



Reaching Further, Bringing You Closer

# Implementation of WRC-15 Decisions Agenda Item 1.6 & Agenda Item 9.1, Issue 9.1.2

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## Opportunities and challenges (WRC-15 A.I. 1.6)

Implementation of WRC-15 Decisions – Agenda Item 1.6:

- Agenda Item 1.6.1 - Additional unplanned uplink and downlink FSS spectrum in Region 1 to address the spectrum shortage
- Agenda Item 1.6.2 - Additional unplanned uplink FSS spectrum in Regions 2 & 3 to address the spectrum imbalance

# WRC-15 Agenda Item 1.6 - Background

Existing unplanned FSS bands in the 10-15 GHz range are used extensively for a myriad of applications



- VSAT services, video distribution, broadband networks, internet services, satellite news gathering, and backhaul links.

Growth in demand for these application → Rapid rise in the demand for spectrum

Satellite traffic is typically symmetrical

- i.e. similar amounts of uplink and downlink traffic are transmitted

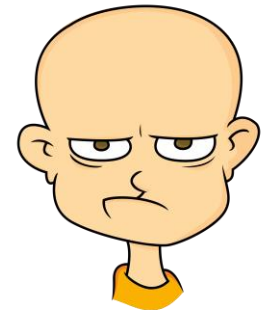
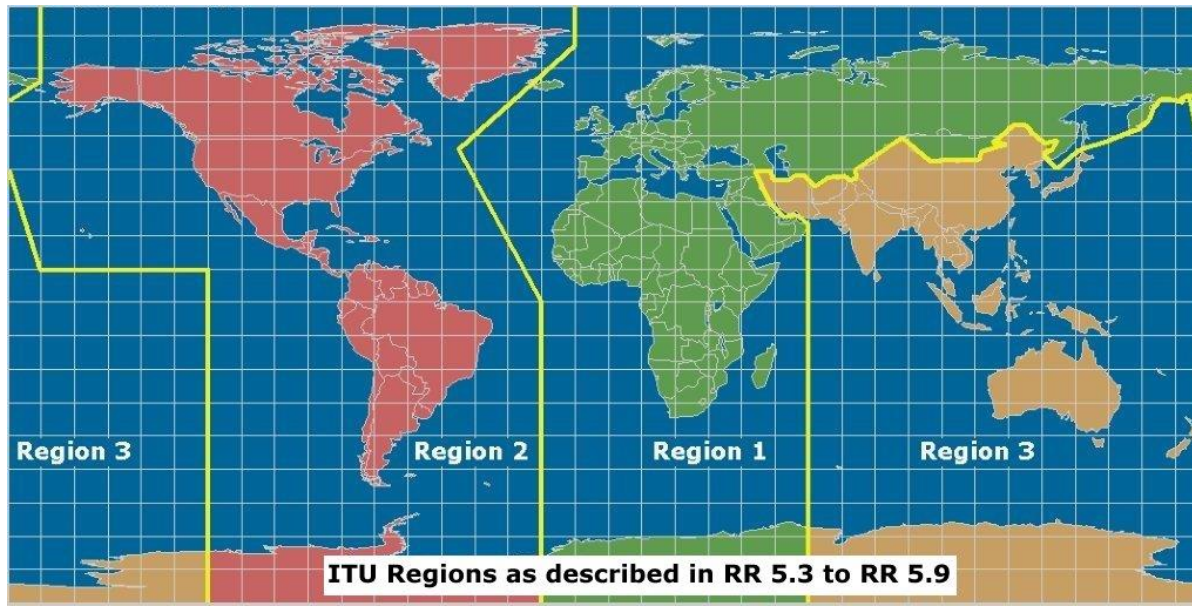
Regions 2 and 3: Lack of uplink spectrum in unplanned Ku-band

- Hinder the downlink spectrum resources from being used efficiently and economically



Region 1: Less spectrum available in unplanned Ku-band as compared to that of Regions 2 and 3

- Lack of spectrum makes it unable to meet the rapid growth of FSS demand in the Ku-band.



