot be pointed towards the horizon and the proposed PFD mask protects antenna pointing angles which do not conform to MS deployments described by WP5A.

Protection of terrestrial services from A-ESIM (3)

Similarly to Option 2 above, the PFD mask provided in Option 3, proposed by Korea and New Zealand, is solely based on the characteristics of the victim receiver and applies a single protection criterion of I/N=-6 dB without any separate consideration for short term and long-term protection nor probability of interference

I/N=-6 dB is a long-term criterion and should be associated with at least 20% of time. Since no time component is considered, the analysis results in an overly conservative PFD mask

Both A-ESIM and MS operation are dynamic in nature, which also results in a dynamic interference environment. Interference can only occur if the main beam of MS stations is pointed towards the aircraft and the mobile station is along the azimuth of A-ESIM antenna. This simultaneous occurrence of events is highly unlikely, especially considering that the mobile stations will be operated in dense urban areas where clutter can be assumed to occur.

The static analysis used to produce the PFD mask in Option 2 and Option 3 overestimates the level of interference produced by A-ESIM.

With regard to the proposal for an altitude limit on A-ESIM, also proposed by Korea and New Zealand, such a limit is not required since compliance with a PFD mask is sufficient to protect terrestrial services

Inmarsat proposal

- Based on the discussion above, Inmarsat requests India to support Method B of the draft CPM Report, with the following protection measures for terrestrial services:
- M-ESIM should operate at a minimum distance from the low-water mark of a coastal state in the range 60-70 km,
- A-ESIM should comply with the PFD mask presented in Option 1 of the example Resolution
- (unless otherwise agreed by the affected administration)

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WRC-19 A.I. 9.1.7 – Unauthorised Earth Station Terminals in the FSS

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WRC-19 Agenda Item 9.1 (Issue 9.1.7)

Issue 2) in the Annex to Resolution 958 (WRC-15)

2) Studies to examine:

*a) whether there is a need for possible additional measures in order to **limit uplink transmissions of terminals to those authorized terminals in accordance with No. 18.1**;*

*b) the **possible methods that will assist administrations in managing the unauthorized operation of earth station terminals** deployed within its territory, as a tool to guide their national spectrum management programme, in accordance with Resolution ITU-R 64 (RA-15).*

WRC-19 Agenda Item 9.1 (Issue 9.1.7)

Unauthorised uplink of earth station terminals in FSS bands

- At the June 2018 meeting, WP1B finalised the draft CPM text.

Two options to address Issue 2a in Annex to Resolution 958 **(WRC-15)**

- **Option 1: no change to the Radio Regulations as current measures are sufficient .**
  - ✓ Article 18 (No 18.1 in particular) of the RR already contains provisions that the earth stations could be operated only if duly authorized.
  - ✓ Unauthorized earth stations and related issues should be considered as national matters
- **Option 2: develop a new WRC Resolution to assist administrations with the application of RR No. 18.1.**
  - ✓ Significant responsibility assigned to the notifying administration without a clear indication/understanding of how such responsibilities can, in practice, be carried out.

  e.g. *Resolves 1) "that notifying administrations shall take appropriate actions to limit operation of earth station terminals to only those licensed or authorized by the administrations in which they are located"*
- **One single option to address Issue 2b in Annex to Resolution 958 (WRC-15)**:
  - ✓ Assistance to administrations in managing unauthorized operation of earth station terminals, can be accommodated with guidelines on satellite monitoring capabilities, ITU-R Reports and/or Handbooks as appropriate.

