
Allocation of 24 - 30 GHz Spectrum

Technical discussion document

17 October 2025



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Invitation for submissions

This document sets out proposed options for the use of radio spectrum between 24 - 30 GHz in New Zealand and considers relevant technical rules and allocation methods.

Interested parties are invited to comment on the content of this document, in particular the questions posed, and on any related issues. Comments should be submitted in writing, no later than **5pm** on **28 November 2025** to:

By email (*preferred*):

Radio.Spectrum@mbie.govt.nz

Subject line: "Allocation of 24 - 30 GHz radio spectrum"

Or

By post:

Allocation of 24 - 30 GHz radio spectrum
Radio Spectrum Management Policy and Planning
Ministry of Business, Innovation and Employment
PO Box 2847
WELLINGTON 6140

Any party wishing to discuss the proposals with Ministry officials should, in the first instance, email Radio.Spectrum@mbie.govt.nz

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Glossary

Abbreviation / Term	Meaning
3GPP	Third Generation Partnership Project
4G	Fourth generation cellular technology
5G	Fifth generation cellular technology
AAS	Active Antenna Systems
ACMA	Australian Communications and Media Authority
A-ESIM	Aeronautical Earth stations in motion
AFEL	Adjacent Frequency Emission Limit
BS	Base Station
CDF	Cumulative distribution function
ECC	Electronic Communications Committee
EESS	Earth Exploration Satellite Service
EHF	Extremely high frequencies (30 GHz to 300 GHz)
e.i.r.p.	Effective Isotropic Radiated Power
eMBB	Enhanced Mobile Broadband
ESA	European Space Agency
ESIM	Earth stations in motion
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FDD	Frequency Division Duplex
FSS	Fixed Satellite Service
FR	Frequency range
FWA	Fixed wireless access
GHz	Gigahertz
GSO	Geostationary satellite orbit
GURL	General User Radio Licence
HTS	High Throughput Satellite
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate frequency
IMT	International Mobile Telecommunications (generic cellular connectivity)
ITU	International Telecommunications Union
L-ESIM	Land Earth stations in motion
LDPC	Low-Density Parity-Check code
LEO	Low Earth orbit (satellite)
LMDS	Local Multipoint Distribution Service
LTE	Long term evolution (4G technology)
M-ESIM	Maritime Earth stations in motion
mmWave	Millimetre wave
MNO	Mobile network operator
MOU	Memorandum of Understanding
MS	Mobile Station
NASA	National Aeronautics and Space Administration
NGSO	Non-geostationary satellite orbits
NR	New Radio (the radio terminology for 5G)
NTN	Non-terrestrial networks
OBUE	Out of band unwanted emissions
QAM	Quadrature Amplitude Modulation
p.f.d.	Power Flux Density

Abbreviation / Term	Meaning
RAS	Radio Astronomy Service
RF	Radio frequency
RR	ITU Radio Regulations
RRF	RSM Register of Radio Frequencies
RSM	Radio Spectrum Management (MBIE)
SHF	Super high frequencies (3 GHz to 30 GHz)
SRS	Space research service
TDD	Time Division Duplex
The Act	Radiocommunications Act 1989
The Crown	The Crown in right of New Zealand, acting through the MBIE Chief Executive
The Ministry	The Ministry of Business, Innovation and Employment (MBIE)
The Regulations	Radiocommunications Regulations 2001
TLA	Territorial local authority
TRP	Total Radiated Power
TWG	Technical Working Group
UE	User Equipment
UEL	Unwanted Emissions Level
VLBI	Geodetic very long baseline interferometry
VSAT	Very small aperture terminal
WISP	Wireless internet service provider

Executive Summary

In April 2021, Radio Spectrum Management (RSM) undertook consultation on 24-30 GHz use in New Zealand, including both the 26 GHz (spanning 24.25 – 27.5 GHz) and the 28 GHz (spanning 27.5 – 29.5 GHz) frequency bands. Taking the consultation feedback into account, in August 2023, New Zealand Government's Cabinet made the following high-level allocation decisions regarding the long-term use of 24-30 GHz radio spectrum in New Zealand:

- The 26 GHz frequency band is to be allocated primarily to mobile service use (including its applications, e.g., International Mobile Telecommunications (IMT) and Fixed Wireless Access (FWA)), with the option to include some satellite services, e.g., Earth Exploration Satellite Service (EESS) and Space Research Service (SRS) (space-to-Earth), in specific areas of the country under technical conditions.
- The 28 GHz band is to be split into two portions:
 - the 27.5 – 28.35 GHz frequency range, which is to be shared between mobile and fixed-satellite services (Earth-to-space) (including its applications, e.g., Earth Station in Motion (ESIM)) with the appropriate sharing model.
 - the 28.35 – 29.5 GHz frequency range will be allocated primarily for satellite services, with the option to include some mobile use under technical conditions (to be defined).

In this consultation, we are *not* seeking further feedback on the August 2023 Cabinet decisions.

Since August 2023, RSM has worked to identify a range of technical options for both the 26 GHz and 28 GHz bands. In coming up with these technical options, RSM has taken into account the current and future spectrum use and its impacts from an in-band as well as an adjacent-band perspective; key use cases in both 26 GHz and 28 GHz frequency bands; spectrum requirements for different use cases; sharing and compatibility considerations including the protection of existing services and spectrum users; and technical considerations to enable the shared use of mobile and Fixed Satellite Service (FSS) (Earth-to-space) use in the 27.5 – 28.35 GHz. Following these developments, this consultation seeks feedback on the following issues:

- Key use cases and spectrum requirements for different radio services in both 26 GHz and 28 GHz frequency bands.
- Technical options for the 26 GHz and 28 GHz frequency bands, including options for sharing 27.5 – 28.35 GHz and the associated segmentation of these frequency bands.
- Applicable technical parameters for new usage.

Our approach - Options and proposals, in brief

24.25 -27.5 GHz (26 GHz band)

We are proposing that the following spectrum use will be enabled/permitted in the 26 GHz band:

- Mobile systems (e.g., mmWave 5G NR, FWA) capable of leveraging large bandwidths to deliver very high volumes of data to dedicated areas (a.k.a., hotspots), likely deployed in larger population centres, e.g., downtown urban areas, or indoor venues requiring high data rates for enhanced user experiences, e.g., sporting arenas, concert venues, etc. These systems will be subject to technical conditions including those to protect existing services.
- EESS and SRS (space-to-Earth), a.k.a., receive-only Earth stations at specific locations subject to technical conditions within 25.5 – 27.0 GHz frequency range.

Commensurate with its current demand, further consideration of the assignment process, and related conditions for mobile systems will be delayed until between 2028 -2030, after which we will look to make spectrum available. No licence applications will be accepted before this time. We consider that 26 GHz is best suited for deployments that complement existing mobile networks (e.g., those that the Mobile Network operators use) and that the 3.25 GHz (27.5 GHz – 24.25 GHz) bandwidth available within this frequency band is sufficient to meet future spectrum needs of mobile systems plus potential other users. Parties who get access to 24.25 – 27.5 GHz will be ineligible to have access 27.5 -28.35 GHz. RSM also considers that assignment should be on a geographic area basis (e.g., urban areas) and that a national basis (i.e., all New Zealand) is not appropriate.

EESS and SRS (space-to-Earth) users will be able to apply for receive protection licences after the conclusions of the 24 - 30 GHz process upon implementation in the form of suitable licensing frameworks and technical conditions, provided that they are for the sites in Annex 2 or identified through the consultation process. RSM may consider new EESS and SRS (space-to-Earth) sites after the 2028 – 2030 period, alongside the assignment process for mobile systems, provided that EESS and SRS (space-to-Earth) users coordinate with mobile system users as part of the licensing process. An overview of this coordination procedure is intended to be developed and described as part of the licensing process during the implementation of the outcomes of this consultation. For each EESS and SRS (space-to-Earth) site, the licensing framework will propose a suitable methodology to protect the EESS and SRS Earth station receivers with a suitable power flux density (p.f.d.) limit, which is based on the receive protection criteria of EESS and SRS receive Earth stations in 25.5 - 27.0 GHz.

27.5 -28.35 GHz (a.k.a., “lower” 28 GHz band)

We are proposing that the following spectrum use will be enabled/permitted in the lower 28 GHz band:

- FSS (Earth-to-space) gateway Earth stations at fixed locations
- FSS (Earth-to-space) User Terminals/Very Small Aperture Terminals (VSAT) at fixed locations (no mobility / not in motion)
- FSS (Earth-to-space) ESIMs for aeronautical (A-ESIM) and maritime (M-ESIM) operating in accordance with the technical limits of the RR Resolution 123 (WRC-23) and Resolution 169 (WRC-19). Land ESIM (L-ESIM) will not be permitted as it cannot co-exist with Mobile in this band

- Shared use of mobile systems (e.g. mmWave 5G New Radio (NR)/FWA) in urban areas of New Zealand in accordance with geography-based sharing options and corresponding technical conditions

At a high level, the geography-based sharing options that we seek feedback on are:

- Option one: Mobile inside urban areas, FSS outside urban areas
- Option two: Mobile and FSS equal priority inside urban areas, FSS priority outside urban areas

Consistent with the 26 GHz band, further consideration of the assignment process for mobile will be delayed until between 2028 - 2030. We consider that lower 28 GHz is best suited for other uses, e.g., private networks dedicated to a given confined area with both the radio access and core network components located within close proximity to enable highly reliable, low latency connectivity. Parties who get access to 27.5 - 28.35 GHz will be ineligible to have access to 24.25 - 27.5 GHz.

After the conclusion of the 24 - 30 GHz process, RSM will set up a licensing process and regime that allows FSS Earth station users to be able to apply for licences for the above new uses for that provide long term certainty on access to spectrum (beyond 2026). RSM will also develop a licensing framework for effective sharing of 27.5 – 28.35 GHz based on the options for sharing.

28.35 -29.5 GHz (Upper 28 GHz band)

We propose that the following new spectrum use will be permitted in the upper 28 GHz band:

- FSS Earth Station (Earth to space) gateways at specific fixed locations.
- FSS Earth station user terminals/VSAT at fixed locations (no mobility) throughout New Zealand based on area licensing (TLAs).
- FSS (Earth-to-space) ESIMs for aeronautical (A-ESIM) and maritime (M-ESIM) operating in accordance with the technical limits of the RR Resolution 123 (WRC-23) and Resolution 169 (WRC-19). Land ESIM will be permitted under a set of technical conditions with a requirement on the minimum elevation angle of the land ESIM station up to the Geostationary Satellite Orbit (GSO) or Non-Geostationary Satellite Orbit (NGSO) satellite, and a limit on the adjacent band effective isotropic radiated power (e.i.r.p.) towards the horizon.

After the conclusion of the 24 - 30 GHz process RSM will set up a licensing process and regime that allows FSS Earth station users to be able to apply for licences for the above new uses providing long term certainty on access to spectrum beyond May 2026. Licensing will be allowed at any location in New Zealand.

Other issues

29.5 - 30 GHz will continue to be available only for FSS (Earth-to-space) use only. In particular, FSS gateway licensing will on the same basis and rules as 28 GHz band. User terminals and ESIMs would require satellite operators to obtain an all-New Zealand licence and consequently, the 29.5 -30 GHz will be removed from the Aeronautical, Maritime, and Satellite Services General User Radio Licence (GURL).

The complimentary 17.7 - 20.2 GHz FSS (space-to-Earth) frequency band will be opened for receive protection licences for stations at specific locations under an individual receive protection licence under the existing FSS Earth station licensing regime. All other use (e.g., wide area user terminals / ESIM use) will be on an opportunistic basis. No changes are proposed for existing fixed links.

Next steps

As a first next step, RSM is working towards making the 28 GHz band available for long-term use by satellite services around May 2026.

Public feedback in response to this consultation will assist us in revising and refining our approaches to allocation and implementation and will inform any updates to our planned timeframes for long term use.

Once industry feedback is received, RSM will analyse the submissions and will publish the submissions on the RSM website.

If any aspects of our allocation approach require regulatory changes, further consultation may be undertaken.

Introduction

Background: consultation and decisions to date

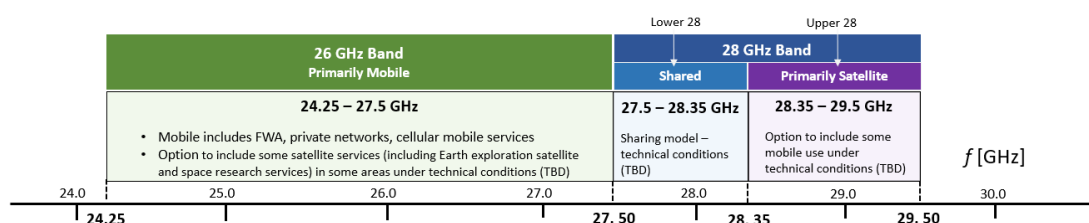
In April 2021, MBIE released a consultation document seeking industry feedback on potential allocations of the 24 – 30 GHz spectrum range. This consultation closed in June 2021, with 24 submissions received. The responses highlighted a range of industry views on how 24 – 30 GHz should be replanned. The 2021 consultation document and submissions received remain available on the RSM website: [24 – 30 GHz use in New Zealand | Radio Spectrum Management New Zealand \(rsm.govt.nz\)](https://rsm.govt.nz/24-30-GHz-use-in-New-Zeland)

Drawing on these submissions and on industry developments, decisions on high-level use cases of the 24 – 30 GHz frequency band were made by Cabinet in August 2023. The Cabinet paper and Minute of Decision are also available on the RSM website: [Future use of the 24 – 30 GHz spectrum | Radio Spectrum Management New Zealand \(rsm.govt.nz\)](https://rsm.govt.nz/future-use-of-the-24-30-GHz-spectrum). Cabinet decisions were:

- The 26 GHz band (24.25 – 27.5 GHz frequency range) will be primarily allocated for mobile use, with the option to include some satellite services in some areas under technical conditions to be determined.
- The 28 GHz band will be split into two portions:
 - ‘Lower 28’: the 27.5 – 28.35 GHz frequency range will follow a sharing model between mobile and satellite services.
 - ‘Upper 28’: the 28.35 – 29.5 GHz frequency range will be primarily allocated for satellite services, with the option to include some mobile use under technical conditions to be determined.

These allocations are shown in the Figure 1 below:

Figure 1: Cabinet allocation of 24 – 30 GHz frequency bands



These decisions were announced in August 2023, along with the notification to existing license holders that their licences could be extended through an interim short-term licence until May 2026.

Following the Cabinet allocation decision, a Technical Working Group (TWG) was established following a call for expressions of interest through RSMs business update¹. Three TWG meetings were held where there were focused technical discussions with stakeholders who have direct interests in 24 – 30 GHz radio spectrum (e.g., satellite and mobile industries, scientific and Earth exploration research communities, and fixed wireless access providers). These meetings were held on 8 November 2023, 28 May 2024, and 21 November 2024.

¹ RSM business updates <https://rsm.createsend1.com/t/r-e-ttuhlrld-l-d/>

Key new services, applications and technologies in 24 - 30 GHz

The key use cases of this spectrum are mobile services (IMT, FWA), fixed satellite services (GSO and NGSO), as well as EESS and SRS.

Mobile service uses include:

- **Enhanced Mobile Broadband:** Provided through 5G-NRcellular systems in millimetric Wave (mmWave) frequencies which aims to provide gigabit-per-second connectivity with mobility; delivering superior user experience and enhanced connectivity. Initial deployments include urban hotspots/areas and indoor venues, e.g., sporting arenas/stadiums, transport hubs, concert venues, etc.
- **Fixed Wireless Access (FWA):** Substitute for fixed copper and fibre connections for “last mile” connectivity which may also be provided through 5G NR. While fibre coverage is available to ~87.5% of New Zealanders, FWA provides an alternative solution in places where fixed infrastructure is not present or only copper wireline is in place.
- **Private/Enterprise Networks:** Integration of vertical industries e.g., manufacturing, logistics, health care. The requirements of private networks are diverse and range from low-rate, low-latency to high-rate, low-latency applications, generally within a confined area. Private/enterprise networks provide an opportunity to replace wired connectivity while supporting the required capacity, latency and reliability levels.
- **Integrated Access and Backhaul:** Integrated access and backhaul uses a fixed wireless terminal to provide connectivity to a separate backhaul core instance. The instance could either be in the core for radio access or distributed closer to the radio nodes to support lower latency inter-site connectivity. It is also possible to use 5G NR to provide such separate access and backhaul solutions.

GSO and NGSO Satellite systems

- **Gateways:** Gateways are fixed installations or a hub that connect the satellite network back into the telecommunications network (e.g., internet, private networks etc). Gateways are often substantial installations with large antennas or antenna arrays with wide bandwidths.
- **User Terminals:** User terminals or VSATs are equipment the end user (e.g., consumer, business user etc) utilises to connect to the satellite network for communications (e.g., broadband internet connectivity). User terminals are small in nature and are normally mounted to the side of a building or on a rooftop.
- **Earth Stations in Motion (ESIMs):** ESIMs provide continuous broadband connectivity to ships (maritime), aircraft (aeronautical) and terrestrial vehicles (land) when they are out of reach of terrestrial networks. They can also assist when terrestrial infrastructure is dysfunctional due to natural disasters.
- **Non-Terrestrial Networks (NTNs):** The integration of NTNs for 5G will permit 5G roll-out in areas which are not covered by terrestrial 5G networks. The NTN acts as a relay between the satellite gateway and user equipment. We envisage that NTNs will operate in appropriate frequency bands as per the allocations in Article 5 of ITU Radio Regulations and appropriate band plans (e.g., set out in 3GPP and / or Recommendation ITU-R M.1036).
- **Earth Exploration Satellite Services (EESS):** These services provide satellite imaging over large land masses supporting the distribution of web-geo platforms and services applicable to environment mapping, agriculture and forestry monitoring, environmental and maritime change detection, and critical functions including speed disaster response and intelligence analysis. These services also map ‘super emitters’ on the Earth’s surface responsible for large releases of greenhouse gases.

- **Space Research Service (SRS):** This service supports lunar and Mars missions and communications and provides for the use and expansion of space probes as well as Geodetic very long baseline interferometry (VLBI) and other Earth Science use.

Relevant decisions from WRC-19 and WRC-23

- According to the provisions contained in Resolution 169 (WRC-19) of the RR, GSO ESIMs use 17.7 – 19.7 GHz (space-to-Earth) and 27.5 – 29.5 GHz (Earth-to-space).
- The provisions contained in Resolution 123 (WRC-23) of the ITU Radio Regulations (RR) have frequency band 17.7 – 18.6 GHz, 18.8 – 19.3 GHz, 19.7 – 20.2 GHz (space-to-Earth) and 27.5 – 29.1 GHz and 29.5 – 30.0 GHz (Earth-to-space) for NGSO ESIM use.

New Zealand spectrum allocations and current licence holders

The existing allocations and summary use for specific radio spectrum frequencies in New Zealand is outlined in Public Information Brochure (PIB) 21: [Table of Radio Spectrum Usage in New Zealand](#). **Annex 1** sets out the detail of international and New Zealand use allocations for 24-30 GHz.

Spectrum range	Current licence holders	Primary future use (Cabinet decision)
26 (24.25-27.5 GHz)	General User Radio licences	Mobile (e.g. 5G)
Lower 28 (27.5-28.35 GHz)	General User Radio licences Major satellite companies	Shared mobile (e.g. 5G) and satellite
Upper 28 (28.35-29.5 GHz)	Major satellite companies	Satellite

Details of these licences can be found in the [Register of Radio Frequencies](#) and / or the [General User Licences](#).

The purpose of this consultation

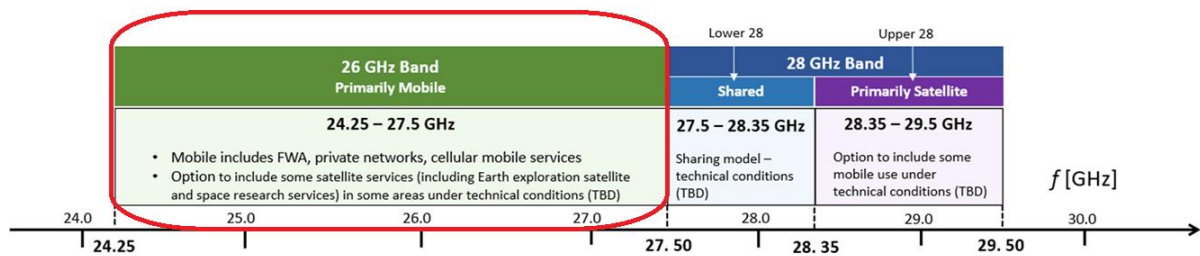
The purpose of this consultation is to seek feedback on proposed options for all three portions of the 24 - 30 GHz band which build on the decisions already made by Cabinet, including further detail on considerations around:

- use-cases and new spectrum use
- impact on existing usage
- applicable technical parameters for new usage.