# WRC-15 Agenda Item 1.6 - Background

## The unplanned FSS bands in 10-15 GHz range (prior to WRC-15)

Frequency bands	Bandwidth	ITU-R Region 1	ITU-R Region 2	ITU-R Region 3
12.7-12.75 GHz	50 MHz		Yes*(50)	
13.75-14.5 GHz	750 MHz	Yes (750)	Yes (750)	Yes (750)
<b>Total spectrum in the uplink</b> ↑		<b>750 MHz</b>	<b>800 MHz</b>	<b>750 MHz</b>
10.95-11.2 GHz	250 MHz	Yes (250)	Yes (250)	Yes (250)
11.45-11.7 GHz	250 MHz	Yes (250)	Yes (250)	Yes (250)
11.7-12.2 GHz	500 MHz		Yes (500)	
12.2-12.5 GHz	300MHz			Yes (300)
12.5-12.75 GHz	250 MHz	Yes (250)		Yes (250)
<b>Total spectrum in the downlink</b> ↓		<b>750 MHz</b>	<b>1000 MHz</b>	<b>1050 MHz</b>

\* the 12.7-12.75GHz (50MHz) uplink spectrum for Region 2 is hardly usable as it is not contiguous with the 13.75-14.5GHz, this is why WRC-15 A.I. 1.6.2 seek for 250MHz of uplink spectrum for Region 2 even the spectrum imbalance is only 200MHz in that Region.

**Problem for Region 1: Shortage of at least 250MHz of unplanned spectrum comparatively (A.I. 1.6.1)**

**Problem for Region 2: Spectrum Imbalance, lack of 250MHz uplink spectrum in Region 2 (A.I. 1.6.2)**

**Problem for Region 3: Spectrum Imbalance, lack of 300MHz uplink spectrum in Region 3 (A.I. 1.6.2)**



# Additional unplanned uplink and downlink FSS spectrum in Region 1 to address the spectrum shortage (A.I. 1.6.1)

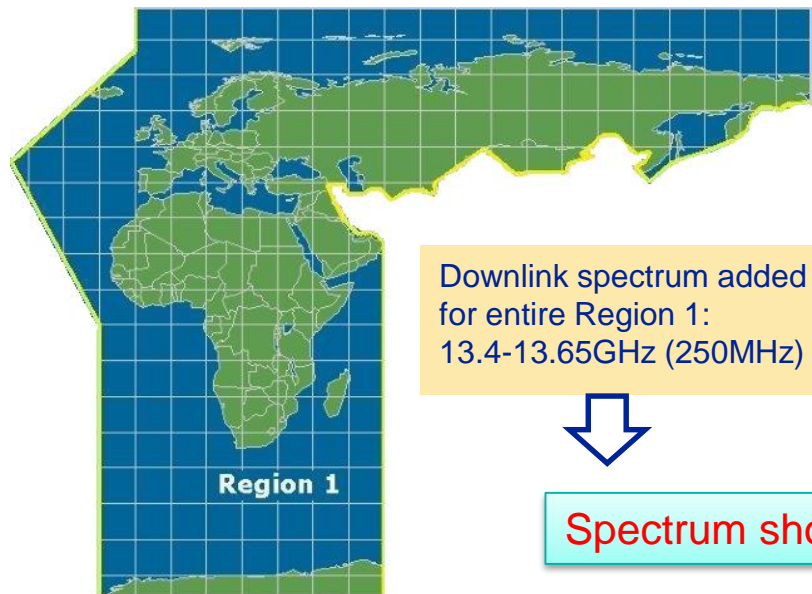
## Summary of outcome for WRC-15 Agenda Item 1.6.1

Additional allocation for FSS (space-to-Earth) in Region 1 in the band 13.4-13.65GHz (250MHz).

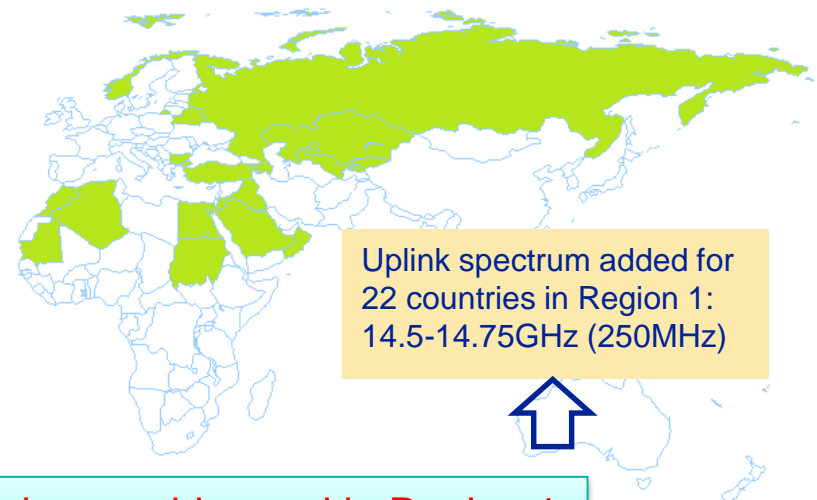
Opening up 14.5-14.75GHz (250MHz) for unplanned FSS (Earth-to-space) in 22 countries in Region 1 including:

- Algeria, Saudi Arabia, Armenia, Azerbaijan, Bahrain, Belarus, Bulgaria, Egypt, the Russian Federation, Iraq, Jordan, Kazakhstan, Kuwait, Mauritania, Morocco, Norway, Oman, Uzbekistan, Qatar, Kyrgyzstan, Sudan and Turkey

Date of entry into force: 1-Jan-2017



Downlink spectrum added for entire Region 1:  
13.4-13.65GHz (250MHz)



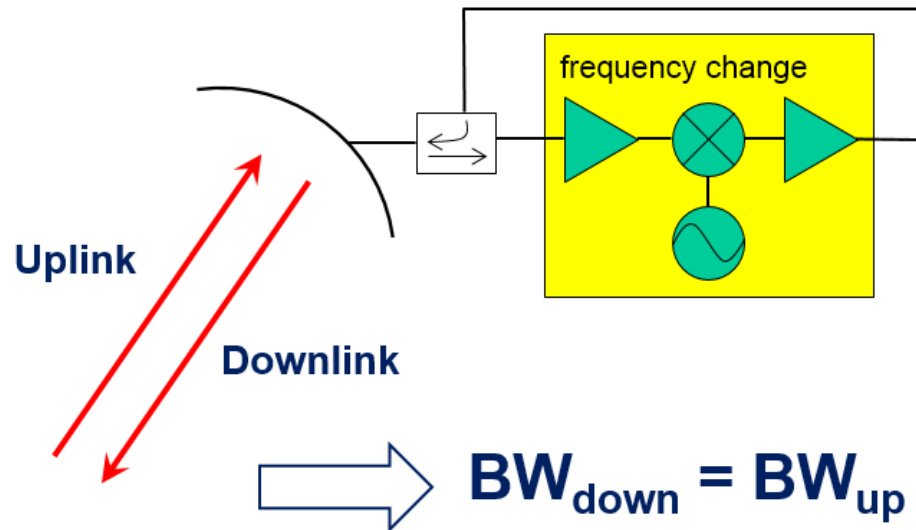
Uplink spectrum added for 22 countries in Region 1:  
14.5-14.75GHz (250MHz)



Spectrum shortage issue addressed in Region 1

# Balancing up- and downlink spectrum (A.I. 1.6.2)

Commercial communication satellites normally use "bent-pipe" technology:



- Amount of spectrum for up- and downlink should match
- Due to satellite antenna design, waveguide and OMTs etc., it is normally most efficient to have up- and downlink in frequency bands in the vicinity of each other



# Additional unplanned uplink FSS spectrum in Regions 2 & 3 to address the spectrum imbalance (A.I. 1.6.2)

## Summary of outcome for WRC-15 Agenda Item 1.6.2

Opening up 14.5-14.8GHz for unplanned FSS (Earth-to-space) in 9 countries in Region 3 including:

- Australia, Cambodia, China, Japan, Lao P.D.R., Pakistan, Papua New Guinea, Thailand and Viet Nam

