



DRAFT FIVE YEAR SPECTRUM OUTLOOK 2022–2026

Setting direction for radio spectrum management

DECEMBER 2021



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Invitation to comment

This draft document sets out our thoughts on the main trends and implications for spectrum management over the next five years.

We would like to receive your comments on whether we have got it right. We'd like you to respond to three questions about spectrum management in the next five years:

1. Have we identified the range of technological advancements and probable new demands relevant to New Zealand?
2. Have we prioritised the right issues that we will need to actively manage through our work programme (to the extent this is possible to predict now)?
3. Are there other matters that we should cover?

Once we have reviewed feedback, we will publish a final outlook.

Comments should be submitted in writing, no later than 5pm on 28 February 2022:

By email: (preferred option)

Radio.Spectrum@mbie.govt.nz
Subject line: "5 Year Spectrum Outlook"

Or by post:

Draft Five Year Spectrum Outlook 2022-2026
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 email, in the first instance, Radio.Spectrum@mbie.govt.nz

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Submissions are also subject to the Official Information Act 1982. If you have any objection to the release of any information in your submission, please set this out clearly with your submission. In particular, identify which part(s) you consider should be withheld, and explain the reasons(s) for withholding the information. The Ministry will take such objections into account when responding to requests under the Official Information Act 1982.

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Introduction

Radio spectrum is a vital resource that enables wireless digital connectivity. It underlies and supports a vast array of economic activities, contributing to our economic growth, innovation and global competitiveness.

New Zealanders aspire to stay ahead of the technology curve and increase productivity and sustainability while supporting market development and protecting consumer interests. Creating an enabling environment for digital transformation using radiocommunications technologies and radio spectrum resources is therefore a high priority for the government.

The speed of technological development in telecommunications requires us to monitor emerging wireless technologies, their use of radio spectrum and anticipate the areas of growth and development in spectrum management.

Radio Spectrum Management (RSM) is part of the Ministry of Business, Innovation and Employment (MBIE) and is responsible for the regulation, administration and investigation of radio spectrum in Aotearoa New Zealand. Our three teams (Policy and Planning, Licensing and Registry, Compliance) work closely with local industry, other government agencies, foreign governments and international bodies.

Our policy and planning functions are funded through taxpayers and our administrative functions through cost recovery on licensing fees and charges. Revenue from spectrum sales goes into the Crown account and is not used directly for administration. It is therefore important that we make opportunities to provide feedback on our approach to the stewardship of spectrum resources.

This is our third Five Year Spectrum Outlook. Publishing an 'Outlook' helps us to communicate our strategic direction in terms of responding to trends that affect access to and use of radio spectrum — and how we will prioritise activities in our day-to-day work.

The priorities that we outline in the Five Year Spectrum Outlook aim to facilitate access to the radio spectrum supporting the Government Future of Connectivity work program. This seeks to enable a greater range of options through which greater rural capacity and coverage can be provided, as well as supporting innovation and productivity in urban areas.

About the Five Year Spectrum Outlook 2022-2026

To give you an idea of the scope of spectrum management in New Zealand, Section 1 provides a summary of the legal and operational framework that guides our work and illustrates the kinds of projects and programmes that we have been involved over the past five years.

The rest of this Outlook takes a closer look at the direction that digital transformation might take, noting the international context and implications for New Zealand. It also highlights the priorities for our work programme and the extent to which we might need to adapt our regulatory frameworks to fully enable new technologies.

Section 2 – Looking forward - technologies driving change

Section 3 – Looking forward - trends in spectrum management

Section 4 - Our priorities.

We have designed this Outlook to be able to align with the development of a Digital Strategy for Aotearoa, the Digital Industry Transformation Plan and future decisions made regarding spectrum allocations.

1 Our Spectrum Management Framework

The radio frequency spectrum is regulated under the **Radiocommunications Act 1989** (the Act), which sets out the rights and obligations of spectrum users and prescribes the basic structure of national radio spectrum management. The Act also recognises the international radiocommunication treaties to which we are signatory, through the International Telecommunication Union (ITU) Constitution, Convention and the ITU Radio Regulations. Administratively, the Chief Executive of MBIE is responsible for the regime.