Feedback from this consultation will inform final decisions on these allocation matters. RSM is working towards:

- Making 28 GHz available to satellite for long term use in mid-2026.
- Making the 26 GHz band available for Earth Exploration Satellite Service (EESS) and Space Research Service (SRS) Earth stations for specific locations shortly after.
- Making 26 GHz and lower 28 GHz bands available to mobile between 2028 – 2030.

1. Our approach to 26 GHz radio spectrum (24.25 – 27.5 GHz)



1.1. Proposed new spectrum uses

The New Zealand Cabinet made the decision to primarily allocate the 26 GHz (24.25 – 27.5 GHz) frequency band to the Mobile Service with the option to include some satellite-based services, e.g., EESS (space-to-Earth) and SRS (space-to-Earth) (see Annex 2). This allocation is aligned with the broader ITU Region 3 allocation as outlined in Article 5 of the ITU RR and PIB 21², where the Mobile Service, EESS (space-to-Earth) and SRS (space-to-Earth) have a co-primary status. This band is also identified for the terrestrial component of IMT through ITU-RR No **5.532AB**. These allocations and the identification were, in part, a result of the outcomes of WRC-19. RSM propose that the new uses within 24.25 – 27.5 GHz band and the adjacent 23.6 – 24 GHz as well as 24 – 24.25 GHz frequency ranges will be the following:

- Mobile systems (e.g. 5G-NR hotspots, FWA, private networks and integrated access and backhaul (IAB)) which are intended to have deployments in large urban population centres (e.g., urban street canyons), entertainment venues, sporting stadiums/venues, and discrete rural locations.
- Receive-only Earth stations at specific locations for operation of EESS (space-to-Earth) and SRS (space-to-Earth) in 25.5 – 27 GHz (recognising that both EESS (space-to-Earth) and SRS (space-to-Earth) are co-primary services in 25.5 – 27 GHz in Article 5 of the ITU RR, which are currently not used or licenced to receive observations in New Zealand territory).
- Radio Astronomy Service (RAS) receive-only sites in the adjacent 23.6 – 24 GHz frequency range (recognising that RAS is a primary service in 23.6 – 24 GHz in Article 5 of the ITU RR, which is currently not used and licenced to receive observations in New Zealand territory).
- No other new use is proposed at this point in time. RSM notes that proposed new uses above does not include all other existing users in 23.6 – 24 GHz (e.g., EESS (passive)) and 24 – 24.25 GHz (e.g., Radiolocation in 24.05 – 24.25 GHz). This includes existing GURL use covering Short-Range Devices³ and Ultra-Wide Band Devices⁴, respectively.

² See pages 104 and 105 of PIB 21, “Table of Radio Spectrum Usage in New Zealand,” Issue 11, June 2021. Accessible at <https://www.rsm.govt.nz/about/publications/pibs/pib-21>.

³ Further information on the Short Range Devices GURL can be obtained from <https://gazette.govt.nz/notice/id/2022-go3100>.

⁴ Further information on the Ultra-Wide Band Devices GURL can be obtained from <https://gazette.govt.nz/notice/id/2017-go406>.

1.2. Impact on existing spectrum users

1.2.1. 24.25 – 27.5 GHz

The 26 GHz frequency band (24.25 – 27.5 GHz) currently includes arrangements for the following existing users:

- Short-Range Devices GURL covering radiodetermination transmitters within the 24.05 – 26.5 GHz frequency range, licenced to transmit over all of New Zealand.
- Ultra-Wide Band Devices GURL covering 10.6 GHz – 100 GHz, licenced to transmit over all of New Zealand.

The Short-Range Devices GURL enables radiodetermination transmitters to be operated within shielded enclosures with a maximum e.i.r.p. of –54 dBW⁵. RSM expects to be able to continue this use in the future due to the usage scenarios of these devices, facilitating coexistence to/from the Short-Range Devices to the new users. RSM notes that the GURL is not afforded protection from licenced services, nor can it cause interference to licenced systems operating a band overlapping with the GURL. RSM propose no changes to this condition. The Ultra-Wide Band Devices GURL enables Ultra-Wide band Devices to transmit and receive within the 10.6 GHz to 100 GHz frequency range. The condition associated with such transmissions/reception is in the form of a maximum e.i.r.p. of –75 dBW. Ultra-Wide Band devices are designed to be robust to interference and must accept interference from other spectrum users, while not causing interference to licenced systems. Under the Ultra-Wide Band GURL, Ultra-Wide Band devices are not afforded protection from licenced services, nor can they cause interference to licenced services. Therefore, no changes are proposed to the existing use and GURL condition⁶.

For both above mentioned existing users, owing to the all of New Zealand transmit nature of the GURLs, RSM does not track the precise number of transmit-receive links covered by the GURLs (within their respective frequency bands) or usage patterns of systems.

RSM notes that as of October 2023, the 24.25 – 27.5 GHz band has been included in the Statement of Government Policy to preserve its future use by preventing licencing activities in the band.⁷ RSM's current assessment is that there is no other recorded use of the 26 GHz band, making it readily available for new use as described in Section 1.1.

1.2.2. 24 – 24.25 GHz

Article 5 of the ITU RR allocates the frequency range 24.0 – 24.05 GHz to Amateur and Amateur-Satellite services. Footnote RR No **5.150** (WRC-12) applies which also designates this frequency range for Industrial, Scientific and Medical applications, following the provisions of Article 15.13 of the ITU RR. The band is also used by Short-Range Devices globally.

Radio Amateur operators may operate stations in the Amateur and Amateur-Satellite services within the frequency band 24.0 – 24.05 GHz under the GURL for Amateur Radio Operators⁸ on a shared

⁵As prescribed in Special condition 27 of the GURL, the maximum e.i.r.p. of –54 dBW applies at 3 metres outside the shielded enclosure over a maximum of 50 MHz bandwidth. The emission outside the shielded enclosure must not exceed a maximum e.i.r.p. density of –71.3 dBW/MHz at any given time.

⁶Provisions in the GURLs may be updated from time to time to align with international short range device and ultra-wide band device provisions when those notices are reviewed, nothing in this consultation prevents appropriate updates to the GURLs in the future.

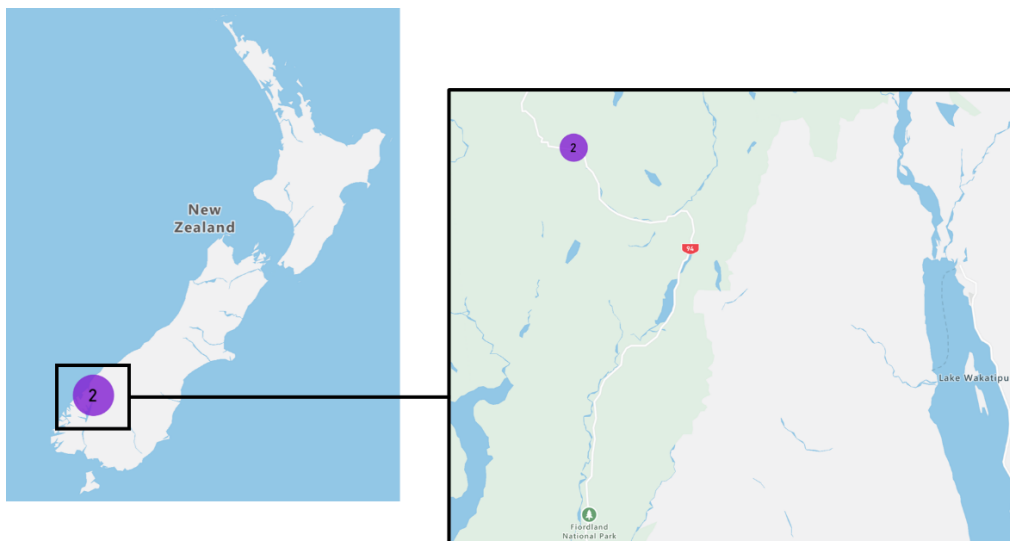
⁷For further information, see <https://gazette.govt.nz/notice/id/2023-go4952>.

⁸For further information, see <https://gazette.govt.nz/notice/id/2025-go3272>

basis. RSM does not have any individual licences in the RSM Register of Radio Frequencies (RRF) for Amateur stations. Short-Range Devices operate under Short-Range Devices GURL, these are not afforded protection from licenced services, nor can they cause interference to licenced services. Industrial, Scientific and Medical applications and devices may also be operating in this band. The frequency range 24.05 – 24.25 GHz is globally allocated to the Radiolocation service with a primary status.

As of October 2025, there is a pair of existing transmit-receive licences (one licence for transmission and the other for receive protection) at the East Homer Weather Station⁹ (–44.76°S, 167.99°E) located off State Highway 94 between Milford and Te Anau. The geographical location of these licences are shown in Figure 2 and are obtained from RSM’s Register of Radio Frequencies (RRF). These licences are used for rain and avalanche detection for the Fiordland National Park area using a 60 cm offset parabolic antenna with a transmit e.i.r.p. of 27.1 dBW (for the transmit licence) over an emission bandwidth of 40 MHz from 24.21 – 24.25 GHz. The transmitter operates with a frequency modulated continuous wave radar, with a sampling frequency of 125 kHz, velocity resolution of 0.188 m/s and minimum detectable radar reflectivity of -2 dB. Both the transmitter and receiver operate from a location altitude of 900 m with an above ground level height of 4 m. The transmit and receiver antenna half power beamwidth in the elevation domain is approximately 1.5° with stringent out-of-band emission characteristics to protect spectrum users both below 24.05 GHz and above 24.25 GHz.¹⁰

Figure 2: Existing transmit and receive Radiolocation licences for rain and avalanche detection at East Homer Weather Station using 24.05 – 24.25 GHz frequency range in the South Island of New Zealand.



As these licences operate in the Fiordland National Park area at a composite height of 904 m (location altitude of 900 m and a further 4 m above ground level height) with a narrow elevation beam resulting in a high gain radar beam, the likelihood of interference being caused to other terrestrial users (both incoming and GURL users) below the horizon of the antenna (relative to its deployment height) is negligible. The likelihood of incoming radio services, such as the Mobile Service transmitters causing aggregate interference (from multiple mobile Base Stations (BS) and/or User Equipment (UE)) to the radar receiver is also low due to the same reasons. Consequently, RSM does not propose any additional technical conditions to incoming Mobile Service users operating

⁹ Further information can be found from RSM’s RRF using Licence ID: 230574 and Licence #: 290150.

¹⁰ The licences operate with a METEK GmbH Micro Rain Radar MRR-2 transmitter and receiver with its RF transmit and receive characteristics reported in its datasheet from <https://metek.de/product/mrr-2/>.

within 24.25 – 27.5 GHz to ensure continued protection of the existing licences in the adjacent frequency range of 24.21 – 24.25 GHz.

1.2.3. 23.6 – 24 GHz

Article 5 of the ITU RR allocates the 23.6 – 24 GHz frequency range exclusively to passive services. In particular, it covers EESS (passive), SRS (passive) and RAS, respectively. This frequency range is subject to RR No 5.340 (WRC-03), where “*all emissions are prohibited*” within 23.6 – 24 GHz. Passive services perform important scientific measurements for a range of applications (e.g., estimating climate change, weather forecasting, measuring temperature of different planets, as well as collecting radio emissions from stars, galaxies and other objects in the universe). As passive services imply *receive-only* functionality, in the case of EESS (passive) and SRS (passive), the receivers on board EESS and SRS satellites must be protected from adjacent-band emissions (e.g., in this case above 24.0 GHz from 24.0 – 24.25 GHz and 24.25 – 27.5 GHz, respectively). For RAS, sites located on a territory receiving scientific observations to understand different cosmic phenomena via a radio telescope must be protected from the same adjacent-band emissions (as those mentioned above) noting there are no currently recognised RAS sites in the RRF in New Zealand.

The EESS (passive) sensors (a.k.a., radiometers) within 23.6 – 24 GHz are low-noise receivers which are extensively used for meteorology and climatology purposes. For example, measurement of atmospheric water vapour content and sea-surface temperature is natural in this frequency range, as it coincides with the primary H_2O (water) spectral line. This is used to understand the concentration of water vapour for assisting accurate weather prediction. Such measurements are made with a range of conical scan, mechanical NADIR scan, and push-broom radiometers, respectively¹¹. Typically, these sensors operate over a 400 MHz bandwidth and receive radiation at very low signal levels such that the maximum acceptable interference level is on the order of –166 dBW/200 MHz¹², with an interference exceedance probability of 0.01 (1%) in any weather condition. This governs the receiver sensitivity of EESS (passive) radiometers and establishes the protection requirements of such receivers from the presence of aggregate emissions in 24.0 – 24.25 GHz and 24.25 – 27.5 GHz, respectively.

Unlike EESS (passive), the closest SRS (passive) sensor (to 23.6 – 24 GHz frequency range) operates at 22 GHz centre frequency over a 900 MHz bandwidth.¹³ This radiometer is used to measure $N_H 3$ (ammonia) spectral line from different planets such as Jupiter and Venus. Such measurements are made with a spinning SRS (passive) satellite (along a pre-defined path) with its antennas aligned to NADIR. To the best of RSM’s understanding, there are no SRS (passive) radiometers or missions

¹¹ The exact type of EESS (passive) radiometers and their associated technical characteristics as well as operational parameters are presented in Recommendation ITU-R RS.1861-1, “*Typical technical and operational characteristics of Earth exploration-satellite service (passive) systems using allocations between 1.4 and 275 GHz*,” December 2021. Accessible at: <https://www.itu.int/rec/R-REC-RS.1861/en>. In particular, 18 different sensor parameters are reported for EESS (passive) in 23.6 – 24 GHz.

¹² This example is specific to EESS (passive) and is specified in Table 2 of Recommendation ITU-R RS.2017-0, “*Performance and interference criteria for satellite passive remote sensing*,” August 2012. Accessible at: <https://www.itu.int/rec/R-REC-RS.2017/en>.

¹³ The exact characteristics can be obtained from “*Juno microwave radiometer*” from Table 4 in Recommendation ITU-R RS.2064-0, “*Typical technical and operating characteristics and frequency bands used by space research service (passive) observation systems*,” December 2014. Accessible at: <https://www.itu.int/rec/R-REC-RS.2064/en>. In general, SRS (passive) missions are split into two categories: (1) Near-Earth missions; and (2) Deep-space missions, with the near-Earth missions operating much closer to Earth in orbits or regions such as the L1/L2 Lagrange points, while deep space missions are defined by the ITU RR in Article 1.184 at over 2 million km from Earth’s surface.

reported to the ITU which covers 23.6 – 24 GHz frequency range.¹⁴ Therefore, no existing SRS (passive) satellite systems currently exist (to be protected) in 23.6 – 24 GHz.

RAS sites (radio telescopes) in 23.6 – 24 GHz are typically used for geodetic very long baseline interferometry (VLBI) measurements – a technique used to study the Earth dynamics and its orientation in space by receiving signals from distant astronomical sources (e.g., quasars or galaxies). VLBI measurements, are essential for locating the North Pole in order for Global Navigation Satellite Systems (GNSS) to operate correctly and accurately. Under the International Terrestrial Reference Frame (ITRF) – a UN treaty defining geospatial applications, New Zealand has obligations to undertake these measurements, where the Warkworth Space Centre (–36.43°S, 174.66°E) has been identified as one of only two facilities in the Southern Hemisphere making such measurements.¹⁵ Typically, the full 400 MHz bandwidth is used for VLBI measurements using 16, 32 or 64 MHz channel sizes (frequency segments) with a highly directional large parabolic reflector antenna having an aperture of ≥ 12 m. RAS sites receiving radio frequency emissions within 23.6 – 24 GHz are also used to measure the statistical distribution of $N_H 3$ spectral lines across stars, gas, dust and dark matter in our home galaxy, assisting interstellar chemistry. These measurements are typically performed over a much narrower bandwidth relative to VLBI (e.g., 250 kHz with an array of antennas), to provide high angular resolution and resolvability from measurements. The protection of RAS sites is defined in terms of a p.f.d. level based on a detrimental-level interference criterion. This is determined by the type of measurement carried out by the RAS site (including its sensitivity)¹⁶. Table 1 depicts the protection criteria and other related information for two typical types of RAS measurements, namely continuum and spectral line. For both categories, the probability of interference exceedance under any weather condition is 0.02 (2%) of time, which implies that protection must be guaranteed for a probability of 0.98 (98%) of time.¹⁷

Table 1: RAS protection criteria and other related information for continuum and spectral line measurements. All parameters are defined and obtained from Recommendation ITU-R RA.769 (referenced in footnote 16).

Measurement type (Note 1)	Centre frequency [MHz]	Bandwidth [MHz]	Receive noise temperature [K]	Threshold interference levels (Note 2)	
				Input power [dBW]	p.f.d. [dB(W/(m ² ·Hz))]
Continuum	23 800	400	30	-195	-233
Spectral line	23 700	0.25	30	-210	-215

Note 1: A measurement integration time of 2 000 s is assumed.

Note 2: The “Threshold interference levels” apply for RAS measurements where the total power is collected by a single antenna. As discussed in Recommendation ITU-R RA.769, less stringent levels may be appropriate for other types of measurements as discussed in Section 2.2 of the Recommendation.

For ease of reference, the technical characteristics, operational parameters and protection criteria of EESS (passive), SRS (passive) and RAS are captured in Table 2. These were used by ITU-R Task Group

¹⁴ This is specified in Table 7 of Annex 2 to Recommendation ITU-R RS.2064-0, which lists the SRS (passive) frequency ranges and observation missions/systems.

¹⁵ For further information, see <https://spaceops.nz/warkworth-space-centre>.

¹⁶ Recommendation ITU-R RA.769-2, “Protection criteria used for radio astronomical measurements,” May 2003. Accessible at <https://www.itu.int/rec/R-REC-RA.769/en>.

¹⁷ This is obtained from Recommendation ITU-R RA.1513-2, “Levels of data loss to radio astronomy observations and percentage-of-time criteria resulting from degradation by interference for frequency bands allocated to the radio astronomy service on a primary basis,” March 2015. Accessible at <https://www.itu.int/rec/R-REC-RA.1513/en>.

5/1 in preparation for WRC-19 for conducting technical sharing and compatibility studies between EESS (passive) or RAS with Mobile Service transmissions in the 26 GHz band by BSs and UEs.¹⁸

Table 2: Technical characteristics, operational parameters and protection criteria for EESS (passive), SRS (passive) and RAS operating in 23.6-24 GHz.

Radio service	Technical characteristics and operational parameters
EESS (passive)	Recommendation ITU-R RS.1861
	Recommendation ITU-R RS.2017
SRS (passive)	Recommendation ITU-R RS.2064
RAS	Recommendation ITU-R RA.769
	Recommendation ITU-R RA.517 ¹⁹

With the above characteristics, results of sharing and compatibility studies of Task Group 5/1 demonstrated that unwanted emission limits on mobile BSs and UEs would be necessary to protect EESS (passive) receivers, where 18 different radiometers were studied (Sensors F1 to F18 in Recommendation ITU-R RS.1861)²⁰. Such unwanted emissions would also assist the protection of RAS sites. However, Task Group 5/1 concluded that the ultimate protection of RAS sites is to be established at a national level²¹. For potential RAS sites operating within New Zealand territories, RSM would determine the suitable protection of RAS sites. The type of measurements performed by the particular radio telescope, modelling of detailed terrain profiles between the RAS receiver and nearest Mobile Service transmitter (including accurate characterisation of clutter loss as well as building entry loss, as applicable) as well as considering other RAS site-specific factors (e.g., impact of vegetation and diffuse scattering) would need to be accounted in this determination. This would need appropriate recognition, licensing and recording in the RRF.