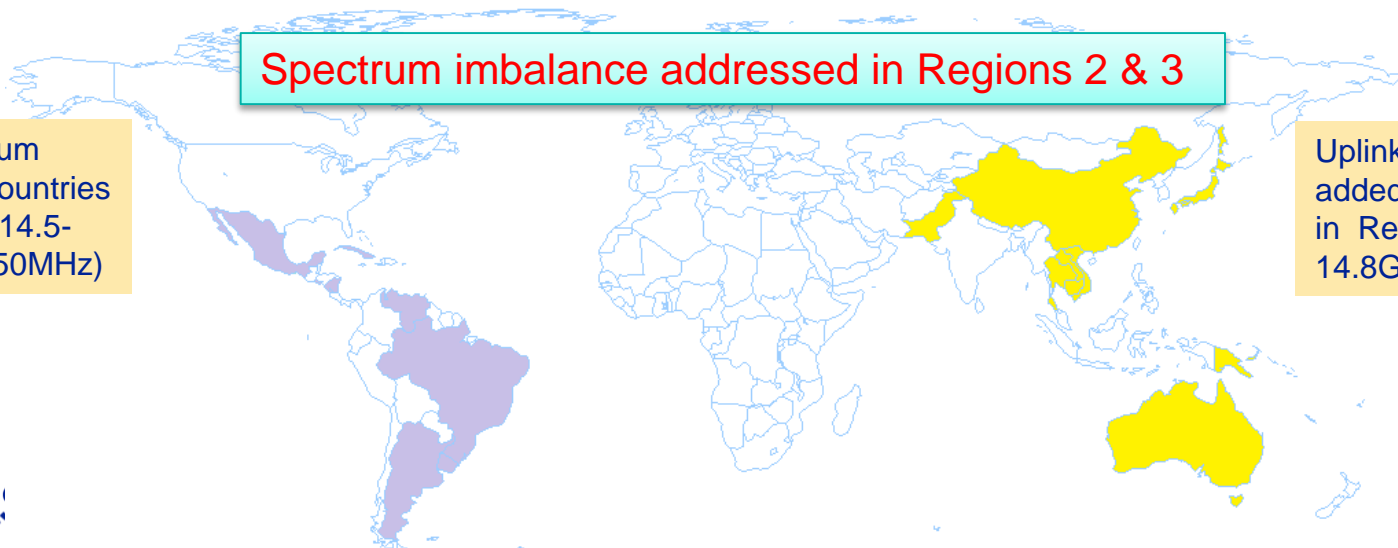
Opening up 14.5-14.75GHz for unplanned FSS (Earth-to-space) in 8 countries in Region 2 including:

- Argentina, Brazil, Cuba, El Salvador, Mexico, Nicaragua, Uruguay and Venezuela

Date of entry into force: 1-Jan-2017

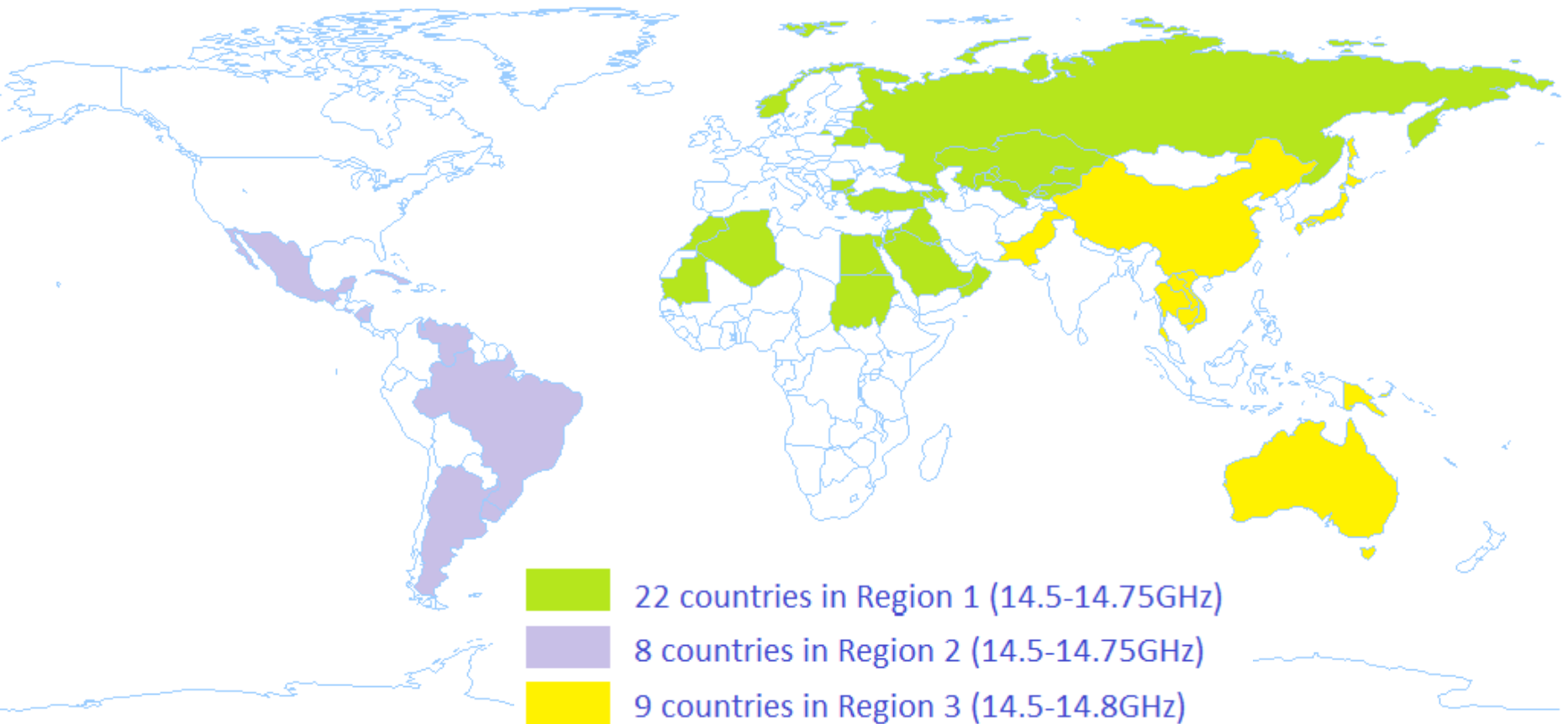


Uplink spectrum added for 8 countries in Region 2: 14.5-14.75GHz (250MHz)



Uplink spectrum added for 9 countries in Region 3: 14.5-14.8GHz (300MHz)

# 39 countries where unplanned uplink FSS earth stations can be deployed in the 14.5-14.75/14.8 GHz band





# Opportunities

**NEW!**

The additional 250MHz of uplink and 250MHz of downlink spectrum in Region 1 help addressing the spectrum shortage problem

The additional 250MHz of uplink spectrum in Region 2 and 300MHz of uplink spectrum in Region 3 help addressing the spectrum imbalance issue in Ku-band for Regions 2 and 3 and allow spectrum resources to be use more efficiently

## Very important to the satellite industry

- ✓ Cope with the rapid rise of demand for capacity
- ✓ Relieve the very congested situation in unplanned Ku-band
- ✓ Address the spectrum imbalance such that the limited spectrum resources can be used efficiently and economically.
- ✓ Opportunity to new comer to access the new Ku-band spectrum



# Challenges

The opening up of 14.5-14.75/14.8GHz (E-s) in 39 countries is subject to a number of stringent conditions e.g.

- Minimum antenna diameter of 6 m
- The earth stations shall be notified at known locations on land
- **a separation distance of at least 500 km** from the border(s) of other countries **unless shorter distances are explicitly agreed by those administrations**



In particular, the condition of **a separation distance of at least 500 km** from the border(s) of other countries unless shorter distances are explicitly agreed by those administrations pose significant constraint on the earth stations deployment



WP4A is developing guidelines to conduct bilateral coordination to obtain explicit agreements of those administrations engaging in such agreements with the aim to enable protection of all existing and planned services in the territories of those administrations





## Improvements to regulatory framework (WRC-15 Issue 9.1.2)

WRC-15 Agenda Item 9.1, Issue 9.1.2

- Reduce “Unnecessary” Coordination

# Today's situation

## Congestion in the arc

- "Paper satellites"
- "Virtual satellites"
- Real operational satellites (every  $2^{\circ}$ - $3^{\circ}$  around the GSO arc)



## Congestion in particular serious in unplanned C- and Ku-band

- Well established and mature technology and applications
- Relatively homogeneous technical parameters have evolved (due to the maturity of the technology and applications and out of necessity due to the congestion)

## Interference completely dominate by first co-frequency, co-coverage adjacent network on either side

- Little impact from farther away networks

## The need to be able to live with first adjacent networks on either side will

- limit operation and capability to cause/receive interference to/from others
- facilitate compatibility with farther away networks

# Coordination requirements

## Extreme coordination requirements

- E.g. ASIAsAT-105.3T
- 1802 networks identified
- 49 administrations
- Orbital separation to identified networks up to 157.8°



## Coordination to be completed within 7 year

- Force administrations to notify without completing coordination (RR 11.41)



**Need to Avoid Unnecessary Coordination!**



# Attempt in addressing the issue



## WRC-12 (Agenda Item 7, Issue 2A)

- Decided to reduce the coordination arc for C- and Ku-band by 2°
- Decided to further study this issue under WRC-15 Agenda Item 9.1, Issue 9.1.2 (Resolution 756 (WRC-12) – looking at ways to facilitate spectrum orbit resource access for new networks)

