Radiocommunication Study Groups

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FURTHE UPDATE TO WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R M.[CONDITIONS 1.1]

At the WP 5D - WG Spectrum meeting in Geneva, 19 - 22 April 2022, comments were received on Section 8.2.1 of the working document and this contribution is proposing further updates to Section 8.2.1 in

ATTACHMENT 1

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R M.[CONDITIONS 1.1]

WORKING DOCUMENT RELATED TO WRC-23 AGENDA ITEM 1.1

Technical and regulatory conditions for the protection of stations of the Aeronautical Mobile Service (AMS) and Maritime Mobile Service (MMS) located in international airspace or waters (i.e. outside national territories) and operating in the frequency band 4 800-4 990 MHz

Editors' note: below revisions from input contributions from Russian Federation (Doc 5D/1093), USA (Doc 5D/1096), China (Doc 5D/1107), France (Docs 5D/1112, 5D/1137) and ITU-APT Foundation of India (Doc 5D/1122) to Annex 4.8 to the WP5D Chairman's Report are shown in track changes as follows:
Russian Federation (Introduction, Sections 9.2.4, 9.3, 10)
USA (Sections 9.2.3 and 10 only, but also editorials to section 9.2.4)
China (Sections 8, 9.2.4, 10)
France (Section 8, 9.2.4, 9.3, 10)
ITU-APT Foundation of India (Sections 2, 6 and 8.2 only)

NOTE: The content of this document is very lengthy. On the other hand there is high priority to finalize the CPM text before the deadline of 21 October 2022. On the other hand this document contains elements which is useful for inclusion in the CPM draft report. Consequently, utmost effort to be made to concentrate and focus on the areas which would serve as elements/candidates for consideration and eventual inclusion in the CPM text. After the CPM deadline, efforts would be made to complete this report as soon as possible for timely submission to SG 5.

[Editor's note: This document is work in progress and is subject to further scrutiny and improvement by the co-responsible groups, namely WP 5D and WP 5B. Input/comments are being sought from WP 5B, which is the responsible group for AMS and MMS, on the conditions of protection for AMS and MMS stations and the development of the analysis.]

1 Introduction

WRC-19 approved WRC-23 agenda item 1.1 calling upon WRC-23 "to consider, based on the results of ITU-R studies, possible measures to address, in the frequency band 4 800-4 990 MHz, protection of stations of the aeronautical and maritime mobile services located in international airspace and

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waters from other stations located within national territories, and to review the power flux-density criteria in RR No. **5.441B** in accordance with Resolution **223 (Rev.WRC-19)**".

Resolution **223 (Rev.WRC-19)**:

– *invites the ITU Radiocommunication Sector* to study the technical and regulatory conditions for the protection of stations of the AMS and the maritime mobile service (MMS) located in international airspace or waters (i.e. outside national territories) and operated in the frequency band 4 800-4 990 MHz;

– *invites the 2023 World Radiocommunication Conference* to consider, based on the results of the studies referred to in *invites the ITU Radiocommunication Sector* above, possible measures to address, in the frequency band 4 800-4 990 MHz, protection of stations of the AMS and MMS located in international airspace and waters from other stations located within national territories and to review the pfd criteria in RR No. **5.441B**.

This Report focuses on studies of technical and regulatory conditions for the protection of AMS and MMS stations located in international airspace or in international waters (i.e. outside national territories) and operating in the frequency band 4 800-4 990 MHz.

The term *operation of vessels and aircrafts in international waters and international airspace*, respectively, referred to in WRC-23 agenda item 1.1, is understood to mean that such operation would take place in an area which is outside the territory under jurisdiction of any administration.

[Although the Radio Regulations, complementing the Constitution an Convention of the ITU, is an international treaty defining the regulatory framework for using radio spectrum, the subject of agenda item 1.1 of WRC-23 may have implications for other international treaties in the area of countries' activities in international airspace and waters.

It should be noted that in accordance with United Nations Convention on the Law of the Sea Coastal States have jurisdictions and sovereign rights in their so called "exclusive economic zones", i.e., within 200 nautical miles from the border of the territorial sea, for the various activities related to the economic exploitation and exploration of these zones. These activities may include establishing artificial islands, building installations and structures, establishing safety zones with a special regulatory regime and others. In exercising their rights and performing their duties under this Convention in the exclusive economic zone, States shall have due regard to the rights and duties of the coastal State and shall comply with the laws and regulations adopted by the coastal State.]

Editor's note: the text in square brackets presents a new approach to the definition of International waters and airspace. Both the proposed approach and the text were not exhaustively discussed at the Interim Meeting. The text was therefore placed in square brackets pending further consideration.

2 Relevant ITU-R Recommendations and Reports

Recommendation ITU-R **Error! Hyperlink reference not valid.**	*Technical characteristics and protection criteria for the aeronautical mobile service systems operating within the 4 400-4 990 MHz frequency range*
Report ITU-R **Error! Hyperlink reference not valid.**	*Operational characteristics of aeronautical mobile telemetry*
Report ITU-R **Error! Hyperlink reference not valid.**	*Sharing between aeronautical mobile telemetry systems for flight testing and other systems operating in the 4 400-4 940 and 5 925-6 700 MHz bands*

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Error! Hyperlink reference not valid.	*A propagation prediction method for aeronautical mobile and radionavigation services using the VHF, UHF and SHF bands*
Recommendation ITU-R **Error! Hyperlink reference not valid.**	*Propagation prediction techniques and data required for the design of trans-horizon radio-relay systems*

[TBD]

3 General description of systems of the aeronautical mobile service operated in international airspace in the frequency band 4 800-4 990 MHz

TBD

4 General description of systems of the maritime mobile service operated in international waters in the frequency band 4 800-4 990 MHz

TBD

5 System characteristics and protection criteria

Editor's note: Information under sub-sections 5.1 and 5.2 may need to be revised following further input from WP 5B

5.1 System characteristics and protection criteria of aeronautical mobile service systems in international airspace in the frequency band 4 800-4 990 MHz

5.1.1 Technical characteristics of aeronautical mobile systems

Technical characteristics for aeronautical mobile stations can be found in Table 1.

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TABLE 1

Typical technical characteristics of representative systems operating in the aeronautical mobile service in the frequency range 4 400-4 990 MHz

<table>
<tr><th>Parameter</th><th>Units</th><th>System 1
Airborne</th><th colspan="3">System 1
Ground</th><th>System 2
Airborne</th><th colspan="3">System 2
Ground</th></tr>
<tr><td colspan="10">Transmitter</td></tr>
<tr><td>Tuning range</td><td>MHz</td><td>4 400-4 990(1)</td><td colspan="3">4 400-4 990(1)</td><td>4 400-4 990(1)</td><td colspan="3">4 400-4 990(1)</td></tr>
<tr><td>Power output</td><td>dBm</td><td>45</td><td colspan="3">45</td><td>35-39</td><td colspan="3">30-39</td></tr>
<tr><td>Bandwidth (3 dB)</td><td>MHz</td><td>1</td><td colspan="3">1</td><td>6 / 10 / 20</td><td colspan="3">6 / 10 / 20</td></tr>
<tr><td colspan="10">Receiver</td></tr>
<tr><td>Tuning range</td><td>MHz</td><td>4 400-4 990(1)</td><td colspan="3">4 400-4 990(1)</td><td>4 400-4 990(1)</td><td colspan="3">4 400-4 990(1)</td></tr>
<tr><td>Selectivity (3 dB)</td><td>MHz</td><td>1</td><td colspan="3">1</td><td>6 / 10 / 20</td><td colspan="3">6 / 10 / 20</td></tr>
<tr><td>Noise figure</td><td>dB</td><td>3.5</td><td colspan="3">3</td><td>3.5</td><td colspan="3">3</td></tr>
<tr><td>Thermal noise level</td><td>dBm</td><td>−110.5</td><td colspan="3">−111</td><td>−102.5 to −97.5</td><td colspan="3">−103 to −98</td></tr>
<tr><td colspan="10">Antenna</td></tr>
<tr><td>Antenna type</td><td></td><td>Omnidirectional</td><td>Omni-directional</td><td colspan="2">Directional</td><td>Omnidirectional</td><td>Omni-directional</td><td colspan="2">Directional</td></tr>
<tr><td>Antenna gain</td><td>dBi</td><td>3</td><td>3</td><td>19</td><td>31</td><td>3</td><td>6</td><td>19</td><td>31</td></tr>
<tr><td>1st sidelobe</td><td>dBi</td><td>N/A(2)</td><td>N/A(2)</td><td>6</td><td>11</td><td>N/A(2)</td><td>N/A(2)</td><td>6</td><td>11</td></tr>
<tr><td>Polarization</td><td></td><td>Vertical</td><td>Vertical</td><td colspan="2">Vertical</td><td>Vertical</td><td>Vertical</td><td colspan="2">Vertical</td></tr>
<tr><td>Antenna pattern</td><td></td><td>N/A(2)</td><td>N/A(2)</td><td colspan="2">Uniform distribution(3)</td><td>N/A(2)</td><td>N/A(2)</td><td colspan="2">Uniform distribution(3)</td></tr>
<tr><td>Horizontal beamwidth</td><td>Degrees</td><td>360</td><td>360</td><td>16</td><td>3.3</td><td>360</td><td>360</td><td>16</td><td>3.3</td></tr>
<tr><td>Vertical beamwidth</td><td>Degrees</td><td>90</td><td>90</td><td>16</td><td>3.3</td><td>90</td><td>90</td><td>16</td><td>3.3</td></tr>
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TABLE 1 (*continued*)

Parameter	Units	System 3 Airborne		System 3 Ground [and shipborne]		System 4 Airborne		System 4 Ground	
Transmitter									
Tuning range	MHz	4 400-4 940(1)		4 400-4 940(1)		4 400-4 940(1)		4 400-4 940(1)	
Power output	dBm	42-50		42		43		37	
Bandwidth (3 dB)	MHz	0.158 / 0.97 / 1.23 / 4.0		0.158 / 0.97 / 1.23 / 4.0		0.158 / 2.4 / 4.8 / 9.6		0.158 / 2.4 / 4.8 / 9.6	
Receiver									
Tuning range	MHz	4 400-4 940(1)		4 400-4 940(1)		4 400-4 940(1)		4 400-4 940(1)	
Selectivity (3 dB)	MHz	0.2 / 1 / 1.5 / 4.5		0.2 / 1 / 1.5 / 4.5		0.2 / 2.6 / 5.0 / 10		0.2 / 2.6 / 5.0 / 10	
Noise figure	dB	2.5		2.5 (ground) / [6 (shipborne)]		2.5		3	
Thermal noise level	dBm	–118.5 to –105.0		–118.5 to –105.0		–118.5 to –101.5		–118 to –101	
Antenna									
Antenna type		Omni-directional	Directional	Omni-directional	Directional	Omni-directional	Directional	Omni-directional	Directional
Antenna gain	dBi	3.5	16	3	30	4.5	16	4	30
1st sidelobe	dBi	N/A(2)	9	N/A(2)	17	N/A(2)	9	N/A(2)	17
Polarization		Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Antenna pattern		N/A(2)	Uniform distribution(3)	N/A(2)	Uniform distribution(3)	N/A(2)	Uniform distribution(3)	N/A(2)	Uniform distribution(3)
Horizontal beamwidth	degrees	360	33	360	4.4	360	33	360	4.4
Vertical beamwidth	degrees	35	33	40	4.4	35	33	60	4.4

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TABLE 1 (*continued*)

Parameter	Units	System 5 Airborne		System 5 Ground [and shipborne]		
Transmitter						
Tuning range	MHz	4 400-4 990(1)		4 400-4 990(1)		
Power output	dBm	45		45		
Bandwidth (3 dB)	MHz	0.4 / 3 / 8.5		0.4 / 3 / 8.5		
Receiver						
Tuning range	MHz	4 400-4 990(1)		4 400-4 990(1)		
Selectivity (3 dB)	MHz	0.4 / 3 / 17		0.4 / 3 / 17		
Noise figure	dB	3.5		3.5 (ground) / [6 (shipborne)]		
Thermal noise level	dBm	–118.5 to –105.0		–118.5 to –105.0		
Antenna						
Antenna type		Omni-directional	Directional	Omni-directional	Directional	
Antenna gain	dBi	3	19	3	19	31
1st sidelobe	dBi	N/A(2)	6	N/A(2)	6	11
Polarization		Vertical	Vertical	Vertical	Vertical	
Antenna pattern		N/A(2)	see equation in (4)	N/A(2)	[see equation in (4) (5) /Uniform distribution(3)]	
Horizontal beamwidth	degrees	360	16	360	16	3.3
Vertical beamwidth	degrees	90	16	360	16	3.3

Notes:

(1) RR No. **5.442** applies.

(2) N/A – Not applicable.

(3) Refer to Recommendation ITU-R M.1851.