With the various unwanted emissions limits proposed within ITU-R Task Group 5/1, for the protection of EESS (passive) receivers, WRC-19 approved a revision to Resolution 750, which under “*resolves 1*” prescribes limits on the unwanted emissions within a specified bandwidth. In particular, the prescribed limits are recommended to be applied in *two* stages:

- *Stage 1 – Initial limits:* Equipment brought into use *before* September 1, 2027, must meet the unwanted emissions limit of –33 dBW/200 MHz for mobile BSs and –29 dBW/200 MHz for UEs.
- *Stage 2 – Final limits:* Equipment brought into use *after* September 1, 2027, must meet the unwanted emissions limit of –39 dBW/200 MHz for mobile BSs and –35 dBW/200 MHz for UEs.²²

¹⁸ The mobile system technical characteristics and operational parameters (including density of BSs and UEs) used in the technical studies of ITU-R Task Group 5/1 towards WRC-19 are reported in Annex 1 of Task Group 5/1’s Chair’s Report in Document Task Group 5/1/478 and Document Task Group 5/1/36 (accessible via the hyperlinks).

¹⁹ Recommendation ITU-R RA.517-4, “Protection of the radio astronomy service from transmitters operating in adjacent bands,” May 2006. Accessible at <https://www.itu.int/rec/R-REC-RA.517/en>.

²⁰ These studies can be obtained from <https://www.itu.int/md/R15-TG5.1-C/en>.

²¹ See Section 2/1.13/3.2.1.2.2 titled “RAS” in report to the 2nd Session of the Conference Preparatory Meeting of WRC-19 (CPM 19-2), “Report of the CPM on technical, operational and regulatory/procedural matters to be considered by the World Radiocommunication Conference 2019”, Geneva, 18 – 28 February 2019. Accessible at <https://www.itu.int/en/history/pages/CPMReportsWRC.aspx>.

²² In Europe, the transition date of September 1, 2027, was brought forward to January 1, 2024, as the expectation was that mass market deployment of 5G-NR systems in the 26 GHz band would likely be reached earlier than the transition date set by WRC-19. This change was introduced by the European

RSM proposes to adopt Stage 2 (Final) limits for protecting EESS (passive), since RSM expects that mobile system deployments in the 26 GHz band are not likely to take place until after 2027 and perhaps not before 2030. This aligns with our overall decision to defer the assignment of the 26 GHz frequency band to Mobile Services till between 2028 - 2030. Despite the technical developments in the BS and UE eco-systems (as well as other parts of the mobile network), in other parts of the world (e.g., Australia²³, United Kingdom²⁴, and Canada²⁵) the uptake of mobile system deployments in 26 GHz has been slow to-date. RSM expects this trend to remain unchanged in the short (approximately 1-2 years from now) to medium-term (approximately 4-5 years from now).

As of October 2025, RSM has no recorded RAS sites licenced in the RRF with receive protection licences. However, from April 2024, RSM has been made aware of stakeholder plans to establish new RAS sites in New Zealand at the specific locations outlined in Table 3. The identified RAS sites are not intended to serve as an exhaustive list and should be viewed as examples to demonstrate future plans of establishing RAS sites within the next five years.

Table 3: Planned/proposed RAS site locations in New Zealand operating in 23.6-24 GHz. This information is accurate as of August 2025.

Planned RAS site location(s)	Spatial coordinates	Planned use
Warkworth	–36.43°S, 174.66°E	VLBI and spectral lines
Orepuki	–46.30°S, 167.73°E	Spectral lines and other cosmic phenomena
Otahu Flat/ Waiau Valley	–45.90°S, 167.70°E	VLBI as part of a wider global observation/geodetic station

The Warkworth site is planned to be at the Warkworth Space Centre, which is also home to FSS gateway Earth stations operating in Earth-to-space direction between 27.5 – 29.5 GHz by different GSO (e.g., Viasat/Inmarsat) and NGSO (e.g., Amazon Project Kuiper) satellite operators. Both the Orepuki and Otahu Flat/Waiau Valley sites are located in the Southland region. The Orepuki site is located within the Orepuki township off State Highway 99 (Orepuki-Riverton highway), approximately 66 km west of Invercargill (the main city in Southland). The overall terrain within the township is relatively flat with an average elevation gain of 22 m. In the south-westerly direction, Orepuki looks towards the Pacific Ocean. Compared with Orepuki, the Otahu flat/Waiau Valley site is located further in-land, approximately 48 km north of Orepuki off State Highway 99. Although the site may be in a valley, the average terrain variation east of the valley towards Otahu (195 m) and Reipihi (228 m) peaks is approximately 130 m.

Commission implementing decision (EU) 2020/590 of April 24, 2020, amending Decision (EU) 2019/784 and CEPT in ECC Decision (18)06 on the harmonised technical conditions for Mobile/Fixed Communications Networks in the 26 GHz band, as amended on 20 November 2020. Further information can be obtained from <https://docdb.cept.org/document/3361>.

²³ For further information, see registered licenced transmitters in the 26 GHz band within the Australian Register of Radiocommunications Licences (RRL), Australian Communications and Media Authority (ACMA). Accessible at <https://web.acma.gov.au/rrl>.

²⁴ See Ofcom, UK's recent public consultation “Enabling mmWave spectrum for new uses”, April 2024. Accessible at <https://www.ofcom.org.uk/spectrum/frequencies/mmwave-spectrum-for-new-uses>.

²⁵ See Innovation, Science and Economic Development (ISED) Canada's recent public consultation “Consultation on the 26 GHz and 38 GHz bands”, March 2025. Accessible at <https://ised-isde.canada.ca/site/spectrum-management-telecommunications/en/learn-more/key-documents/consultations/consultation-26-ghz-and-38-ghz-bands>.

Once established and operational, if requested, these sites may be considered for licencing under RSM's radio licencing framework with receive protection licences, such that they can be protected from mobile system emissions in the adjacent 24.25 – 27.5 GHz. RSM has yet to determine a precise and appropriate licencing framework and technical ruleset for RAS sites in 23.6 – 24 GHz²⁶. RSM has considered whether additional technical measures, on top of the prescribed unwanted emissions limits of Resolution 750 (WRC-19), would be necessary to protect the planned RAS sites. To this end, RSM proposes to undertake a site-specific technical analysis to understand the likelihood of aggregate adjacent-band interference (from mobile systems) exceeding the criteria outlined in Table 1. In the case where RSM find that suitable receive protection is not guaranteed, RSM may implement exclusion areas in the vicinity of these sites, restricting the placement of outdoor mobile BSs and UEs to be outside of these exclusion areas. The exclusion areas are to be calculated based on a range of technical considerations, including:

1. The type of Mobile Service use case (e.g., 5G-NR hotspots, FWA, etc.,) which determines the technical characteristics and operational parameters of the mobile BS and UEs transmitters. This would naturally include details on the BS and UE antenna radiation patterns, specific mechanical and electrical downtilting of BS antennas as well as differences in BS sector orientations (for different BS sites) relative to the location of the RAS receiver.
2. Accurate modelling of the interference path(s) from the BS(s) or UE(s) to the RAS receiver, including path profile analysis based on a high-resolution digital terrain model. This will take into account RAS and BS or UE site-specific peculiarities which contribute to the overall path loss and would lead to a more accurate characterisation of the overall interference link(s).
3. Accurate modelling of the RAS receiver including its antenna radiation pattern both within operational frequency range of 23.6 – 24.0 GHz and from 24.0 -27.5 GHz, as applicable. This would be done while considering that a typical RAS receiver uses a heterodyne circuit architecture²⁷ with a cooled low-noise amplifier at its front-end, followed by a multistage cascade of mixers and local oscillators to down-convert the received observations to a lower intermediate frequency (IF). For spectral line measurements, at the IF stage, band pass filters are implemented (typically in hardware optimising the passband ripple) to select the desired spectral lines, and the signal is then digitised by an analog-to-digital converter. The digitised data is then processed by a digital backend, often using field programmable gate arrays to extract spectral and polarimetric information.

Additionally, as indicated in Section 1.2.1, RSM has current radiodetermination Short-Range Devices operating under the GURL within the 24.05 – 26.5 GHz frequency range and Ultra-Wide Band Devices covering 10.6 GHz – 100 GHz. While both GURL uses are licenced to transmit over all of New Zealand territory, RSM is of the view that the technical conditions as part of the GURLs outlined Section 1.2.1 are sufficient to protect the ongoing use of EESS (passive), while protecting future use of SRS (passive) and RAS, respectively.

²⁶ These may be developed after the closure of this consultation to take into account the feedback received as part of this consultation.

²⁷ For more information on typical RAS receiver architectures, see Morgan and Fisher, “*Next generation radio astronomy receiver systems*,” Instrumentation and Methods for Astrophysics, August 2009. Accessible at <https://arxiv.org/pdf/0908.3849>.

Questions

1. Do you agree with RSM's proposed new spectrum uses outlined in Section 1.1? If not, provide details on the modifications you wish to propose with appropriate reasoning.
2. Do you agree with RSM's assessment of the impact on existing users within 23.6 – 24 GHz, 24 – 24.25 GHz and 24.25 – 27.5 GHz, including the proposed technical and operational considerations, as well as technical conditions for the protection of EESS (passive) and potential RAS use in 23.6 – 24 GHz from future Mobile Service emissions in the adjacent 24.25 – 27.5 GHz band? If not, please provide further specific technical details and rationale, including technical studies.
3. Are you aware of other locations apart from those listed in Table 3 which would be likely be used for RAS within New Zealand? If so, please provide details of these locations including the technical and operational parameters of the RAS receiver along with supporting material showing firm plans to establish a site at these locations.
4. Are there any further application/system details you wish to provide which qualifies as an existing user?

1.3. Spectrum requirements for enabling different services and applications in 24.25 – 27.5 GHz

1.3.1. Mobile service

Mobile systems in 24.25 – 27.5 GHz are expected to provide very high data rates to dedicated areas, e.g., for hotspots in urban street canyons and transport hubs (with large population densities), as well as for private networks, FWA and IAB, using 5G-NR technology²⁸. Relative to systems operating in 3.3 – 3.8 GHz or below 2.7 GHz, the 24.25 – 27.5 GHz band offers much larger bandwidths at the expense of higher radio wave propagation losses, which have to be compensated by antenna gain at both transmit and receive link ends. The Third Generation Partnership Project (3GPP) has developed core and performance specifications to facilitate the equipment availability of mobile BSs and UEs within 24.25 – 27.5 GHz. RSM understands that Time-Division Duplex (TDD) mode of operation is expected in this frequency band with multiple band combinations that are standardised by 3GPP for interworking of systems in 3GPP band n258 (24.25 – 27.5 GHz) with those operating in 3GPP band n78 (3.3 – 3.8 GHz).

Mobile BSs operating in this band fall under class type 1-O or 2-O, designed honouring the specifications detailed in 3GPP TS 38.104²⁹. For these types of BSs, the conducted characteristics are defined as an integrated package that includes the physical antenna ports and transceiver units. Typically, the BSs can support carrier bandwidths up to 400 MHz, typically supporting adaptive coding and modulation with up to 64-Quadrature Amplitude Modulation (QAM) for 100 MHz bandwidths and 256-QAM for 400 MHz bandwidth. The increase in the modulation order is done while ensuring that linearity conditions of the power amplifier are met (i.e., operation within the

²⁸ The identified use cases span the broad categories of enhanced mobile broadband (eMBB), ultra-reliable low-latency communications (uRLLC), and massive machine-type communications (mMTC), as highlighted in Figure 2 of Recommendation ITU-R M.2083-0, “*IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond*,” September 2015. Accessible at <https://www.itu.int/rec/R-REC-M.2083/en>.

²⁹ 3GPP TS 38.104, “*Base station (BS) radio transmission and reception*,” June 2025. Accessible at <https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3202>.

linear region of its characteristic curve up to the 1 dB compression point), while the local oscillator phase noise can be kept within acceptable error vector magnitudes.

While there are variations to be expected between specific BS products from different equipment vendors (meeting the 3GPP specifications), BSs operating in 24.25 – 27.5 GHz are expected to use active antenna arrays. These arrays have on the order of 320 antenna elements configured in a uniform planar array, which in-turn consists of 4 sub-arrays³⁰. Each sub-array has 4 horizontal and 20 vertical cross-polarised elements with an inter-element spacing of 0.5λ (where λ is the operating wavelength) in the horizontal and 0.7λ in the vertical domains.³¹ This results in an azimuth 3 dB beamwidth of approximately 22° and an elevation 3 dB beamwidth of approximately 4° , respectively. In general, microstrip patch antennas fabricated on custom silicon (in the form of integrated printed circuit boards) are preferred, where two RF ports per-element on the antenna backplane feed both horizontal and vertical polarisations. Due to the amalgamation of high RF circuit power consumption of the upconverters and power amplifiers with high signal processing complexity to support large bandwidths, analog beamforming or hybrid beamforming is employed, rather than digital beamforming that is often used for BSs operating in 3.3 – 3.8 GHz.³² Each sub-array transmits a single beam, yielding 4 beams for the 4 sub-arrays. This is executed by the baseband waveform passing through a 4-stream multiplexer before being filtered and upconverted to the centre frequency. As highlighted in the literature (see reference in footnote 30), such configurations can have up to 16 power amplifiers distributed across two polarisation states in the array. For the vertical polarisation, one power amplifier can drive 20 elements and in the horizontal polarisation, one power amplifier can drive one element. With such a BS architecture, maximum e.i.r.p. on the order of 62 dBm is expected.

On the UE side, 3GPP specification TS 38.101³³ is expected to facilitate the development of the UE eco-system. In contrast with UEs operating in 3.3 – 3.8 GHz or below 2.7 GHz, UEs are standardised to support up to 400 MHz of bandwidth and will also employ an active antenna array which provides additional array gain needed to extend the overall link distance. Some pre-commercial field trials have demonstrated that the UE could have an antenna architecture supporting the transmission/reception of 4 beams and a maximum antenna gain in the range of 5 – 10 dBi with a total transmitter conducted output power of 23 dBm. The UEs are expected to support fixed and mobile operations at typical pedestrian (0 – 5 kilometres per-hour) and highway speeds (80 – 110 km/h).

Accounting for the characteristics discussed above, Report ITU-R M.2410³⁴ specifies the user experience spectral efficiencies – defined at the 5th percentile point of the per-user spectral efficiency cumulative distribution function (CDF) – over a range of possible deployment environments. These are summarised in Table 4.

³⁰ In this context, a “sub-array” is defined as the subset of the overall antenna array comprised of multiple smaller arrays each equipped with multiple antenna elements (individual radiators) of a given polarisation.

³¹ See M. Shafi, H. Tataria, A. F. Molisch, F. Tufvesson and G. Tunnicliffe, “Real-time deployment aspects of C-band and millimeter-wave 5G-NR systems, *IEEE International Conference on Communications (ICC)*, June 2020. Accessible at <https://ieeexplore.ieee.org/abstract/document/9148902>.

³² See H. Tataria, M. Shafi, A. F. Molisch, M. Dohler, H. Sjöland, and F. Tufvesson, “6G wireless systems: Vision, requirements, challenges, insights and opportunities,” *Proceedings of the IEEE*, Volume 109, Number 7, Pages 1166-1199, July 2021. Accessible at <https://ieeexplore.ieee.org/document/9390169>.

³³ 3GPP TS 38.101,

³⁴ Report ITU-R M.2410-0, “Minimum requirements related to technical performance for IMT-2020 radio interface(s),” November 2017. Accessible at <https://www.itu.int/pub/R-REP-M.2410>.

Table 4: Downlink and uplink user experience spectral efficiencies for different environments as per Report ITU-R M.2410.

Environment	Spectral efficiencies [bits/seconds/Hz]	
	Downlink (BS to UE link)	Uplink (UE to BS link)
Indoor hotspot	0.3	0.21
Dense urban	0.225	0.15
Sub-urban/rural	0.12	0.045

Note that across all specified environments, the downlink spectral efficiencies are higher than the uplink due to the smaller antenna gains and conducted output powers of the UE relative to the BS. Taking the example of a dense urban environment, the downlink (BS to UE link) spectral efficiency can be translated into the 5th percentile per-user data rate as shown in Table 5.

Table 5: 5th percentile per-user downlink data rate as a function of bandwidth for dense urban environment.

Bandwidth	5 th percentile per-user data rate (bits/seconds)
100 MHz	22.5 Mbps
200 MHz	45 Mbps
400 MHz	90 Mbps
800 MHz	180 Mbps

As the bandwidth increases from 100 to 800 MHz, the data rate is seen to increase linearly as a function of the bandwidth. For a bandwidth of 800 MHz, a user experience data rate of 180 Mbps is feasible, while 400 MHz bandwidth offers a user experience data rate of 90 Mbps. RSM understands that in both cases, the peak achievable data rates are likely to be considerably higher than the user experience data rates with the exact values reliant on the overall radio access and core network designs (in addition to the operational bandwidth).

RSM recognise that the treatment of spectrum requirements relies on 3GPP standardised 5G-NR mobile systems, and that there may be other equipment available which could comply to other standards (e.g., European Telecommunications Standards Institute (ETSI) or Institute of Electrical and Electronics Engineers (IEEE)). RSM also recognise that not all Mobile Service radio products may be designed conforming to an associated standard.

Within the TWG, industry indicated that they estimate that up to 800 MHz of spectrum will be required per operator to meet the capacity needs for mobile growth and specific new applications. RSM believe that 800 MHz is upper limit of spectrum needs where actual needs may be as low as 400 MHz, noting this is the maximum carrier bandwidth is 400 MHz. In any case with 3.25 GHz of spectrum available in 26 GHz, the spectrum needs of New Zealand's Mobile Network Operators (MNO) plus other users can be accommodated within the band. If at a future stage more spectrum is needed, RSM has indicated in its spectrum outlook that the 40.5 -43.5 GHz frequency band may be considered for 5G / 6G mmWave mobile.

1.3.2. EESS (space-to-Earth) and SRS (space-to-Earth)

Article 5 of the ITU RR allocates the 25.5 – 27.0 GHz frequency range to EESS (space-to-Earth), Fixed Service, Inter-Satellite Service, Mobile Service, and SRS (space-to-Earth) on a co-primary basis. EESS and SRS space-to-Earth links use this frequency range for transmitting high data volumes from EESS and SRS satellites performing Earth observation or supporting scientific research missions. Therefore, the spectrum requirements for these services are primarily driven by the space-to-Earth

data rate requirements and the minimum link reliability levels for communication with acceptable error rates.

EESS satellites are typically deployed in circular low-Earth orbits (LEOs) to effectively collect high-resolution imagery and environmental data related to the Earth. As the EESS satellite passes through the field-of-view of the EESS Earth station, the collected data is transmitted from the satellite at target (per-satellite) data rates between 500 Mbps and 2 Gbps in all weather conditions³⁵. In contrast, SRS cover both near Earth and deep space missions and consequently determines the suitable satellite orbit relating to a particular mission. The most sensitive SRS missions are satellites operating near the L1 and L2 Lagrange points and near the moon. Typically, they support periodic telemetry (given a set duty cycle) and continuous scientific data return with target data rates ranging from 10 Mbps to 1 Gbps. This is despite extreme temperature swings around the lunar cycle of approximately 308°C (calculated as the differential of the highest temperature on the moon of approximately 124°C and its lowest temperature of –184°C due to the lack of atmosphere at the moon).

As highlighted in Recommendation ITU-R SA.1862, both EESS and SRS space-to-Earth links use phase shift keying modulation of order 4 (4/Q-PSK) or 8 (8-PSK), with forward error correction coding from the satellite transponder either using low-density parity-check (LDPC) or Turbo codes, respectively.³⁶ Considering other differences in the EESS and SRS satellite system design and transmission parameters, this leads to spectral efficiencies on the order of 2 to 4 bps/Hz for EESS links, and 1 to 3 bps/Hz for SRS links³⁷. To this end, a per-satellite EESS link of 2 Gbps with 2 bps/Hz requires approximately 1 GHz of spectrum. Similarly, a 100 Mbps SRS probe³⁸ with 1 bps/Hz spectral efficiency would require 100 MHz of spectrum. Therefore, a constellation of 10 SRS spacecraft (with one probe each, yielding 10 probes) will require an aggregate 1 GHz of spectrum. This demonstrates the need to use most of the available 25.5 – 27 GHz space-to-Earth allocations for EESS and SRS.

Questions

5. Do you agree with RSM's understanding of the spectrum requirements and key usage scenarios for enabling different services and applications (e.g., Mobile Service, EESS and SRS) in 24.25 – 27.5 GHz?
6. What are your spectrum estimates for the use of Mobile Services, EESS and SRS in 24.25 – 27.5 GHz which you wish to implement or use? Present a technical analysis with appropriate justification.
7. Can you provide a link budget of a system which you plan to operate in 24.25 – 27.5 GHz, which will assist RSM to better plan, allocate and assign this frequency range?
8. Do you plan on operating mobile systems that are not standardised by 3GPP? If so, what type of equipment do you plan to operate and what are its technical characteristics? Where possible, please provide the relevant supporting technical documentation.