## WRC-15 (Agenda Item 9.1, Issue 9.1.2)

- *resolves 1* of Resolution 756 (WRC-12)  
to consider alternative types of criteria used in the coordination and notification process
- *resolves 2* of Resolution 756 (WRC-12)  
to consider further reduction of the size of the coordination arc for C-, Ku- and Ka-band

## Two separate and independent issues under Issue 9.1.2 (WRC-15)

- Issue 1: Size of coordination arc (unplanned C, Ku, Ka)
- Issue 2: Type of coordination triggers and protection criteria used



# Issue 1 (part 1): Size of coordination arc – C/Ku-band

## Coordination arc prior to WRC-15

- 8° - unplanned C-band
- 7° - unplanned Ku-band



## Reality

- C- and Ku-band satellites every 2° - 3° apart
- First adjacent satellite networks (co-frequency, co-coverage) on either side will dominate adjacent satellite interference
- Farther away networks will have little impact

Arc (before  
WRC-15)

7/8 °

Reality

2-3 °



Room for further reduction of the arc!



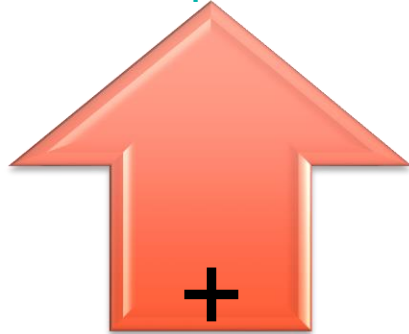
WRC-15 decision: New coordination arc adopted! (effective: 1-Jan-2017)

- 7° - unplanned C-band
- 6° - unplanned Ku-band

# Issue 1 (part 2): Size of coordination arc – Ka-band

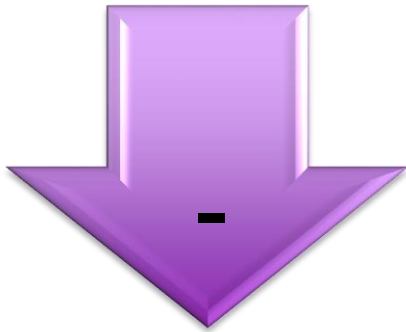
## What about Ka-band?

- Proposals in WRC-15 to reduce size of Ka-band coordination arc  $8^\circ \rightarrow 6^\circ$



Would reduce of coordination requirements identified under RR No. 9.7

Due to higher frequency, a smaller coordination arc might appear logical



Criteria independent on filed parameters requires somewhat homogeneous satellite implementations

Although there are many Ka-band filings, there are

- fewer satellites with significant commercial Ka-band payloads and
- applications and technical parameters would seem to diverge more than at C- and Ku-band

Has Ka-band reached the required level of maturity and homogeneity to justify further reduction in the size of the coordination arc?

**WRC-15 decision: No reduction of coordination arc in Ka-band**



# Potential issues with coordination arc reduction

Would reduce amount of unnecessary coordination identified under RR No. 9.7



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graph TD; A[Would reduce amount of unnecessary coordination identified under RR No. 9.7] --> B[Could lead to a corresponding increase of identification of coordination requirements under RR No. 9.41]; B --> C[With no changes to the types of criteria used under RR Nos. 9.41 and/or 11.32A, much of the gain from the reduction of the coordination arc could be lost!]
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Could lead to a corresponding increase of identification of coordination requirements under RR No. 9.41

With no changes to the types of criteria used under RR Nos. 9.41 and/or 11.32A, much of the gain from the reduction of the coordination arc could be lost!

## Issue 2: Type of coordination triggers and protection criteria used – why need to address that?

### WRC-2000 introduced coordination arc concept

- Aiming at reducing unnecessary coordination

### WRC-12 reduced the size of the arc by 2° for unplanned C/Ku-band

- Again aiming at further reducing the unnecessary coordination



However....

