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28 August 2021

ITU-APT Foundation of India (IAFI)[1]

DRAFT NEW APT REPORT ON VEHICLE MOUNTED EARTH STATIONS (VMES) OPERATING WITH GSO FSS NETWORKS IN THE KU-BAND IN APT COUNTRIES

Background

At the 27th meeting, it was planned to finalize the proposed new Report on "Vehicle-Mounted Earth Station (VMES) Operating with GSO FSS Networks in the Ku-Band in APT Countries". AWG-27 discussed the two received contributions and the preliminary draft new report was updated (AWG-27/TMP-03(Rev.2)). However, during the discussion at the 2nd WG Technology Aspects session, one administration raised concerns, such as whether the scope of this study completely falls into WG Technology Aspects, and its potential connection to a WRC-23 Agenda Item. AWG-27 therefore did not reach an agreement and decided to carry forward the document for further consideration at next AWG meeting.

Discussions

Under the revised AWG structure being considered in the CG on Restructuring, this kind of activity will fall under WG-SAM.

This Report provides usefulinformation on the current spectrum usage and future plans in the Ku-band (i.e.10.7-12.75 GHz and 14.0-14.5 GHz) and its related domestic regulations in the Asia-Pacific Region and it could help administrations using or planning to deploy land based ESIM (e.g. VMES) to understand the application and coordination regulation situation with other co-primary services, but also could facilitate the national efficient use of these bands.

Proposal

This contribution proposes to add information from India's National Frequency Plan to the working document contained in AWG/TMP-03 Rev.02. Further minor editorial updates to the working document are also proposed in the attachment.

It is proposed that this document may be further considered under the new WG SAM, as and when it is constituted.

[1] ITU-APT Foundation of India (IAFI) is a new Affiliate member of APT. Details of IAFI can be seen at itu-apt.org

Contact: IAFI Email: info@itu-apt.org

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DRAFT NEW APT REPORT ON VEHICLE MOUNTED EARTH STATIONS (VMES) OPERATING WITH GSO FSS NETWORKS IN THE KU-BAND IN APT COUNTRIES

1. Introduction

Land based earth stations in-motion (ESIM) are being deployed with GSO (geosynchronous orbit) networks operating in the frequency bands 10.7-12.75 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space) under the allocations made to the Fixed-Satellite Service (FSS). The space-to-Earth and Earth-to-space frequency bands are collectively called the Ku-band. The land based ESIM offer a range of communication services, including broadband and Internet of things. Vehicle Mounted Earth Stations (VMES) are applications of land based ESIM.Land based ESIM provide numerous two-way serviceswhich are of significant benefit to vehicle manufacturers and users on vehicles and trains.

Land based ESIM are to be deployed with GSO satellite networks already in operation or such networks that may be deployed in the future. Technical studies have been carried out by one of regional organizations (i.e. the CEPT) to assess the compatibility between land based ESIM and other services authorized in the 14-14.5 GHz band, namely the FS and the RAS. The 14-14.5 GHz band is allocated on a worldwide and primary basis to the FSS (Earth-to-space) in the ITU Radio Regulations and is generally available for satellite services.

It is noted that Land based ESIM including VMES may operate under FSS networks in the band 10.7-12.75 GHz and 14.0-14.5 GHz pursuant to Radio Regulations No. 4.4 which shall not claim protection from, nor cause interference to, other services having allocations in these bands. However, as pointed out in section 6 of this Report, some APT countries have already agreed to allow the deployment of VMES operations in their territories where Radio Regulation No. 4.4 does not apply, and specific national regulations apply. In addition, section 7 and section 8 of this Report give references on how to deploy VMES operations.

2. Scope

This Report is to provide information on the current spectrum usage and future plans in the Ku-band (i.e.10.7-12.75 GHz and 14.0-14.5 GHz) and its related domestic regulations in the Asia-Pacific Region. This could not only help those administrations who are using or planning to deploy land based ESIM (e.g. VMES) to understand the application and coordination regulation situation with other co-primary services, but also could facilitate the national efficient use of these bands. This Report will alsohelp to ensure that the authorization of land based ESIM within the APT countries subject to the harmonized conditions such as those stipulated in this report.

To complement the understanding of current and planned implementation of the land based ESIM within the region, some technical analysis has been possible taking into account the input material provided. The Group will be guided by contributions received for the meetings.

Vocabulary of terms

For the purposes of this Report, the following abbreviations apply:

ITU	: International Telecommunication Union
VMES	: Vehicle Mounted Earth Stations
ACMA	: Australian Communications and Media Authority
NFAP	: National Frequency Allocation Plan
ESIM	: Earth Stations in Motion

3. ITU Radio Regulations Allocations

In the Radio Regulations (2020edition), the frequency bands 10.7 – 12.75 GHz and 14.0 – 14.5 GHzare allocated in three Regions as follows:

10.7- 11.7 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
10.7-10.95 FIXED FIXED-SATELLITE (space-to-Earth) 5.441 (Earth-to-space) 5.484 MOBILE except aeronautical mobile	**10.7-10.95** FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE except aeronautical mobile	
10.95-11.2 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B (Earth-to-space) 5.484 MOBILE except aeronautical mobile	**10.95-11.2** FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B MOBILE except aeronautical mobile	
11.2-11.45 FIXED FIXED-SATELLITE (space-to-Earth) 5.441 (Earth-to-space) 5.484 MOBILE except aeronautical mobile	**11.2-11.45** FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE except aeronautical mobile	
11.45-11.7 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B (Earth-to-space) 5.484 MOBILE except aeronautical mobile	**11.45-11.7** FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B MOBILE except aeronautical mobile	

11.7- 12.75 GHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td rowspan="3">11.7-12.5
FIXED
MOBILE except aeronautical mobile
BROADCASTING
BROADCASTING-SATELLITE 5.492