(4) For antenna gain 19 dBi: $G(\psi) = 20.\log_{10}(|sinc(3.19\pi \sin(\psi))|) + 19.0 \ \forall\psi \in [-68.43°, 68.43°]$ and $G(\psi) = -20$ otherwise. Here, $\mathrm{sinc}(x) = \frac{\sin(x)}{x} \ \forall\, x \neq 0$ (x in radians) and $\mathrm{sinc}(0) = 1$.

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[5] For antenna gain 31 dBi: $G\psi = 20.\log 10 sinc 15.5\pi \sin\psi + 31.0 \; \forall \psi \in -64.25°, 64.25°$ and $G(\psi) = -20$ otherwise. Here, $\text{sinc}(x) = \frac{\sin(x)}{x} \; \forall \, x \neq 0$ (x in radians) and $\text{sinc}(0) = 1$.

[Editor's note: The need of this equation should be confirmed. One possible solution is to keep using footnote (3) in case of uniform distribution]

In the Table "-" means range of values, and "/" means discrete values.

[Editor's note: The noise figure in some parts of Table 1 needs to be further clarified]

TABLE 1 (*continued*)

Parameter	Units	System 6 Airborne 1	System 6 Airborne 2	System 6 Ship borne		System 6 Ground	
Transmitter							
Tuning range	MHz	4 800-4 990	4 800-4 990	4 800-4 990		4 800-4 990	
Power output	dBm	27-33	27-33	35		35	
Bandwidth (3 dB)	MHz	5/10/20/40 (software configurable)	5/10/20/40 (software configurable)	5/10/20/40 (software configurable)		5/10/20/40 (software configurable)	
Receiver							
Tuning range	MHz	4 800-4 990	4800-4 990	4 800-4 990		4 800-4 990	
Selectivity (3 dB)	MHz	5/10/20/40	5/10/20/40	5/10/20/40		5/10/20/40	
Noise figure	dB	6	6	6		4	
Thermal noise level	dBm	−101 to -92	−101 to -92	−103 to −94		−103 to −94	
Antenna							
Antenna type		Omnidirectional	Omnidirectional	Omni-directional	Directional	Omni-directional	Directional
Antenna gain	dBi	4.7	4.7	6	11.8	6	11.8
1st sidelobe	dBi	N/A	N/A	N/A	Note 2	N/A	Note 2
Polarization		Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Antenna pattern		N/A	N/A	Note 1	Note 2	Note 1	Note 2
Horizontal beamwidth	Degrees	360	360	360	30	360	30
Vertical beamwidth	Degrees	90	90	28	18	28	18

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TABLE 1 (*continued*)

Parameter	Units	System 7 Airborne 1	System 7 Airborne 2
Transmitter			
Tuning range	MHz	4 400-4 990	4 400-4 990
Power output	dBm	30-43	30-43
Bandwidth (3 dB)	MHz	5 / 0.008	5 / 0.008
Receiver			
Tuning range	MHz	4 400-4 990	4 400-4 990
Selectivity (3 dB)	MHz	5 / 0.008	5 / 0.008
Noise figure	dB	[6]	6
Thermal noise level	dBm	-103 / −131	-103/ −131
Antenna			
Antenna type		Directional	Directional
Antenna gain	dBi	14	14
1^{st} sidelobe	dBi	-1	-1
Polarization		Vertical	Vertical
Antenna pattern		Uniform distribution (Refer to Rec. ITU-R M.1851)	Uniform distribution (Refer to Rec. ITU-R M.1851)
Horizontal beamwidth	Degrees	24	28
Vertical beamwidth	Degrees	24	28

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TABLE 1 *(end)*

Parameter	Units	System 8 Airborne	System 8 Ground	System 8 Shipborne
Transmitter				
Tuning range	MHz	4 800-4 990	4 800-4 990	4 800-4 990
Power output	dBm	26	46	46
Bandwidth (3 dB)	MHz	40/50/60/80/100 (software configurable)	40/50/60/80/100 (software configurable)	40/50/60/80/100 (software configurable)
Receiver				
Tuning range	MHz	4 800-4 990	4 800-4 990	4 800-4 990
Selectivity (3 dB)	MHz	40/50/60/80/100	40/50/60/80/100	40/50/60/80/100
Noise figure	dB	9	5	5
Thermal noise level	dBm	−89 … -85	−93 … -89	−93 … -89
Antenna				
Antenna type		Omnidirectional	Directional (steerable, MIMO)	Directional (steerable, MIMO)
Antenna gain	dBi	0	15	15
1st sidelobe	dBi	N/A	N/A	N/A
Polarization		Vertical	Vertical	Vertical
Antenna pattern		N/A	Rec ITU-R F.1336	Rec ITU-R F.1336
Horizontal beamwidth	Degrees	360	65	65
Vertical beamwidth	Degrees	90	90	90

5.1.2 Protection criteria for aeronautical mobile systems

An increase in receiver effective noise of 1 dB would result in significant degradation in communication range.

Such an increase in effective receiver noise level corresponds to an $(I + N)/N$ ratio of 1.26, or an I/N ratio of about −6 dB. This represents the required protection criterion for the AMS systems referenced herein from interference due to another radiocommunication service. If multiple potential interference sources are present, protection of the AMS and MMS systems requires that this criterion is not exceeded due to the aggregate interference from the multiple sources.

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5.2 System characteristics and protection criteria of maritime mobile service systems in international waters in the frequency band 4 800-4 990 MHz

5.2.1 Technical characteristics of maritime mobile systems

Technical characteristics for aeronautical mobile stations can be found in Table 2.

TABLE 2

Typical technical characteristics of representative systems operating in the maritime mobile service in the frequency range 4 400-4 990 MHz

Parameter	Units	System 1 Shipborne			System 1 Ground			System 2 Shipborne	System 2 Ground
Transmitter									
Tuning range	MHz	4 400-4 940			4 400-4 940			4 800-4 990	4 800-4 990
Power output	dBm	39			39			46	46
Bandwidth (3 dB)	MHz	5.6/11.3/22.6			5.6/11.3/22.6			40/50/60/80/100 (software configurable)	40/50/60/80/100 (software configurable)
Receiver									
Tuning range	MHz	4 400-4 940			4 400-4 940			4 800-4 990	4 800-4 990
Selectivity (3 dB)	MHz	5.6/11.3/22.6			5.6/11.3/22.6			40/50/60/80/100	40/50/60/80/100
Noise figure	dB	6			6			5	5
Thermal noise level	dBm	-100.5 to -94.5			-100.5 to -94.5			−93 … -89	−93 … -89
Antenna									
Antenna type		Omnidirectional			Omni-directional			Directional (steerable, MIMO)	Directional (steerable, MIMO)
Antenna gain	dBi	6	4.2	2.5	6	4.2	2.5	15	15
1st sidelobe	dBi	N/A(1)			N/A(1)			N/A(1)	N/A(1)
Polarization		Vertical			Vertical			Vertical	Vertical
Antenna pattern		N/A(1)			N/A(1)			Rec ITU-R F.1336	Rec ITU-R F.1336
Horizontal beamwidth	Degrees	360			360			65	65
Vertical beamwidth	Degrees	30	37	69	30	37	69	90	90

Notes:

(1) N/A – Not applicable.

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5.2.2 Protection criteria for maritime mobile systems

An increase in receiver effective noise of 1 dB would result in significant degradation in communication range.

Such an increase in effective receiver noise level corresponds to an $(I + N)/N$ ratio of 1.26, or an I/N ratio of about −6 dB. This represents the required protection criterion for the MMS systems referenced herein from interference due to another radiocommunication service. If multiple potential interference sources are present, protection of the MMS systems requires that this criterion is not exceeded due to the aggregate interference from the multiple sources.

5.3 System Characteristics of IMT systems operated in the band 4 800-4 990 MHz

Tables 3 and 4 provide the deployment-related parameters of IMT systems for the frequency bands between 3 and 6 GHz. Implementation of AAS (see Table 5) as well as antenna characteristics in Recommendation ITU-R F.1336 are considered for IMT base stations in these frequency bands. For IMT user equipment / mobile stations, implementation of AAS is not considered.

TABLE 3

Deployment-related parameters for bands between 3 and 6 GHz

	Rural (optional, see Note A below)	**Urban/suburban macro**	**Small cell (outdoor)/Micro cell**	**Indoor (small cell)**
Base station characteristics/Cell structure				
Cell radius / Deployment density (non-AAS)	1.2 km / isolated BSs or a cluster of four BSs with the density of 0.001-0.006 BSs/km^2 (Note 2)	Typical cell radius 0.3 km urban / 0.6 km suburban	1-3 per urban macro cell <1 per suburban macro site	Depending on indoor coverage/ capacity demand
Cell radius / Deployment density (AAS)	1.6 km / isolated BSs or a cluster of four BSs with the density of 0.001-0.006 BSs/km^2 (Note 2)	Typical cell radius 0.4 km urban / 0.8 km suburban (10 BSs/km^2 urban / 2.4 BSs/km^2 suburban (Note 2))	1-3 per urban macro cell <1 per suburban macro site	Depending on indoor coverage/ capacity demand
Antenna height	35 m	20 m urban / 25 m suburban	6 m	3 m
Sectorization	3 sectors	3 sectors	Single sector	Single sector
Non-AAS BS downtilt (Note 1)	3 degrees	10 degrees urban / 6 degrees suburban	n.a.	n.a.
Frequency reuse	1	1	1	1
Non-AAS BS antenna pattern (Note 1)	Rec. ITU-R F.1336 (*recommends* 3.1) *ka* = 0.7 *kp* = 0.7 *kh* = 0.7 *kv* = 0.3 Horizontal 3 dB beamwidth: 65 degrees	Rec. ITU-R F.1336 (*recommends* 3.1) *ka* = 0.7 *kp* = 0.7 *kh* = 0.7 *kv* = 0.3 Horizontal 3 dB beamwidth: 65 degrees	Rec. ITU-R F.1336 (omni: *recommends* 2)	

	Rural (optional, see Note A below)	**Urban/suburban macro**	**Small cell (outdoor)/Micro cell**	**Indoor (small cell)**
	Vertical 3 dB beamwidth: determined from the horizontal beamwidth by equations in Rec. ITU-R F.1336. Vertical beamwidths of actual antennas may also be used when available.	Vertical 3 dB beamwidth: determined from the horizontal beamwidth by equations in Rec. ITU-R F.1336. Vertical beamwidths of actual antennas may also be used when available.		
Non-AAS BS antenna polarization	Linear/±45 degrees	Linear/±45 degrees	Linear	Linear
Indoor base station deployment	n.a.	n.a.	n.a.	100%
Indoor base station penetration loss	n.a.	n.a.	n.a.	Rec. ITU-R P.2109
Below rooftop base station antenna deployment	0%	Urban: 50% Suburban: 0%	100%	n.a.
Non-AAS BS feeder loss (Note 1)	3 dB	3 dB	3 dB	3 dB
Typical channel bandwidth	40 or 80 or 100 MHz	40 or 80 or 100 MHz	40 or 80 or 100 MHz	40 or 80 or 100 MHz
Maximum Non-AAS BS output power (Note 1)	52 dBm in 40 MHz 55 dBm in 80 MHz 56 dBm 100 MHz	49 dBm in 40 MHz 52 dBm in 80 MHz 53 dBm in 100 MHz	24 dBm in 40 or 80 or 100 MHz	24 dBm in 40 or 80 or 100 MHz
Maximum Non-AAS BS antenna gain (Note 1)	18 dBi	18 dBi	5 dBi	0 dBi
Maximum Non-AAS BS output power/sector (e.i.r.p.) (Note 1)	67 dBm in 40 MHz 70 dBm in 80 MHz 71 dBm in 100 MHz	64 dBm in 40 MHz 67 dBm in 80 MHz 68 dBm in 100 MHz	29 dBm in 40 or 80 or 100 MHz	24 dBm in 40 or 80 or 100 MHz
Network loading factor (base station load probability X%) (see section 3.4 below and Rec. ITU-R M.2101 Annex 1, section 3.4.1 and 6)	50%	20%, 50%	20%, 50%	20%, 50%
Average Non-AAS BS power/sector (e.i.r.p.) taking into account activity factor (Note 1)	Use Rec. ITU-R M.2101 (see section 3.4 below)	Use Rec. ITU-R M.2101 (see section 3.4 below)	Use Rec. ITU-R M.2101 (see section 3.4 below)	Use Rec. ITU-R M.2101 (see section 3.4 below)
TDD / FDD	TDD	TDD	TDD	TDD
BS TDD activity factor	75%	75%	75%	75%

Note 1: This parameter is only applicable for non-AAS base stations. Antenna characteristics for AAS base stations (for frequency bands above 1710 MHz) are provided in Table 9.

Note 2: “1 BS” = 1 sector in 3-sector cell.

Note A to Table 6-1 above and Table 6-2 below:
For the 3-6 GHz range, contiguous coverage is not expected in this frequency range in rural areas,

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and any such base stations that may exist in small numbers will be isolated installations at specific locations, and therefore, the rural deployment environment may or may not be included in the sharing and compatibility studies, depending on the area of study.