³⁵ ITU-R Recommendation SA.1862-0, "Guidelines for efficient use of the band 25.5 – 27.0 GHz by the Earth exploration satellite service (space-to-Earth) and space research service (space-to-Earth)," January 2010. Accessible at <https://www.itu.int/rec/R-REC-SA.1862/en>.

³⁶ See K.S. Andrews, et al., "The development of Turbo and LDPC codes for deep-space applications," *Proceedings of the IEEE*, Volume 95, Number 11, Pages 2142-2156, November 2007. Accessible at <https://ieeexplore.ieee.org/abstract/document/4383367>.

³⁷ D. J. Costello Jr., "Error control techniques for satellite and space communications," Annual Status Report to NASA, University of Norte Dame, United States of America, October 1991. Accessible at <https://ntrs.nasa.gov/api/citations/19920002010/downloads/19920002010.pdf>.

³⁸ A space probe is an unmanned spacecraft equipped with instruments to explore and gather scientific data from celestial bodies and phenomena beyond Earth's atmosphere.

1.4. Proposed technical conditions

Considering the existing use in 23.6 – 24 GHz, 24 – 24.25 GHz and 24.25 – 27.5 GHz, based on the studies conducted in ITU-R Task Group 5/1 within the WRC-19 study cycle, RSM propose the following technical conditions on the operation of Mobile Service transmitters within 24.25 – 27.5 GHz:

1. As detailed in Section 1.2, to protect EESS (passive) receivers operating in 23.6 – 24 GHz, RSM proposes to apply the Stage 2 (Final) unwanted emission limits on mobile BSs and UEs contained in “*resolves 1*” of Resolution 750 (WRC-19). These limits are intended for mobile BSs or UEs brought into use after September 1, 2027, and are –39 dBW/200 MHz for BSs and –35 dBW/200 MHz for UEs, respectively.
2. To protect RAS receivers within 23.6 – 24 GHz at the planned RAS site locations specified in Table 3, site-specific technical analysis will be undertaken to understand the likelihood of aggregate interference from Mobile Service transmitters within 24.25 – 27.5 GHz. Accounting for terrain-specific wave propagation modelling and the most accurate technical characteristics of the RAS receiver as well as the Mobile Service transmitters, the RAS protection criteria will need to be met for 98% of time for both the continuum and spectral line measurements, as specified in Table 1. In the case where it is found that suitable receive protection at any of the planned RAS site cannot be guaranteed, exclusion areas may be implemented in the vicinity of the planned RAS sites, restricting the placement of outdoor mobile BSs and UEs to be outside these exclusion areas. The proposed factors in determining the exclusion areas are detailed after Table 3 in Section 1.2.3.
3. Unwanted emissions from mobile BSs operating within 24.25 – 27.5 GHz should conform to the –60 dBW/MHz spurious emission limit, as specified in Category B of Recommendation ITU-R SM.329³⁹. This is necessary to protect EESS (passive) receivers operating in frequency ranges 50.2 – 50.4 GHz and 52.6 – 54.25 GHz from the second harmonic of mobile BS emissions, as specified in “*recognising d*” of Resolution 242 (WRC-19). New Zealand normally applies Category B spurious emissions limits and RSM believes that mobile BSs in 24.25 – 27.5 GHz will be built for a global market to leverage equipment harmonisation, where most equipment standards would meet the Category B spurious emissions limits of Recommendation ITU-R SM.329.
4. In accordance with “*considering j*” of Resolution 242 (WRC-19), a “*very limited*”, implying a small percentage, of the total number of BSs⁴⁰ are expected to communicate with a positive elevation angle towards indoor mobile UEs (e.g., in high-rise buildings). RSM interpret and propose this to mean that $\leq 5\%$ of the total BSs should point above the horizon⁴¹ at any given instance of time. While RSM recognise that the quantification of the terms “*very limited*” in Resolution 242 (WRC-19) is subjective, our technical justification behind the $\leq 5\%$ quantification relies on the stochastic treatment of the subset of BSs pointing above the horizon, which we denote as $X(t)$, out of a total number of BSs, denoted as $Y(t)$, where t denotes an instance of time. It is known from probability theory that so long as $Y(t) \geq 30$,

³⁹ Recommendation ITU-R SM.329-13, “*Unwanted emissions in the spurious domain*,” September 2023. Accessible at <https://www.itu.int/rec/R-REC-SM.329-13-202409-I/en>.

⁴⁰ We refer to the term “*total number of BSs*” to imply the number of active BSs which are transmitting at any given instance of time, at a given carrier centre frequency within 24.25 – 27.5 GHz, over a certain bandwidth.

⁴¹ The term “*horizon*” is defined at 90° nominal elevation angle on the basis of a conventional right-hand three-dimensional coordinate system/frame, where the elevation angle is measured from the z – axis, which points towards the nadir direction of +180°, while 0° points towards the ground (Earth’s surface). Consequently, the azimuth angle is measured on the $(x - y)$ plane and therefore naturally has a span of 360° from –180° to 180° across the $(x - y)$ plane. We note that in the satellite communication system literature, the “*horizon*” is often defined at 0° nominal elevation angle, which implies a 90° shift.

in accordance with the Central Limit Theorem⁴² the resulting distribution of $X(t)$, on average, would converge in a mathematically almost sure sense to a Gaussian distribution with mean μ and variance σ^2 . Utilising the properties of the Gaussian density, the probability, $\Pr [\mu - 2\sigma \leq X(t) \leq \mu + 2\sigma] \approx 0.95$ (= 95%). Obtaining the complement of 0.95 yields $1 - 0.95 = 0.05$ (= 5%). This denotes the total probability outside of $\pm 2\sigma$ of the Gaussian density, where σ denotes the standard deviation. This quantification allows RSM to build a relationship with “resolves 2.1” of Resolution 242 (WRC-19) which states that “practical measures” should be taken to ensure that the BS antenna points “normally” below the horizon. Specifically, the Resolution requires the “mechanical pointing” of the BSs to be “at or below the horizon”. In this regard, RSM understand and propose the use of the term “normally” to mean 95% of $Y(t)$, and the use of the terms “practical measures” to imply electrical and mechanical down tilting of the BS antenna below the horizon. This is to ensure that the boresight of the main beam generated from the BS within its horizontal and vertical steering range points below the horizon. RSM recognises that the provisions of Resolution 242 (WRC-19) do not explicitly recognise the likelihood grating lobes⁴³ which may point above the horizon even if the main beam of the BS is steered to desired location below the horizon.

5. RSM recognises that multiple TDD synchronisation options exist for the operation of Mobile Services in 24.25 – 27.5 GHz. Electronic Communications Committee (ECC) Report 307⁴⁴ outlines and compares synchronised, semi-synchronised and unsynchronised modes of operations. Considering the expected diversity in use cases and smaller overall link distances relative to lower frequency bands (e.g., 3.3 – 3.8 GHz), RSM proposes to use synchronised and semi-synchronised TDD modes. For synchronised TDD systems, RSM would require the definition of the following parameters:
 - a. A common phase clock reference and its accuracy, and
 - b. A common frame structure which includes:
 - i. Selection of a timing reference (beginning of the frame);
 - ii. Selection of a frame format
 - iii. Selection of a sub-carrier spacing
 - iv. Selection of normal or extended prefix, and
 - v. Selection of a special slot configuration.
6. Due to increased Doppler frequencies and oscillator phase noise limitations, RSM recognises that 3GPP standardised mobile systems in 24.25 – 27.5 GHz use 60 kHz and 120 kHz sub-carrier spacing. This corresponds to a slot length of 250 μ s and 120 μ s, respectively. In contrast, semi-synchronised operation aims to strike a balance between being more flexible (when compared to synchronised operation) while accepting some data rate degradation. In some implementations of semi-synchronised TDD operation, the 5G-NR control plane can be protected by ensuring that the control signals do not fall within the flexible part of the frame. This differs from unsynchronised operation, where both the control and data channels can be interfered with, leading to potentially larger loss of data rates. RSM believe that semi-synchronised operation can also be applied to the case of co-existence between different technologies operating in adjacent frequency channels.

⁴² See W. Feller, “An Introduction to Probability Theory,” 3rd Edition, John Wiley Sons & Co., 1968.

⁴³ For discrete aperture antennas (e.g., phased arrays) in which the element spacing is greater than 0.5λ , a spatial aliasing effect allows plane waves incident to the array from visible angles other than the desired direction to be coherently added, causing grating lobes. See C. A. Balanis, “Antenna Theory: Analysis and Design”, 3rd Edition, John Wiley Sons & Co., 2005.

⁴⁴ ECC Report 307, “Toolbox for the most appropriate synchronisation regulatory framework including coexistence of MCFN in 24.25 – 27.5 GHz in unsynchronised and semi-synchronised mode”, March 2020. Accessible at <https://docdb.cept.org/document/13859>.

7. RSM have been made aware of stakeholder plans to establish EESS (space-to-Earth) and SRS (space-to-Earth) links within 25.5 – 27 GHz at specific locations within New Zealand, as outlined in Table 6. As of October 2025, RSM has no recorded EESS and SRS sites licenced in the RRF with receive protection licences. The identified sites are not intended to serve as an exhaustive list and should be viewed as examples to demonstrate plans of establishing EESS and SRS sites within the next five years.

Table 6: Planned/proposed EESS (space-to-Earth) and SRS (space-to-Earth) site locations in New Zealand operating in 25.5 - 27 GHz.

Planned location(s)	Spatial coordinates	Planned use
Awarua Space Centre	–46.52°S, 168.38°E	Supporting lunar missions under SRS (space-to-Earth) and satellite imaging as well as mapping of super emitters under EESS (space-to-Earth)
Orepuki	–46.30°S, 167.73°E	Satellite imaging under EESS (space-to-Earth)

RSM proposes that a site-specific analysis be conducted to protect these sites by taking into account the most accurate technical characteristics of the EESS and SRS receivers as well as Mobile Service transmitters. Based on the sharing and compatibility studies conducted in ITU-R Task Group 5/1, RSM recognises that exclusion areas may need to be developed to protect the receiving Earth stations from potential aggregate mobile BS and UE transmissions. Depending on the wave propagation model and system assumptions, RSM expect an exclusion zone with a radius on the order of approximately 10 km within which mobile BSs and UEs would not be permitted to operate. This is consistent with what is observed by some of the studies presented in ITU-R Task Group 5/1⁴⁵. To licence each EESS (space-to-Earth) and SRS (space-to-Earth) site, a dedicated receive protection radio licencing framework will need to be developed along with a technical ruleset to protect the Earth stations operations. This will be done based on the feedback received in response to the current consultation.

1.5. Licencing, award mechanisms and pricing

1.5.1. Mobile services in 24.25 – 27.5 GHz

RSM understands that international use of 24.25 – 27.5 GHz by the Mobile Service is still developing, with the precise use cases for mobile systems yet to mature. The equipment ecosystems suitable for economically feasible mobile deployments within 24.25 – 27.5 GHz has a long development pathway ahead to leverage economies of scale. To the best of RSM’s understanding, on the UE end, while dedicated customer premise equipment for FWA may be available in some jurisdictions, UEs in the form of mobile phones still have limited availability to utilise 24.25 – 27.5 GHz. This is despite all the urgency expressed prior to WRC-19 to identify 24.25 – 27.5 GHz for International Mobile Telecommunications, in accordance with Resolution 242 (WRC-19). As of October 2025, RSM also understand that there is not an immediate demand from the mobile industry stakeholders to obtain access to 24.25 – 27.5 GHz. It is therefore unlikely that mobile network operators and other Mobile Service operators in New Zealand will have immediate and widespread demand for this spectrum.

⁴⁵ See Annex 3 to Document 406 of ITU-R Task Group 5/1. Accessible from <https://www.itu.int/md/R15-TG5.1-C-0406/en>.

Considering the above, RSM proposes that the establishment of an assignment process (e.g., an auction) for mobile systems in 24.25 – 27.5 GHz, including future licensing arrangements or any form of spectrum management rights (Crown or private) should be delayed until between 2028 - 2030 when there may be sufficient spectrum demand to make new communications services available to the New Zealand public and hence warrant an assignment process. As a result, RSM intends to start the assignment process between 2028 - 2030 to make the spectrum available for use after this time. No licence applications will be accepted before this time.

RSM is taking this opportunity to seek your early views on your intended use cases for this spectrum and how 24.25 – 27.5 GHz could be best licenced in future to accommodate these uses. Which licensing regime is most appropriate will depend on the intended services that will be supplied in this frequency band. Options include:

1. ***Private/national management rights:*** Private/national management rights would be appropriate if MNOs intend to supply nation-wide services, including in urban, sub-urban and rural areas. To be consistent with previous Management Right assignments in New Zealand and overseas, RSM would likely auction management rights through a Combinatorial Clock Auction process. Details of this process would be developed closer to the 2028 - 2030 timeframe and the feedback received as part of this current consultation would also be considered. RSM is of the view that nation-wide mobile deployments in 24.25 – 27.5 GHz are unlikely, due to the relatively smaller link distances on offer by these systems in comparison to say mobile systems operating at 3.3 – 3.8 GHz or below. Use cases such as FWA could facilitate link distances on the order of a few kilometres at best with highly optimised customer premise equipment, however the majority of the other use cases can be classified as local (e.g., 5G-NR hotspots in urban population centres or sporting venues, private networks etc). These deployments would be expected to operate over much shorter link distances intending to deliver extremely high data rate links with low latencies to yield the benefit of 5G-NR systems at 24.25 – 27.5 GHz. Since wide area coverage is unlikely, RSM do not consider that nation-wide management rights will be the most efficient use of spectrum. This will likely mean that this valuable spectrum could go unused in many areas of New Zealand and cannot be used by other radio services due to the exclusivity of management rights. Therefore, RSM do not consider nationwide management rights to be the most appropriate option for this band. It is noteworthy that other jurisdictions, such as Australia and the United Kingdom, have not made 24.25 – 27.5 GHz spectrum available on a nationwide basis. RSM seeks further stakeholder feedback on this issue (see question 22 below).
2. ***Crown management right (administered by The Crown):*** This option would be most appropriate if MNOs intend to supply regional or area-specific services (e.g., only within urban or only within rural areas of New Zealand). In this case, to award 24.25 – 27.5 GHz spectrum, RSM has the following options:
 - a. Auction licences on an individual basis using a Simultaneous Multiple Round Ascending auction, where bidders simultaneously bid for specific frequencies at specific locations within New Zealand,
 - b. Auction licences on a bundled basis, where bidders bid for frequencies across defined areas, i.e., frequency lots applicable to all cities of New Zealand or available to the top 20 cities within New Zealand (which is approximately 80% of the country's population), or
 - c. Establish an administrative incentive pricing regime that sets the price of a given licence in an area, commensurate to the total economic value of 24.25 – 27.5 GHz spectrum, which is then scaled (multiplied) by the estimated population of that area.

RSM invites stakeholder feedback on all three options outlined under The Crown management right (see question 22 below). RSM is of the view that spectrum is best made available on an area or licenced basis and the optimal allocation mechanism within the current regulatory framework of radiocommunication services in New Zealand is to use Crown Management rights. We anticipate that the areas would largely consist of major populated centres, urban area, sporting venues, concert and entertainment venues, ports and industrial plants, as well as rural FWA and IAB deployments. Additional licensing mechanisms (e.g. first in first served) may be established for areas with lower population densities (e.g. rural areas); the appropriate mechanism is still to be determined.

RSM consider that there is sufficient spectrum to within the 24.25 -27.5 GHz frequency band to provide for 5G / 6G mmWave mobile systems for MNOs. Therefore, RSM intend to develop rules where licensees / operators with access to 24.25 – 27.5 GHz will not be able to access 27.5 -28.35 GHz. If at a future stage there is more demand for bandwidth, RSM has indicated in its spectrum outlook that the 40.5 -43.5 GHz frequency band may be considered for 5G / 6G mmWave mobile.

1.5.2. EESS (Space-to-Earth) and SRS (Space-to-Earth) in 25.5 – 27 GHz

RSM considers that EESS (space-to-Earth) and SRS (space-to-Earth) receivers could have a more immediate demand for licensing relative to mobile systems. This is particularly given that RSM has been made aware of stakeholder plans to establish new EESS (space-to-Earth) and SRS (space-to-Earth) sites to support the download of data from space relating to Earth imaging via satellites, mapping of super emitters, and support of lunar missions, such as those carried out by National Aeronautics and Space Administration (NASA), United States and European Space Agency (ESA).

RSM propose that it will accept application of licences starting with the sites in Table 6. Initially, the proposed licencing activity would be carried out through the radio licensing framework with receive protection, however, a new licence type may be needed should a management right be created covering the 25.5 – 27 GHz frequency range. RSM anticipate the licences will continue with similar characteristics under the management right (i.e., same receive protections continue) and that this would still be on an administrative basis (i.e., administrative fees only). RSM are unlikely to consider new/other sites outside of those identified in Table 6 or as otherwise identified as part of this consultation, until it undertakes its assignment process for Mobile Services between 2028 - 2030.

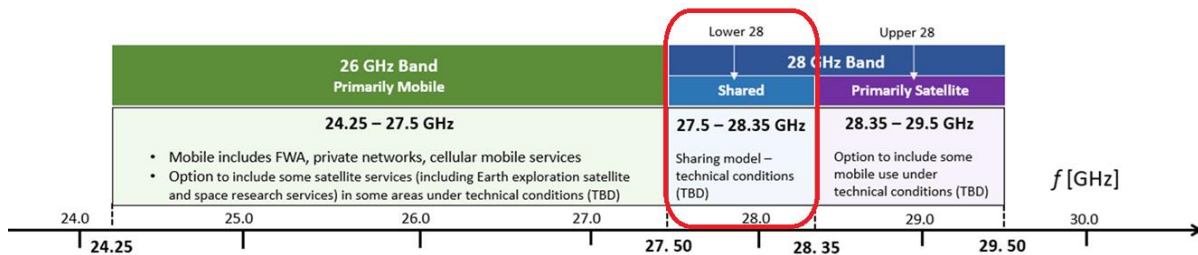
1.5.3. RAS in 23.6 – 24 GHz

Detailed considerations on licencing RAS sites within New Zealand have been presented in Section 1.2.3. For consistency purposes, RSM proposes the RAS site licences to be based on administrative fees only and will not be considering new/other RAS sites outside of those defined in Table 3, until it undertakes its assignment process for Mobile Services in 2028 - 2030.

Questions

9. Does the mobile BS and UE you wish to operate within 24.25 – 27.5 GHz have unwanted emissions falling within 23.6 – 24 GHz of –39 dBW/200 MHz for BSs and – 35 dBW/200 MHz for UEs? If so, could you provide details of the unwanted emission mask as a function of frequency? If not, could you provide the unwanted emissions limits of the equipment you wish to operate with the necessary technical justification?
10. Does the mobile BS you wish to operate meet the –60 dBW/MHz Category B spurious emissions limit from Recommendation ITU-R SM.329? If not, what do you propose for the necessary protect EESS (passive) receivers in 50.2 – 50.4 GHz and 52.6 – 54.25 GHz from the second harmonic of mobile BS emissions within 24.25 – 27.5 GHz?
11. Do you agree with our 5% quantification for the use of the terms “very limited” number of BSs operating in 24.25 – 27.5 GHz that are expected to communicate with a positive elevation angle towards indoor mobile UEs? If not, what technical modifications would you suggest to this quantification?
12. For mobile system deployments envisaged in 24.25 – 27.5 GHz, what are the typical range of values for electrical and mechanical tilts which you intend to use? Do these parameters relate to the deployment environment (i.e., urban, sub-urban, etc)? If so, provide details of the relationship.
13. How would you mathematically characterise the term “normally” pointing the BS below the horizon, as quoted in “resolves 2.1” of Resolution 242 (WRC-19)?
14. What would be your mobile BS’s typical elevation beam steering range and would the composition of the BS antenna array cause grating lobes to occur? If so, would you be able to quantify the direction and magnitude of these grating lobes?
15. What type of TDD synchronisation options would you prefer and why? Do you prefer to have a default frame structure? What do you consider the underlying technical conditions to manage the any potential interference should be?
16. Do you agree with RSM’s assessment on the need to design exclusion areas around the proposed EESS and SRS (space-to-Earth) sites in 25.5 – 27.0 GHz to protect them from aggregate Mobile Service emissions in 24.25 – 27.5 GHz? If not, what other technical alternative(s) would you suggest?
17. Do you agree with RSM’s assessment of the licencing framework for EESS (space-to-Earth) and SRS (space-to-Earth) anticipated to operate in 25.5 – 27 GHz? If yes, provide your reasoning. If no, which other alternative would you suggest to licence these services and why?
18. Do you agree with RSM’s assessment of the licencing framework for RAS operating in 23.6 – 24 GHz? If yes, provide your reasoning. If no, which other alternative would you suggest to licence these services and why?