5.487 5.487A</td><td>11.7-12.1
FIXED 5.486
FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.488
Mobile except aeronautical mobile 5.485</td><td rowspan="2">11.7-12.2
FIXED
MOBILE except aeronautical mobile
BROADCASTING
BROADCASTING-SATELLITE
5.492

5.487 5.487A</td></tr>
<tr><td>12.1-12.2
FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.488
5.485 5.489</td></tr>
<tr><td>12.2-12.7
FIXED
MOBILE except aeronautical mobile
BROADCASTING
BROADCASTING-SATELLITE
5.492

5.487A 5.488 5.490</td><td>12.2-12.5
FIXED
FIXED-SATELLITE (space-to-Earth) 5.484B
MOBILE except aeronautical mobile
BROADCASTING
5.487 5.484A</td></tr>
<tr><td>12.5-12.75
FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B (Earth-to-space)

5.494 5.495 5.496</td><td>12.7-12.75
FIXED
FIXED-SATELLITE (Earth-to-space)
MOBILE except aeronautical mobile</td><td>12.5-12.75
FIXED
FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B
MOBILE except aeronautical mobile
BROADCASTING - SATELLITE
5.493</td></tr>
</table>

14.0-14.5 GHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td colspan="3">14-14.25
FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B
RADIONAVIGATION 5.504
Mobile-satellite (Earth-to-space) 5.504B 5.504C 5.506A
Space research
5.504A 5.505</td></tr>
</table>

<table>
<tr><td colspan="3">14.25-14.3
FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B
RADIONAVIGATION 5.504
Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.508A
Space research
5.504A 5.505 5.508</td></tr>
<tr><td>14.3-14.4
FIXED
FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B
MOBILE except aeronautical mobile
Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A
Radionavigation-satellite
5.504A</td><td>14.3-14.4
FIXED-SATELLITE (Earth-to-space) 5.457A 5.484A 5.484B 5.506 5.506B
Mobile-satellite (Earth-to-space) 5.506A
Radionavigation-satellite

5.504A</td><td>14.3-14.4
FIXED
FIXED-SATELLITE (Earth-to-space) 5.457A 5.484A 5.484B 5.506 5.506B
MOBILE except aeronautical mobile
Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A
Radionavigation-satellite
5.504A</td></tr>
<tr><td colspan="3">14.4-14.47
FIXED
FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B
MOBILE except aeronautical mobile
Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A
Space research (space-to-Earth)
5.504A</td></tr>
<tr><td colspan="3">14.47-14.5
FIXED
FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B
MOBILE except aeronautical mobile
Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A
Radio astronomy
5.149 5.504A</td></tr>
</table>

4. Current usage in the Ku-band

Based on the responses to question# 2 and question#4 of the VMES questionnaire from 7 administrations received at AWG-25 meeting, below are the frequency usage of each administration in the frequency bands 10.7-12.75 GHz and in the frequency bands 14 – 14.5 GHz.

Country	**Current usage on the frequency bands 10.7 – 12.75 GHz**	**Current usage on the frequency bands 14 – 14.5 GHz**
New Zealand	The band 10.7-11.7 GHz is allocated to Fixed Service on a primary basis in New Zealand. Receiving satellite downlink does not require a licence in	The band 14-14.5 GHz is permitted for ubiquitous satellite uplink use in New Zealand.

	this band but such downlink is not subject to receive-protection. The band 11.7-12.75 GHz is permitted for ubiquitous satellite downlink use in New Zealand.	
Bangladesh	According to NFAP, 10.7-12.75 GHz band is allocated for FIXED, FIXED-SATELLITE, BROADCASTING and BROADCASTING-SATELLITE Services. Currently, parts of this band are used for terrestrial backhaul connectivity and various satellite services.	According to NFAP, 14-14.5 GHz band is allocated for FIXED, FIXED-SATELLITE and RADIONAVIGATION Services. Currently, parts of this band are used for VSAT service.
Australia	FIXED SATELLITE (Space-to-earth): 10.7 - 11.7 GHz and 12.2 – 12.75 GHz Land Mobile satellite (Space-to-earth): 12.2 – 12.75 GHz BROADCASTING-SATELLITE: 11.7 – 12.2 GHz and 12.5 – 12.75 GHz Broadcasting: 11.7 – 12.5 GHz Mobile except aeronautical mobile: 10.7 – 12.75 GHz FIXED: 10.7 – 12.75 GHz The Space Object Class Licence currently only includes authorisation for reception of radio emissions (i.e. communications in the space-to-Earth direction) for the 10.7–12.75 GHz band. This means that holders of a Space licence in this band are authorized to receive communications from space-to-Earth in Australia. The 10.7-11.7 GHz band is also heavily used for fixed-point-to-point services in Australia.	FIXED SATELLITE (Earth-to-space): 14.0 – 14.5 GHz Mobile satellite (Earth-to-space): 14.0 – 14.5 GHz RADIONAVIGATION: 14.0 – 14.3 GHz Radionavigation-satellite: 14.3 – 14.4 GHz Space Research: 14.0 – 14.3 GHz Space Research (space-to-earth): 14.4 – 14.5 GHz Mobile except aeronautical mobile: 14.3 – 14.5 GHz Fixed: 14.3 – 14.5 GHz Radio Astronomy: 14.47 – 14.5 GHz Radiocommunications (Communication with Space Object) Class Licence 2015(the Space Object Class Licence) currently includes authorisation for transmission of radio emissions (i.e. communications in the Earth-to-space direction) for the 14.0–14.5 GHz band. This means that holders of a Space Receive licence in this band are authorized to transmit from Earth-to-space in line with the conditions on their licence.
Papua New Guinea	Please refer to the Papua New Guinea Ku-band frequency allocation table as stated in section 4.1. below.	Please refer to the Papua New Guinea Ku-band frequency allocation table as stated in section 4.1. below.