TABLE 4

UE parameters for bands between 3 and 6 GHz

	Rural (optional, see Note A above)	**Urban/suburban macro**	**Small cell (outdoor)/Micro cell**	**Indoor (small cell)**
User terminal characteristics				
Indoor user terminal usage	50%	70%	70%	100%
Indoor user terminal penetration loss	Rec. ITU-R P.2109 (traditional building)	Rec. ITU-R P.2109	Rec. ITU-R P.2109	Rec. ITU-R P.2109
User equipment density for terminals that are transmitting simultaneously (Note 1)	3 UEs per sector	3 UEs per sector	3 UEs per sector	3 UEs per sector
UE height (Note 2)	1.5 m	1.5 m	1.5 m	1.5 m
Average user terminal output power	Use transmit power control	Use transmit power control	Use transmit power control	Use transmit power control
Typical antenna gain for user terminals	−4 dBi	−4 dBi	−4 dBi	−4 dBi
Body loss	4 dB	4 dB	4 dB	4 dB
UE TDD activity factor	25%	25%	25%	25%
Transmit power control				
Power control model	Refer to Recommendation ITU-R M.2101 Annex 1, section 4.1			
Maximum user terminal output power, PCMAX	23 dBm	23 dBm	23 dBm	23 dBm
Power (dBm) target value per RB, P0_PUSCH (Note 3)	−92.2	−92.2	−87.2	−87.2
Path loss compensation factor, α (same as "balancing factor" mentioned in Rec. ITU-R M.2101)	0.8	0.8	0.8	0.8

Note 1: UEs share equally the channel bandwidth, i.e. each UE is allocated 1/3 of the channel bandwidth (see Rec. ITU-R M.2101, Section 3.4.1, item 1e-f.). In sharing studies, it is assumed that the AAS BS beamforms towards each UE using the entire array.

Note 2: In principle, indoor UEs are distributed over different floors of the building. It should be noted that the number of floors of buildings vary within the environment and among the countries. Moreover, the number of floors of buildings is not related to Macro BS antenna height (parameter given in the Table). In particular in small cities, sub-urban and rural areas, many or most of antennas are installed on masts. Therefore, for outdoor BSs, indoor UEs are assumed to be modelled on the ground floor for the sharing study.

Note 3: The target power is defined per Resource Block (RB), considering 180 kHz RB bandwidth corresponding to 15 kHz subcarrier spacing.

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TABLE 5

Beamforming antenna characteristics for IMT in 1 710-4 990 MHz

		Rural macro	Suburban macro	Urban macro	Urban small cell (outdoor)/Micro cell	Indoor (small cell)
1	**Base station antenna characteristics**					
1.1	Antenna pattern	Refer to the extended AAS model in Table A of Annex 3			Refer to section 5 of Rec. **Error! Hyperlink reference not valid.**	N/A
1.2	Element gain (dBi) (Note 1)	6.4	6.4	6.4	6.4	N/A
1.3	Horizontal/vertical 3 dB beam width of single element (degree)	90º for H 65º for V	90º for H 65º for V	90º for H 65º for V	90º for H 65º for V	N/A
1.4	Horizontal/vertical front-to-back ratio (dB)	30 for both H/V	30 for both H/V	30 for both H/V	30 for both H/V	N/A
1.5	Antenna polarization	Linear ±45º	Linear ±45º	Linear ±45º	Linear ±45º	N/A
1.6	Antenna array configuration (Row × Column) (Note 2)	4 × 8 elements	4 × 8 elements	4 × 8 elements	8 × 8 elements	N/A
1.7	Horizontal/Vertical radiating element/sub-array spacing, d_h /d_v	0.5 of wavelength for H, 2.1 of wavelength for V	0.5 of wavelength for H, 2.1 of wavelength for V	0.5 of wavelength for H, 2.1 of wavelength for V	0.5 of wavelength for H, 0.7 of wavelength for V	N/A
1.7a	Number of element rows in sub-array, M_{sub}	3	3	3	N/A	N/A
1.7b	Vertical radiating element spacing in sub-array, $d_{v,sub}$	0.7 of wavelength of V	0.7 of wavelength of V	0.7 of wavelength of V	N/A	N/A
1.7c	Pre-set sub-array down-tilt, $\theta_{subtilt}$ (degrees)	3	3	3	N/A	N/A
1.8	Array Ohmic loss (dB) (Note 1)	2	2	2	2	N/A
1.9	Conducted power (before Ohmic loss) per antenna element/sub-array (dBm) (Note 5, 6)	28	28	28	16	N/A
1.10	Base station horizontal coverage range (degrees)	±60	±60	±60	±60	N/A
1.11	Base station vertical coverage range (degrees) (Notes 3, 4, 7)	90-100	90-100	90-100	90-120	N/A
1.12	Mechanical downtilt (degrees) (Note 4)	3	6	6	10	N/A
1.13	Maximum base station output power/sector (e.i.r.p.) (dBm)	72.28	72.28	72.28	61.53	N/A

Note 1: The element gain in row 1.2 includes the loss given in row 1.8 and is per polarization. This means that this parameter in row 1.8 is not needed for the calculation of the BS composite antenna gain and e.i.r.p.

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Note 2: For the small/micro cell case, 8 × 8 means there are 8 vertical and 8 horizontal radiating elements. For the extended AAS model case, 4 × 8 means there are 4 vertical and 8 horizontal radiating sub-arrays.

Note 3: The vertical coverage range is given in global coordinate system, i.e. 90° being at the horizon.

Note 4: The vertical coverage range in row 1.11 includes the mechanical downtilt given in row 1.12.

Note 5: The conducted power per element assumes 8 × 8 × 2 elements for the micro/small cell case, and 4 × 8 × 2 sub-arrays for the macro case (i.e. power per H/V polarized element).

Note 6: In sharing studies, the transmit power calculated using row 1.9 is applied to the typical channel bandwidth given in Table 5-1 and 6-1 respectively for the corresponding frequency bands.

Note 7: In sharing studies, the UEs that are below the base station vertical coverage range can be considered to be served by the "lower" bound of the electrical beam, i.e. beam steered towards the max. coverage angle. A minimum BS-UE distance along the ground of 35 m should be used for urban/suburban and rural macro environments, 5 m for micro/outdoor small cell, and 2 m for indoor small cell/urban scenarios.

6 Propagation models

Editor's note: P.2108 should be also added to this section, and possibly other propagation models used in the studies (the work is contribution driven) - France

Recommendation ITU-R P.528 contains a method for predicting basic transmission loss in the frequency range 100 MHz to 30 GHz for aeronautical services: for air-to-air, ground-to-air, and air-to-ground paths. It provides a step-by-step method to compute the basic transmission loss for time percentages of 1 to 99%. The only data needed for this method are the distance between antennas, the heights of the antennas above mean sea level, the frequency, the polarization, and the time percentage. According to *recommends 1* of Recommendation P.528, the integral software in the Recommendation should be used to generate basic transmission loss values and curves for terminal heights, frequencies, and time percentages likely to be encountered in the aeronautical services.

Basic transmission loss is defined in recommends 1.2 of Recommendation ITU-R P.341 as follows:

Basic transmission loss (of a radio link) (symbols: Lb or Ab): The ratio, usually expressed in decibels, for a radio link between the power radiated by the transmitting antenna and the power that would be available at a conjugately matched receiver antenna input if the antennas were replaced by isotropic antennas with the same polarization as the real antennas, including the attenuation effects on the propagation path, but with the effects of obstacles close to the antennas being disregarded.

$$Lb = Lbf + Lm \quad \text{dB,}$$

where Lm is the loss relative to free space (symbols: Lm or Am).

Editor's note: There is a consideration to swap Sections 8 and 9

8 Technical studies

[TBD]

Editor's note: Elements of Section 8 suitable for further discussion with the view to be included in the CPM text should be identified and worked on – Iran

Editor's note: Section 8 may be further split into several subsections based on different approaches.

Editor's note: This Section should be reviewed after the regulatory studies are concluded.

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Editor's Note: Irrespective of any results obtained from theoretical calculations of the value of pfd which is required at the receiver of AMS/MMS it is understood that every possible effort wis to be made to agree on a workable pfd which allows both systems, AMS/MMS on one hand and IMT on the other hand, to function satisfactorily.

8.1 Methodology to derive a pfd limit

This section provides a method calculating the power flux density at the AMS/MMS receiver. The following equation provides the calculation required to convert the interference to noise ratio (*I/N*) to the pfd at the AMS/MMS receiver:

$$pfd_{\ agg} \leq 10log_{10}(kTB) + NF + \frac{I}{N} - 10log_{10}(\frac{\lambda^2}{4\pi}) - G_r \ + L_f \text{ dB(W/(}m^2\text{*MHz))} \quad (1)$$

Where:

Pfd_{agg}: power flux density at the receiving antenna surface of the AMS/MMS system[1] dB(W/(m^2*MHz);

B: reference bandwidth (1 MHz);

k: Boltzmann's constant;

T: noise temperature of receiver (300 K);

NF: noise figure of the AMS/MMS system (dB).

I/N: interference to noise ratio protection criterion (-6 dB);

G_r: gain of AMS/MMS in the direction of source of interference (dBi);

L_f: feeder loss (dB) .

Table 6 provides the calculations for the pfd required to protect AMS systems when the interferer located in the maximum receiving antenna gain direction based upon the characteristics provided in Table 1. It should be noted that some of the AMS systems contain a shipborne component and therefore will be considered in Table 6. Table 7 provides the calculations for the pfd required to protect MMS systems based upon the characteristics provided in Table 2. These calculations assume a wavelength of 0.0612m (corresponding to a frequency of 4 900 MHz) which yield an effective aperture constant ($(\frac{\lambda^2}{4\pi})$ of 0.000298. These calculations also assume the AMS/MMS systems are pointing towards the interferer with their maximum gain. Both Tables 6 and 7 assume a *I/N* protection criteria of -6 dB.

[Editor's note: The conversion from I/N to PFD needs to take into account all losses between receiver antenna and receiver input (e.g. feeder loss). Future contributions will need to consider such factors.]

TABLE 6

Calculated pfd required to protect AMS systems for maximum receiving antenna gain direction

Parameter (Unit)	AMS Receiver Antenna Gain (dBi)	Power Flux Density (dB(W/m^2*MHz))
System 1 Airborne	3	-114.07

[1] The pfd in Eq. (1) does not account for polarization loss at the AMS/MMS receiver antenna

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Parameter (Unit)	AMS Receiver Antenna Gain (dBi)		Power Flux Density (dB(W/m^2*MHz))	
System 2 Airborne	3		-114.07	
System 3 Airborne	3.5 (omni)	16 (directional)	-115.57 (omni)	-128.07 (directional)
System 3 Shipborne	3 (omni)	30 (directional)	-111.57 (omni)	-138.57 (directional)
System 4 Airborne	4.5 (omni)	16 (directional)	-116.57 (omni)	-128.07 (directional)
System 5 Airborne	3 (omni)	19 (directional)	-114.07 (omni)	-130.07 (directional)
System 5 Shipborne	3 (omni)	31 (directional)	-111.57 (omni)	-139.57 (directional)
System 6 Airborne 1	4.7		-113.27	
System 6 Airborne 2	4.7		-113.27	
System 6 Shipborne	6 (omni)	11.8 (directional)	-114.57 (omni)	-120.37 (directional)
System 7 Airborne 1	14		-122.57	
System 7 Airborne 2	14		-122.57	
System 8 Airborne	0		-105.57	
System 8 Shipborne	15		-124.57	

TABLE 7

Calculated pfd required to protect MMS systems for maximum receiving antenna gain direction

Parameter (Unit)	MMS Receiver Antenna Gain (dBi)	Power Flux Density (dB(W/m^2*MHz))
System 1 Shipborne	6	-114.57
System 2 Shipborne	15	-124.57

8.1.2 Methodology to derive a pfd limit per station (for low gain AMS/MMS antenna)

This methodology assumes that MMS/AMS receiver antenna has a low gain in order to define pfd_{single} based on the aggregate pfd limit pfd_{agg}. Assuming NF+L_f=4 dB, this leads to

$$pfd_{agg} = -113.7 \frac{dBW}{MHz.m^2}$$

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For the case where M Base stations with isotropic antenna (e.g. indoor small cells) deployed in the area of interest whose size ensures that distances between each hotspot and the MMS/AMS receiver are similar:

$$pfd_{single} = \frac{pfd_{agg}}{M^*} \quad (2)$$

For the general case where BSs high gain antenna (passive and active sectors) are deployed in a simulation area with varying distances (between BS and the MMS/AMS receiver), it is not possible to define a proper aggregation factor because all sources of interference do not have the same influence on the MMS/AMS victim receiver due to varying parameters (antenna gain towards the victim, distance from the victim, visibility elevation angle towards the AMS/MMS receiver). It is then necessary to define an ***equivalent*** number of sources M^* by considering aggregate and single interference distributions. The wording "equivalent" is given to this parameter because it is not (in general) equal to the number of active base-stations. To define M^*, let us notice:

– That the number of active BSs $NbactiveBSs$ within the simulation area is (assumed to be) given in the table of IMT parameters[2] as an average value. This means that this number is a variable of the event *i*, denoted $NbactiveBSs(i)$.