Along with the Act, there is a range of regulatory tools through the **Radiocommunications Regulations 2001** and public information brochures (PIBs) that establish licencing regimes and guide compliance and enforcement.

All transmissions of radio waves must be licenced and recorded on the Register of Radio Frequencies (RRF). The legislation provides three approaches to licencing:

Administrative licencing - used where spectrum supply is sufficient to meet demand. In these cases RSM makes spectrum available for licencing of specified services and issues radio licences to applicants on a first-come, first-served basis. Each licence is for a given geographic area. These licences may be revoked by RSM and are not tradable.

Property rights - used for spectrum where demand exceeds supply, in particular the frequencies suitable for cellular and broadcasting services. Rights are created by RSM, enabling the owner to assign licences within a particular frequency range, at any location in the country. These rights are known as "Management Rights". They have a maximum duration of 20 years. Management Rights are treated as business assets, and can be traded and mortgaged. The spectrum licences assigned within a Management Right are similarly tradable.

General user licences (GULs) – created to cover spectrum bands allocated for wide spread consumer technology, for example, Wi-Fi, wireless microphones, and remote-controlled devices. Lack of global harmonisation (in some bands) means that not all consumer devices from other countries are suitable for use here. The GUL regime enables some control on the import and distribution of these products.

Other legislative requirements relevant to radiocommunications include the Commerce Act 1986, which supports the competition aspects of wireless markets; and the Telecommunications Act 2001, which establishes the legal frameworks for telecommunication services provision.

In general, regulating radio spectrum:

- › Supports public policy objectives, including providing for Te Reo Māori and public broadcasting
- › Supports economic growth by enabling information and communications technology innovation, and competitive broadcasting and communications sectors
- › Meets the growing demand for wireless services
- › Facilitates non-commercial spectrum uses that benefit New Zealand, including public safety and defence communications, short-range devices (such as Wi-Fi) and industrial, scientific and medicinal applications.

1.1 Our continued role in international harmonisation

It is important to keep in mind the importance of New Zealand's continued international engagement to ensure that it makes the best radio frequency spectrum decisions. Radio equipment is generally made for large markets which support economies of scale. Global and regional harmonisation of radio spectrum is important so that radio equipment is available, affordable and interoperable. We are mindful that New Zealand has a small-scale market which cannot achieve economies of scale on its own. We need to make spectrum management decisions that recognise the international context and how other jurisdictions are managing issues, especially aligning with our closest neighbour and trading partner, Australia. As such, decisions that affect vendors and the long-term availability of equipment internationally can have significant impact on radiocommunications sector participants domestically. Broadly, the drivers of harmonisation and spectrum management decisions include:

1. Technology developments and standardisation (for example, initiatives led by the ITU, the Third Generation Partnership Project (3GPP), the Institute of Electrical and Electronics Engineers (IEEE) and the European Telecommunications Standards Institute (ETSI)).
2. Countries or regions with large populations making spectrum available for a particular use (Europe, Americas, and larger jurisdictions in the Asia-Pacific).
3. Development and update of international regulatory frameworks on spectrum allocation and allotment (for example updates to the ITU Radio Regulations).

These drivers are often iterative and one or more of these may influence harmonisation and spectrum management decisions.

Radio Spectrum Management (RSM) closely monitors international developments and engages with other administrations, regions and the broader industry on issues. In our role as a member state of the ITU, we contribute to shaping international use of radio frequency spectrum, and the benefits of standardisation and harmonisation. We take part in international study groups and World Radiocommunication Conferences. In the Asia-Pacific Telecommunity, New Zealand plays an active role in developing proposals to help support spectrum management. As part of this we host the New Zealand Radio Sector Group, a national forum of government agencies, industry, licensees and stakeholders to discuss and debate issues affecting spectrum use.