China (People's Republic of)	The frequency band 10.7 – 12.75 GHz are being used for Fixed service, Mobile except aeronautical mobile service, Broadcasting service, Broadcasting-Satellite service and Radiolocation service.	The frequency band 14 – 14.5 GHz are being used for the Radionavigation service, Fixed service, Mobile except aeronautical mobile service, Mobile-satellite service (Earth-to-space), Space research service, Radionavigation satellite service and Radio astronomy service.
India (Republic of)	Please refer to the India's Ku-band frequency allocation Plan as stated in section 4.4. below.	Please refer to the India's Ku-band Frequency Allocation Plan as stated in section 4.4. below.
Indonesia (Republic of)	Please refer to the Indonesia Ku-band frequency allocation table as stated in section 4.2. below.	Please refer to the Indonesia Ku-band frequency allocation table as stated in section 4.2. below.
Thailand	Please refer to the Thailand Ku-band frequency allocation table as stated in section 4.3. below.	Please refer to the Thailand Ku-band frequency allocation table as stated in section 4.3. below.
Islamic Republic of Iran	The frequency band 10.7 – 12.75 GHz are being used for: 1. There are some operational point to point systems in the frequency band 10.7-11.7 GHz. No more such license would be issued in this frequency band. 2. Short Range Devices, mostly for Detecting Movement and alert equipment. 3. FSS uplink earth stations in the frequency bands 10.7-11.7 GHz and 12.2-12.7 GHz. 4. Broadcasting-satellite service in the frequency band 11.7-12.2 GHz in accordance with ITU RR Appendix **30**.	The frequency band 14.0 – 14.5 GHz are being used for: 1. FSS uplink. 2. Point to point radio communication systemsin the frequency band 14.3-14.5 GHz. However, for protection of FSS uplink in this band, we issue radio license for utilization of this band by point to point systems in exceptional cases. 3. For ESV as provided by the ITU RR Nos. 5.457 and 5.506A; 4. For feeder links for the broadcasting-satellite service as provided by ITU RR No. 5.506. Some of these stations are installed on mobile vehicles; especially the reporters are using this type of station.

4.1. Papua New Guinea Ku-Band Frequency Allocation Table

Frequency Band	Papua New Guinea Allocation of Services
10.7 – 11.7 GHz	FIXED MOBILE except aeronautical mobile
11.7 – 12.2 GHz	FIXED MOBILE except aeronautical mobile BROADCASTING BROADCASTING-SATELLITE
12.2 – 12.5 GHz	FIXED MOBILE except aeronautical mobile BROADCASTING
12.5 – 12.75 GHz	FIXED MOBILE except aeronautical mobile BROADCASTING- SATELLITE

Frequency Band	Papua New Guinea Allocation of Services
14 – 14.3 GHz	RADIONAVIGATION Mobile-satellite (Earth-to-space) Space research
14.3 – 14.4 GHz	FIXED MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) Radionavigation-satellite
14.4 – 14.47 GHz	FIXED MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) Space research
14.47 – 14.5 GHz	FIXED MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) Radio astronomy

4.2. Indonesia (Republic of) Ku-Band Frequency Allocations Table

The allocation in 10.7-12.75 GHz band in Indonesia is same with the allocation in Region 3 of Radio Regulation Edition 2016 with addition of national footnote INS30, INS30bis, INS34 and INS34A.

Frequency Band	Indonesia Allocation of Services
10.7-10.95 GHz	FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE except aeronautical mobile INS30 INS30bis
10.95-11.2 GHz	FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B MOBILE except aeronautical mobile INS30 INS34
11.2-11.45 GHz	FIXED

	FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE except aeronautical mobile INS30 INS30bis INS34
11.45-11.7 GHz	FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B MOBILE except aeronautical mobile INS30 INS34
11.7-12.2 GHz	FIXED MOBILE except aeronautical mobile BROADCASTING BROADCASTING-SATELLITE 5.492 5.487 5.487A INS34A
12.2-12.5 GHz	FIXED FIXED-SATELLITE (space-to-Earth) 5.484B MOBILE except aeronautical mobile BROADCASTING 5.487 5.484A
12.5-12.75 GHz	FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B MOBILE except aeronautical mobile BROADCASTING-SATELLITE 5.493

INS30: The frequency bands 4 400–5 000 MHz, 6 425–7 110 MHz, 7 125–7 425 MHz, 7 425–7 725 MHz, 7 725–8 275 MHz, 8 275–8 500 MHz, 10.7–11.7 GHz, 12.75–13.25 GHz, 14.4–15.35 GHz, 17.7–19.7 GHz, 21.2–23.6 GHz, 31.8–33.4 GHz, 37–39.5 GHz, 71–76 GHz, and 81–86 GHz are used for point to point communication system.

INS30bis: The frequency bands 4 500–4 800 MHz, 6 725–7 025 MHz, 10.7–10.95 GHz, 11.2–11.45 GHz, and 12.75–13.25 GHz in planned band are planned for the implementation of fixed-satellite service.

INS34: The frequency bands 10 990–11 662 MHz (downlink) and 13 790–13 862 MHz (uplink), 11 150–11 222 MHz (downlink) and 13 950–14 022 MHz (uplink), 11 490–11 562 MHz (downlink) and 14 290–14 362 MHz (uplink), 11 650–11 700 MHz (downlink) and 14 450–14 522 MHz (uplink) are prioritized for Fixed Satellite Service.

INS34A: The frequency band 11.7–12.2 GHz in planned band is planned for the implementation of broadcasting-satellite service.

The allocation in 14-14.5 GHz band in Indonesia is same with the allocation in Region 3 of Radio Regulation Edition 2016 with addition of national footnote INS30 and INS34 (Note: the allocation of fixed service on primary basis in the frequency band 14-14.3 GHz in Indonesia is additional allocation as described in No.**5.505**).