2. Our approach to lower 28 GHz radio spectrum (27.5 – 28.35 GHz)



2.1. Proposed new spectrum uses

The New Zealand Cabinet has made the decision to allocate the 27.5 – 28.35 GHz frequency range to the FSS (Earth-to-space) and Mobile Service on a *shared* basis (see Annex 1). This allocation is aligned with the broader ITU-R Region 3 allocation as outlined in PIB 21 and in Article 5 of the ITU RR, where both FSS and Mobile Service have co-primary status. These allocations are, in part, a result of the outcomes of WRC-19 and WRC-23. We propose that the new uses in the band will be the following:

- Continued existing and new use of FSS (Earth-to-space) gateway Earth stations/sites at specific fixed locations
- FSS (Earth-to-space) Earth station user terminals at fixed locations (not in motion)
- FSS (Earth-to-space) ESIMs for Aeronautical (A-ESIM) and Maritime (M-ESIM) under the technical conditions prescribed in RR Resolution 123 (WRC-23) and 169 (WRC-19) only, and
- Mobile systems (e.g., FWA and/or private networks) in dedicated/specific areas of the country in accordance with the sharing options and the associated technical conditions (discussed later in the section).

2.2. Impact on existing spectrum users

The lower 28 GHz frequency range currently includes arrangements for the following existing users:

- Individually licenced FSS GSO and NGSO gateway Earth stations for transmissions from the gateway Earth station up to a GSO or an NGSO satellite(s); and
- Ultra-Wide Band Devices GURL covering 10.6 GHz – 100 GHz, licenced to transmit over all of New Zealand⁴⁶.

Currently, there are no FSS GSO or NGSO fixed (not in motion) user terminals, as well as A-ESIM and M-ESIM terminals licenced to transmit in the Earth-to-space direction within 27.5 – 28.35 GHz. The following analyses the impact on existing spectrum users as a result of enabling new uses outlined in Section 2.1.

2.2.1. Individually licenced FSS GSO and NGSO gateway Earth stations

These are typically large hubs that connect the GSO or NGSO satellite system to the internet and/or to private networks. The term “*individually licenced*” (sometimes known as “*coordinated*”) refers to the gateway Earth station operating from a permanent, specific geographical location in New

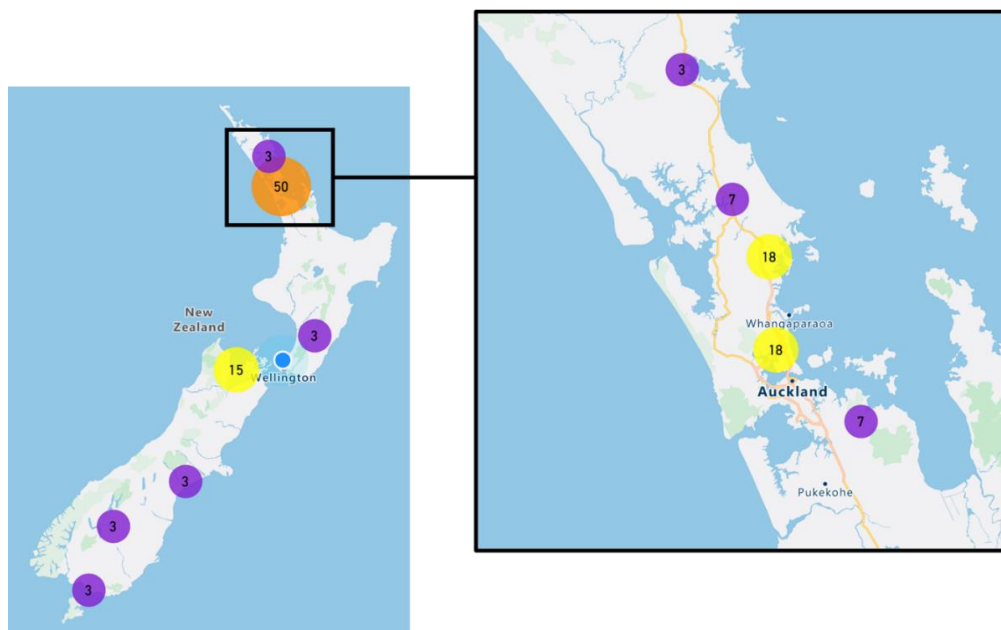
⁴⁶ Further information on the Ultra-Wide Band Devices GURL can be found from <https://gazette.govt.nz/notice/id/2017-go406>.

Zealand, under the current technical and policy guidelines associated with RSM’s radio licencing framework in PIB 38 and PIB 58, respectively⁴⁷.

As of September 2025, there are 81 existing radio licences for FSS gateway Earth stations within New Zealand to GSO or NGSO satellites orbiting the Earth. Following the Cabinet decisions of August 2023, these licenses are currently valid until May 2026, after which implementation of decisions (in the form of licencing) from the outcome of this consultation is expected to provide continued certainty of operation to the existing licence holders. RSM will also enable a pathway for new licence applications for enabling the growth of FSS GSO and NGSO gateway sites by existing and future FSS operators under the established licencing framework.

The geographical distribution of existing licenses in 27.5 – 28.35 GHz frequency range across both the North and South Islands of New Zealand is depicted in Figure 3 with a focus (as an example) over a cluster of 53 radio licenses in the vicinity of the greater Auckland area. This information is obtained from RSM’s RRF⁴⁸. It is noteworthy that typically, a single FSS gateway Earth station site has multiple licences due to the same gateway site covering different frequency channels within 27.5 – 28.35 GHz (with the appropriate emissions designators) or due to communication with different satellites or orbital slots associated with different ITU satellite filings.

Figure 3: Geographical breakdown of radio licenses for FSS (Earth-to-space) gateway Earth stations/sites in 27.5-28.35 GHz in the North Island and South Islands of New Zealand.



Considering the distribution of these licences within 27.5 – 28.35 GHz, future introduction of mobile systems (e.g., FWA or private networks), will be considered on a *shared* basis with the existing and new FSS (Earth-to-space) use, subject to specific sharing options and associated conditions presented in Section 2.4. This is necessary to strike the right balance between protection of existing use without unduly constraining its future growth and facilitation of the incoming use (Mobile

⁴⁷ Further information can be obtained from <https://www.rsm.govt.nz/about/publications/pibs/pib-38> and <https://www.rsm.govt.nz/about/publications/pibs/pib-58>.

⁴⁸ This information can be verified by the “Search Licences” function in the RRF found in <https://rrf.rsm.govt.nz/ui>.

Service) while being mindful of its future expansion. RSM will aim to optimise this balance to ensure the impact on existing users is minimal.

Since the FSS gateway Earth stations transmit beams from fixed locations in New Zealand to receivers onboard GSO or NGSO satellites, the satellite receivers need to be protected from any potential interference stemming from Mobile Service transmitters operating within 27.5 – 28.35 GHz, and in the adjacent 26 GHz band (from 24.25 – 27.5 GHz). Therefore, potential aggregate interference from mobile BSs and UEs located within the overall footprint of the satellite’s receive beams needs to be characterised. Due to the spot beam nature of most 28 GHz GSO and NGSO satellite systems, only the beam footprints covering the land area of New Zealand has been analysed. Reciprocally, for successful co-existence between the existing and incoming system(s), the likelihood and impact of potential interference from the GSO and NGSO gateway Earth stations to mobile BSs and UEs also has been characterised. This will lead to an understanding of the required separation distances between a GSO or NGSO FSS gateway and a mobile BS or UE receiver. The above manifests into the sharing and compatibility scenarios, as depicted in Table 7 below.

Table 7: Sharing and compatibility scenarios between FSS GSO and NGSO gateway Earth stations, satellite receivers, and mobile BSs and UEs.

Service/ System	FSS (Earth-to-space) GSO and NGSO gateways	Mobile service transmit/receive
Frequency range(s)	27.5 – 28.35 GHz (in- band)	27.5 – 28.35 GHz (in-band)
		24.25 – 27.5 GHz (adjacent-band)
Resulting sharing and compatibility scenarios (denoted as #)		
Satellite system type	GSO	#1: GSO FSS gateway transmit into mobile BS/UE ⁴⁹ receive
		#2: Mobile BS/UE transmit into GSO satellite receive
	NGSO	#3: NGSO FSS gateway transmit into mobile BS/UE receive
		#4: Mobile BS/UE transmit into GSO satellite receive

RSM has conducted sharing and compatibility studies for assessing the co-existence feasibility of transmitting FSS gateway Earth stations and Mobile Service receivers, as well as Mobile Service transmissions into FSS receivers. Scenarios #1, #3, and #4 were analysed in detail to examine the compatibility of mobile BSs receivers with GSO and NGSO FSS gateway transmissions, as well as a GSO FSS receiver at a fixed orbital position (by means of example). While recognising the importance of each scenario described in Table 7, RSM studied the abovementioned scenarios, as they were considered to be the most significant for assessing the sharing and compatibility. For clarity of presentation and reasons of brevity, these studies have not been included in this discussion document⁵⁰. Our studies have demonstrated that for scenarios #1 and #3, the interference from 27.5 – 28.35 GHz GSO and NGSO FSS gateway Earth stations transmissions “seen” at mobile BS receivers operating within 27.5 – 28.35 GHz and 24.25 – 27.5 GHz is negligible. As a result, both the gateway

⁴⁹ The term “mobile BS/UE” in Table 7 is used to refer to *either* mobile BS or UE, respectively.

⁵⁰ Interested parties wishing to obtain a copy of these studies should request them via e-mail to radio.spectrum@mbie.govt.nz with the e-mail subject: “Request for RSM study on sharing and compatibility between Mobile and FSS (Earth-to-space) in 27.5-28.35 GHz”.

and the mobile BS receiver can be located within close proximity, if the following conditions are satisfied:

1. Considering the above ground level height difference between the FSS GSO or NGSO gateway and the mobile BS, the minimum elevation angle of the GSO or NGSO FSS gateway is 20° above the horizon⁵¹
2. The maximum e.i.r.p. density of the GSO or NGSO gateway site towards the horizon is ≤ -15 dBW/MHz within the frequency range 27.5 – 28.35 GHz
3. The maximum e.i.r.p. density of the GSO or NGSO gateway site towards the horizon is ≤ -35 dBW/MHz within the 24.25 – 27.5 GHz (adjacent) frequency band
4. The mechanical pointing of mobile BS antenna (panel), assumed to be capable of performing adaptive beamforming, shall be below the horizon with its RF performance compliant to the core RF specifications outlined in 3GPP TS 38.104 and other related standards
5. The representative propagation losses between the FSS GSO or NGSO gateway Earth stations and the mobile BS receivers are calculated by the use of Recommendation ITU-R P.452⁵² with the default representative clutter height values and 10% as the required time percentage for which the calculated basic transmission loss not to be exceeded by⁵³ and
6. The protection criteria for a mobile BS receiver is deterministic and takes the form of $I/N = -6$ dB, as defined in Report ITU-R M.2292⁵⁴.

For both GSO and NGSO FSS gateways at fixed locations within New Zealand, the minimum elevation angle of 20° can be easily met. This can be verified by taking the example of a GSO satellite, e.g., at the orbital position of 180° E (Inmarsat - KA/5F3 180° E)⁵⁵, which receives both TT&C and payload data/beams from 27.5 - 30 GHz while serving New Zealand from its associated GSO gateways at Warkworth Space Centre⁵⁶ (-36.43° S, 174.66° E) and Albany⁵⁷ (-36.74° S, 174.69° E). From both gateway locations, the elevation look angle to 180° E GSO orbital position is approximately 47° , exceeding the 20° minimum elevation angle condition by 27° . Similarly, for an NGSO gateway site, e.g., at Hinds⁵⁸ (-44.00° S, 171.57° E), communicating with the SpaceX (Starlink) STEAM-2B NGSO

⁵¹ The term “horizon” is defined at 90° nominal elevation angle on the basis of a conventional right-hand three-dimensional coordinate system/frame, where the elevation angle is measured from the z – axis, which points towards the nadir direction of $+180^\circ$, while 0° points towards the ground (Earth’s surface). Consequently, the azimuth angle is measured on the $(x - y)$ plane and therefore naturally has a span of 360° from -180° to 180° across the $(x - y)$ plane. We note that in the satellite communication system literature, the “horizon” is often defined at 0° nominal elevation angle, which implies a 90° shift.

⁵² Recommendation ITU-R P.452-18, “Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 100 MHz”, February 2023. Accessible at: <https://www.itu.int/rec/R-REC-P.452/en>.

⁵³ There are other important technical considerations, e.g., the antenna radiation patterns of both the FSS gateway site and the Mobile Service receiver, orientation/facing direction of the Mobile Service receiver, etc., which influence the results of the abovementioned sharing and compatibility studies. However, for conciseness, only the key factors influencing the results are ones mentioned.

⁵⁴ Report ITU-R M.2292-0, “Characteristics of terrestrial IMT-Advanced systems for frequency sharing/interference analyses,” December 2013. Accessible at: <https://www.itu.int/pub/R-REP-M.2292>.

⁵⁵ The associated ITU satellite filing and associated satellite information can be found from <https://www.itu.int/itu-r/space/apps/public/spaceexplorer/networks-explorer/space-stations/dashboard/non-plans/INMARSAT-KA%20180E/111520050>.

⁵⁶ Further information can be found from RSM’s RRF using Licence ID: 409602 (as an example due to the multiplicity of them) and Licence #: 407346 (as an example due to the multiplicity of them).

⁵⁷ Further information can be found from RSM’s RRF using Licence ID: 410570 (as an example due to the multiplicity of them) and Licence #: 409693 (as an example due to the multiplicity of them).

⁵⁸ Further information can be found from RSM’s RRF using Licence ID: 410570 (as an example due to the multiplicity of them) and Licence #: 409693 (as an example due to the multiplicity of them).

satellite constellation 59, the minimum elevation angle is specified based on the NGSO constellation's orbital characteristics (e.g., altitude of operation, number of satellites per-plane, right ascension of the ascending node spacing, satellite inclination angle, etc.), the desired on-ground coverage radius (a.k.a., service range of satellite beams) and the corresponding maximum beam steering angle of each satellite. For this case, taking into account the maximum beam steering angle of approximately 60° at an altitude of 500 km with an on-ground coverage radius of 870 km, the minimum elevation angle satisfying this geometry is 25°, exceeding the 20° condition by ≥ 5 . RSM estimates that other large NGSO satellite constellations will result in similar minimum elevation angles.

The maximum e.i.r.p. density of $\leq -15 \frac{\text{dBW}}{\text{MHz}}$ towards the horizon from both GSO and NGSO gateway Earth stations can be verified and met when calculating the e.i.r.p. density CDF across the ensemble of all off-axis angles (0° – 180°).

In turn, this involves calculating the antenna gain for each off-axis angle and selecting the respective gain in the direction of the horizon relative to the pointing angle of the antenna (a.k.a., on-axis angle). Assuming a fixed level of maximum conducted power (with negligible variance) delivered to the gateway antenna, the on-axis antenna gain is expected to be much higher at the look angle (for the GSO gateway) or the minimum elevation angle (for the NGSO gateway) relative to what is observed at the horizon. This provides a significant level of attenuation to protect mobile BS receivers and assists in meeting the maximum e.i.r.p. density from 27.5 – 28.35 GHz.

The precise level of attenuation can be quantified by subtracting the maximum e.i.r.p. by the antenna gain at the horizon in the logarithmic domain. Typically, the actual antenna gain patterns of GSO and NGSO gateway sites are not disclosed by FSS operators for reasons of confidentiality. Hence, envelope antenna pattern masks are used for sharing and compatibility evaluations. For GSO gateways, Recommendation ITU-R S.465⁶⁰ and S.580⁶¹ are most employed, while for NGSO gateways, Recommendation ITU-R S.1428⁶² is often used. In practice, for both GSO and NGSO gateways, the average e.i.r.p. towards the directions of mobile BSs and UEs would be much lower due to the actual gateway antenna characteristics and lower clear sky e.i.r.p. relative to conditions where there is rain fade. Typically, FSS systems operating in 27.5 – 28.35 GHz employ adaptive coding and modulation, which allows the availability of the satellite link to be relatively constant despite the link suffering from degradation due to higher propagation losses yielding to lower data rates.⁶³ For NGSO gateways, the average e.i.r.p. would be even lower due to the dynamic (spatio-temporally varying) beam pointing of the gateway antenna from the minimum elevation angle up to the maximum angle designed to track the active NGSO satellites, while ensuring that the GSO

⁵⁹ The corresponding ITU filing and the associated space station information can be found from <https://www.itu.int/itu-r/space/apps/public/spaceexplorer/networks-explorer/space-stations/dashboard/non-plans/STEAM-2B/117520027>.

⁶⁰ Recommendation ITU-R S.465-6, "Reference radiation pattern of earth station antennas in the fixed-satellite service for use in coordination and interference assessment in the frequency range from 2 to 31 GHz," January 2010. Accessible at <https://www.itu.int/rec/R-REC-S.465/en>.

⁶¹ Recommendation ITU-R S.580-6, "Radiation diagrams for use as design objectives for antennas of earth stations operating with geostationary satellites," January 2004. Accessible at <https://www.itu.int/rec/R-REC-S.580/en>.

⁶² Recommendation ITU-R S.1428-1, "Reference FSS earth-station radiation patterns for use in interference assessment involving non-GSO satellites in frequency bands between 10.7 GHz and 30 GHz," February 2001. Accessible at <https://www.itu.int/rec/R-REC-S.1428/en>.

⁶³ See Recommendation ITU-R S.2131-0, "Method for the determination of performance objectives for satellite hypothetical reference digital paths using adaptive coding and modulation," September 2019. Accessible at <https://www.itu.int/rec/R-REC-S.2131/en>.

avoidance angles are excluded. The dynamic beam pointing is performed in accordance with the satellite tracking strategy which prescribe a set of rules that can be used to identify particular satellites selected for optimising link performance while carrying out efficient beam and traffic load balancing as well as satellite handovers. Typically, these tracking strategies are not disclosed by the NGSO satellite operators and hence simplified assumptions are made on its functionality, usually consisting of:

- Filtering – from those satellites visible above a minimum elevation angle and outside of the GSO avoidance angle, and
- Selection – Selecting satellites from a candidate set available at a given time, based on a pre-defined criteria which optimises the load balancing of traffic and handover efficiency.

The maximum e.i.r.p. density of $\leq -35 \frac{\text{dBW}}{\text{MHz}}$ in the adjacent band of 24.25 - 27.5 GHz is set to align with the harmonised European standard ETSI EN 303 699. RSM understands that in practice, the emissions will fall well below the -35 dBW/MHz limit due to optimised bandpass filtering implemented in both the RF hardware and software, respectively.

To minimise the likelihood of interference further, the mechanical pointing of mobile BS antennas with dynamic beamforming capabilities should be normally below the horizon with the same practical measures applied in 27.5 – 28.35 GHz relative to 24.25 – 27.5 GHz, as per Resolution 242 (WRC-19) and RSM's proposals for 26 GHz. This is while recognising that the typical mobile BS design is likely to comply with 3GPP BS type 2-O where the antenna array, radio distribution network, and transceiver unit array are integrated as a package, as described in 3GPP TS 38.104.