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WRC-19 A.I. 9.1/Issue 9.1.1

Implementation of IMT in the frequency bands 1 885-2 025 MHz and 2 110-2 200 MHz

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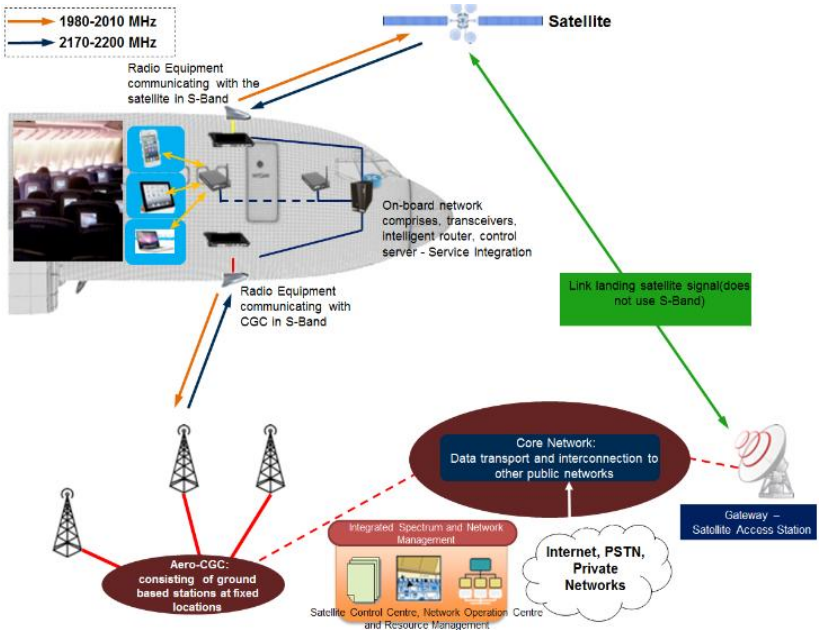
Agenda Item 9.1 Issue 9.1.1

- Resolution **212 (Rev.WRC-15)**. **Implementation of IMT in the frequency bands 1 885-2 025 MHz and 2 110-2 200 MHz.**
- The Resolution invites the ITU-R to study possible technical and operational measures to ensure coexistence and compatibility between terrestrial and satellite components of IMT, in particular in the frequency bands 1980 - 2010 MHz and 2170 - 2220 MHz.
- The band 1980-2010 MHz and 2170-2200 MHz are allocated to the MSS and the fixed and mobile services, and are identified for the satellite component of IMT and the terrestrial component of IMT
- Bands are prioritised for MSS in Europe - which may include a complementary ground component.

Current and planned uses

- Bands are used in Europe by two operators: (1) Inmarsat for the European Aviation Network, and (2) Echostar
- New non-GSO satellite systems proposed (Omnispace and Sky & Space Global)
- Licences for terrestrial IMT which cover some parts of the bands have been issued in USA and Canada – not used for terrestrial IMT in Europe
- Japan plans to introduce both satellite and terrestrial
- Many countries have little/zero use of the bands

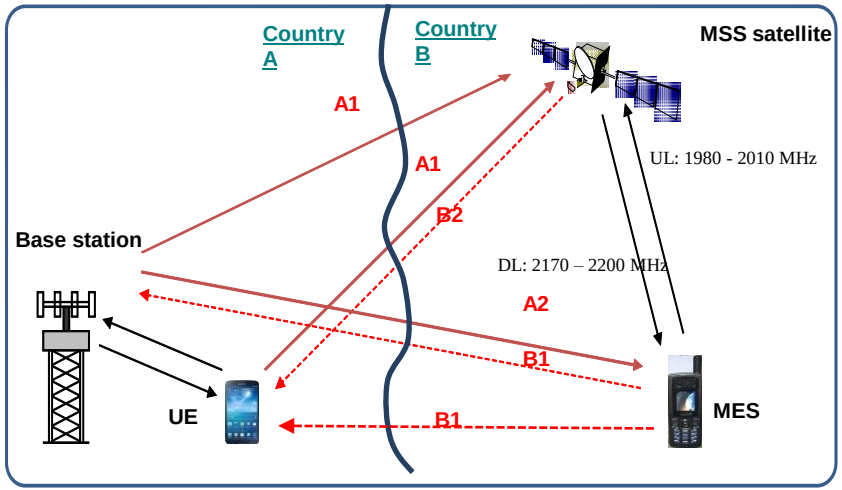


Inmarsat EAN (European Aviation Network)