Frequency Band	**Indonesia Allocation of Services**

14-14.25 GHz	FIXED 5.505 FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B RADIONAVIGATION 5.504 Mobile-satellite (Earth-to-space) 5.504B 5.504C 5.506A Space research 5.504A 5.505 INS34
14.25-14.3 GHz	FIXED 5.505 FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B RADIONAVIGATION 5.504 Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.508A Space research 5.504A 5.505 5.508 INS34
14.3-14.4 GHz	FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.484A 5.484B 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Radionavigation-satellite 5.504A INS34
14.4-14.47 GHz	FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.484B 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Space research (space-to-Earth) 5.504A INS30 INS34

INS30: The frequency bands 4 400–5 000 MHz, 6 425–7 110 MHz, 7 125–7 425 MHz, 7 425–7 725 MHz, 7 725–8 275 MHz, 8 275–8 500 MHz, 10.7–11.7 GHz, 12.75–13.25 GHz, 14.4–15.35 GHz, 17.7–19.7 GHz, 21.2–23.6 GHz, 31.8–33.4 GHz, 37–39.5 GHz, 71–76 GHz, and 81–86 GHz are used for point to point communication system.

INS34: The frequency bands 10 990–11 662 MHz (downlink) and 13 790–13 862 MHz (uplink), 11 150–11 222 MHz (downlink) and 13 950–14 022 MHz (uplink), 11 490–11 562 MHz
(downlink) and 14 290–14 362 MHz (uplink), 11 650–11 700 MHz (downlink) and 14 450–14 522 MHz (uplink) are prioritized for Fixed Satellite Service.

4.3. Thailand Ku-Band Frequency Allocations Table

Frequency range (GHz)	Services
10.7 – 11.7	FIXED FIXED-SATELLITE (Space-to-earth) MOBILE (except aeronautical mobile)
11.7 – 12.2	FIXED MOBILE (except aeronautical mobile) BROADCASTING BROADCASTING-SATELLITE
12.2 – 12.5	FIXED FIXED-SATELLITE (Space-to-earth)
12.5 – 12.75	FIXED FIXED-SATELLITE (Space-to-earth) BROADCASTING-SATELLITE

NOTE: At the present, Thailand mostly uses 10.7 – 12.75 GHz band for FIXED-SATELLITE equally with FIXED services.

Frequency range (GHz)	Services
14 – 14.3	FIXED-SATELLITE (Earth-to-space) Radionavigation Mobile-satellite (Earth-to-space) Space research
14.3 – 14.4	FIXED FIXED-SATELLITE (Earth-to-space) Mobile (except aeronautical mobile) Mobile-satellite (Earth-to-space) Radionavigation-satellite
14.4 – 14.47	FIXED FIXED-SATELLITE (Earth-to-space) Mobile (except aeronautical mobile) Mobile-satellite (Earth-to-space) Space research
14.47 – 14.5	FIXED FIXED-SATELLITE (Earth-to-space) Mobile (except aeronautical mobile) Mobile-satellite (Earth-to-space) Radio astronomy

NOTE: At the present, Thailand mostly uses 14 – 14.5 GHz band for FIXED-SATELLITE services.

4.4 India: India's National Frequency Allocation Plan 2018 (NFAP-18) includes the following IND remarks related to these bands (only portion relating to the relevant bands are copied below)

IND 17: The *bands* 14-14.5 GHz (Earth to space), 10.7-11.7 GHz (space-to-Earth), and 12.5-12.75 GHz (space-to-Earth) may be used for earth-stations on land transportations, ships and aircrafts, as per the applicable provisions of the Radio Regulations and or its Resolutions. The use these bands or part thereof and the associated *satellite-orbit* shall be taken together as a *resource* and the number of such resources shall be limited to the

minimum essential to satisfy the needs of earth-stations on land transportations, ships and aircrafts. The use of these bands shall be limited to satellites coordinated with India.

IND 31: Frequency bands 10.95-11.2 GHz, 11.45-11.7 GHz and 12.2-12.75 GHz may predominantly be used for fixed satellite service (down links).

5. Views on Technical Coexistence Issues between VMES in Uplink and Downlink Direction with other services

Based on the responses on question#3 and question#5 of the VMES questionnaire from several administrations received at AWG-25 meeting, below are some APT members' views on the technical coexistence between VMES and other services in the uplink and downlink direction that might constraints the introduction of VMES in their countries.

Country	Views on Technical Coexistence Issues in Uplink Direction	Views on Technical Coexistence Issues in Downlink Direction
New Zealand	Given that the upper adjacent band 14.5-15.35 GHz is allocated to Fixed Service on a primary basis in New Zealand, technical measures have been put in place when permitting the ubiquitous satellite uplink in the band 14-14.5 GHz through General User Radio Licence (GURL) for Satellite Services. The special conditions as prescribed in this GURL are intended to ensure coexistence with existing terrestrial fixed links in New Zealand. Refer to https://www.rsm.govt.nz/licensing/frequencies-for-anyone/satellite-services-gurl.	Given that the band 10.7-11.7 GHz is allocated to Fixed Service on a primary basis in New Zealand, any licence for satellite downlink receive-protection would be considered on a case-by-case basis and also need to be coordinated with the terrestrial fixed link licences, where necessary.
Bangladesh	Not available	Not available
Australia	Under the arrangements proposed in the ACMA consultation paper Australia has opted to take a flexible approach requiring the operator to submit an interference assessment addressing coexistence issues. This assessment could include: > a statement of various coordination agreements reached > compliance with applicable ITU requirements > compliance with relevant FCC or ECC requirements	The view of the ACMA as articulated in the consultation paper was that operation of ESIM is able to be authorised in 10.7-12.75 GHz and 14-14.5 GHz via space and space receive licences in concert with the Space Object Class Licence, subject to meeting licensing assessment procedures. Arrangements for ubiquitous satellite receiver use of the 10.7–11.7 GHz is now supported by the ACMA. The introduction of class-licensed earth station receivers should not lead to