RSM notes that since FSS GSO and NGSO user terminals at both fixed locations and operating in the form of A-ESIMs and M-ESIMs will communicate in the same (Earth-to-space) direction in comparison with the FSS GSO and NGSO gateways, protection of GSO and NGSO satellite receivers is the key relevant issue to assess the impact on existing users. This is covered by sharing and compatibility scenarios #2 and #4 in Table 7. RSM's study for scenario #4 has demonstrated that the level of aggregate interference from mobile BSs covering New Zealand to a GSO satellite receiver at 180° East is negligible if the following conditions are met:

- The peak gain of the GSO FSS receive antenna does not exceed 46.6 dBi with a receive antenna radiation pattern upper bounded by Recommendation ITU-R S.672 with ≤ -25 dB near-in sidelobe level.⁶⁴
- A single receive spot beam is covering the land area of New Zealand with its RF properties captured in the ITU filing of Inmarsat-KA/5F3 180°E (see footnote 10).
- The density and the number of mobile BSs within the satellite receive beams are calculated using the land area-based method agreed in Task Group 5/1 of the WRC-19 study cycle for urban and sub-urban hotspots.⁶⁵
- The mobile BS antenna pattern is upper bounded by Recommendation ITU-R M.2101 with conducted power delivered to each antenna element limited to 10 dBm/200 MHz. The mechanical downtilt of BS must be at least 10°, with a maximum coverage angle 120° and 30°, in azimuth and elevation of respectively.

⁶⁴ See Section 1.1 of Annex 1 of ITU-R Recommendation S.672-4, "Satellite antenna radiation pattern for use as a design objective in the fixed-satellite service employing geostationary satellites," September 1997. Accessible at <https://www.itu.int/rec/R-REC-S.672/en>.

⁶⁵ For further information, see Attachment 2 of [Document TG 5-1/36](#) from the WRC-19 study cycle, noting that the studies were for the 24.25 -27.5 GHz frequency band.

- Each desired link between the mobile BS and the UEs is modelled via 3GPP TR 38.901⁶⁶, whereas the interfering link from the mobile BS to the GSO satellite receiver is modelled via Recommendation ITU-R P.619⁶⁷ with the slant path clutter loss modelled from Recommendation ITU-R P.2108⁶⁸ and the building entry loss from Recommendation ITU-R P.2109⁶⁹, respectively.
- The protection criteria of the GSO satellite receiver takes on I/N values according to its short-term and long-term exceedance margins based on the satellite link availability and other service level characteristics. In particular, multiple I/N values were selected, e.g., $I/N = -6$ dB, -10.5 dB and -12.2 dB. For each of these values, the interference was found to be negligible.

2.2.2. Ultra-Wide Band Devices GURL

Under the Ultra-Wide Band Devices GURL, RSM permits an all of New Zealand licence to transmit from 10.6 – 100 GHz under certain technical conditions (see footnote 1). Specifically, as prescribed in “*Special Condition 2*” associated with the GURL, the maximum mean e.i.r.p. density should not exceed -85 dBm/MHz with a maximum permissible e.i.r.p. of -75 dBW. Considering the nature of the GURL and operation of Ultra-Wide Band devices over all of New Zealand, RSM does not track the precise number of links or usage patterns. From a protection of an existing spectrum user viewpoint, RSM notes that Ultra-Wide Band Devices are designed to avoid causing interference to licenced services (e.g., FSS (Earth-to-space)). Under the GURL, Ultra-Wide Band Devices are not able to claim protection from licenced services, nor can it cause interference to licenced services. With this de-facto understanding no changes are proposed to the existing use under this GURL.

Questions

19. Do you agree with RSM’s proposed new spectrum uses within 27.5 – 28.35 GHz, noting the growing demand for FSS (Earth-to-space) GSO and NGSO gateways and user terminals?
20. Do you agree with RSM’s assessment of the impact on existing users, including the sharing and compatibility scenarios, considerations and overall conclusions in the form of conditions to be met for the protection of existing users such as individually licenced FSS GSO and NGSO Earth stations, as well as FSS satellite receivers operating within 27.5 – 28.35 GHz? If not, please provide further specific technical details and rationale.
21. Is there any further application/system details you wish to provide which qualifies as an existing user? If so, please provide the details, including any relevant technical information.

⁶⁶ See Sections 7.2 and 7.4 of 3GPP TR 38.901, “*Study on channel model for frequencies from 0.5 to 100 GHz*,” April 2024. Accessible at

<https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3173>

⁶⁷ Recommendation ITU-R P.619-5, “*Propagation data required for the evaluation of interference between stations in space and those on the surface of the Earth*,” September 2021. Accessible at

<https://www.itu.int/rec/R-REC-P.619/en>.

⁶⁸ Recommendation ITU-R P.2108-1, “*Prediction of clutter loss*,” September 2021. Accessible at

<https://www.itu.int/rec/R-REC-P.2108/en>.

⁶⁹ Recommendation ITU-R P.2109-2, “*Prediction of building entry loss*,” August 2023. Accessible at

<https://www.itu.int/rec/R-REC-P.2109/en>.

2.3. Spectrum requirements for enabling different services and applications in 27.5 – 28.35 GHz

In this section, RSM shares its understanding on the spectrum requirements for enabling spectrally efficient services and applications which we wish to enable in 27.5 – 28.35 GHz.

2.3.1. FSS (Earth-to-space) and its applications

To meet the increasing performance demands of FSS systems, such as higher data rates, higher reliability and lower latency, RSM understands that access to 27.5 – 28.35 GHz spectrum (as part of the 28 GHz band) is important. For data intensive applications, this is reflected by the increasing number of High Throughput Satellite (HTS) systems that are currently deployed or under development across both GSO and NGSO orbits. Typically, HTS systems in 27.5 – 28.35 GHz enable data rates on the order of tens-to-hundreds of gigabits per-second at each satellite. This is enabled by a multitude of factors such as increasingly powerful satellites, advanced antenna design, enhancement in payload technology and digital signal processing algorithms. Specifically, HTS systems use efficient solar arrays with triple junction systems to optimise thermal control and use electric propulsion via plasma thrusters to deliver output powers on the order of tens-to-hundreds kilowatts. In conjunction with this, multibeam antennas (e.g., electronically steerable phased arrays) with multiple wideband transponders assists each satellite to form a large number of spot beams enabling greater frequency re-use even if orbit and spectrum allocations are similar. As the size of the on-board satellite antenna is constrained by the launch vehicle fairing capacity, the use of higher frequencies (e.g., 27.5 – 28.35 GHz leads to narrower beamwidths, typically around 0.5°). HTS systems offer advanced digital modulations with more efficient channel coding techniques (e.g., turbo coding) as well as improved latency performance via traffic congestion avoidance mechanisms like load balancing.

RSM recognises that the 28 GHz band for FSS (Earth-to-space) is paired with the 18 GHz (17.7 – 20.2 GHz) band for the reciprocal space-to-Earth links, both of which allow FSS systems to utilise large contiguous spectrum while being in more favourable propagation conditions either side of the water absorption lines. While some FSS systems are able to utilise the entire 28 GHz band, other systems are only able to utilise portions of the band. Typically, FSS GSO gateway Earth stations use high gain, narrow beamwidth, parabolic reflector antennas on the order of 8 – 13 meters for delivering a stable and high-quality signal to the GSO satellite. FSS NGSO gateway Earth stations use 2.4 m or larger antennas depending on their longitude/latitude, the target satellite orbit and its parameters as well as the service requirements. For NGSO gateways, multiple antennas are often co-located at the same gateway site in order to access a number of visible NGSO satellites simultaneously from the same location. It is typical that both GSO and NGSO gateways access spectrum in up to 500 MHz frequency channels. In the context of 27.5-28.35 GHz, this would span up to 2 x 500 MHz channels from 27.5-28.0 GHz and relevant part of the 28.0-28.5 GHz channel. The transmit antennas at the gateways often use polarisation diversity to increase spectral efficiency. Specifically, gateway antennas utilise circular polarisation to enable two beams – one for left-hand and the other for right-hand circular polarisation – to be simultaneously transmitted within the same frequency channel.

RSM understands that currently there are 1485 GSO and 209 NGSO ITU satellite network filings spanning the 28 GHz frequency band, most of which are capable of operating from 27.5 – 30 GHz⁷⁰. The number of ITU filings are likely to be greater than the number of operational satellites. For FSS user terminals, the spectrum requirements stem from the performance requirements of satellite-to-user terminal link for a given application. Taking the example of NGSO-based consumer-grade

⁷⁰ These figures are valid as of July 2025. Further information is available from <https://www.itu.int/itu-r/space/apps/public/spaceexplorer/networks-explorer>.

satellite broadband access to user terminals at fixed rural locations, the *average*⁷¹ per-terminal data rate of over 100 Mbps is typically achieved.⁷² In accordance with this, FSS operators will require a proportional amount of spectrum in the Earth-to-space direction to match the average per-user data rates in the space-to-Earth direction. In a conventional bent-pipe satellite system architecture, broadband traffic is weighted more in the space-to-Earth direction relative to the Earth-to-space direction, noting that the consumer “download” link covers the satellite gateway Earth station to the satellite and down to the user terminal. This is in contrast to the consumer “upload” link, which originates from the satellite user terminal to the satellite and back down to the satellite gateway.

For GSO-based consumer grade satellite broadband, average per-terminal data rates of 50 -100 Mbps are also expected, especially for A-ESIM for in-flight connectivity on commercial aircraft and M-ESIMs for connectivity on commercial maritime vessels or cruise ships. Some A-ESIM or M-ESIM use cases may require higher than 100 Mbps average per-terminal data rates to support greater broadband demand or to be reduced for applications using smaller Earth station antennas. The technical studies carried out under Agenda Item 1.5 for WRC-19 (GSO A-ESIM and M-ESIM) and Agenda Item 1.16 for WRC-23 (NGSO A-ESIM and M-ESIM) determined appropriate technical conditions in the form of p.f.d. masks and distance from the coast for A-ESIM and M-ESIM operation without impacting other existing users and constraining future incoming services.

In accordance with Article 5 of the ITU RR, since 27.5 – 28.35 GHz is part of non-planned FSS bands, both GSO and NGSO FSS operators share the use of this spectrum via the coordination procedures outlined in Article 9 of the RR⁷³. Therefore, deriving accurate spectrum estimates requires an understanding of the precise ITU satellite network coordination process for GSO to GSO, GSO to NGSO and NGSO to NGSO systems. Generally coordination aims to analyse the amount of $\frac{C}{I}$ level which the two coordinating satellite systems can sacrifice in the presence of constant interferers. Coordination is carried out such that satellite link availability is not degraded below a certain level required for supporting the necessary end applications. For NGSO to NGSO systems, the key coordination trigger is frequency overlap, while For GSO to GSO systems, the coordination trigger is a combination of frequency overlap, spatial separation of both systems on the GSO orbital arc and calculated values of $\Delta T/T$.⁷⁴ Coordination allows FSS operators to re-use the same spectrum in the same geographical area, taking benefit of the Earth station antenna and polarisation discriminations. To this end, coordination ultimately determines the amount of spectrum which can be shared between operators and therefore is performed before finalising operational plans of the satellite system. Note that New Zealand is not the ITU filing administration for satellite networks in these frequency bands therefore is not involved in this coordination.

⁷¹Due to the random variables involved in determining the achievable data rate (e.g., propagation channel variations, antenna gain variations as a function of spatial direction, etc.), the achievable data rate is also a random variable varying over time and spatial domains. Note that the average data rate is defined as the average value of the achievable data rate CDF over the estimated spatial locations and time periods.

⁷²This has recently been indicated by the measurement results carried out by The Commerce Commission in rural New Zealand, as reported in <https://comcom.govt.nz/regulated-industries/telecommunications/monitoring-the-telecommunications-market/monitoring-new-zealands-broadband/Reports-from-Measuring-Broadband-New-Zealand>.

⁷³Satellite coordination is a bilateral or multilateral process between existing and planned satellite networks (e.g., from FSS operators) of ITU Member States (a.k.a., administrations), typically performed before finalising the operational plans of the satellite system.

⁷⁴The $\Delta T/T$ criterion is based on the calculation of the increase in noise temperature at the receiver due to the presence of interference. Typically, $\Delta T/T \geq 6\%$ is considered as the presence of potential interference requiring further analysis of C/I levels.

2.3.2. Mobile Service and Applications

The same use cases for mobile services as those described in the 26 GHz frequency band (e.g., FWA, and private networks) apply in 27.5 – 28.35 GHz band. This implies that the spectrum requirements in 27.5 – 28.35 GHz are very similar to those outlined 26 GHz.

Questions

22. Do you agree with RSM's understanding of the spectrum requirements for enabling different services and applications, e.g., FSS (Earth-to-space) and Mobile Service in 27.5 – 28.35 GHz?
23. What are your spectrum estimates for FSS (Earth-to-space) and Mobile Services (including their applications) which you wish to implement or use in the 27.5 – 28.35 GHz range?
24. Can you provide a link budget of systems which you plan to operate in 27.5 – 28.35 GHz, which will assist RSM to better plan, allocate and assign this frequency range?
25. Can you provide further insights into the typical metrics and calculation methodologies often used for GSO to GSO, GSO to NGSO and NGSO to NGSO FSS coordination? In doing so, given an application, how can we ultimately determine the amount of spectrum an FSS operator can ultimately use relative to another, while respecting the provisions contained in Article 9 of the ITU RR? RSM encourages you to share as much detail as possible.

2.4. Technical options

2.4.1. Sharing 27.5 – 28.35 GHz between FSS (Earth-to-space) and Mobile Service

RSM has not analysed (from a sharing and compatibility viewpoint) the impact of fixed GSO and NGSO FSS (Earth-to-space) user terminals on the introduction of mobile systems. This is because currently (as of July 2025), there are no existing licenced GSO or NGSO FSS (Earth-to-space) user terminals operating within 27.5 – 28.35 GHz. Consistent with Section 2.1, RSM are looking to enable the use of fixed FSS user terminals and mobile systems in the form of FWA and/or private networks. This leads to the following considerations:

1. Aggregate interference into mobile BSs and UEs would need to be analysed from multiple GSO and NGSO FSS user terminals transmitting from different directions, undergoing different spatial and temporal propagation variations.
2. The GSO and NGSO FSS user terminals could operate throughout the 28 GHz band and hence the impact (in terms of potential interference) of both the desired (27.5 – 28.35 GHz) and adjacent (28.35 – 29.5 GHz) channel transmissions into the mobile BSs and UEs needs to be characterised. This is while recognising that different types of GSO and NGSO FSS user terminals may access spectrum in different frequency segments within the 28 GHz band.
3. Typically, the size of the GSO FSS terminal spans from 0.75 m to 2.4 m, while the NGSO terminal antenna's largest dimension spans from 18 cm (=0.18 m) to 80 cm (=0.8 m), respectively. The significant reduction in size of the NGSO FSS terminals in comparison with the GSO terminals could imply that the relative density NGSO terminals relative to GSO terminals is higher.
4. In order to accurately assess the impact of possible interference to mobile BSs and UEs, accurate deployment models of GSO and NGSO FSS terminals are needed to understand the possible terminal densities across different environments, as well as their relationship with

other deployment factors such as population density (measurement of human population per-unit land area).

5. Operation of many fixed FSS user terminals operating within close proximity of mobile BS and UEs could lead to an increased likelihood of worst-case interference geometry, where the main beam of the FSS user terminal(s) is in spatial alignment with the mainlobe of the mobile BS or UE's receive beam. Furthermore, multiple sidelobes from different FSS terminals in the direction of mobile BS or UE's receive beam of the could also yield higher interference likelihood, which would be further pronounced by the electronic steering of beams by NGSO terminals requiring tracking antennas.
6. The risk of interference to mobile BSs and UEs could be increased due to the high power and full-duplex nature of some NGSO user terminals, which transmit peak e.i.r.p.'s in the order of 35 to 45 dBW with a typical peak e.i.r.p. density on the order of -20 to -40 dBW/MHz.
7. The type of FSS terminals operating in 28.35 -29.5 GHz should be considered (e.g., the operation of GSO or NGSO L-ESIM) as that would impose further restrictions on the operation of mobile systems.

To avoid the risk of interference from FSS user terminals operating within 27.5 – 28.35 GHz (and immediately above 28.35 GHz) to mobile BSs and UE receivers operating in 27.5 – 28.35 GHz (as well as within the 26 GHz band), technical measures may be necessary. Since frequency separation is not possible, such measures would need to be derived based on physical separation of GSO or NGSO FSS user terminals and mobile BS as well as UEs. An alternative is to create a priority for a particular service over a given geographical area, where the secondary service would have to accept interference without claiming protection from the primary service.

In Table 8, *two options to share* the 27.5 – 28.35 GHz frequency range between FSS (Earth-to-space) and Mobile Service are provided. This presents the necessary technical and regulatory conditions needed for each respective option.

Table 8: Options to share the 27.5 – 28.35 GHz frequency range between FSS (Earth-to-space) and Mobile Service.

Option	Basis of sharing	Form of sharing
1	Geography-based by area type	Geographical split of services
2	Geography-based by priority of service in a given area	Priority split (primary vs. secondary)

In particular, Option 1 introduces a geographical split in the possible operational areas of FSS (Earth-to-space) and Mobile Services, while Option 2 aims to create a tiered access model with a priority split of primary vs. secondary services within a given geographical area.

2.4.2. Options for sharing of 27.5 – 28.35 GHz between Mobile and FSS 1 based on geography-based by area type

These options partition the land area of New Zealand into four area categories as defined by Statistics New Zealand's urban accessibility methodology and classification⁷⁵. The aim of Statistics New Zealand's urban accessibility classification was to characterise degree of urban influence New

⁷⁵Further information can be found from Statistics New Zealand, 2020 on <https://www.stats.govt.nz/assets/Uploads/Methods/Urban-accessibility-methodology-and-classification/Download-document/Urban-accessibility-methodology-and-classification.pdf>.

Zealand's urban areas have on the surrounding rural areas. The recommended four categories are as follows:

1. Major, large and medium, and small urban areas
2. High, medium or low urban accessibility areas
3. Remote and very remote accessibility areas, and
4. Inland waters (not inclusive of harbour entry points).

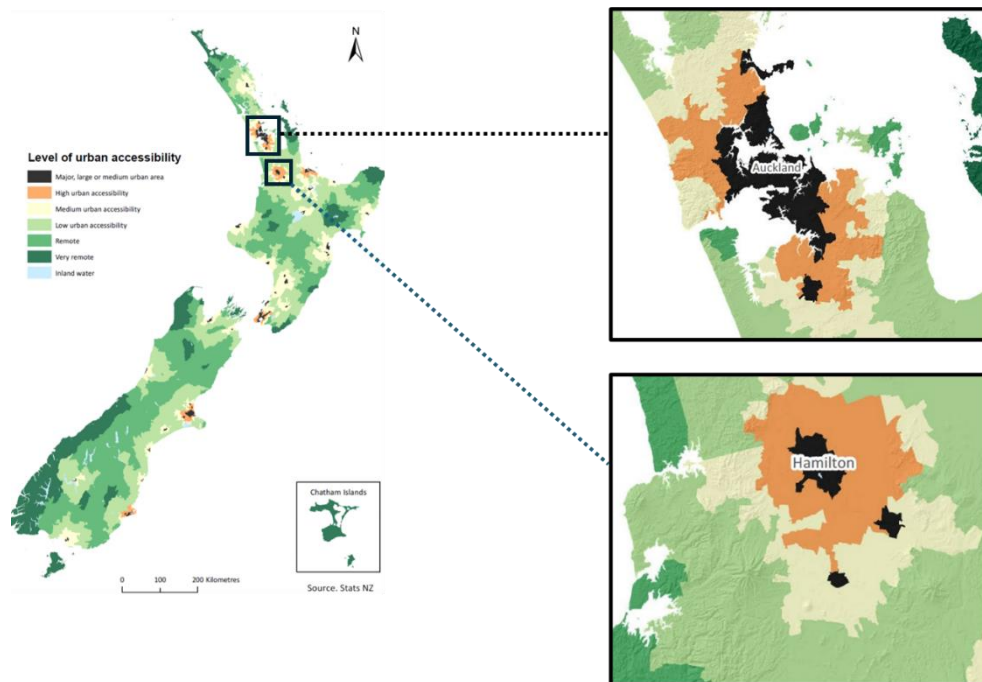
The major, large, medium and small urban areas are classified and differentiated based on a population condition. Major urban areas are those defined with 100,000 or more residents; large urban areas are those defined as having 30,000 – 99,999 residents; medium urban areas are defined as having 10,000 – 29,999 residents and small urban areas are defined as having 1,000 – 9,999 residents. Relative to this, high, medium or low urban accessibility areas, as well as remote or very remote accessibility areas are defined by the drive time in an ordinary four-wheel passenger car. More specifically, the drive time is based on the average traffic conditions at an average driving speed of 50 km/h based on proximity to health, educational, social, retail, recreational/cultural facilities and employment services. Table 9 depicts the duration of the drive time proportional to each urban or remote accessibility area leading to the understanding of New Zealand's urban – rural continuum.