– That the aggregate and single interferences are defined at the receiver antenna and can be expressed as (in linear scale) follows:

$$I_{single\ i,j} = \frac{P.G_{BS\ i,j}}{PL_{i,j}.CL_{i,j}} G_r \text{ and } I_{agg\ i} = \sum_{j=1}^{NbactiveBSs(i)} I_{single\ i,j}$$

Where P relates to the conducted power at each BS, $G_{BS\ i,j}$ defines the gain of the active BS #*j* at snapshot #*i*, $PL_{i,j}, CL_{i,j}$ respectively correspond to the free-space-loss and clutter loss (>0) between active BS #*j* and MMS/AMS receiver at snapshot #*i* and G_r refers to the AMS/MMS receiver antenna gain.

– If it is obvious that the interference from a single BS spatially and timely varies, the aggregate interference from all active BSs in the simulation area also does at every event *i* because the number and the locations of the most influencing BSs (within the simulation area) vary at every snapshot.

A way to define an equivalent number of sources M^* would be to divide at each snapshot *i* the aggregate interference over a X^{th} percentile of the single interference (still at snapshot #*i*). The choice of this X^{th} percentile is explained below:

– An average value would result in achieving $NbactiveBSs$ as the aggregation factor (in linear scale) as showed in developing

$$M(i) = \frac{I_{agg\ i}}{\frac{1}{Nbactive\ BSs(i)} \sum_{j=1}^{Nbactive\ BSs(i)} I_{single\ i,j}} = Nbactive\ BSs(i)$$

Such assumption would lead to linear dependency of the pfd per station with the number of active BSs in the simulation area (whatever Ra/Rb, BS activity factors are applied on large zone). Indeed, such trend contradicts the slower growth of any practical aggregation factor compared to the number of active BSs when extending the simulation area because interference from remote BSs decrease much faster due to larger distance than its discrimination antenna gain rises up.

– This means that the slope of the M^* parameter as a function of the simulation area needs to be as soft as the evolution of the aggregation interference, probably because closer BSs

[2] Featured as a network load or a base-station activity.

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have likely more impact on the MMS/AMS receiver than remote ones. Such rationale is equivalent to consider higher/highest percentile of the interference of a single active BS in the calculation of $M(i)$.

To illustrate this idea, consider the following example: if there are two active BSs within the simulation area and one of them has always (for every snapshot *i*) dominant impact over the other then: $pfd_{single\ (most\ dominant)} \approx pfd_{agg}$ and $M = 1$.

$M(i)$ is a random variable whose sample is given at every snapshot *i*. Its expression is given:

$$M(i) = \frac{I_{agg\ i}}{I_{single\ i(X\%)}} \text{ where } X \text{ could be equal to } 90\%$$

By taking the same X^th^ percentile of the $M(i)$ *cumulative density function (cdf)*, we get: $M_{X\%}(i) \triangleq M^*$, the equivalent number of sources is obtained, and formula (2) can be applied for the general case of AAS BSs deployment. Consequently, the pfd per station formula can be established for AMS/MMS receiver operating with low gain:

$$pfd_{single} = \frac{I_{max}\frac{4\pi}{\lambda^2.G_r}}{M^*} \quad (3)$$

8.1.3 Study to derive a pfd limit per station

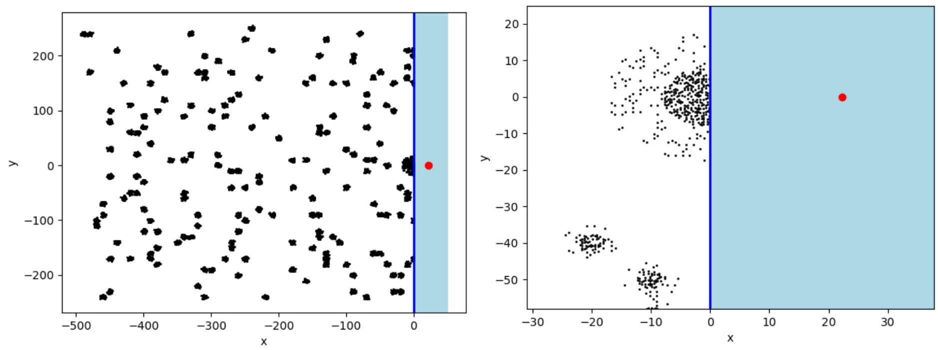
The methodology described in section 8.1 has been used in this study for the case of the protection of an AMS receiver

8.1.3.1 Assumptions

Assumptions for IMT

FIGURE 1

Distribution of AAS BS (x and y in km, before filtering those outside of LOS)



IMT AAS Base Stations sectors are generated as clusters in suburban/urban areas (“cities”) that are randomly distributed around a terrain (with the exception of a “main” city with coordinates (0,0)). Cities are generated with a random radius both for the suburban and urban parts (and a maximum area of 1 000 km² for the suburban part and 200 km² for the urban part), in conformity with the assumption of Ra_urban=45%, Ra_suburban=20% and Rb=5%. For all cities except the “main” one, the urban part has half the radius of the suburban part. The seaside is materialized by the line x=0, with terrestrial part on x<0 locations and waters on x>0 areas.

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Editor's note: The base station number is calculated assuming that Rb is 5%. However, in a closely related study on AI 1.2 (Doc. ***Error! Hyperlink reference not valid.****), the Rb is assumed to be 1% or 3%. The difference in the scenarios may need to be clarified. The initial response offered by the proponents is that 5% is an appropriate value provided that the simulation area is limited by the costal area - France*

Generated IMT base stations have 3 AAS sectors (0°, 120° and 240° azimuth relative to north, mechanical tilt of −10° for urban, −6° for suburban) and use parameters as agreed (Recommendation ITU-R M.2101 extended pattern with sub-arrays, relevant mechanical tilt depending on urban/suburban areas, 3 UEs per sector, network load of 20%, etc).

A spherical earth model was assumed i.e. only IMT base stations that can be in visibility with the victim receiver are kept in the simulation, taking into account earth curvature and the antenna height of both the IMT station and the AMS/MMS receiver.

Assumptions for AMS

For AMS, the victim receiver (red dot on figure above) is assumed to be located at 10 km altitude in international waters in front of the main city (i.e. x = +22.5 km, y = 0, z = 10 km). It is for the moment assumed to have an omnidirectional antenna with 3 dBi gain.

Considering the IMT and AMS antenna heights, the maximum distance for LOS is 375 km. With those parameters above, this leads to approximately 7 000 IMT sectors in the simulation in total.

With regards to the clutter layer, the P.2108 § 3.3 was applied (both current recommendation and the update under consideration were implemented).

Editor's note: There is need to check and confirm the assumption made on antenna height for MMS

Assumptions for MMS

For MMS, the victim receiver (same red dot on figure above) is assumed to be located at 36 m altitude in international waters in front of the main city (i.e. x = +22.5 km, y = 0, z = 36 m). It is for the moment assumed to have an omnidirectional antenna with 3 dBi gain.

Considering the IMT and AMS antenna heights, the maximum distance for LOS is 39 km. With those parameters above, this leads to approximately 350 IMT sectors in the simulation in total.

With regards to the clutter layer, the P.2108 §3.2 was applied, using the distance between the IMT base station and the coastline.

Propagation assumptions

For each generated terrain, a Monte-Carlo simulation is performed (where UEs and clutter layer are refreshed). The clutter is considered using Recommendation ITU-R P.2108 in urban areas, with *p*-factor as a random variable of uniform law between 0..100% (clutter has not been applied in suburban areas considering that IMT antenna height is 25 m and buildings are assumed to be typically 10m height. It has been applied on half of the urban sites considering the assumption that half of IMT base stations are above the clutter). Free space loss is assumed above the clutter.

Editor's note: this subsection may be reviewed upon the conclusion of discussion on clutter loss in the relevant propagation model ~~used in studies in AI 1.2~~

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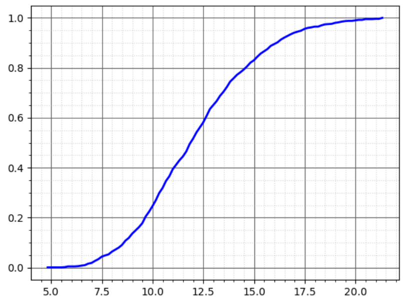
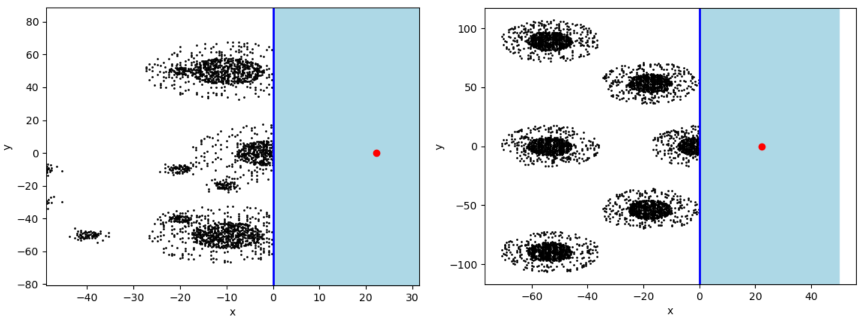
8.1.3.3 Results

Results for AMS

With the parameters above (N=1000 iterations), the average value for M* is [20 in linear scale i.e. 13 dB]. The graph below shows an illustration of the CDF for M(i).



Sensitivity analysis



When forcing the deterministic generation of other large cities in the surroundings of the victim (e.g. see figures above) while keeping all things equal, the mean value for M* becomes 35.6 in linear scale i.e. 15.51 dB. In addition to that, when increasing the network load from 20% to 50% (which could be justified when considering small areas), the mean value for M* becomes 77.75 in linear scale (i.e. 19 dB).

Editor's note: In the sensitivity analysis, the network loading factor was assumed to be 20% and 50% According to the IMT parameters document, the typical value of network loading factor for large area should be 20%. Proponents were requested to provide further clarification.

When focusing on a much more restricted scenario (130 base stations, small city as depicted in figure below) and a network load of 50%, the mean value of M* is 10 dB.

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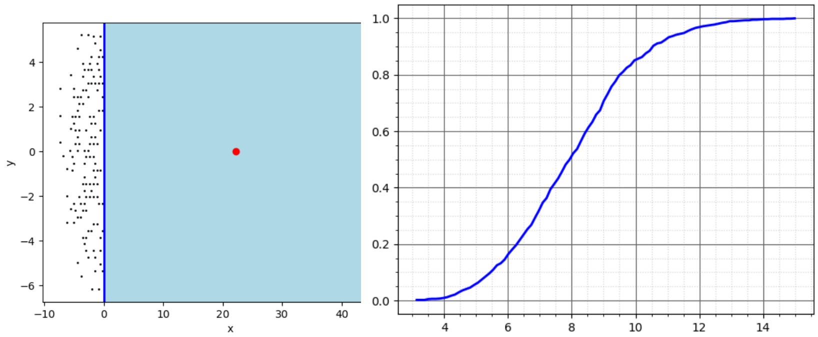
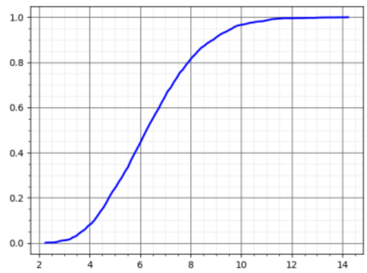


Results for MMS

With the parameters above (N = 1 000 iterations), the average value for M^* is [10 in linear scale i.e. 10 dB]. The graph below shows an illustration of the CDF for M(i).



8.2 Study on basic transmission loss between air borne station of the aeronautical mobile service and terrestrial base station.

The objective of this study is to provide an understanding of how the basic transmission loss between an airborne station and a terrestrial station changes with the altitude of the airborne station and its distance from the terrestrial station.

There are three modes of transmission: line of sight within the radio horizon; diffraction near and beyond the radio horizon and; scattering beyond the radio horizon.

The radio horizon[3] is the locus of points at which direct rays from an antenna are tangential to the surface of the Earth. Note: If the Earth were a perfect sphere and there were no atmospheric anomalies, the radio horizon would be a circle. In practice, the distance to the radio horizon is affected by the height of the transmitting antenna, the height of the receiving antenna, atmospheric conditions, and the presence of obstructions, e.g., mountains.