### Inclusion under RR 9.41 increased after WRC-12 reduce coordination arc

- 1854 networks requested included between 01.01.2013 and February 2014
- 33 networks requested included on average per coordination request
- 20 on average before 01.01.2013

### Root cause: Unrealistic filing parameters

- Criteria under RR 9.41 ( $\Delta T/T$ ) and RR 11.32A (C/I) are still based upon filed parameters
- Filings can be designed with parameters that are artificially sensitive to interference, triggering coordination and unduly blocking access for other networks
- The Bureau has confirmed that there are several filings with artificial parameters already in the Master Register

**Solution: Need to seek criteria that are independent of individually filed parameters, but at the same time could give adequate protection to operational networks**



# Consideration on ensuring adequate protection

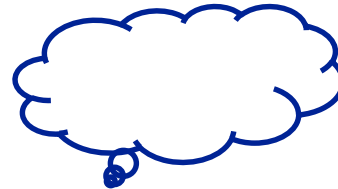
Requires operational networks to have fairly stable technology and relatively homogeneous parameters

- C and Ku-band? (Mature, highly congested band)
- Ka-band not mature yet?



Possible protection criteria independent of parameters contained in individual filings

- **Coordination arc**  
like under RR No. 9.7
- **Pfd masks/thresholds**  
has already been implemented in Appendix 30 and 30A (WRC-2000) and for BSS in 21.4-22 GHz band (WRC-12)
- **Epdf limits**  
to protect GSO satellite networks from NGSO networks (Article 22)



**Goal**

Reduce unnecessary coordination - criteria adequately protect satellite networks with technical parameters within a reasonable range

- No additional protection for networks with parameters outside this range
- Avoid overprotection stemming from unrealistic parameters contained in filings

# Types of coordination triggers/protection criteria in commonly used unplanned frequency bands

Provision	Stage	Criterion
RR 9.7	Identification of coordination requirements	Coordination arc  Independent of filed parameters
RR 9.41	Inclusion in coordination of networks outside the coordination arc	$\Delta T/T = 6\%$  Calculated from filed parameters
RR 11.32A (prior to WRC-15)	Determination of probability of harmful interference (in case of outstanding coordination requirements)	$C/I = C/N + 12.2$ ( $\Delta T/T = 6\%$ )  C/N calculated from filed parameters

# Representative parameters for determining the PFD Threshold/Mask

Equivalent $\Delta T/T$	6%	6%
<b>Uplink</b>	Adopted (WRC-15)	Adopted (WRC-15)
Frequency	6GHz	14GHz
Maximum Satellite G/T	0dB/K	11dB/K
<b>Downlink</b>	Not adopted	Adopted (WRC-15)
Frequency	4GHz	10/11/12GHz
Range of antenna diameters	1.2 – 18m	0.45 – 11m
Noise temperature	95K	125K
Antenna efficiency	70%	70%
Maximum Satellite G/T	0dB/K	11dB/K

\* Main lobe: According to Appendix 8, Section III; Sidelobes:  $29-25\log\theta$  dBi  
 (Recommendation ITU-R BO.1213, which implements these main and sidelobe characteristics, was used in deriving the pfd threshold)

