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**APT REPORT ON**

**VEHICLE MOUNTED EARTH STATIONS (VMES) OPERATING WITH GSO FSS NETWORKS IN THE KU-BAND IN APT COUNTRIES**

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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 services which 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 decided to deploy VMES operations in their territories with specific national regulations taking into account the cross border coordination with concerned country, if required. In addition, section 7 and section 8 of this Report give some information on how to deploy VMES operations.

1. **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.

To complement the understanding of current and planned implementation of the land based ESIM within the region, some information on technical analysis which have been conducted by other regional group (e.g. CEPT) are attached to this report.

**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

1. **ITU Radio Regulations Allocations**

In the Radio Regulations (2020 edition), the frequency bands 10.7 – 12.75 GHz and 14.0 – 14.5 GHz are 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**

| **Allocation to services** | | |
| --- | --- | --- |
| **Region 1** | **Region 2** | **Region 3** |
| **11.7-12.5**  FIXED  MOBILE except aeronautical mobile  BROADCASTING  BROADCASTING-SATELLITE 5.492  5.487 5.487A | **11.7-12.1**  FIXED 5.486  FIXED-SATELLITE  (space-to-Earth) 5.484A 5.484B 5.488  Mobile except aeronautical mobile 5.485 | **11.7-12.2**  FIXED  MOBILE except aeronautical mobile  BROADCASTING  BROADCASTING-SATELLITE 5.492  5.487 5.487A |
| **12.1-12.2**  FIXED-SATELLITE  (space-to-Earth) 5.484A 5.484B 5.488  5.485 5.489 |
| **12.2-12.7**  FIXED  MOBILE except aeronautical mobile  BROADCASTING  BROADCASTING-SATELLITE  5.492  5.487A 5.488 5.490 | **12.2-12.5**  FIXED  FIXED-SATELLITE (space-to-Earth) 5.484B  MOBILE except aeronautical mobile  BROADCASTING  5.487 5.484A |
| **12.5-12.75**  FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B (Earth-to-space)  5.494 5.495 5.496 | **12.5-12.75**  FIXED  FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B  MOBILE except aeronautical mobile  BROADCASTING- SATELLITE 5.493 |
| **12.7-12.75**  FIXED  FIXED-SATELLITE (Earth-to-space)  MOBILE except aeronautical mobile |

**14.0-14.5 GHz**

| **Allocation to services** | | |
| --- | --- | --- |
| **Region 1** | **Region 2** | **Region 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 | | |
| **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 | | |
| **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 | **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 | **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 |
| **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 | | |
| **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 | | |

1. **Current Ku-band usage in some APT Members**

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 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. | The band 14-14.5 GHz is permitted for ubiquitous satellite uplink 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](http://www.legislation.gov.au/Series/F2015L01486) (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. |
| 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 systems in 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. |

* 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 |

* 1. 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.

* 1. 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.

1. **Views of some APT Members 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 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). | 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 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. |
| 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. |

1. **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 14-14.5 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. | 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 |
| 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](https://www.acma.gov.au/theACMA/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[[1]](#footnote-1), 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](https://www.acma.gov.au/theACMA/~/link.aspx?_id=23385C3A6B7346339D3ED01AEECD1360&_z=z), to address the operation of ESIM in the 11.7–12.75 GHz and 14–14.5 GHz bands in the future. | 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. |
| 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 in news gathering, emergency and disaster events, especially in places where telecommunication infrastructures have been damaged, is common in our country. | No decision has been made yet.  What could be an easy sample recommended national regulation? |

1. **Existing Technical Information on the use of VMES in Other Regions and ITU**

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.

1. **Summary**

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

1. 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;
2. may 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);
3. provide the technical conditions which could be referred to Attachment-1 of this report 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 decided to deploy the VMES operations, 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) attachments below which refer to ECC Decision 18(04) [[2]](#footnote-2) 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.

Attachment-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.

Attachment-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.

Attachment-3 describes 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 in CEPT countries.

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

**ATTACHMENT-1: DETAILED METHODOLOGY FOR DETERMINING THE PROTECTION ZONE AROUND FS STATIONS (COPY OF ANNEX-1 OF ECC DECISION 18(04))**

**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 𝑎𝑧contour of the contour,

𝑜ffset = 𝑎𝑧𝑐ontour − 𝑎𝑧𝐹S (1)

where

𝑎𝑧𝑐ontour (°) is the azimuth under consideration (from -180 to 180°, or 0 to 360°)

𝑎𝑧𝐹S (°) is the azimuth where the FS station is pointing

𝑜ffset (°) 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).

**A1.3 DETERMINATION OF THE FSS EARTH 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.

(2)

where

* (°) is the latitude of the earth station
* (°) is the longitude of the earth station
* (km) is the Earth radius (6378 km)
* (km) is the altitude of the earth station
* , , (km) are the ECEF coordinates of the earth station

(3)

where

* (°) is the longitude of the FSS satellite
* (km) is the Earth radius (6378 km)
* (km) is the altitude of the GSO satellite (36000 km)
* , , (km) are the ECEF coordinates of the FSS satellite

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

(4)

The direction of the FS station as seen from the ES station VES is given by equation (5)

(5)

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

(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.

|  |  |
| --- | --- |
| EIRPES (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.1.4 Determination 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.

(7)

where

* (dBW/4 kHz) is the EIRP of the FSS earth station towards the horizon
* (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
* (dB) is the FS feeder loss

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

**A1.5 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 the percentage of time associated with the FS protection criterion considered.

The final separation distance for the azimuth 𝑎𝑧𝑐ontour 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.

ATTACHMENT-2: Detailed methodology to determine the protection contour around ras stations (Copy of annex-2 of ecc decision 18(04))

**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 FSS LAND 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.

(8)

where

* (°) is the latitude of the earth station
* (°) is the longitude of the earth station
* (km) is the Earth radius (6378 km)
* (km) is the altitude of the earth station
* , , (km) are the ECEF coordinates of the earth station

(9)

where

* (°) is the longitude of the FSS satellite
* (km) is the Earth radius (6378 km)
* (km) is the altitude of the GSO satellite (36000 km)
* , , (km) are the ECEF coordinates of the FSS satellite

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

(10)

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

(11)

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

(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

|  |  |
| --- | --- |
| EIRPES (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.

(13)

where

* (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 in Recommendation 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.

ATTACHMENT-3: Technical and operational requirements for land based earth stations In motion operating to GSO FSS satellite networks in the frequency bands 10.7­12.75 GHz and 14.0-14.5 GHz IN CEPT Countries (COPY OF ANNEX-3 OF ECC decision 18(04))

Land based ESIM operating to GSO FSS satellite networks in the frequency bands 10.7­12.75 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:
3. antenna miss-pointing;
4. variations in the antenna pattern;
5. variations in the transmit e.i.r.p..
6. 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;
7. The land based in motion earth station shall cease transmissions in protection zones in frequency bands where FS and RAS stations are operated;
8. 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.

**ATTACHMENT-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 (COPY OF ANNEX-4 OF ECC DECISION 18(04))**

Any GSO ESIM operator intending to deploy VMES, land based ESIM application, 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 the local regulator**

|  |  |
| --- | --- |
| **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** |  |

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. 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). [↑](#footnote-ref-1)
2. *See* https://docdb.cept.org/download/fbff3f53-335c/ECCDec1804.pdf [↑](#footnote-ref-2)