The transmission mode from an airborne station to a region before its radio horizon is the line-of-sight mode, consisting of atmospheric absorption and the transmission loss corresponding to free-space conditions. For radio paths extending only slightly over the horizon, or for paths extending over an obstacle or over mountainous terrain, diffraction will generally be the propagation mode

[3] https://www.its.bldrdoc.gov/fs-1037/dir-030/_4378.htm

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determining the field strength. Attenuation for diffracted signals increases very rapidly with distance and with frequency, and the anomalous propagation probability is relatively small, eventually the long-term principal mechanism is that of tropospheric scatter. These mechanisms may be used to establish “trans-horizon” radiocommunication.[4].

According to *recommends* 1 of Recommendation ITU-R P.528, the integral software in the Recommendation should be used to generate basic transmission loss values and curves for terminal heights, frequencies, and time percentages likely to be encountered in the aeronautical services.

In this study, basic transmission losses were generated based on the following parameters:

TABLE 8.2-1

Input to P.528 software	**Value used in study**
Great-circle distance between the stations, d (km)	Vary
Height of terrestrial station above mean sea level, h1 (m)	25m
Height of air borne station above mean sea level, h2 (m)	Vary
Frequency (MHz)	4 800 MHz
Polarization (1=Vertical, 0=Horizontal)	1
Time percentage (%)	5%

Figure 8.2-1 provide plots of basic transmission loss against the distances between stations for different altitudes of the airborne station.

[4] Recommendation ITU-R P.617-5 Propagation prediction techniques and data required for the design of trans-horizon radio-relay systems.

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Frequency (MHz)	4800	4800	4800	4800	4800
h1 (m)	25	25	25	25	25
h2 (m)	1000	2400	5000	7500	10000
Polarization	1 (vertical)	1 (vertical)	1 (vertical)	1 (vertical)	1 (vertical)
p (Time percentage)	5%	5%	5%	5%	5%
d (km)	P.528 BT loss (dB) at h2 = 1000 m	P.528 BT loss (dB) at h2 = 2400 m	P.528 BT loss (dB) at h2 = 5 000 m	P.528 BT loss (dB) at h2 = 7 500 m	P.528 BT loss (dB) at h2 = 10 000 m
50	135.1	135.7	136.5	137.2	137.7
100	140.5	140.7	141.4	141.5	141.6
150	145.3	144.0	143.5	143.9	143.9
200	180.6	147.5	146.3	145.6	146.4
250	191.2	175.2	149.3	148.4	147.8
300	199.9	188.6	151.7	150.9	150.3
350	207.3	197.9	181.5	153.0	152.4
400	213.8	205.8	192.7	177.8	154.3
450	219.8	212.5	201.6	191.1	177.5
500	225.5	218.6	209.1	200.4	191.4
550	230.9	224.4	215.6	208.2	200.7
600	235.9	229.9	221.6	214.9	208.6
650	240.5	235.1	227.2	221.0	215.3

FIGURE 8.2-1

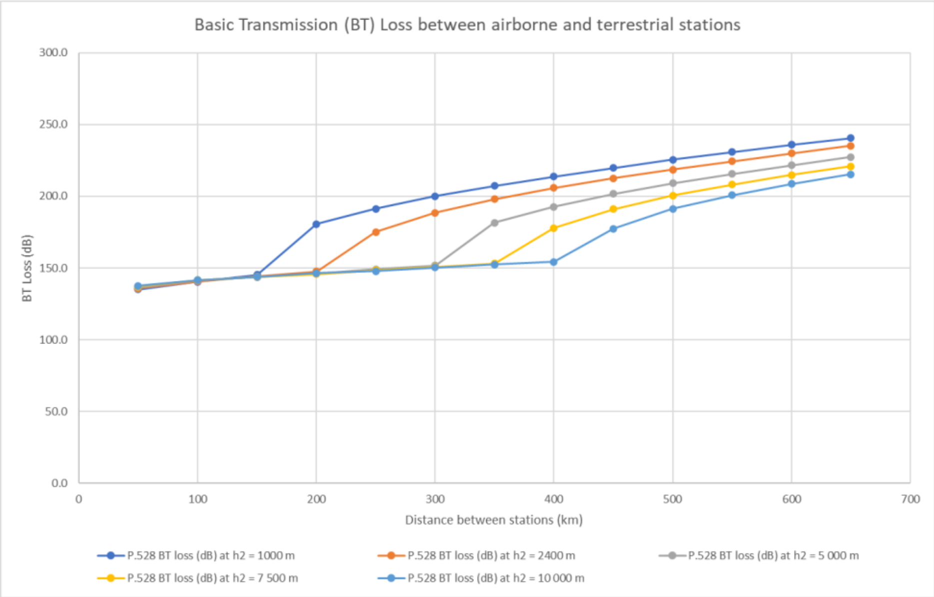

Figure 8.2-2 below shows how basic transmission loss change with altitude at particular distances between stations.

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Frequency (MHz)	4 800.0
Distance, d	370, 450 km
h1 (m)	25.0
h2 (m)	Vary
Polarization	1 (vertical)
p (Time percentage)	5.0%

The distances of 450 km is selected due to bullet point number 6 of *resolves* 1 of Resolution **416 (WRC-07)** and *resolves* 3 of Resolution **223(Rev.WRC-19)**

The distance of 370 km is approximately 200 nautical miles, which is the breadth of the exclusive economic zone of a coastal state. (Refer Article 57 of United Nations Convention on the Law of the Sea)

h2 (m)	BT loss (dB) @ 450 km	BT loss (dB) @ 370 km
500	223.4	214.0
1000	219.8	210.0
1500	216.9	206.6
2000	214.4	203.6
2500	212.1	200.6
3000	209.9	197.8
3500	207.8	194.9
4000	205.7	192.1
4500	203.6	189.3
5000	201.6	186.6
5500	199.5	183.5
6000	197.4	179.7
6500	195.3	173.7
7000	193.2	161.8
7500	191.1	153.8
8000	189.0	153.7
8500	186.8	153.6
9000	184.4	153.4
9500	181.4	153.3
10000	177.5	153.2
10500	170.5	153.1
11000	161.0	153.0
11500	155.6	152.9
12000	155.5	152.7
12500	155.4	152.6
13000	155.3	152.6

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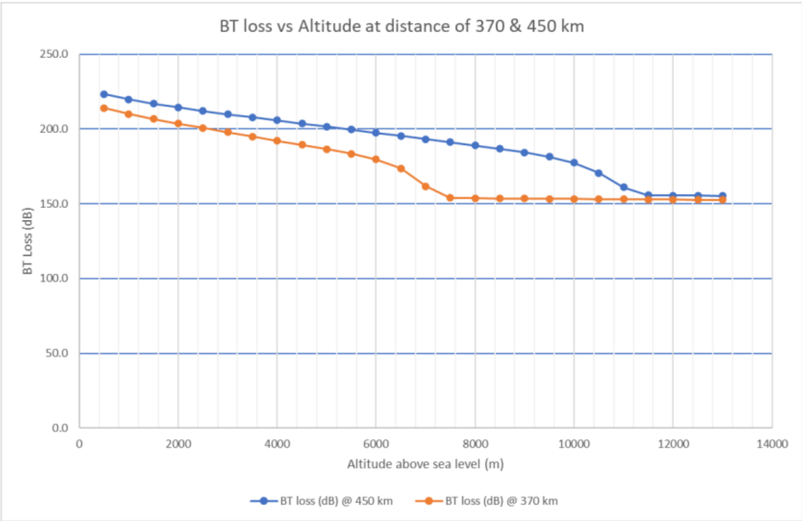
FIGURE 8.2-2

Basic Transmission Loss against altitudes



8.2.1 Observation

~~An airborne station of the aeronautical mobile service is mobile and can therefore mitigate interference by moving to a practical altitude and at a practical distance so that terrestrial stations that may cause interference are beyond its radio horizon.~~

~~*Editor's note: Concerns were raised wrt. the principle of interference mitigation proposed in Section 8.2.1. On the other hand a view was expressed that the Observation provides a mitigation measure which may need to be considered under all studies. Further review of the 8.2.1 requeired.*~~

At specific minimum separation distances and maximum altitudes, the basic transmission loss is high enough to provide the isolation needed to comply with the pfd_{agg} limit given in Section 8.1.2

8.2.1.1 Isolation for BS output of 48 dBm/MHz and pfd_{agg} = -113.78 dB(W/(m². MHz))

Isolation = BS output e.i.r.p (dBW/MHz) – Ae - pfd_{agg} – Building Entry Loss dB

= 167.0 dB

where,

BS output = Maximum Non-AAS BS output power/sector (e.i.r.p.) = 64 dBm in 40 MHz

= 48 dBm/MHz

= 18 dBW/MHz, for Urban/suburban macro deployment

Ae = 10log($\left(\frac{\lambda^2}{4\pi}\right)$ =-35.26 dBm^2

From Section 8.1: assume a wavelength of 0.0612m (corresponding to a frequency of 4 900 MHz) which yield an effective aperture constant ($\left(\frac{\lambda^2}{4\pi}\right)$ of 0.000298

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pfd_{agg} = - 113.7 dB(W/(m^2. MHz))

Building entry loss = 0 dB for outdoor deployment

8.2.1.2 Basic transmission loss to produce isolation of 167 dB

At a minimum separation distance of 200km and ~~maximum altitude of~~up to 1250m AMSL, the basic transmission loss is 176.6[5] dB, providing a margin of nearly 10 dB over the required isolation of 167 dB for Urban/suburban macro deployment at the coast.

The distance of 200 km is selected to serve as an example. The distance could be less if the ~~maximum~~ altitude is lower. The basic transmission loss is at least 176.8 dB at a maximum distance of 150km at altitudes up to 500m. The ~~maximum~~ altitude can be higher if the separation distance is further: at 370 km, 6000m the basic transmission loss is 179.7[6] dB.

~~The maximum separation distance and maximum altitude to be determined by WRC-23~~

8.3 Conclusions

TBD

9 Regulatory Studies

Note: it is important and fundamental to identify relevant part of Section 9 which could be included in Section 5 of the CPM text. Similarly, it is also essential to identify other elements of Section 9 which could be included in Section 3 of the CPM text.

9.1 Provisions of the Radio Regulations for the band 4800-4990 MHz

Provisions RR No. **5.441B** stipulates:

Quote

> "**5.441B** In Angola, Armenia, Azerbaijan, Benin, Botswana, Brazil, Burkina Faso, Burundi, Cambodia, Cameroon, China, Côte d'Ivoire, Djibouti, Eswatini, Russian Federation, Gambia, Guinea, Iran (Islamic Republic of), Kazakhstan, Kenya, Lao P.D.R., Lesotho, Liberia, Malawi, Mauritius, Mongolia, Mozambique, Nigeria, Uganda, Uzbekistan, the Dem. Rep. of the Congo, Kyrgyzstan, the Dem. People's Rep. of Korea, Sudan, South Africa, Tanzania, Togo, Viet Nam, Zambia and Zimbabwe, the frequency band 4 800-4 990 MHz, or portions thereof, is identified for use by administrations wishing to implement International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. The use of IMT stations is subject to agreement obtained under No. **9.21** with concerned administrations, and IMT stations shall not claim protection from stations of other applications of the mobile service. In addition, before an administration brings into use an IMT station in the mobile service, it shall ensure that the power flux-density (pfd) produced by this station does not exceed −155 dB(W/(m^2 · 1 MHz)) produced up to 19 km

[5] Frequency = Base station antenna height = 25m, frequency = 4900 MHz, vertical polarisation, time percentage = 5%

[6] Frequency at 4800 MHz

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above sea level at 20 km from the coast, defined as the low-water mark, as officially recognized by the coastal State. This pfd criterion is subject to review at WRC-23. Resolution **223 (Rev.WRC-19)** applies. This identification shall be effective after WRC-19. (WRC-19)"

Unquote

Editor's note: The results of the study could have impact on this footnote. This may need to be reviewed and revised, as appropriate, under AI 1.1.

Resolution **223 (Rev.WRC-19)** establishes additional conditions for the band 4 800-4 990 MHz. In particular, Resolution **223 (Rev.WRC-19)** *decides*:

3 that in the frequency bands 4 800-4 825 MHz and 4 835-4 950 MHz, in order to identify potentially affected administrations when applying the procedure for seeking agreement under No. ***9.21*** *by IMT stations in relation to aircraft stations, a coordination distance from an IMT station to the border of another country equal to 300 km (for land path)/450 km (for sea path) applies;*

4 that in the frequency band 4 800-4 990 MHz, in order to identify potentially affected administrations when applying the procedure for seeking agreement under No. ***9.21*** *by IMT stations in relation to fixed-service stations or other ground-based stations of the mobile service, a coordination distance from an IMT station to the border of another country equal to 70 km applies;*

5 that the power flux-density (pfd) limits in No. ***5.441B****, which is subject to review at WRC-–23, shall not apply to the following countries: Armenia, Brazil, Cambodia, China, Russian Federation, Kazakhstan, Lao P.D.R., Uzbekistan, South Africa, Viet Nam and Zimbabwe.*

9.2 The analysis of the regulatory conditions for the protections of stations of the aeronautical mobile service

9.2.1 Analysis of Mobile service allocations and their use for AMS applications in the 4 800-4 990 MHz band

The frequency range 4 400-4 990 MHz is allocated on a primary basis in all three ITU regions to the mobile service. Under the mobile service allocation, systems and networks operating in the aeronautical mobile service comprise stations for broadband, airborne data-links to support remote sensing and stations of aeronautical mobile telemetry. RR No. **5.442** states:

In the frequency bands 4 825-4 835 MHz and 4 950-4 990 MHz, the allocation to the mobile service is restricted to the mobile, except aeronautical mobile, service. In Region 2 (except Brazil, Cuba, Guatemala, Mexico, Paraguay, Uruguay and Venezuela), and in Australia, the frequency band 4 825-4 835 MHz is also allocated to the aeronautical mobile service, limited to aeronautical mobile telemetry for flight testing by aircraft stations. Such use shall be in accordance with Resolution ***416 (WRC-07)*** *and shall not cause harmful interference to the fixed service. (WRC-15)*

Table XX below provides a summary of the regulatory status of aeronautical mobile service in the various portions of the band as an easy reference and for better understanding of the situation.