Table 9: Accessibility categories of New Zealand based on the drive time relative to major, large, and medium urban areas.

Accessibility category	Duration condition: Drive time (In average traffic conditions at 50 km/h)
High urban	0 – 15 minutes from major urban areas
Medium urban	15 – 25 minutes from major urban areas
	0 – 25 minutes from large urban areas
	0 – 15 minutes from medium urban areas
Low urban	25 – 60 minutes from major urban areas
	25 – 60 minutes from large urban areas
	15 – 60 minutes from medium urban areas
Remote	60 – 120 minutes from major, large, or medium urban areas
Very remote	More than 120 minutes from major, large, or medium urban areas

Figure 4 depicts the urban – rural continuum of New Zealand defining the transition from urban to rural areas conditional on the definitions of major, large and medium urban areas, as well as urban and rural accessibility areas. Specific examples of Auckland and Hamilton are demonstrated in the two right-hand black outlined squares, where the different levels of accessibility are color coded according to the key presented.

Figure 4: Urban – rural continuum of New Zealand as defined by Statistics New Zealand.



Considering these definitions, RSM makes the following sharing proposal for Option 1 with the associated technical conditions.

Option 1 – Geography based by area type –Mobile inside urban areas, FSS outside urban areas:

Part A: Inside major, large, medium, small urban areas, and high urban accessibility areas:

1. Continue the operation of FSS GSO and NGSO gateway Earth stations at existing licenced sites as per RSM's RRF in accordance with the licencing framework established in PIB 38 and PIB 58.
2. To allow expansion of services, at existing licenced sites RSM will consider applications to expand current FSS GSO and NGSO gateway Earth station licences within these areas in accordance with licencing framework based on the established framework in PIB 38 and 58.
3. RSM will allow the operation of GSO and NGSO FSS fixed user terminals of all types at discretely defined locations only at the existing sites used for Gateways with a new licencing framework established as part of the licencing process. RSM will allow the operation of GSO and NGSO A-ESIM and M-ESIMs with p.f.d. limits prescribed by ITU RR Resolution 169 (WRC-19) and Resolution 123 (WRC-23). The licencing framework for GSO and NGSO A-ESIM and M-ESIMs will be defined as part of the licencing component of the long-term allocation. L-ESIMs will not be permitted for use due to potential sharing and compatibility difficulties which could arise with future introduction of Mobile Services (e.g., FWA and private networks).
4. RSM will allow the use of Mobile Services by coordination with the FSS GSO and NGSO gateways and user terminals. This coordination will be facilitated with the information provided by FSS operators as part of the licensing processes for gateways and user terminals. Further details of this coordination framework will be included in the licencing process. Although the risk of interference from GSO or NGSO FSS gateways to mobile BSs is negligible should relevant conditions be met, this coordination procedure will further mitigate risk of interference which could be overlooked by RSM's sharing and compatibility studies.

5. To co-exist with FSS (Earth-to-space), mobile BSs should take practical measures to ensure that its transmitting antennas are mechanically pointed below the horizon.
6. RSM proposes that the sharing and compatibility of two mobile systems will be managed with the same TDD synchronisation structure; and if semi-synchronisation is to be considered/used, additional technical conditions in the form of site-by-site coordination will be required as part of the licencing process.

Part B: Inside medium and low urban accessibility, as well as remote and very remote areas:

1. RSM will allow the operation of FSS GSO and NGSO gateway Earth stations and user terminals of all types, at any location. For user terminals, RSM will define a new licencing framework (as mentioned in Part A).
2. RSM will consider new gateway Earth station licence applications from GSO and NGSO operators following a licencing framework based on the existing rules in PIB 38 and PIB 58. Transmissions from these areas will need to adhere to a p.f.d. or technical limits (to be defined in the licencing phase of the assignment process) to ensure compatibility with mobile BS and UE receivers in major, large, or medium urban areas and high urban accessibility areas (as described in Part A of Option 1).
3. RSM will allow the operation of GSO and NGSO FSS fixed user terminals of all types at discretely defined areas with a new licencing framework established as part of the licencing process.
4. RSM will allow the operation of GSO and NGSO A-ESIMs and M-ESIMs with a new licencing framework (as mentioned in Part A, option 1) under the technical conditions of ITU RR Resolution 123 (WRC-23) and 169 (WRC-19) technical limits only.
5. RSM will not permit the use of Mobile Services in these areas.

Questions

26. Do you agree with the geography-based by area type option of sharing the 27.5 – 28.35 GHz frequency range between FSS (Earth-to-space) and Mobile Services, as detailed in Option 1? If not, please propose alternatives with the required details for RSM's consideration.
27. Do you agree to divide Option 1 by Part A and Part B by using the Statistics New Zealand defined area accessibility criteria? If not, please suggest an alternative criterion which RSM could use?
28. In accordance with Part A of Option 1, do you agree that L-ESIMs should not be permitted inside major, large, medium, small urban areas and high urban accessibility areas? If not, please provide an alternative with a detailed explanation.
29. To facilitate the use of the Mobile Service in accordance with Option 1, do you have any suggestions on how RSM could implement coordination of mobile BSs with FSS (Earth-to-space) GSO and NGSO gateways and user terminals? In particular, which coordination trigger and methodology should RSM use (including any relevant reasons)?
30. In accordance with Part B of Option 1, do you agree that Mobile Service (and its applications) should not be allowed to operate inside medium and low urban accessibility areas, as well as remote and very remote areas? If not, please provide an alternative with a detailed explanation.
31. Would you like to propose any modifications for Option 1? If so, please provide modifications with relevant associated details.

Option 2 – Priority based on geography–Mobile and satellite equal priority inside urban areas, FSS priority outside urban areas:

Part A: Inside major, large, medium, small urban areas, and high urban accessibility areas:

FSS (Earth-to-space) and Mobile Service have equal priority, i.e., a co-primary status

- RSM will continue the operation of GSO and NGSO FSS gateway Earth stations at existing licensed sites in RSM's RRF in accordance with the licencing framework established in PIB 38 and PIB 58.
- Coordination zones for each FSS gateways and user terminals (of all types) and mobile BSs would be calculated based on a coordination criteria defined as part of the licencing process.
- If either the FSS (Earth-to-space) and Mobile Services operate inside any of these coordination zones, they would be subject to mutually documented coordination agreement. This will form part of the licensing procedure.
- Licencing conditions will be necessary to devise the appropriate technical restrictions, if any, and are to be determined.

Part B: Inside Medium and low urban accessibility, as well as remote and very remote areas:

FSS (Earth-to-space) has priority over Mobile Service; therefore, FSS (Earth-to-space) primary and Mobile secondary status

- FSS GSO and NGSO gateway earth stations: Each FSS gateway will have a coordination zone calculated based on the specific characteristics and surrounding terrain. Mobile Service stations (BSs and UEs) operating within this coordination zone must accept/tolerate any interference. Transmissions from these areas will need to adhere to a p.f.d. or other technical limits (to be defined in the implementation phase of the allocation) to ensure co-existence with reception in major, large, or medium urban areas and high urban accessibility areas (as described in Part A of Option 2).
- FSS GSO and NGSO user terminals and A-ESIMs and M-ESIMs: If the FSS Earth station location is moving or portable, an area would be defined based on the technical characteristics and other properties of the FSS user terminal(s). Transmissions from these areas will need to adhere to a power flux density/or technical limits (to be defined in the implementation phase of the allocation) to ensure co-existence with reception in major, large, or medium urban areas and high urban accessibility areas (as described in Part A of Option 2).
- Any Mobile Service use is on a secondary basis, implying that if a new FSS Earth station is established at any point in time (in the future), existing Mobile Service stations in the coordination zone will have to accept/tolerate the level of interference.

Questions

32. Do you agree with the geography-based by priority of service type option of sharing the 27.5 – 28.35 GHz frequency range between FSS (Earth-to-space) and Mobile Services, as detailed in Option 2? If not, please propose alternatives with the required details for RSM's consideration.
33. Which areas would you like FSS to have priority over Mobile Services, and vice versa, and why?
34. How would you recommend RSM to calculate the coordination zones described in Part A and Part B of Option 2?
35. Are there any other suggestions for licencing conditions which you wish to see included as part of Option 2? RSM encourages details of specific conditions for different types of FSS user terminals, e.g., fixed terminals vs. A-ESIMs and M-ESIMs.
36. Would you like to see any additional technical conditions which facilitate sharing for Parts A and B of Option 2? Describe in detail, the changes you would want to make to this proposal.

2.4.3. ESIM use in 27.5 – 28.35 GHz

FSS (Earth-to-space) NGSO and GSO A-ESIMs and M-ESIMs will be permitted to operate under the technical conditions prescribed in ITU RR Resolution 123 (WRC-23) and 169 (WRC-19) technical limits only.

These technical limits are in the form of p.f.d. limits for A-ESIM which, in practice, can only be met by A-ESIM terminals, e.g., in commercial aircraft flying above the altitude of 3 km. For M-ESIMs, a distance from the coast of 70 km is prescribed by these technical limits. These limits provide sufficient protection to mobile BS and UE receivers all scenarios.

A-ESIM and M-ESIM would not be allowed to exceed these limits meaning that RSM proposes to not permit the use of gate-to-gate and pier-to-pier operation in 27.5 – 28.35 GHz. RSM will not permit the use of L-ESIMs in 27.5 – 28.35 GHz. However, a licence for a fixed location could be sought by GSO or NGSO FSS operators which allows use of A-ESIMs and M-ESIMs, while stationary at an airport or port provided that it is not in motion.

Questions

37. Do you agree with our approach of ESIM use in 27.5 – 28.35 GHz?
38. Do you wish to offer, implement or use pier-to-pier or gate-to-gate M-ESIM and A-ESIM applications in 27.5 – 28.35 GHz?
39. Is there any other change which you wish to see in our approach for using A-ESIM and M-ESIM? If so, provide the relevant details.

2.5. Pricing and licencing considerations

2.5.1. Pricing

Under the Radio Licencing regime, New Zealand does not currently charge radio licence holders access to spectrum, other than a \$150 annual administrative fee, per licence. To date, GSO and NGSO FSS systems have been operational under radio licences. RSM have considered the introduction of additional pricing (above the administrative fees) for both FSS and mobile access to 28 GHz band but propose that no additional charges are introduced for either technology type in this band at this stage.

RSM typically use market mechanisms (e.g., auctions or incentive pricing) to enable spectrum access in situations where demand for spectrum is greater than supply. This helps to ensure spectrum is used efficiently and goes to the most efficient operators. Examples of such spectrum assignment include spectrum for mobile and broadcasting. In the case of 27.5 – 28.35 GHz (i.e., the spectrum to be shared between mobile and satellite services), RSM considered whether introducing a charge for both satellite and mobile operators would help facilitate efficient spectrum use and successful spectrum sharing in geographical areas where there is direct competition between satellite and mobile technologies.

However, currently RSM do not consider there to be sufficient evidence that there would be greater demand than supply for spectrum in 27.5 – 28.35 GHz. We understand that at this stage, Mobile Services are unlikely to have much demand for 28 GHz spectrum due to the limited global uptake of mobile technology at these frequencies. In addition, mobile services are likely to have much better and greater access to equivalent spectrum in 24.25 – 27.5 GHz.

GSO and NGSO operators, who we expect to be the majority users across 28 GHz will likely not compete for spectrum at the domestic (New Zealand) level, as they rely on coordination mechanisms and processes at the ITU. In addition, different types of satellite user terminals can share the same spectrum in the same location as they communicate with different satellites and are coordinated via ITU coordination. These factors mean that in the FSS industry, demand for spectrum (within the available spectrum range) does not exceed supply in the New Zealand context.

RSM understands that other operators who do pay for spectrum access, such as MNOs and Wireless Internet Service Providers (WISPs), may consider this unfair, especially when all the above operators compete when offering broadband services. However, we note across different frequency bands, MNOs usually require and obtain exclusive access to spectrum due to the nature of mobile system design. This results in much higher costs for spectrum access. It is also worth highlighting that both MNOs and WISPs also hold a large number of radio licences (e.g. for fixed point to point links) which are under radio licencing (administrative fees only) or make use of General User Licences where no fees apply (e.g. short-range devices in 2.4 GHz, 5 GHz and 60 GHz).

If the 28 GHz band becomes competitive in future as mobile technologies develop, RSM may consider introducing a resource charging regime. RSM would consult on this regime prior to its introduction.

2.5.2. Licensing

2.5.2.1. Mobile Service

Given there is not an immediate demand of need for mobile in 28 GHz we propose that establishment of an assignment process and licensing should be delayed for a couple of years until such time as there is sufficient spectrum demand to warrant an assignment process. We intend to start the assignment process between 2028 - 2030, in line with 26 GHz to make the spectrum available for use after this time.

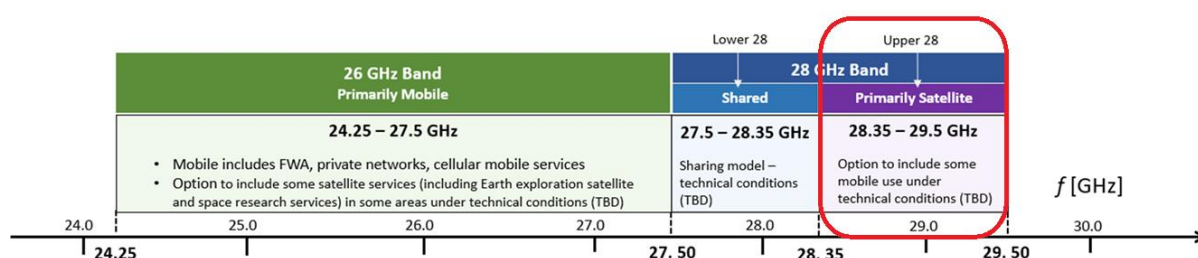
RSM's view New Zealand's MNO spectrum needs can be accommodated within the 26 GHz band. Rules would be set so that any parties / right holders in the 26 GHz band cannot hold licences in the 28 GHz band. Anyone holding licences in the 28 GHz band at any time will also not be eligible to hold rights in the 26 GHz band. We anticipate that 28 GHz would be for users other than those with deployments in areas across the country (e.g. MNOs) and rules will be established accordingly.

2.5.2.2. FSS User Terminals

RSM considers that GSO and NGSO FSS user terminals at fixed locations will have a more immediate demand for licencing as there are existing GSO and NGSO satellite networks operational in New Zealand.

RSM will look to set up a licensing regime that allows continuity from 2026 and long-term access to spectrum. This licensing regime would permit the proposed new FSS spectrum uses in 27.5 – 28.35 GHz. After 2028 - 2030, when RSM look at the Mobile assignment process, we will look to implement a sharing option that is in accordance with the feedback received on our earlier consultation questions.

3. Our approach to upper 28 GHz radio spectrum (28.35 – 29.5 GHz)



3.1. Proposed new spectrum uses

The New Zealand Cabinet has made the decision to allocate the 28.35-29.5 GHz frequency range to the satellite uses, with the option to include some mobile use under technical conditions. Article 5 of the ITU RR and PIB 21 allocates FSS (Earth-to-space) as a co-primary service in 28.35 – 29.5 GHz. Considering this, while keeping in mind the proposals made by RSM in 27.5 – 28.35 GHz frequency range, it is proposed that the new uses in 28.35 – 29.5 GHz will comprise of the following:

- FSS Earth Station (Earth to space) gateways as specific fixed locations across New Zealand;
- FSS Earth station user terminals / very small aperture terminal (VSAT) at fixed locations (i.e. not in motion) across New Zealand (nation-wide);
- FSS Earth Stations in Motion (ESIMs) for Aeronautical (A-ESIM), Maritime (M-ESIM) under technical conditions prescribed in under the technical conditions prescribed in RR Resolution 123 (WRC-23), Resolution 169 (WRC-19) only
- FSS Earth Stations in Motion (ESIMs) for Land ESIM (L-ESIM) will be allowed are areas of, or at any location in New Zealand under the technical conditions in in Section 3.4.

RSM are not proposing other use, including Mobile Services (both indoor and outdoor in 28.35 – 29.5 GHz.

3.2. Impact on existing spectrum users

In New Zealand, the 28.35 – 29.5 GHz frequency range currently includes the same spectrum users as those in 27.5 – 28.35 GHz, providing FSS (Earth-to-space) with both NGSO and GSO systems. The impact on the existing spectrum users as a result of the proposed new spectrum uses in Section 3.1 is the same as the 27.5 – 28.35 GHz frequency range.

This also demonstrates the global maturity of FSS (Earth-to-space) links across the entire 28 GHz band, which spans from 27.5 – 30 GHz.

3.3. Spectrum requirements for enabling different services and applications in 28.35 – 29.5 GHz

In New Zealand, the 28.35 – 29.5 GHz frequency range currently includes the same spectrum users as those in 27.5 – 28.35 GHz, providing FSS (Earth-to-space) with both NGSO and GSO systems. The spectrum requirements for enabling different services and applications in 28.35 – 29.5 GHz is the same as the 27.5 – 28.35 GHz frequency range.

3.4. Proposed technical conditions

Due to the similarity with 27.5 – 28.35 GHz, the technical conditions and options proposals for FSS (Earth-to-space) GSO and NGSO gateway Earth stations, FSS (Earth-to-space) fixed user terminals (e.g., VSATs), and FSS (Earth-to-space). Moving user terminals, for providing ESIM connectivity, specifically for A-ESIM and M-ESIM remain the same as those in 27.5 – 28.35 GHz where these will only be permitted under the technical conditions of RR Resolution 123 (WRC-23), Resolution 169 (WRC-19).

RSM proposes to allow the operation of GSO and NGSO L-ESIMs anywhere within areas of New Zealand from 28.35 – 29.5 GHz, so long as L-ESIM terminals have a minimum elevation angle of 30° to avoid the likelihood of interference with possible Mobile Service users that could be operating in adjacent channels of 27.5 – 28.35 GHz frequency range. As part of the L-ESIM licencing procedure, RSM would request L-ESIM GSO and NGSO FSS operators to disclose the land ESIM parameters for licence coordination to manage adjacent channel interference with mobile operators as part of the licensing rule set/process.

The exact licencing procedures have yet to be developed, which would be done after considering feedback received from this consultation. RSM requests stakeholder feedback on licencing frameworks suitable for L-ESIMs to give FSS GSO and NGSO operators flexibility to licence these services, while ensuring the protection of Mobile Service operations in the adjacent 27.5 – 28.35 GHz frequency range.

Questions

40. Do you agree with RSM's proposed new spectrum uses outlined in Section 3.1? If not, provide details on the modifications you wish to seek with appropriate reasoning.
41. What is the likelihood of interference from land ESIM terminals operating in 28.35 – 29.5 GHz to Mobile Service receivers (BSs and UEs) operating in 27.5 – 28.35 GHz under possible shared use of FSS (Earth-to-space) and Mobile Services in 27.5 – 28.35 GHz?
42. What technical conditions may be required to ensure that future L-ESIM use is not constrained in 28.35 – 29.5 GHz while protecting possible Mobile Service receivers in 27.5 – 28.35 GHz. Provide necessary technical justification to support your answer.
43. To not constrain future use of A-ESIMs and L-ESIMs, do you propose any changes to the technical conditions for operating A-ESIMs and L-ESIMs within 28.35 – 29.5 GHz? If so, what would these be and what assumptions as well as processes did you use to derive these changes?

3.5. Licencing considerations

3.5.1. Individually licenced FSS GSO and NGSO gateway Earth station

Based on the current technical and operational policy guidelines contained in PIB 38 and PIB 58, under RSM's radio licencing framework, RSM currently allows individually licenced FSS GSO and NGSO gateway Earth stations operating from discrete locations within New Zealand to communicate with satellites in the GSO or NGSO orbits. RSM proposes a comparable licencing procedure and to apply a comparable technical and policy ruleset to both current and future GSO or NGSO FSS gateways. This ruleset will be updated upon the conclusion of this process. RSM will assess new proposals to establish FSS gateways on a case-by-case basis in accordance with the ruleset.