	including: > equivalent isotropically radiated power limits for ESIM > ESIM controlled by a network control facility > power flux density restrictions > ESIM that use closed-loop tracking of the satellite signal shall employ an algorithm that is resistant to capturing and tracking signals from nearby satellite; earth stations shall immediately cease transmissions when they detect that unintended satellite tracking has happened or is about to happen > engineering assessments undertaken. For a licence to be issued, the assessment should demonstrate that appropriate interference management measures are in place for all ubiquitous earth station to be authorised (both fixed and VMES).	constraints on the future deployment and growth of fixed links. The introduction of class-licensed earth station receivers should not lead to constraints on the future deployment and growth of fixed links.
Papua New Guinea	Yes, we will consider technical coexistence studies to be taken into account	Yes, we will consider technical coexistence studies to be taken into account. This will be further considered in the future
China (People's Republic of)	To avoid causing harmful interference to existing services and stations, some technical requirement, such as off-axis EIRP density limit, maximum antenna diameter, pointing error, and minimum antenna elevation, may be necessary to be settled for the VMES.	VMES should not claim protection from other services and stations operating in accordance with domestic radio regulations. Therefore, the manufacturer and operator of VMES should take mitigation measure to decrease the interference from other service and no technical constrains to other authorized stations. There is no need to constraint the area, in which VMES could be deployed.
India	Further study is needed regarding the impact of the introduction of VMES to	Further study is needed regarding the impact of the introduction of VMES to

(Republic of)	existing usages.	existing usages.
Indonesia (Republic of)	Further study is needed regarding the impact of the introduction of VMES to existing usages.	Further study is needed regarding the impact of the introduction of VMES to existing usages.
Thailand	It should protect the existing services from interference issues.	It should protect the existing services from interference issues.
Islamic Republic of Iran	Due to proficiency of applicants, interference issues expected to be mitigated by users by means of geographical separation.	The frequency band 11.7-12.2 GHz is almost in use by rooftop DTH systems.

6. Considerations and Other Issues on VMES Introduction

Based on the responses to question# 1, question# 6, and question#7 of the VMES questionnaire from several administrations received at AWG-25 meeting, below are some APT members' views on the introduction of VMES in their countries.

Country	**Consideration to the future use of VMES**	**Timetable and Other Issues regarding the introduction of VMES**
New Zealand	The bands 10.7–12.75 GHz (space-to-Earth direction) and 14-14.5 GHz (Earth-to-space direction) are available for Fixed-Satellite Service in New Zealand. Downlink licence for vehicle-mounted earth station is not compulsory but can be considered if receive-protection is required in the band 11.7-12.75. Given that the band 10.7-11.7 GHz is allocated to Fixed Service on a primary basis in New Zealand, any licence for satellite downlink receive-protection would be considered on a case-by-case basis and also need to be coordinated with the terrestrial fixed link licences, where necessary. Uplink licence for vehicle-mounted earth station is compulsory. Since the band 14-	It is already permitted in New Zealand through General User Radio Licence (GURL) for Satellite Services. Refer to https://www.rsm.govt.nz/licensing/frequencies-for-anyone/satellite-services-gurl. No other issues regarding the introduction of VMES

	14.5 GHz is permitted for ubiquitous satellite uplink, this use is permitted through General User Radio Licence (GURL) for Satellite Services, subject to certain technical parameters as outlined in the respective special conditions. Refer to https://www.rsm.govt.nz/licensing/frequencies-for-anyone/satellite-services-gurl. The GURL regime provides for certain classes of radio transmitters to be used without the need for the user to obtain an individual licence in New Zealand. This is similar to a licence-exempt regime in other jurisdictions where frequency use is on a no-interference no-protection basis.	
Bangladesh	Not yet considered.	Not yet decided. No other issues at this point of time regarding the introduction on VMES.
Australia	The Australian regulator, the Australian Communications and Media Authority (ACMA), released a consultation paper in March 2019 regarding Earth stations in motion in Ku band. This paper provides a summary of the current national arrangements in the Ku band covering spectrum allocations, services supported and licensing options for satellite services in Australia. The paper also provides a review of current licence assessment procedures for Ku ESIM, including VMES[2], in Ku band. The paper proposed additional provisions for inclusion in the Business operating procedure—Submission and processing of applications for space and space receive apparatus licences, to address the operation of ESIM in the 11.7–12.75 GHz	Whilst Australia is not aware of any immediate planned services, it is updating its processes in anticipation of demand for these services developing in the near future with some in industry predicting roll-out to begin in 2020. No other issues regarding the introduction of VMES.

[2]Arrangements in Ku band Australia do not currently, and are not proposed to, distinguish between land-based, air-based or sea-based mobile terminals and are collectively referred to as Earth stations in Motion (ESIM).

	and 14–14.5 GHz bands in the future.	
Papua New Guinea	Yes, given the trend of the technology	None at the moment with regard to the timetable on the introduction of VMES in Papua New Guinea. None at the moment with regard to other issues related with the introduction of VMES.
China (People's Republic of)	Yes, the VMESs can be deployed in 14-14.25 GHz band (Earth-to-space) in accordance with the domestic radio regulation in China since 2013.	VMES can be authorized to operate in CHINA in 14-14.25GHz (Earth-to-space) band since 2013. No other issues regarding the introduction of VMES.
Indonesia (Republic of)	The application of Vehicle-Mounted Earth Stations (VMES) in the future could provide an alternative technology for transportation vehicles that requires communication infrastructure and would support the implementation of Intelligent Transport Systems (ITS). It would also create new opportunity for satellite operator to expand their services.	Currently the timetable for the introduction of VMES is not developed yet. Further study is needed on the identification of the other issues which need to be considered regarding the introduction of VMES.
Thailand	No consideration yet on the future use of VMES	Not available yet on the timetable of VMES introduction in Thailand.
Islamic Republic of Iran	Use of this application innews gathering, emergency and disaster events, especially in places where telecommunication infrastructureshavebeen damaged, is common in our country.	No decision has been made yet. What could be an easy sample recommended national regulation?

7. Existing Technical Compatibility Studies on VMES

The below table shows the developments of VMES,land based ESIM applications in other regional organizations.