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TABLE XX

Status of Aeronautical Mobile Service in 4 800-4 990 MHz

Editor's note: This table may be revisited

	Region 1	**Region 2**	**Region 3**
4 800-4 825	Mobile primary	Mobile primary and, in addition, AMT may be used for aeronautical mobile telemetry for flight testing by aircraft stations (except Brazil, Cuba, French overseas departments and communities, Guatemala, Paraguay, Uruguay and Venezuela). Reference: RR No. **5.440A**	Mobile primary and, in addition, AMT may be used in Australia for aeronautical mobile telemetry for flight testing by aircraft stations Reference: RR No. **5.440A**
4 825-4 835	Mobile primary, allocation restricted to the mobile, except aeronautical mobile, service. Reference: RR No. **5.442**	Mobile primary, allocation restricted to the mobile, except aeronautical mobile, service. And, in addition, Aeronautical mobile service is allocated in Region 2 except in Brazil, Cuba, Guatemala, Mexico, Paraguay, Uruguay, and Venezuela, but limited to aeronautical mobile telemetry for flight testing by aircraft stations. Reference: RR No. **5.442**	Mobile primary allocation restricted to the mobile, except aeronautical mobile, service. Ad, in addition, Aeronautical mobile service is allocated in Australia but limited to aeronautical mobile telemetry for flight testing by aircraft stations. Reference: RR No. **5.442**
4 835-4 940	Mobile primary	Mobile primary and, in addition, AMT may be used for aeronautical mobile telemetry for flight testing by aircraft stations (except Brazil, Cuba, French overseas departments and communities, Guatemala, Paraguay, Uruguay and Venezuela) Reference: RR No. **5.440A**	Mobile primary and, in addition, AMT may be used in Australia for aeronautical mobile telemetry for flight testing by aircraft stations Reference: RR No. **5.440A**
4 940-4 950	Mobile primary	Mobile primary	Mobile primary
4 950-4 990	Mobile primary, allocation restricted to the mobile, except aeronautical mobile, service. Reference: RR No. **5.442**	Mobile primary, allocation restricted to the mobile, except aeronautical mobile, service. Reference: RR No. **5.442**	Mobile primary, allocation restricted to the mobile, except aeronautical mobile, service. Reference: RR No. **5.442**

9.2.2 Analysis of Recommendation ITU-R M.2116 on the use of Airborne data links (ADL)

Recommendation ITU-R **Error! Hyperlink reference not valid.**, which is currently being revised, provides technical characteristics and protection criteria for aeronautical mobile service systems operating in the 4 400-4 990 MHz frequency range.

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As stated in *considering a)* of Recommendation ITU-R M.2116, “systems and networks operating in the aeronautical mobile service are used for broadband, airborne data-links to support remote sensing, e.g. earth sciences, land management, energy distribution, etc., applications”.

In addition, Recommendation ITU-R M.2116 states that “...aeronautical mobile data links are operated between aeronautical stations and aircraft stations, or between aircraft stations equipped with AMS data links (ADL) and can be deployed anywhere within a country whose administration has authorized their use in accordance with regulations”.

The working document towards a preliminary draft revision to Recommendation ITU-R M.2116-0, contained in WP 5B Chairman's Report #26, indicates that some countries are operating AMS systems in support to disaster relief and search and rescue activities within international airspace.

However, it should be understood that the AMS systems in the Recommendation ITU-R M.2116 in frequency bands 4 800-4 990 MHz do not operate in support of safety of life aeronautical applications.

Editor’s Note: Ad-Hoc WRC 23 AI 1.1 could not consider this document beyond this point. Inputs for the subsequent sections are therefore preserved in track change and respective colour highlight for possible consideration at the June 2022 meeting.

9.2.3 Analysis of the use of the bands for aeronautical mobile telemetry (AMT)

The use of the frequency band 4 800-4 990 MHz for AMT in Region 2 (except some countries) and in Australia is subject to RR No. **5.440A**[7], No. **5.442**, and Resolution **416 (WRC-07)**, which decides that in the portions of the frequency band 4 800-4 990 MHz where it is permitted, AMT emissions are limited to transmission from aircraft stations only (see RR No. **1.83**).

Here the use of AMT stations is only related to country use. ~~and therefore implementations of AMT in international airspace is not relevant.~~ except as noted in Figure 1 of Report ITU-R M. 2119 in the case of one administration. In accordance with Resolution **416 (WRC-07)** transmissions limited to designated flight test areas, where flight test areas are airspace designated by administrations for flight testing.

In accordance with Resolution **416 (WRC-07)** in the band 4 800-4 990 MHz, also AMT in the aeronautical mobile service is not considered an application of a safety service as per RR No. **1.59**.

In ~~the~~ any case ~~that~~ where the receiver is ground based, protection of the AMS stations is ~~not~~ covered by ~~the pfd limit applying to protect systems operating in international sea and airspace and is rather ensured by~~ the ~~fact~~ provision that the use of IMT by an administration is subject to an agreement under RR No. **9.21**, pursuant to RR No. **5.441B**. Therefore, a pfd limit at the 19 km above sea level is not required for the protection of the aeronautical telemetry in this case.

In accordance with RR No. **5.440A** any use of AMT does not preclude the use of this band by other mobile service applications or by other services to which this band is allocated on a co-primary

[7] ***5.440A*** In Region 2 (except Brazil, Cuba, French overseas departments and communities, Guatemala, Paraguay, Uruguay and Venezuela), and in Australia, the band 4 400-4 940 MHz may be used for aeronautical mobile telemetry for flight testing by aircraft stations (see No. **1.83**). Such use shall be in accordance with Resolution **416 (WRC-07)** and shall not cause harmful interference to, nor claim protection from, the fixed-satellite and fixed services. Any such use does not preclude the use of this band by other mobile service applications or by other services to which this band is allocated on a co-primary basis and does not establish priority in the Radio Regulations. (WRC-07)

Commented [USA1]: USA note: as proposed by doc 5D/944 Figure 1 in Report ITU-R M.2119 indicates that at least one administration conducts AMT operations in international airspace.

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basis and does not establish priority in the Radio Regulations. According to Resolution **416 (WRC-07)** in the frequency band 4 400-4 940 MHz it is necessary to carry out bilateral coordination of transmitting AMT aircraft stations in relation to the fixed and mobile receiving stations when an AMT aircraft station is located within a distance of 450 km from the receiving fixed or mobile stations.

Editor's note: From USA (Doc **Error! Hyperlink reference not valid.***)*

[However, iIt should be noted that the application of RR No. **9.21** to the mobile stations in the frequency band 4 400-4 940 MHz in accordance with RR. No. **5.441B** with respect to AMT stations, is not in conflict with does not contradict Resolution **416 (WRC-07)** because RR No. **9.21** applies to the AMT receiver and Resolution **416 (WRC-07)** applies to the AMT transmitter. Because there is no priority established in the Radio Regulations both provisions shall be applicable. In other words, reading RR No. **5.440A** in harmony with RR No. **5.441B** leads to the observation that, while other applications of the mobile service, such as IMT, are not precluded by AMT (RR No. **5.440A**), IMT must still satisfy , the conditions for operation in the band 4 800-4 990 MHz such as agreement obtained under RR No. **9.21** with concerned administrations in (RR No. **5.441B**) shall still apply.].

RR No. **5.441B** states that "The use of IMT stations is subject to agreement obtained under No. **9.21** with concerned administrations, and IMT stations shall not claim protection from stations of other applications of the mobile service." RR No. **5.441B** goes on to establish the pfd criterion for IMT protection of the aeronautical and maritime mobile services to be reviewed at WRC-23. Moreover, Resolution **223 (Rev. WRC-19)** establishes additional conditions for IMT use of the band 4 800-4 990 MHz. In particular, it *decides:*

3 that in the frequency bands 4 800-4 825 MHz and 4 835-4 950 MHz, in order to identify potentially affected administrations when applying the procedure for seeking agreement under No. ***9.21*** *by IMT stations in relation to aircraft stations, a coordination distance from an IMT station to the border of another country equal to 300 km (for land path)/450 km (for sea path) applies;*

4 that in the frequency band 4 800-4 990 MHz, in order to identify potentially affected administrations when applying the procedure for seeking agreement under No. ***9.21*** *by IMT stations in relation to fixed-service stations or other ground-based stations of the mobile service, a coordination distance from an IMT station to the border of another country equal to 70 km applies;*

Editor's note: From RUS (Doc 5D/779)

[However, it should be noted that in the case above the application of RR No. **9.21** to the mobile stations in the frequency band 4 400-4 940800-4 990 MHz in accordance with RR. No. **5.441B** with respect to AMT stations does not contradict is not in conflict with Resolution **416 (WRC-07)** because RR No. **9.21** applies is relevant to the protection ofto the AMT receiver and Resolution **416 (WRC-07)** applies to AMT transmitterthe protection of fixed and mobile service. At the same time in accordance with Resolution **416 (WRC-07)** administrations authorizing AMT per RR Nos **5.440A**, **5.442** in the bands 4 400-4 940 MHz shall implement technical and/or operational measures on AMT where appropriate to facilitate sharing with other services and applications in these bands. Because Based on the fact that there is no priority established in the Radio Regulations both provisions shall may be applicable. In other words, reading RR No. **5.440A** in harmony with RR No. **5.441B** leads to the observation that, while other applications of the mobile service, such as IMT, are not precluded by AMT, the conditions in RR No. **5.441B** shall still apply.]

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Other cases of implementation of AMT stations not relevant to RR Nos **5.440A** and **5.442** cases or cases of operation of AMT in international airspace/waters in the band 4 800-4 990 MHz were not considered in the Radio ~~r~~Regulations and ITU-R Recommendation and Reports (except as noted in Figure 1 of Report ITU-R M.2119). In accordance with Resolution **416 (WRC-07)** and Report ITU-R M.2119 the studies have been conducted within ITU-R concerning only the sharing and compatibility of AMT for flight testing with other services in the bands 4 400-4 940 MHz. In the case of no use of AMT in international airspace~~, the~~ study ~~on~~of conditions of its protection is not required and therefore, ~~a~~ pfd limit in the band 4 800-4 990 MHz is not relevant for AMT.

Comment – In some regional organisations the band 4 800-4 990 MHz is not considered for AMT (e.g. CEPT in accordance to ERC Recommendation 62-02 the only band recommended for AMT is 2 300-2 400 MHz).

*Editor's note: Further clarification might be needed on how provision RR No. **9.21** and Res. **416 (WRC-07)** work together. More information about usage of aeronautical mobile telemetry in international airspace and waters might be needed.*

9.2.4 Analysis of existing practice to protect stations in AMS in the international airspace

There is common understanding that no country has jurisdiction over the use of spectrum in international airspace/waters.

According to the provision in RR No. **8.1**, "The international rights and obligations of administrations in respect of their own and other administrations' frequency assignments shall be derived from the recording of those assignments in the Master International Frequency Register (the Master Register) or from their conformity, where appropriate, with a plan. Such rights shall be conditioned by the provisions of these Regulations and those of any relevant frequency allotment or assignment plan."

However, there is no specific notification and registration procedure in international airspace and waters for frequency assignments of AMS and MMS stations in this band pursuant to RR No.**11.14**. Such situation does not provide possibility to obtain international rights recognition in respect to frequency assignments of AMS stations in international airspace and waters and to claim protection against subsequent assignments from another country taking into account Article RR 8.1, taking also into account that there is no frequency allotment or assignment Plan in the 4 800-4 990 MHz frequency band for the AMS nor MMS services. Therefore, protection of AMS/MMS stations in international airspace/waters on the basis of registration of frequency assignments is not feasible. At the same time, it should be noted that AMS/MMS frequency assignments for coast and aeronautical stations can cover a service area which overlaps with international airspace/waters. For this case (such as in Figure 1 of Report M.2119), application of No. **9.21** would enable the protection of AMS/MMS stations in the international airspace covered by the service area.