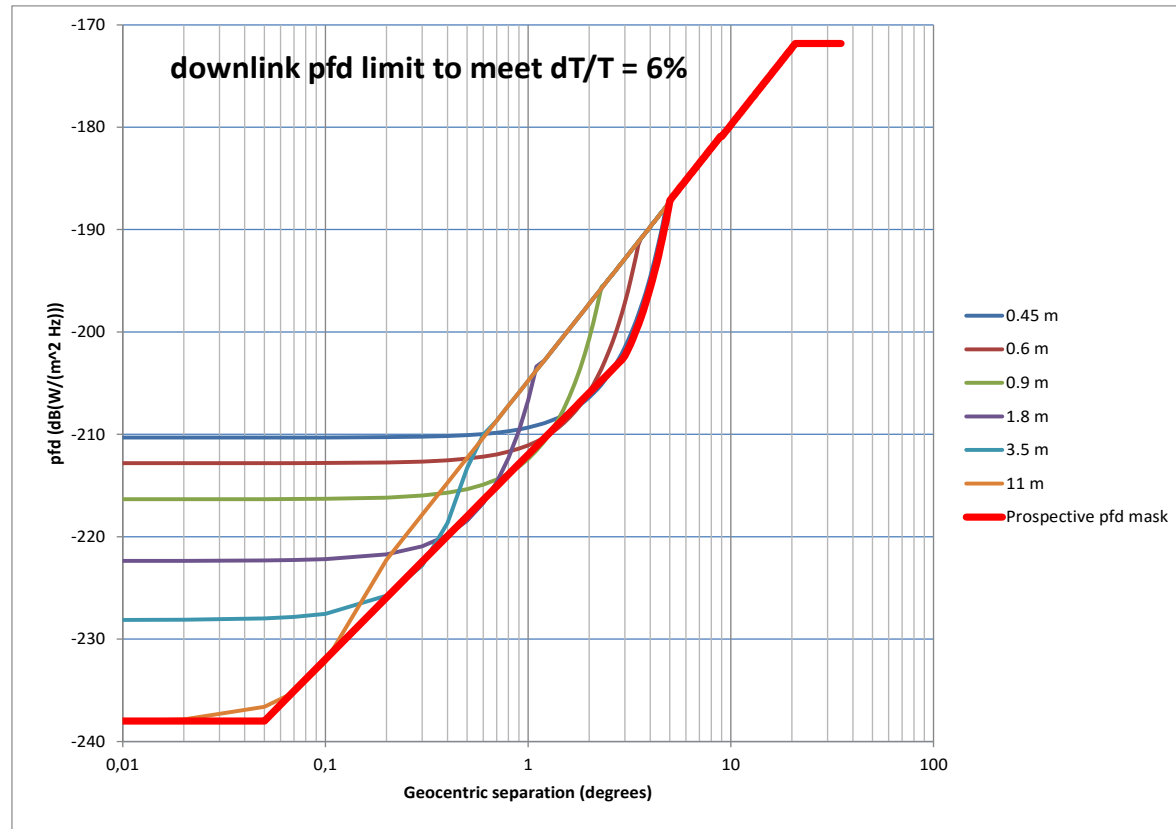
# Pfd criteria adopted in WRC-15

Calculated based upon interference levels equivalent to  $\Delta T/T = 6\%$  and a set of representative parameters

Uplink pfd thresholds: (Both C- and Ku-bands were adopted in WRC-15)

- C-band:  $-204 \text{ dB(W/(m}^2 \cdot \text{Hz))}$
- Ku-band:  $-208 \text{ dB(W/(m}^2 \cdot \text{Hz))}$

Downlink pfd mask: (Only Ku-band was adopted by WRC-15)



# Advantages of pfd criteria and its implementation

## Advantages

- Define protection in a way that is independent of filed parameters
- Artificially sensitive parameters will not be able to unduly block coordination of other networks
- No need to define allowable range for parameters in filing



## Implementation

Could be introduced at different stages prior entering into MIFR, WRC-15 decided to introduce the pfd criteria in RR No. 11.32A and the detail of the criteria is defined in Resolution 762 (WRC-15)

- RR No. 9.7
- RR No. 9.41
- **RR No. 11.32A**



WRC-15 decided to apply the pfd criteria to networks outside the coordination arc only (i.e. for  $>7^\circ$  in C-band and  $>6^\circ$  in Ku-band)

- Concerns were raised in WRC-15: some special networks may require special protection inside the arc where the pfd criteria may not be able to protect them

# Summary of outcome for Issue 9.1.2 (WRC-15)

## Issue 1: Size of coordination arc

### Reduction of coordination arc for C-band and Ku-band by 1 degree

- ❖ Unplanned C-band: Coordination arc reduced from 8° to **7°**
- ❖ Unplanned Ku-band: Coordination arc reduced from 7° to **6°**

## Issue 2: Type of coordination triggers and protection criteria

### PFD criteria adopted - No. 11.32A and Resolution 762 (WRC-15)

- ❖ Based upon interference levels equivalent to  $\Delta T/T = 6\%$
- ❖ For networks outside the coordination arc only  
(i.e. for  $>7^\circ$  in C-band and  $>6^\circ$  in Ku-band)
- **Uplink pfd thresholds:**
  - ❖ C-band for networks with orbital separation more than 7 degree
  - ❖ Ku-band for networks with orbital separation more than 6 degree
- **Downlink pfd mask:**
  - ❖ Ku-band for networks with orbital separation more than 6 degree
  - ❖ No consensus on C-band in WRC-15 and therefore the downlink pfd mask is not applicable for C-band

**Regulatory framework improved!  
Help reducing unnecessary coordination!**



# ASIASAT

## Thank you!

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Reaching Further, Bringing You Closer

ITU Workshop on the Efficient Use of the Spectrum/Orbit Resource, Bali, Indonesia, 6<sup>th</sup> September 2016