	Ku Band			
Terminal Type	**USA (FCC)**	**CEPT (ECC)**	**Europe (ETSI)**	**International (ITU)**

VMES	CFR 47§25.226	ECC/DEC 18(04) published in 2019	EN 302 977	Recommendation ITU-R S.1857

Land based ESIM considered in the ECC Decision 18(04) are to be deployed with GSO satellite networks already in operation or may be deployed in the future. The ECC Decision 18(04) addresses the harmonized use, exemption from individual licensing, and free circulation and use of land based ESIM operating to Ku-band GSO satellite networks. This ECC Decision provides a regulatory framework for authorizing land based ESIM on the condition that such deployment will not cause harmful interference to other authorized services. The regulatory framework specifies that land based ESIM should be exempt from individual licensing and offered free circulation and use. The other authorized services within the CEPT are limited to the fixed service (FS) in the band 14.25-14.5 GHz, deployed in limited number of administrations, and radio astronomy service (RAS) in the 14.47-14.5 GHz, where astronomy observations are carried out at a limited number of observatories within the CEPT. The technical conditions established for land based ESIM to maintain compatibility with FS and RAS are also described in this ECC Decision.

Technical studies carried out by the CEPT have identified the technical solutions to protect the FS in the 14.25-14.5 GHz band and RAS in the 14.47-14.5 GHz band. Such protection is achieved by ceasing transmissions from land based ESIM in the frequency bands that overlap the frequency assignments of FS and/or RAS stations when the land based ESIM enter or located within the zones identified for the protection of FS and/or RAS stations ("protection zones").

The cessation of transmissions is carried out autonomously by certain inherent control functions of the land based ESIM and/or by the Network Control Facility (NCF) of the satellite networks specified in the harmonized standards EN 302 977 [11] for vehicles and EN 302 448 [12] for trains. Such transmissions remain disabled until an appropriate control signal is received from the NCF to re-establish transmissions in those frequency bands. These measures are implemented without the involvement of individual user of the land based ESIM. Such ability of GSO satellite networks deploying land based ESIM to protect FS and RAS deployments, without involving individual users of land based ESIM, allows administrations to consider exemption of land based ESIM from requiring individual licenses for their operation in the 14-14.5 GHz band. Further, administrations will be able to consider offering free circulation and use.

It should be noted that cessation of transmissions described above, to maintain compatibility with FS and RAS, applies only to the frequency bands that overlap the assignments of FS or RAS stations associated with the protection zones, and the land based ESIM will be able to continue to transmit, without such restrictions, in other frequency bands within the 14-14.5 GHz band.

8. Conclusions

The purpose of this Report is to summarize the situation within the APT on VMES, land based ESIM application and from this add guidance which would assist to:

a) harmonize the use of the frequency bands 10.7-12.75 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space) for the use of land based ESIM operating to GSO FSS satellite networks;
b) allow free circulation and use of land based ESIM operating to GSO FSS satellite networks in the frequency bands 10.7-12.75 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth to space);
c) establish the technical conditions necessary to ensure harmful interference is not caused by land based ESIM to fixed service (FS);

To date, this Report has provided information on the current spectrum usage and future plans in the Ku-band (i.e.10.7-12.75 GHz and 14.0-14.5 GHz) and its related domestic regulations in the Asia-Pacific Region. This is of value to those administrations who are using or planning to deploy land based ESIM in order to understand the application and regulatory coordination with other co-primary services, so to facilitate the efficient national use of these bands. However, based on the responses to the VMES questionnaire, some APT members have allowed the use of VMES, land based ESIM application, in their countries such as Australia, New Zealand, and China with specific technical and regulatory measures without creating interference issues to other services operating in the same frequency bands.

Four(4) annexes below will help administrations who are using or planning to deploy VMES, land based ESIM, to be able co-exist with other co-primary services operating in these bands.

Annex-1 describes the methodology for determining the protection contour around a given fixed services station. The main parameter needed for this determination is the land based ESIM EIRP towards the horizon, which is the direction of the FS station.

Annex-2 describes the methodology for determining the protection contour around a given RAS station. The main parameter needed for this determination is the land based ESIM e.i.r.p towards the horizon, which is the direction of the RAS station.

Annex-3describes the technical and operational requirements for land based ESIM operating to GSO FSS in the frequency bands 10.7 – 12.75 GHz and 14.0 – 14.5 GHz.

Annex-4 gives an example of declaration form need to be submitted to the local regulator by the GSO ESIM operator plan to deploy VMES.

ANNEX 1: DETAILED METHODOLOGY FOR DETERMINING THE PROTECTION ZONE AROUND FS STATIONS

A1.1 INTRODUCTION

This Annex describes the methodology for determining the protection contour around a given FS station. The main parameter needed for this determination is the land based ESIM e.i.r.p. towards the horizon, which is the direction of the FS station.

A1.2. DETERMINATION OF THE FS ANTENNA GAIN TOWARDS THE FSS EARTH STATION

Only the discrimination in azimuth is taken into account, which constitutes a worst case. In order to determine the antenna, gain of the FS station in the direction of the FSS earth station, it is necessary to determine the offset angle between the pointing direction of the FS station and the location of the FSS earth station.

For each azimuth azc_{ontour} of the contour,

$$offset = az_{c\text{ontour}} - az_{FS} \qquad (1)$$

where
$az_{c\text{ontour}}$ (°) is the azimuth under consideration (from -180 to 180°, or 0 to 360°)
az_{FS} (°) is the azimuth where the FS station is pointing
$o$ffset (°) is the offset angle between both directions

The FS antenna gain is then determined by using the last version of Recommendation ITU-R F.699 [16] with the appropriate maximum antenna gain for the FS station and the offset angle found in (1).

A1.3DETERMINATION OF THE FSSEARTH STATION E.I.R.P. TOWARDS THE FS EARTH STATION

The e.i.r.p. towards the horizon can be provided by the FSS operator.