The inability to address protection of AMS/MMS stations in international airspace/waters via the registration procedure in accordance with RR Article **11.14** does not exclude the possibility of applying other mechanisms, through current and future provisions in the Radio Regulations.

Within international airspace the operation of AMS shall comply with the Radio Regulations. Analysis of Radio Regulations indicates that certain measures can be applied to mitigate harmful interference to aeronautical mobile stations outside national territories. Mechanisms for enabling the protection of AMS in international airspace include the following:

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- Pfd limit, at a certain height and distance from the coast as in RR **5.441B**. It should, however, be noted that **5.441B** is under review and is set to be reconsidered at WRC-23, under agenda item 1.1.
- Measures based on frequency planning

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It can be noted that:

- the Radio regulation specifically provides for the international protection of frequencies relating to distress and safety and flight safety and control use in RR (e.g. Article **31** and Appendix **27**) which operated in AMS or MMS. However, it should be noted that 4 800-4 990 MHz frequency band is neither a GMDSS frequency band nor an AM(R)S frequency band.
- RR No. **9.21** may enable the protection of some zones in international airspace /waters that are in the service area of AMS land stations. This solution is therefore valid only for very specific area/cases and not for the general case of operations in international airspace/water. Therefore the use of 9.21 may be applicable in some areas/cases without additional measures.

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Based on the review of current RR, it is observed that:

- There are examples of RR footnotes providing protection for services in international airspaces and waters, such as **5.502** and **5.509D** and,
- There are cases where no specific measures are provided to protect mobile service systems operated in international airspace or waters (e.g. all the bands identified for IMT except the band 4 800-4 990 MHz which is currently under review).
- There are cases wherein mobile service systems operated in international airspace or waters protect authorized stations operating within national territories. (e.g. ESV, IMT onboard vessels and aircrafts).

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This variety of situations is likely to reflect the differences of circumstances under which WRC have decided a new allocation or identification.

It should, be noted that RR No. **5.509D** addresses the case of restriction on FSS earth stations in order to protect stations in international airspace. As for mobile service systems which can also operate in the 14.5-14.8 GHz band (e.g. see Recommendation M.2068 “Characteristics of and protection criteria for systems operating in the mobile service in the frequency range 14.5-15.35 GHz”) there are no limitations placed on their operation on the national territories.

It should also be noted that the provision of No. **5.502** RR protects stations both in national and international waters, but are is not related to international airspace.

Editor’s note: an alternative revision to the sentence above is proposed below:

It should also be noted that the provision of RR No.**5.502** RR protects stations both in national and international waters, but are not related to international airspace.

~~*Editor’s Note: Further discussion is needed to reconcile and agree on the text below:*~~

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Most elements below are already touched upon in the text above, for example the reference to "cases where no specific measures are provided" or the "differences of circumstances under which WRC have decided a new allocation or identification". It is therefore proposed to delete the 2 options.

~~[Option 1:~~ Comparison of other similar cases where we have IMT identification and aeronautical mobile service in the Radio ~~regulations~~ *Regulations* and administrations operate~~s~~ AMS ~~services~~ *systems* in accordance ~~to~~ *with the* relevant Recommendations (**Error! Hyperlink reference not valid.**, **Error! Hyperlink reference not valid.**, etc.) with the case of 4 800-4 990 MHz band ~~demonstrates~~ *suggests* that it is not possible to ~~make a conclusion~~*conclude* that *the* situation~~s~~ ~~on~~ *with* the use of ~~the~~ *such* bands differ ~~one from each other.~~*from one another.*

It should also be noted that for countries of Region 2, in a similar situation ~~in~~ *whithin* the band 4800-4990 MHz, RR No **5.441A** does not define additional measures like a pfd limit for the protection of the ~~aeronautical mobile service~~ AMS or MMS stations in the band 4 800 - 4 900 MHz against possible interference from IMT stations.

~~Option 2:~~*On the other hand* ~~C~~*c*omparison with cases where there are pfd limits to protect stations in international airspace and waters show that the decisions made by relevant WRC~~s~~ are based on their considerations of existing services and applications at that time, based on the principle that incumbent services and applications have to be protected. Therefore, when there is a significant incumbent usage, WRC *may* take~~s~~ measures to provide for protection. *Similar measures,* such as ~~WRC-15 with~~ the pfd limit of RR No. **5.441B**, were discussed by WRC-15 and WRC-19, *however no final decision has been taken yet.* ~~]~~

Editor's note: an alternative revision to the paragraph above is proposed below:

Option 2: ~~Comparison with cases where there are pfd limits to protect stations in international airspace and waters show that t~~The decisions made by relevant WRC are based on their considerations of existing services and applications at that time, based on the principle that incumbent services and applications have to be protected. Therefore, when there is a significant incumbent usage, WRC takes measures to provide for protection~~, such as WRC-15 with the pfd limit of **5.441B**.~~ However, the protection of AMS and MMS operated in international airspace and waters in 4800-4990 MHz frequency band was explicitly raised for the first time in this agenda item]

9.3 The analysis of the regulatory conditions for the protection of stations of the maritime mobile service

The frequency range 4 800-4 990 MHz is allocated, on a primary basis in all three ITU regions, to the mobile service. As the mobile allocation is generic, the band or portions of it, can be used by stations of maritime mobile service in accordance with the Radio Regulations. With specific reference to the status of the maritime mobile service in this band, there are no band-specific restrictions in the RR and therefore station of that service can use any part of the band.

~~*Editor's note: From RUS (Doc 5D/779*~~

[However, MMS stations in the band 4 800-4 990 MHz are not registered in MIFR. The stations are only authorized by the administration of the flag state of ship and such authorizations do not provide exclusivity on spectrum usage for MMS systems in international waters. There are no frequency allotment or assignment plans for MMS in this band.]

These elements were already discussed in 9.2.4. for AMS. Instead of replicating the same debate, it is proposed to delete the text in square brackets to to refer to 9.2.4

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~~[However,~~ Section 9.2.4 addresses the fact that there is no specific notification and registration procedure in international airspace and waters for frequency assignments of AMS and MMS stations and the regulatory consequences. ~~MMS stations in the band 4 800-4 990 MHz are not registered in MIFR. The stations are only authorized by the administration of the flag state of ship and such authorizations do not provide exclusivity on spectrum usage for MMS systems in international waters. There are no frequency allotment or assignment plans for MMS in this band.]~~

RR No. **5.441B** provides a pfd limit, which is subject to review by WRC-23, applicable in the band 4 800-4 990 MHz based on assumptions relevant to AMS. In practice, the existing provisions of RR No. **5.441B** protects MMS operations in international waters. However, it should be confirmed, based on the studies under WRC-23 agenda item 1.1, whether specific measures are required for the protection of MMS in international waters, if any, also taking into account allocations in the various portions of the band.

~~Ed note: Proposed Ed Notes below were not fully agreed at Meeting 37. They will be further considered at a future Meeting.~~

[Editor's note: The use of the band 4 800-4 990 MHz for the maritime mobile service (MMS) has not been considered until WRC-19. Development of ~~technical criteria such a specific pfd limit any possible measures~~ for the protection of the MMS in international waters, if necessary, requires appropriate studies. In this regard, Recommendation ITU-R M.2116, under revision process, provides technical characteristics and protection criteria for the systems operating in the maritime mobile service within the 4 400-4 990 MHz frequency range]

~~[Editor's note: The use of the band 4 800-4 990 MHz for the maritime mobile service (MMS) has not been considered until WRC-19. Development of technical criteria such a specific pfd limit for the protection of the MMS in international waters, if necessary, requires appropriate studies. In this regard, Recommendation ITU-R M.2116, under revision process, provides technical characteristics and protection criteria for the systems operating in the maritime mobile service within the 4 400-4 990 MHz frequency range~~

It should be noted that MMS systems within the band 4 800-4 990 MHz were only recognized as an actual user of the band by WRC-19. Before WRC-19 no studies with regard to compatibility between IMT and MMS had been conducted and MMS characteristics were not available either. Therefore, MMS systems in the band 4800-4990 MHz cannot be considered as an incumbent user compared to IMT systems.

[~~Editor's note: some text about application of maritime mobile service in international waters to be developed]~~

~~Editor's note: from RUS (doc 5D/779~~

Editor's note: it is proposed to discuss further next three paragraphs noting the comments expressed

[~~[To demonstrate t~~The current experience and principles of regulation of systems operated in international waters show that the technical and regulatory restrictions are brought to the new service or application. For ~~the~~ example of Resolution **902 (WRC-03)** ~~can be used. This Resolution~~ provides the regulatory framework for ESV in the bands 5 925-6 425 MHz and 14-14.5 GHz with ~~. The Resolution defines~~ distances from the low-water mark as officially recognised by the coastal

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State within which permission from potentially affected administrations must be obtained, in order to protect fixed service. This is justified by the fact that fixed service was existing before ESV were authorized in this band. *It is also similar to the situation in the band 4800-4990 MHz where IMT systems were introduced before MMS systems.*

~~Similar example can be given to demonstrate~~ *~~Similarly, s~~* Some *other* regulatory measures applied for IMT systems used on board of vessels ~~. Some measures were~~ developed at regional levels in order to provide *~~interference-free operation towards~~protection to* the existing systems operated by administrations ~~on~~*in* their national territories ~~and there are no limitations put on the IMT systems used in the land.~~

~~T~~hus in the above mentioned examples the priority ~~into~~ *have* protection ~~is~~*was* given to *the* existing ~~other~~ systems *operated in national territories, which is also relevant to IMT systems in the band 4800-4990 MHz.* [~~In the case of the frequency band 4.8-4.99 GHz,,MMS was incumbent service with existing applications andWRC-15 decided to protect such use from the new application (ie IMT).~~] ~~operated by administrations in their national territories rather than systems operated in international waters. And there are no requirements to protect~~ systems in international waters. ~~.~~]

Editor's note: the text below is proposed to replace the text above up to the next Editor's note

These elements were already discussed in 9.2.4. for AMS. Instead of replicating the same debate, it is proposed to delete the text in square brackets and to refer to 9.2.4

The mechanisms for enabling the protection of MMS in international waters are the same as for AMS in international airspace, as well as the analysis of the current regulations (see section 9.2.4)

10 [~~Conclusions~~/Provisional Summary] on the technical and regulatory studies

~~Editor's note: From FRA (Doc 5D/827~~

~~Editorial note : Text taken from 9.2.5. It may be better to keep only one text (i.e. to remove 9.2.5). This text is also proposed for section 3 of the draft CPM report for AI 1.1~~

[Editor's note: this sections reflects preliminary results and can be review at following meetings taking into account the comments expressed and further contributions.]

This sections contains summary of the results of the studies of technical and regulatory conditions for the protection of AMS and MMS stations located in international airspace or in international waters (i.e. outside national territories) and operating in the frequency band 4 800-4 990 MHz.

Technical studies

TBD

Regulatory studies

Based on the allocation of AMS in the Radio regulations ~~T~~the protection of aeronautical stations might be considered and discussed only for the frequency bands 4 800-4 825 MHz and 4 835-4- 950 MHz and not for the whole band 4 800-4 990 MHz.

[The existing provisions of RR No. **5.441B** protects MMS operations in international waters, it should be confirmed, based on the studies under WRC-23 agenda item 1.1, whether specific

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Commented [RUS3]: The allocation to MS existed for many years. So LMS and MMS were allocated at the same time. There is no evidance that MMS was an incumbent application berfore IMT. It never been studied before WRC-19. So it looks that IMT came first. Moreover WRC-19 did not decide on protection of services in international airspace and waters.

Commented [RUS4]: It is obvious that applications of other services are not directly aplicable to the case of MMS. At the same time we see that MMS usually is not protected from other services except plan frequencies and GMDSS case. Similarly to AMS case we see that in all IMT bands MMS can be implemented without any additional measures for its protection. In opposite the IMT onbards vessels, which look like MMS, should protect stations on the land. Moreover before WRC-15 and WRC-19 we did not consider MMS as an application in the band 4800-4990 MHz. From this point of view indeed MMS applications can be concidered as a newcomer comparing to IMT.

Commented [FE5]: There is no point to say that since in some cases the priority is given to land deployment against ESV or other it should be always the case. WRC are taking into account who is the newcomer and who is the incumbent. In this case, IMT was the new application against incumbent AMS/MMS

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measures are required for the protection of MMS in international waters, if any, also taking into account allocations in the various portions of the band

~~The protection of ship stations under MMS was ensured through the pfd limit derived for the protection ofAMS. Specific technical provision could be considered for the protection of MMS in international waters, in particular in the portion of the band where AMS has no right for protection.]~~

[The protection of ship stations under MMS ~~wascan be~~ was ensured~~, in practice,~~ through the ~~existing provisions of No. **5.441B**provisions~~ pfd limit derived for the protection of~~relevant to~~ AMS. Specific technical provision ~~would~~could be ~~necessary~~considered for the protection of MMS in international waters, in particular in the portion of the band where AMS has no right for protection.]