3.5.2. FSS GSO and NGSO fixed user terminals

Considering the information presented in 27.5 – 28.35 GHz, RSM believes that allowing the use of fixed FSS GSO and NGSO user terminals will be done through requiring that satellite operators obtain a radio licence for user terminals. This could comprise of one licence per-Territorial Local Authority (TLA). This would strike the right balance between giving FSS operators flexibility to deploy fixed FSS user terminals in different parts of New Zealand while RSM would maintain a record of the operators, the systems and how the spectrum is used in different parts of the country at a given time, unlike for GURL use. Such an approach also allows RSM to strike the right balance between implementation complexity in RSM's RRF and managing administrative burden of licencing.

3.5.3. FSS GSO and NGSO moving user terminals (ESIMs)

For allowing the use of ESIMs (A-ESIM, M-ESIM and L-ESIM) RSM would require that satellite operators obtain a licence for ESIM (moving user terminals) applying the technical conditions in Section 3.4. This could comprise of one licence per-Territorial Local Authority (TLA). This would strike the right balance between giving FSS operators flexibility to deploy fixed FSS user terminals in different parts of New Zealand while RSM would maintain a record of the operators, the systems and how the spectrum is used in different parts of the country at a given time, unlike for GURL use. Such an approach also allows RSM to strike the right balance between implementation complexity in RSM's RRF and managing administrative burden of licencing.

Questions

44. Do you agree with RSM's proposed licencing arrangement to licence FSS (Earth-to-space) GSO or NGSO gateways operating in 28.35 – 29.5 GHz? If not, what changes would you recommend?
45. Which licencing option would you prefer for licencing FSS GSO and NGSO fixed user terminals and moving user terminals (ESIMs), respectively? RSM requests for appropriate justification to support your answer.

3.6. Our approach to 29.5 -30 GHz radio spectrum

In the 29.5 -30 GHz band, FSS Gateways currently have short-term licences expiring in 2026. FSS user terminals / VSATs and ESIMs operate in the 29.5 - 30 GHz under the following General User Radio Licences (GURLs)⁷⁶ :

- [GURL for Satellite Service](#)⁷⁷ with Special Condition 5 applying⁷⁸
- [GURL for Aeronautical Purposes](#)– Special Condition 12⁷⁹, and
- [GURL for Maritime Purposes](#) – Special Condition 27⁸⁰.

⁷⁶ General User Licences (GUL) are frequencies have been licensed for anyone to use in New Zealand. They allow New Zealanders to use particular types of radio transmitters, under certain technical conditions without applying for a dedicated licence of their own. In other jurisdictions, these are also called "licence-exempt", "unlicensed" or "class licences", respectively.

⁷⁷ See <https://gazette.govt.nz/notice/id/2017-go2843>

⁷⁸ Transmissions are permitted from land Earth stations operating in accordance with the class of station known as ESIM to communicate with satellite network for the purpose of FSS (or MSS for the purposes of the GURL).

⁷⁹ Note that here the use is limited to aircraft Earth station operating in accordance with the class of station known ESIM.

⁸⁰ Note that here the use is limited to Earth stations on-board vessels operating in accordance with the class of station ESIM.

The 29.5 -30 GHz is only used by FSS (Earth-to-space) GSO and NGSO systems and RSM is not proposing any changes to the usage in the band other than to update the licensing arrangements to be consistent with the remainder 27.5 – 28.35 GHz and 28.35 GHz. The provisions of the GURLs that cover 29.5 - 30 GHz frequency bands will be revoked and licences will instead need to be obtained.

It is also noted that this portion of the band was not within scope of the original cabinet decision as there was no proposed new use/change of use. Because the 29.5 -30 GHz band is used for satellite in conjunction with the 27.5 -29.5 GHz band, the licensing rules should be coherent with the other portions of the band.

Questions

46. Do you agree with RSM's proposed approach to 29.5 – 30 GHz? If not, what modifications would you suggest to our proposal?

3.7. Comments on 17.7 – 20.2 GHz radio spectrum

Article 5 of the RR and PIB 21 allocated the 17.7 – 20.2 GHz frequency band on a co-primary basis to FSS (space-to-Earth) and the Fixed Service in ITU Region 3. For FSS, 17.7 – 20.2 GHz frequency band is used for space-to-Earth links, which is reciprocal to the 27.5 – 29.5 GHz frequency band for FSS (Earth-to-space) transmissions.

In New Zealand, there are currently existing Fixed Links operating within 17.7 – 20.2 GHz, in accordance with the channel plans set out in PIB 22 and the technical as well as policy rules set out in PIB 38 and PIB 58, respectively. It is also noted that there are various restrictions on licensing for some of the fixed link channels in the frequency range 18.8 - 19.05 GHz and 19.05 - 19.3 GHz portions of the band, as highlighted in Section 5.7 of PIB 58.

RSM does not intend to make any changes to the existing fixed link use and expect FSS GSO and NGSO operators operating space-to-Earth links to work around this use. This means that FSS (space-to-Earth) links will either need to work in areas where fixed links do not cause them interference issues or FSS (space-to-Earth) links should accept any interference, including harmful interference from fixed links. RSM will update its licensing rules to allow receive protection licences to be obtained for individually licenced GSO or NGSO FSS gateway Earth stations, FSS fixed user terminals and FSS moving terminals in the form of ESIMs operating at specific locations under a radio licence. All other use (e.g., wide area user terminal or ESIM use) will be on an opportunistic basis.

RSM notes that under the guidelines contained in PIB 60⁸¹, it is not mandatory to have a licence for FSS receivers (space-to-Earth links) in New Zealand. However, those FSS operators using this approach need to bare the risk that RSM provides no status to such receive licences and such use will not be protected from interference or considered in future spectrum re-planning or licencing reform work that RSM may undertake.

Questions

47. Do you agree with RSM's proposed approach to 17.7 – 20.2 GHz? If not, what modifications would you suggest to our proposal?

⁸¹ PIB 60, "Operational Satellite Policy", Issue 1, February 2018. Accessible at <https://www.rsm.govt.nz/about/publications/pibs/pib-60>.

Annex 1: Current frequency allocation and usage of 24-30 GHz

The table below summarises the current New Zealand allocations and usage for 23.6 - 30 GHz. This table extends the frequency range to 23.6 GHz to show the allocations to the Earth Exploration-Satellite (passive), Space Research (Passive) and Radio Astronomy Services which are relevant to some of the planning considerations for spectrum between 24.25 and 27.5 GHz. (Table extracted from [PIB 21](#) and updated to remove expired licences (PIB 21 last updated 2021)).

Frequency Range	ITU Region 3 Allocation	New Zealand Allocation	Current Usage	References and policies
23.6-24 GHz	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340	RADIO ASTRONOMY SPACE RESEARCH (passive)		
24-24.05 GHz	AMATEUR AMATEUR-SATELLITE 5.150	AMATEUR AMATEUR-SATELLITE	24-24.25 • GHz Amateur usage • Industrial, scientific and medical band (ISM) • Short Range Devices	GURL for: • Amateur Radio Operators • Short range devices PIB 58: Radio License Policy Rules
24.05-24.25 GHz	RADIOLOCATION Amateur Earth exploration-satellite (active) 5.150	RADIOLOCATION Amateur		
24.25-24.45 GHz	RADIONAVIGATION FIXED MOBILE 5.338A 5.532AB	RADIONAVIGATION FIXED MOBILE		
24.45-24.65 GHz	FIXED INTER-SATELLITE MOBILE 5.338A 5.532AB RADIONAVIGATION 5.533	FIXED MOBILE RADIONAVIGATION		
24.65-24.75 GHz	FIXED FIXED-SATELLITE (Earth-to-space) 5.532B INTER-SATELLITE MOBILE 5.338A 5.532AB	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE		
24.75-25.25 GHz	FIXED FIXED-SATELLITE (Earth-to-space) 5.535 MOBILE 5.338A 5.532AB	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE		

25.25-25.5 GHz	FIXED 5.534A INTER-SATELLITE 5.536 MOBILE 5.338A 5.532AB Standard frequency and time signal-satellite (Earth-to-space)	FIXED MOBILE		
25.5-27 GHz	EARTH EXPLORATION-SATELLITE (space-to-Earth) 5.536B FIXED 5.534A INTER-SATELLITE 5.536 MOBILE 5.338A 5.532AB SPACE RESEARCH (space-to-Earth) 5.536C Standard frequency and time signal-satellite (Earth-to-space) 5.536A	EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED MOBILE	22-26.625 GHz Short Range Vehicular Radar (until 1 January 2022)	Radio Spectrum Auctions GURL for Vehicular radar short range devises
27-27.5 GHz	FIXED 5.534A FIXED-SATELLITE (Earth-to-space) INTER-SATELLITE 5.536 5.537 MOBILE 5.338A 5.532AB	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE	27-27.5 GHz Fixed satellite “Ka” band – uplink	PIB 58: Radio License Policy Rules
27.5-28.5 GHz	FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.517A 5.539 MOBILE 5.538 5.540	27.5–29.5 GHz FIXED FIXED-SATELLITE (Earth-to-space) MOBILE	27.5-29.5 GHz Fixed satellite “Ka” band – uplink	PIB 58: Radio License Policy Rules
28.5-29.1 GHz	FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.517A 5.523A 5.539 MOBILE Earth exploration-satellite (Earth-to-space) 5.541, 5.540			
29.1-29.5 GHz	FIXED FIXED-SATELLITE (Earth-to-space) 5.516B 5.517A 5.523C 5.523E 5.535A 5.539 5.541A MOBILE Earth exploration-satellite (Earth-to-space) 5.541, 5.540			

29.5-29.9 GHz	FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 Earth exploration-satellite (Earth-to-space) 5.541 Mobile-satellite (Earth-to-space) 5.540 5.542	FIXED-SATELLITE (Earth-to-space) Mobile-satellite (Earth-to-space)	29.5-30 GHz Fixed Satellite "Ka" band – uplink (including earth station in-motion) 29.5-30 GHz Mobile satellite "Ka" band – uplink	GURL for: • Satellite Services • Maritime Purposes • Aeronautical Purposes PIB 58 Radio License Policy Rules
29.9-30 GHz	FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 MOBILE-SATELLITE (Earth-to-space) Earth exploration-satellite (Earth-to-space) 5.541 5.543 5.525 5.526 5.527 5.538 5.540 5.542	FIXED-SATELLITE (Earth-to-space) MOBILE-SATELLITE (Earth-to-space)	29.5-30 GHz Mobile satellite "Ka" band – uplink	• Aeronautical Purposes PIB 58 Radio License Policy Rules

Annex 2: Geographical areas wanting receive protection for space-to-Earth transmissions for specific parts of the 24-30 GHz

(Planned) Location(s)	Spatial Coordinates	Planned Use/Purpose	Applicable frequency range/Notes
Warkworth Space Centre (Operational)	36.4°S, 174.6°E	RAS, VLBI, lunar mission support, and SRS	23.75 – 24 GHz Note: Primary EESS (passive), RAS allocation in the ITU RR from 23.6 – 24 GHz
			25.5 – 27 GHz
Awarua Satellite Farm (Operational)	46.523°S, 168.38°E	SRS	25.5 – 27 GHz
Orepuki (Planned)	46.3°S, 167.73°E	Establishment of communications to the South Pole under SRS (passive)	23.75 – 24 GHz
Otahu Flat/Waiau Valley (Planned)	45.9°S, 167.70°E	RAS, VLBI global observation system (VGOS) radio observatory and geodetic station	23.75 – 24 GHz

Annex 3: Summary of questions asked

1. Do you agree with RSM's proposed new spectrum uses outlined in Section 1.1? If not, provide details on the modifications you wish to propose with appropriate reasoning.
2. Do you agree with RSM's assessment of the impact on existing users within 23.6 – 24 GHz, 24 – 24.25 GHz and 24.25 – 27.5 GHz, including the proposed technical and operational considerations, as well as technical conditions for the protection of EESS (passive) and potential RAS use in 23.6 – 24 GHz from future Mobile Service emissions in the adjacent 24.25 – 27.5 GHz band? If not, please provide further specific technical details and rationale, including technical studies.
3. Are you aware of other locations apart from those listed in Table 3 which would be likely be used for RAS within New Zealand? If so, please provide details of these locations including the technical and operational parameters of the RAS receiver along with supporting material showing firm plans to establish a site at these locations.
4. Are there any further application/system details you wish to provide which qualifies as an existing user?
5. Do you agree with RSM's understanding of the spectrum requirements and key usage scenarios for enabling different services and applications (e.g., Mobile Service, EESS and SRS) in 24.25 – 27.5 GHz?
6. What are your spectrum estimates for the use of Mobile Services, EESS and SRS in 24.25 – 27.5 GHz which you wish to implement or use? Present a technical analysis with appropriate justification.
7. Can you provide a link budget of a system which you plan to operate in 24.25 – 27.5 GHz, which will assist RSM to better plan, allocate and assign this frequency range?
8. Do you plan on operating mobile systems that are not standardised by 3GPP? If so, what type of equipment do you plan to operate and what are its technical characteristics? Where possible, please provide the relevant supporting technical documentation.
9. Does the mobile BS and UE you wish to operate within 24.25 – 27.5 GHz have unwanted emissions falling within 23.6 – 24 GHz of –39 dBW/200 MHz for BSs and – 35 dBW/200 MHz for UEs? If so, could you provide details of the unwanted emission mask as a function of frequency? If not, could you provide the unwanted emissions limits of the equipment you wish to operate with the necessary technical justification?
10. Does the mobile BS you wish to operate meet the –60 dBW/MHz Category B spurious emissions limit from Recommendation ITU-R SM.329? If not, what do you propose for the necessary protect EESS (passive) receivers in 50.2 – 50.4 GHz and 52.6 – 54.25 GHz from the second harmonic of mobile BS emissions within 24.25 – 27.5 GHz?
11. Do you agree with our 5% quantification for the use of the terms “very limited” number of BSs operating in 24.25 – 27.5 GHz that are expected to communicate with a positive elevation angle towards indoor mobile UEs? If not, what technical modifications would you suggest to this quantification?
12. For mobile system deployments envisaged in 24.25 – 27.5 GHz, what are the typical range of values for electrical and mechanical tilts which you intend to use? Do these parameters relate to the deployment environment (i.e., urban, sub-urban, etc)? If so, provide details of the relationship.
13. How would you mathematically characterise the term “normally” pointing the BS below the horizon, as quoted in “resolves 2.1” of Resolution 242 (WRC-19)?

14. What would be your mobile BS's typical elevation beam steering range and would the composition of the BS antenna array cause grating lobes to occur? If so, would you be able to quantify the direction and magnitude of these grating lobes?
15. What type of TDD synchronisation options would you prefer and why? Do you prefer to have a default frame structure? What do you consider the underlying technical conditions to manage the any potential interference should be?
16. Do you agree with RSM's assessment on the need to design exclusion areas around the proposed EESS and SRS (space-to-Earth) sites in 25.5 – 27.0 GHz to protect them from aggregate Mobile Service emissions in 24.25 – 27.5 GHz? If not, what other technical alternative(s) would you suggest?
17. Do you agree with RSM's assessment of the licencing framework for EESS (space-to-Earth) and SRS (space-to-Earth) anticipated to operate in 25.5 – 27 GHz? If yes, provide your reasoning. If no, which other alternative would you suggest to licence these services and why?
18. Do you agree with RSM's assessment of the licencing framework for RAS operating in 23.6 – 24 GHz? If yes, provide your reasoning. If no, which other alternative would you suggest to licence these services and why?
19. Do you agree with RSM's proposed new spectrum uses within 27.5 – 28.35 GHz, noting the growing demand for FSS (Earth-to-space) GSO and NGSO gateways and user terminals?
20. Do you agree with RSM's assessment of the impact on existing users, including the sharing and compatibility scenarios, considerations and overall conclusions in the form of conditions to be met for the protection of existing users such as individually licenced FSS GSO and NGSO Earth stations, as well as FSS satellite receivers operating within 27.5 – 28.35 GHz? If not, please provide further specific technical details and rationale.
21. Is there any further application/system details you wish to provide which qualifies as an existing user? If so, please provide the details, including any relevant technical information.
22. Do you agree with RSM's understanding of the spectrum requirements for enabling different services and applications, e.g., FSS (Earth-to-space) and Mobile Service in 27.5 – 28.35 GHz?
23. What are your spectrum estimates for FSS (Earth-to-space) and Mobile Services (including their applications) which you wish to implement or use in the 27.5 – 28.35 GHz range?
24. Can you provide a link budget of systems which you plan to operate in 27.5 – 28.35 GHz, which will assist RSM to better plan, allocate and assign this frequency range?
25. Can you provide further insights into the typical metrics and calculation methodologies often used for GSO to GSO, GSO to NGSO and NGSO to NGSO FSS coordination? In doing so, given an application, how can we ultimately determine the amount of spectrum an FSS operator can ultimately use relative to another, while respecting the provisions contained in Article 9 of the ITU RR? RSM encourages you to share as much detail as possible.
26. Do you agree with the geography-based by area type option of sharing the 27.5 – 28.35 GHz frequency range between FSS (Earth-to-space) and Mobile Services, as detailed in Option 1? If not, please propose alternatives with the required details for RSM's consideration.
27. Do you agree to divide Option 1 by Part A and Part B by using the Statistics New Zealand defined area accessibility criteria? If not, please suggest an alternative criterion which RSM could use?

28. In accordance with Part A of Option 1, do you agree that L-ESIMs should not be permitted inside major, large, medium, small urban areas and high urban accessibility areas? If not, please provide an alternative with a detailed explanation.
29. To facilitate the use of the Mobile Service in accordance with Option 1, do you have any suggestions on how RSM could implement coordination of mobile BSs with FSS (Earth-to-space) GSO and NGSO gateways and user terminals? In particular, which coordination trigger and methodology should RSM use (including any relevant reasons)?
30. In accordance with Part B of Option 1, do you agree that Mobile Service (and its applications) should not be allowed to operate inside medium and low urban accessibility areas, as well as remote and very remote areas? If not, please provide an alternative with a detailed explanation.
31. Would you like to propose any modifications for Option 1? If so, please provide modifications with relevant associated details.
32. Do you agree with the geography-based by priority of service type option of sharing the 27.5 – 28.35 GHz frequency range between FSS (Earth-to-space) and Mobile Services, as detailed in Option 2? If not, please propose alternatives with the required details for RSM's consideration.
33. Which areas would you like FSS to have priority over Mobile Services, and vice versa, and why?
34. How would you recommend RSM to calculate the coordination zones described in Part A and Part B of Option 2?
35. Are there any other suggestions for licencing conditions which you wish to see included as part of Option 2? RSM encourages details of specific conditions for different types of FSS user terminals, e.g., fixed terminals vs. A-ESIMs and M-ESIMs.
36. Would you like to see any additional technical conditions which facilitate sharing for Parts A and B of Option 2? Describe in detail, the changes you would want to make to this proposal.
37. Do you agree with our approach of ESIM use in 27.5 – 28.35 GHz?
38. Do you wish to offer, implement or use pier-to-pier or gate-to-gate M-ESIM and A-ESIM applications in 27.5 – 28.35 GHz?
39. Is there any other change which you wish to see in our approach for using A-ESIM and M-ESIM? If so, provide the relevant details.
40. Do you agree with RSM's proposed new spectrum uses outlined in Section 3.1? If not, provide details on the modifications you wish to seek with appropriate reasoning.
41. What is the likelihood of interference from land ESIM terminals operating in 28.35 – 29.5 GHz to Mobile Service receivers (BSs and UEs) operating in 27.5 – 28.35 GHz under possible shared use of FSS (Earth-to-space) and Mobile Services in 27.5 – 28.35 GHz?
42. What technical conditions may be required to ensure that future L-ESIM use is not constrained in 28.35 – 29.5 GHz while protecting possible Mobile Service receivers in 27.5 – 28.35 GHz. Provide necessary technical justification to support your answer.
43. To not constrain future use of A-ESIMs and L-ESIMs, do you propose any changes to the technical conditions for operating A-ESIMs and L-ESIMs within 28.35 – 29.5 GHz? If so, what would these be and what assumptions as well as processes did you use to derive these changes?

44. Do you agree with RSM's proposed licencing arrangement to licence FSS (Earth-to-space) GSO or NGSO gateways operating in 28.35 – 29.5 GHz? If not, what changes would you recommend?
45. Which licencing option would you prefer for licencing FSS GSO and NGSO fixed user terminals and moving user terminals (ESIMs), respectively? RSM requests for appropriate justification to support your answer.
46. Do you agree with RSM's proposed approach to 29.5 – 30 GHz? If not, what modifications would you suggest to our proposal?
47. Do you agree with RSM's proposed approach to 17.7 – 20.2 GHz? If not, what modifications would you suggest to our proposal?