Alternatively, since the land based ESIM will be the same equipment as those used in the US, the FCC e.i.r.p. mask can be used to determine the maximum EIRP towards the horizon (. In order to do so, the location of the FSS earth station and the position of the GSO satellite have to be known. They are the converted in an Earth Centered Earth Fixed (ECEF) reference using equations (2) and (3) for respectively the earth station and the FSS satellite.

$$\begin{aligned} x_{ES} &= (R_e + alt_{ES})\cos(lat_{ES})\cos(long_{ES}) \qquad (2)\\ y_{ES} &= (R_e + alt_{ES})\cos(lat_{ES})\sin(long_{ES}) \\ z_{ES} &= (R_e + alt_{ES})\sin(lat_{ES}) \end{aligned}$$

where

- lat_{ES} (°) is the latitude of the earth station
- $long_{ES}$ (°) is the longitude of the earth station
- R_e (km) is the Earth radius (6378 km)
- alt_{ES} (km) is the altitude of the earth station
- x_{ES}, y_{ES}, z_{ES} (km) are the ECEF coordinates of the earth station

$$x_{SAT} = (R_e + alt_{SAT})\cos(long_{SAT})$$
$$y_{SAT} = (R_e + alt_{SAT})\sin(long_{SAT}) \quad (3)$$
$$z_{SAT} = 0$$

where

- $long_{SAT}$ (°) is the longitude of the FSS satellite
- R_e (km) is the Earth radius (6378 km)
- alt_{SAT} (km) is the altitude of the GSO satellite (36000 km)
- $x_{SAT}, y_{SAT}, z_{SAT}$ (km) are the ECEF coordinates of the FSS satellite

The vector from the earth station towards the FSS satellite is given by (4)

$$x_{ES-SAT} = x_{SAT} - x_{ES}$$
$$y_{ES-SAT} = y_{SAT} - y_{ES} \quad (4)$$
$$z_{ES-SAT} = z_{SAT} - z_{ES}$$

The direction of the FSstation as seen from the ES station V_{ES} is given by equation (5)

$$x_{FS} = \sin(az_{contour})\sin(long_{ES}) + \cos(az_{contour})\cos(long_{ES})\sin(lat_{ES})$$
$$y_{FS} = -\sin(az_{contour})\cos(long_{ES}) + \cos(az_{contour})\sin(long_{ES})\sin(lat_{ES}) \quad (5)$$
$$z_{FS} = -\cos(az_{contour})\cos(\mathrm{lat_{ES}})$$

The offset angle theta between the pointing direction of the FSS earth station and the direction of the FSstation is given by (6).

$$\theta = \arcsin\left(\frac{V_{ES-SAT} \times V_{RAS}}{|V_{ES-SAT}|}\right) \quad (6)$$

where × is the cross product.

The e.i.r.p. of the FSS earth station $e.i.r.p._{ES}$ is then given by the table below, function of offset angle.

$EIRP_{ES}$ (dBW/(4 kHz))	Offset angle θ
15-25logθ	1.5° ≤ θ ≤7°
-6	7° < θ ≤9.2°
18-25logθ	9.2° < θ ≤19.1°
-14	19.1° < θ ≤180°

A.1.4DETERMINATION OF THE REQUIRED PROPAGATION LOSS TO MEET THE FS PROTECTION CRITERIA

The minimum propagation loss required to meet the FS long-term and short term protection criteria is given by (7), and can be calculated for all azimuths around the FS station.

$$L = EIRP_{ES} + G_{FS} - N - \frac{I}{N} - L_F - 10\log(4000) \quad (7)$$

where

- $EIRP_{ES}$ (dBW/4 kHz) is the EIRP of the FSS earth station towards the horizon
- G_{FS} (dBi) is the FS antenna gain in the direction of the FSS earth station
- N (dBW/Hz) is the noise level of the FS station
- I/N (dB) is the protection criterion threshold, either short or long-term
- L_F (dB) is the FS feeder loss

The protection criterion to be used should be either based on ITU-R recommendations such as RecommendationsITU-R F.758 or SF.1650 or any protection criterion imposed by the individual administration.

A1.5DETERMINATION OF THE SEPARATION DISTANCES

The determination of separation distances that would meet the required propagation loss can be done using a relevant propagation model. Recommendation ITU-R P.452 is recommended to this effect with a relevant digital terrain elevation model such as SRTM (Shuttle Radio Topography Mission).

The percentage of time to be used in the propagation model is the percentage of time associated with the FS protection criterion considered.

The final separation distance for the azimuth az_{contour} considered is the maximum between the distance obtained for the short-term and the distance obtained for the long-term. The protection contour around a given FS station is given by the envelope of separation distances calculated over all 360° azimuths.

ANNEX-2: DETAILED METHODOLOGY TO DETERMINE THE PROTECTION CONTOUR AROUND RAS STATIONS

A2.1 INTRODUCTION

This Annex describes the methodology for determining the protection contour around a given RAS station. The main parameter needed for this determination is the land based ESIM e.i.r.p. towards the horizon, which is the direction of the RAS station.

A2.2 DETERMINATION OF THE FSSLAND BASED ESIM E.I.R.P. TOWARDS THE RAS STATION

The e.i.r.p. towards the horizon can be provided by the FSS operator.