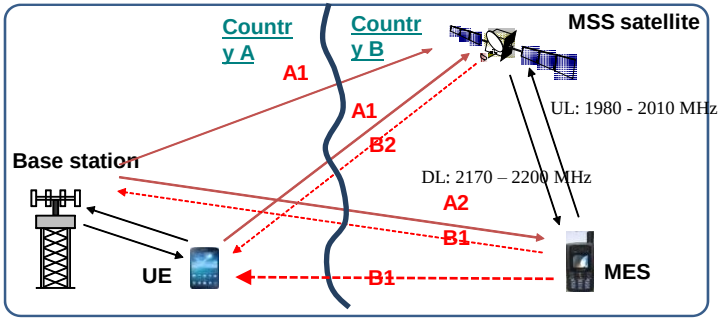
Interference scenario

- Considering the recommended frequency arrangements for the terrestrial component for IMT, as contained in Recommendation ITU-R M.1036, there are four interference scenarios to be considered as shown:

Scenario	From	To
A1	Terrestrial IMT base station or mobile station	Satellite IMT space station
A2	Terrestrial IMT base station	Satellite IMT MES
B1	Satellite IMT MES	Terrestrial IMT base station or UE
B2	Satellite IMT space station	Terrestrial IMT UE

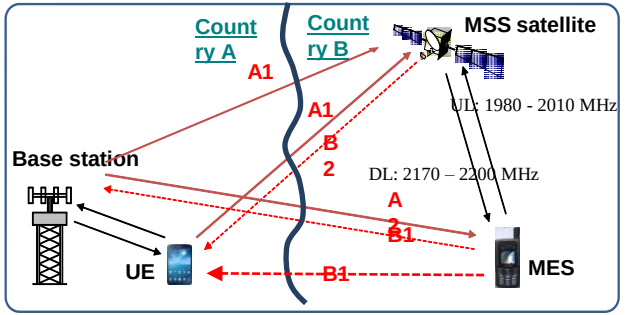


Sharing studies results



Scenario	Results	Conclusion
A1 - from terrestrial IMT to satellite	Interference for terrestrial base stations very high (approx. 50 dB above criterion). Interference from terrestrial UEs benign	Use of terrestrial IMT in downlink (BS transmit) direction can cause harmful interference. Ideally any terrestrial IMT use would be in uplink direction (UE transmit)
A2 – from terrestrial IMT to mobile earth station	Separation distance of 10s km required	Can be managed by current cross-border coordination procedures
B1 – From mobile earth station to terrestrial IMT	Separation distance of 10s km required	Can be managed by current cross-border coordination procedures
B2 – from satellite to terrestrial IMT	Some MSS systems meeting protection requirements, while some MSS systems exceed the protection requirements	Some MSS systems need to mitigate interference. PFD thresholds in Appendix 5 exist for the protection of all terrestrial services. However, higher PFD values would still provide adequate protection to terrestrial IMT and would be less constraining to MSS.

Inmarsat position



Scenario	Action at WRC-19	Note
A1 - from terrestrial IMT to satellite	Inmarsat supports restricting the band 1980-2010 MHz for terrestrial IMT uplinks only, for example by EIRP limit (i.e. only UE transmit).	This would provide protection to MSS uplinks and would allow countries that might wish to deploy terrestrial IMT in the bands 1980-2010 MHz and 2170-2200 MHz to do so in a standard FDD arrangement. An exception to the restriction could be made for countries in footnote 5.389B, where priority is given to terrestrial IMT and some countries have already deployed terrestrial IMT.
A2 – from terrestrial IMT to mobile earth station	No action necessary	Current cross-border coordination process may be used to avoid interference
B1 – From mobile earth station to terrestrial IMT	No action necessary	Current cross-border coordination process may be used to avoid interference
B2 – from satellite to terrestrial IMT	Ensure that the current pfd threshold values apply. Add the additional pfd threshold value of -105.8 dB(W/m^2) applicable to terrestrial IMT systems.	Addition of the additional pfd limit of -105.8 dB(W/m^2) may assist in coordination.

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Thank You!

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