~~[The protection of ship stations under MMS wascan be was ensured, in practice, through the existing provisions of No. **5.441B**provisions pfd limit derived for the protection ofrelevant to AMS. Specific technical provision wouldcould be necessaryconsidered for the protection of MMS in international waters, in particular in the portion of the band where AMS has no right~~ for protection.]

Alternative text (to be used instead of paragraph above): The protection of MMS systems against the possible interference from IMT stations is not justified for those MMS systems that are not registered in the Master Register, moreover the implementation of MMS systems in the band 4800-4900 MHz began after IMT was brought in use in accordance with the Radio regulations.

There is common understanding that no country has jurisdiction over the use of spectrum in international airspace/waters.

As mentioned in section 1, there is a certain relationship between the various activities of states within the "exclusive economic zone" (up to 370 km from the baselines from which the breadth of the territorial see is measured) of a coastal State regulated by the UNCLOS and those related to the use of the radio spectrum regulated by the ITU RR.

According to the UNCLOS, even all states have freedom of navigation and overflight within the exclusive economic zone of a coastal State, they shall have due regard to the rights and duties of this coastal State and shall comply with the laws and regulations adopted by this coastal State. This is a fundamental principle that governs the respective priorities for the various types of activities exercised by a costal State within its exclusive economic zone and by other states.

Although the use of radio spectrum is not directly governed by the UNCLOS, certain restrictions on the use of radio equipment onboard ships and aircraft may emerge as a result of a special regulatory regime established by a costal State in a part of its exclusive economic zone.

Based on the above, the view that AMS /MMS systems in international airspace and waters (i.e. outside national territories) should be unconditionally protected contradicts with one of the basic principles of the UNCLOS establishing a higher priority of coastal states in their respective exclusive economic zones over other states.

Therefore the unconditional protection of AMS/MMS systems authorized by other States cannot be provided when operating within the exclusive economic zones of costal States.

[However, the ~~administrations may agree on tThe~~ application of technical provisions such as pfd limits ~~is~~can be a ~~which is the only can be the only~~ regulatory means to protect stations of the aeronautical ~~and maritime~~ mobile services located in international airspace and waters (i.e., outside national territories)- under the agreement between related countries since there is no notification and registration procedure for frequency assignments in international airspace and waters.] Such a means could be an option to protect stations of AMS in international airspace and waters subject to

Commented [ANFR6]: Alignment with the agreed text in 9.3

Commented [RUS7]: For the protection of MMS, if needed, we cannot apply one pfd in entire band. We have parts of the band which are not allocated to AMS. We can also condider other measure for protection of MMS if required.

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Commented [8]: For the protection of MMS, if needed, we cannot apply one pfd in entire band. We have parts of the band which are not allocated to AMS. We can also condider other measure for protection of MMS if required.

Commented [9]: MMS was not mention until the establish of WRC-23 AI 1.1. It can be considered that the pfd limit in current version of 5.441B is not related to MMS.

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Commented [RUS10]: Indeed in the case where stations of AMS or MMS are not known it is not efficent to limit other applications generally. It should be a balance between possible limitation of IMT and posibility of use of AMS in the areas where IMT implemented. We dont know about usage of AMS and MMS. Comparing to other IMT bands we dont see the diference in level of use. In this case if AMS or MMS want to be protected they have to make something to become more visible. Otherwise it leads to inefficient of use of spectrum. Existing lack of registration procedures for AMS and MMS in international space is a problem of these services but not IMT. It looks like AMS and MMS try to solve their problems by expence of other applications which are not guilty in that.

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the consent of the concerned administrations of coastal states operating radio systems in their national territories.

[There are some cases in the Radio regulations where non-safety services operations are protected through PFD provisions, e.g. RR No. **5.502** for the protection of radars in the band 13.75-14 GHz and RR No. **5.509D** for the protection of AMS and MMS in the band 14.5-14.8 GHz from earth stations, following the introduction of new rights for FSS in these two bands at WRC-03 and WRC-15 respectively..]]

[

Option 1 : Comparison of other similar cases where we have IMT identification and aeronautical mobile service in the Radio regulations and administrations operates AMS services in accordance to relevant Recommendations (M.2114, M.2115, etc.) with the case of 4800-4990 MHz band demonstrates that it is not possible to make a conclusion that situation on the use of the bands differ one from each other.

It is proposed to use instead of the controversial text in square brackets and various options the agreed text from section 9.2.4

It is observed that:

- There are examples of RR footnotes providing protection for services in international airspaces and waters, such as No. **5.502** and No. **5.509D** and.
- There are cases where no specific measures are provided to protect mobile service systems operated in international airspace or waters (e.g. all the bands identified for IMT except the band 4 800 – 4 990 MHz).
- There are cases wherein mobile service systems operated in international airspace or waters protect authorized stations operating within national territories. (e.g. ESV, IMT onboard vessels and aircrafts).

This variety of situations is likely to reflect the differences of circumstances under which WRC have decided a new allocation or identification.

[There are other cases in the Radio regulations where non-safety services operations are protected through similarF provisions, e.g. RR No. **5.502** for the protection of radars in the band 13.75-14 GHz and RR No. **5.509D** for the protection of AMS and MMS in the band 14.5-14.8 GHz from earth stations, following the introduction of new rights for FSS in these two bands at WRC-03 and WRC-15 respectively.

Option 1: Comparison of other similar cases where we have IMT identification and aeronautical mobile service in the Radio regulations and administrations operates AMS services in accordance to relevant Recommendations (M.2114, M.2115, etc.) with the case of 4 800-4 990 MHz band demonstrates that it is not possible to make a conclusion that situation on the use of the bands differ one from each other.

Option 1: Comparison of other similar cases where we have IMT identification and aeronautical mobile service in the Radio regulations and administrations operates AMS services in accordance to relevant Recommendations (M.2114, M.2115, etc.) with the case of 4 800-4 990 MHz band demonstrates that it is not possible to make a conclusion that situation on the use of the bands differ one from each other.

Editor's note: the paragraph below provides editorial revision of the paragraph above proposed earlier]

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Commented [RUS11]: RUS proposes to keep the text and further discuss this paragraph. The foonotes RR 5.509D and 5.502 only show that in RR we have pfd applied towards the international space. At the same time the relevance to the band 4800-4900 MHz is misleading noting that in the band 14.5-14,8 GHz we do not have any limitations for applications of MS. The proposal is not to consider these examples (relevant to other services) in the context of 4800-4900 MHz. Or provide additional explanations where these cases relevant and where not.

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Comparison of other similar cases where we have IMT identification and aeronautical mobile service in the Radio Regulations and administrations operate AMS systems in accordance with the relevant Recommendations (ITU-R M.2114, ITU-R M.2115, etc.) with the case of 4 800-4 990 MHz band suggests that it is not possible to conclude that the situations with the use of such bands differ from one another.

Option 2: On the other hand Ccomparison with cases where there are pfd limits to protect stations in international airspace and waters show that the decisions made by relevant WRC are based on their considerations of existing services and applications at that time, based on the principle that incumbent services and applications have to be protected. It may be relevant to international airspace and waters provided that such protection was agreed by concerned administrations of coastal States . Therefore, when there is a significant incumbent usage, WRC takes measures to provide for protection, such as WRC-15 with the pfd limit of 5.441B

Option 2: Comparison with cases where there are pfd limits to protect stations in international airspace and waters show that the decisions made by relevant WRC are based on their considerations of existing services and applications at that time, based on the principle that incumbent services and applications have to be protected. Therefore, when there is a significant incumbent usage, WRC takes measures to provide for protection, such as WRC-15 with the pfd limit of 5.441B

[Editor's Note The following text was to be replaced by Option1/Option 2 but some additional elements may need to be kept in the final text]

[Though none of the provisions in the RR, apart from No. 5.441B which is under review, sets pfd limits on stations in the mobile service operating in the same frequency bands as stations in international airspace enjoying the protection via a pfd limit. Moreover, none of the frequency bands identified for IMT in the RR, apart from 4800-4990 MHz which is under review, has a pfd limit at certain distance from the cost attached in the footnote to the IMT identification as a condition, and it would be therefore reasonable to maintain this approach unless the concerned administrations decide otherwise.]] Several countries were excluded at WRC-19 from the application of the pfd limit in the band 4800-4990 MHz in accordance to Resolution 223 (rev.WRC-19). [The implementation of regulatory restrictions on IMT such as coordination mechanisms like RR 9.21 can not ensure protection in all cases (eg for transmissions not involving a land station) ,.][Therefore, WRC-23 need to consider technical and regulatory measures (e.g., PFD limit, TRP limit, etc.]) to provide the protection of AMS/MMS stations in international airspace/waters noting the need of other countries to use spectrum efficiently for IMT stations on their national territories.[]

Option 2: Comparison with cases where there are pfd limits to protect stations in international airspace and waters show that the decisions made by relevant WRC are based on their considerations of existing services and applications at that time, based on the principle that incumbent services and applications have to be protected. Therefore, when there is a significant incumbent usage, WRC takes measures to provide for protection, such as WRC-15 with the pfd limit of **5.441B**

[Editor's Note: The following text was to be replaced by Option 1/Option 2 but some additional elements may need to be kept in the final text]

[Though none of the provisions in the RR, apart from No. **5.441B** which is under review, sets pfd limits on stations in the mobile service operating in the same frequency bands as stations in international airspace enjoying the protection via a pfd limit. Moreover, none of the frequency bands identified for IMT in the RR, apart from 4 800-4 990 MHz which is under review, has a pfd limit at certain distance from the cost attached in the footnote to the IMT identification as a

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condition, and it would be therefore reasonable to maintain this approach unless the concerned administrations decide otherwise.]]

[The exclusion of sSeveral countries were excluded at WRC-19 from the application of the pfd limit in the band 4 800-4 990 MHz in accordance to Resolution **223 (Rev.WRC-19)**. This raises a question of fairness. also confirms the assumption that t[The implementation of regulatory additional specific technical restrictions on IMT such as is not necessary (other coordination mechanisms like RR No. **9.21** can not ensure protection in areas where no assignment can be notified)all cases (e.g. for transmissions not involving a land station) , and may lead to inefficient use of spectrum at the national territories.]

Option 1: Comparison of other similar cases where we have IMT identification and aeronautical mobile service in the Radio regulations and administrations operates AMS services in accordance to relevant Recommendations (M.2114, M.2115, etc.) with the case of 4 800-4 990 MHz band demonstrates that it is not possible to make a conclusion that situation on the use of the bands differ one from each other.

Coordination mechanisms like RR No. **9.21** can be used to provide protection for incumbent services through agreement with other administrations and can be complemented by additional technical measures to ensure protection.

[Therefore, WRC-23 need to may consider technical and regulatory other measures ([not necessarily based on a mandatorye.g., PFD limit, TRP limit, etc.]) to provide the protection of AMS/MMS stations in international airspace/waters noting the need of other countries to use spectrum efficiently for IMT stations on their national territories.-[Such measures can include coordination of the use of the frequency band by different applications in the mobile service through the application of RR **9.21** where appropriate and other measures like frequency planning. For the latter case an appropriate ITU-R Recommendation can be developed].]

Editor's note: below is an alternative to the paragraph above

[Therefore, WRC-23 need to may consider technical and regulatory other measures ([not necessarily based on a mandatorye.g., PFD limit, TRP limit, etc.]) to provide the protection of AMS/MMS stations in international airspace/waters Therefore, some other measures may be considered to eliminate the potential interference between AMS/MMS stations operated in international airspace or waters and IMT systems noting the need of other countries to use spectrum efficiently for IMT stations on their national territories.-[Such measures can include coordination of the use of the frequency band by different applications in the mobile service through the application of RR **9.21** where appropriate and other measures like frequency planning. For the latter case an appropriate ITU-R Recommendation can be developed].

[TBD]

Commented [RUS12]: If we are going to invent different refulation for this band it should be logicaly explained and based on concept and the provisions of RR. We cannot see the difference between 4800-4990 MHz comparing to other IMT bands. Probably this band is used by AMS more intensively but there is no proof for that. The example of 3.5 GHz only confirms this and there is flexibility to apply pfd limit and it is not placed to protect something in the air or ocean far from the border.

Commented [FE13]: The argument seems to say that since there is no other place where a there is pfd limit at a distance from the coast, so this should not apply in 4.8 GHz. With this argument, it could have been told that pfd at the border in 3.5 GHz could not be accepted since it was the first time for IMT with such a limit … All regulations for IMT have been in the past "a first time".

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Commented [FE14]: Frequency Plan can not be based on an ITU-R Recommendation, if this is restraining the use of spectrum in certain areas.

Commented [RUS15]: We believe that solution can be technical and rulatory. Frequency planning should not be excluded. Recommendation is not necessary for planning but for coordination of conditions among administrations.

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Commented [16]: Frequency Plan can not be based on an ITU-R Recommendation, if this is restraining the use of spectrum in certain areas.

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