Alternatively, the FCC e.i.r.p. mask can be used to determine the maximum EIRP towards the horizon. In order to do so, the location of the FSS earth station and the position of the GSO satellite have to be known. They are the converted in an Earth Centered Earth Fixed (ECEF) reference using equations (8) and (9) for respectively the earth station and the FSS satellite.

$$\begin{aligned} x_{ES} &= (R_e + alt_{ES})\cos(lat_{ES})\cos(long_{ES}) \\ y_{ES} &= (R_e + alt_{ES})\cos(lat_{ES})\sin(long_{ES}) \\ z_{ES} &= (R_e + alt_{ES})\sin(lat_{ES}) \end{aligned} \quad (8)$$

where

- lat_{ES} (°) is the latitude of the earth station
- $long_{ES}$ (°) is the longitude of the earth station
- R_e (km) is the Earth radius (6378 km)
- alt_{ES} (km) is the altitude of the earth station
- x_{ES}, y_{ES}, z_{ES} (km) are the ECEF coordinates of the earth station

$$\begin{aligned} x_{SAT} &= (R_e + alt_{SAT})\cos(long_{SAT}) \\ y_{SAT} &= (R_e + alt_{SAT})\sin(long_{SAT}) \\ z_{SAT} &= 0 \end{aligned} \quad (9)$$

where

- $long_{SAT}$ (°) is the longitude of the FSS satellite
- R_e (km) is the Earth radius (6378 km)
- alt_{SAT} (km) is the altitude of the GSO satellite (36000 km)
- x_{SAT}, y_{SAT}, z_{SAT} (km) are the ECEF coordinates of the FSS satellite

The vector from the earth station towards the FSS satellite is given by (10)

$$\begin{aligned} x_{ES-SAT} &= x_{SAT} - x_{ES} \\ y_{ES-SAT} &= y_{SAT} - y_{ES} \end{aligned} \quad (10)$$

$$z_{ES-SAT} = z_{SAT} - z_{ES}$$

The direction of the RAS station as seen from the ES station V_{ES} is given by equation (11)

$$x_{RAS} = \sin(az_{contour}) \sin(long_{ES}) + \cos(az_{contour}) \cos(long_{ES}) \sin(lat_{ES})$$
$$y_{RAS} = -\sin(az_{contour}) \cos(long_{ES}) + \cos(az_{contour}) \sin(long_{ES}) \sin(lat_{ES}) \quad (11)$$
$$z_{RAS} = -\cos(az_{contour})\cos(\mathrm{lat_{ES}})$$

The offset angle theta between the pointing direction of the FSS earth station and the direction of the RAS station is given by (12).

$$\theta = \arcsin\left(\frac{V_{ES-SAT} \times V_{RAS}}{|V_{ES-SAT}|}\right) \quad (12)$$

where × is the cross product.

The e.i.r.p. of the FSS earth station $e.i.r.p._{ES}$ is then given by the table below, function of offset angle.

Table 2: Maximum e.i.r.p. of FSS earth station

$EIRP_{ES}$ (dBW/(4 kHz))	Offset angle θ
15-25logθ	1.5° ≤ θ ≤7°
-6	7° < θ ≤9.2°
18-25logθ	9.2° < θ ≤19.1°
-14	19.1° < θ ≤180°

A.2.3 DETERMINATION OF THE REQUIRED PROPAGATION LOSS TO MEET THE RAS PROTECTION CRITERIA

The minimum propagation loss required to meet the RAS protection criteria is given by (13), and can be calculated for all azimuths around the RAS station.

$$L = EIRP_{ES} - I - 10\log(4) + 10\log(150) \quad (13)$$

where

- $EIRP_{ES}$ (dBW/4 kHz) is the EIRP of the FSS earth station towards the horizon
- I (dBW/150 kHz) is the RAS detrimental threshold level

The interference threshold level I is given inRecommendation ITU-R RA.769 as a received power of -214 dBW/150 kHz. The data loss threshold value of 2% from Recommendation ITU-R RA. 1513 applies to this band.

A2.4 DETERMINATION OF THE SEPARATION DISTANCES

The determination of separation distances that would meet the required propagation loss can be done using a relevant propagation model. Recommendation ITU-R P.452 is recommended to this effect with a relevant digital terrain elevation model such as SRTM (Shuttle Radio Topography Mission).

The percentage of time to be used in the propagation model is 2%.

The protection contour around a given RAS station is given by the envelope of separation distances calculated over all 360° azimuths.

ANNEX 3: TECHNICAL AND OPERATIONAL REQUIREMENTS FOR LAND BASED IN-MOTION EARTH STATIONS OPERATING TO GSO FSS SATELLITE NETWORKS IN THE FREQUENCY BANDS 10.7-12.75 GHZ AND 14.0-14.5 GHZ

Land based ESIM operating to GSO FSS satellite networks in the frequency bands 10.7-12.75 GHz and 14.0-14.5 GHz shall comply with the following technical and operational requirements:

1. The land based ESIM shall operate under the control of a Network Control Facility (NCF);

2. The design, coordination and operation of the land based ESIM shall take into account the following factors:

   a) antenna miss-pointing;

   b) variations in the antenna pattern;

   c) variations in the transmit e.i.r.p..

3. Land based ESIM that use closed-loop tracking of the satellite signal shall employ an algorithm that is resistant to capturing and tracking signals from nearby satellite. The earth stations shall immediately cease transmissions when they detect that unintended satellite tracking has happened or is about to happen;

4. The land based in motion earth station shall cease transmissions in protection zones in frequency bands where FS and RAS stations are operated;

5. Land based ESIM shall conform to the Harmonised European Standard EN 302 977 for in-motion earth stations on vehicles or EN 302 448 for in-motion earth stations on trains.

ANNEX-4: DECLARATION FORM TO BE SUBMITTED TO THE LOCAL REGULATOR BY THE ESIM OPERATOR DEPLOYING LAND BASED ESIM AND INFORMATION RELATING TO FS AND RAS DEPLOYMENTS

Any GSO ESIM operator intending to deploy VMES, land based ESIMapplication,within their own territory is required to submit to the local regulator a declaration given in Table 3. Any future changes to the information sought by the declaration should also be brought to the attention of the administration as soon as possible.

Table 3 Declaration to be provided to thelocalregulator

Information required	Information
ESIM operator's name	
ESIM operator's Contact Information	
Commercial name of the satellite network(s)	
Network Control Facility (NCF) contact details (address, telephone number, email)	
Names of the administrations where protection measures have been implemented by the ESIM Operator to protect FS stations	
Names of the administrations where protection measures have been implemented by the ESIM Operator to protect RAS stations	
Confirmation that Land based ESIM operating comply with the following technical and operational requirements in Annex-3	
Confirmation of the systems compatibility with the FS and the RAS	