1.2 Our spectrum management activities

The activities of RSM in spectrum management and allocation can be considered in the four broad areas shown in Figure 1: input and engagement internationally, technical assessment and advice, commercial and competition and delivering government outcomes through policy development and decision-making. Compliance monitoring and enforcement activities fall both within the technical and commercial and competition areas.

▶ **Figure 1: RSM Spectrum Management and Allocation**



Over the last five years, the activities of the three RSM teams (licensing, compliance, and policy and planning) have included creating licences, carrying out compliance activities, resolving interference problems, and generating policy to support Government decisions. In terms of spectrum rights, along with managing Crown spectrum holdings, there has been renewals, technical consultations, discussions with Māori on interests in radio spectrum, and preparing for 5G.

Table 1 provides a snapshot of some of the projects RSM has been involved in between 2017 and 2021. These projects illustrate the range of activities that have made a significant contribution to enabling connectivity that supports all aspects of New Zealanders' lives.

Table 1: Key RSM projects 2017 – 2021

<p>RSM Licensing Developing the new Registry</p>	<p>RSM is required to maintain a Register of Radio Frequencies (RRF). Launched in 2005, the RRF is at the end of its operational life and requires a technology refresh.</p> <p>We have worked towards replacing the RRF since 2019 and expect the new RRF to be finished in mid-2022. Not only will the new RRF make licence applications and spectrum management more efficient, it will also modernise and transform licence administration by using cloud computing, enhanced API support and GIS capabilities. The integration with other New Zealand government digital platforms like RealMe Authentication, Quick Pay and NZBN will also make RSM services more user-friendly.</p>
<p>RSM Compliance Support for international events Resolving interference complaints</p>	<p>The compliance team is responsible for much of the day-to-day work of RSM in the field.</p> <p>Throughout 2020 and into 2021, we worked with the America's Cup project team to ensure interference issues were minimised during America's Cup races. We also worked closely with the Ministry of Foreign Affairs and Trade (MFAT) to prepare for the Asia-Pacific Economic Cooperation (APEC) conference (which due to COVID-19 was switched to a virtual platform).</p> <p>Interference complaints and supplier auditing are a large part of the work of the compliance team. Since 2010 the complexity of cases has increased which has been driven mainly by an increase in different types of radio devices operating in close proximity to each other.</p>
<p>RSM Policy and Planning International engagement Enabling access to spectrum, including 5G Government Policy Statement Maori Spectrum Working Group</p>	<p>RSM has continued to engage with trading partners, regional groups and relevant international organisations on a wide variety of radio spectrum issues including through the Asia Pacific Telecommunity (APT) and ITU-R study groups. This culminated in representing New Zealand at the World Radiocommunications Conference (WRC) negotiations in 2019. The outcome of WRC-19 is currently being implemented through trade treaty processes and work continues in preparation for WRC-23.</p> <p>In terms of spectrum allocations, we coordinated early access to unused 3.5 GHz spectrum to enable industry to initiate the 5G roll-out, renewed rights to the 1800 and 2100 MHz bands, consulted on 1700 and 2300 MHz bands, and continued to manage licensing in the Crown Managed Spectrum Park (2575-2620 MHz) and auction sound broadcasting licenses.</p> <p>One of the responsibilities that the Radiocommunications Act 1989 gives to the Minister responsible for radiocommunications is the ability to issue a 'Statement of Government Policy and Directions' to guide administration of the radio licensing regime. The 2021 Policy Statement has directed RSM to reserve the 1427 MHz – 1525 MHz frequency block that has been internationally identified for mobile broadband development (4G and 5G). Spectrum will also be reserved for the Emergency Services in the 1800 MHz band.</p> <p>Since 2019, RSM has worked closely with the Māori Spectrum Working Group (MSWG) to progress discussions about spectrum interests with the Crown on behalf of Māori. The establishment of the Interim Māori Spectrum Commission (IMSC), the operational arm of the MSWG, has been a milestone achievement that aims to develop Māori leadership in the digital economy.</p>

In the next sections, we look forward and highlight the trends we think are likely to affect how we regulate radio spectrum in New Zealand. The trends identified are grouped into two broad categories:

- › technologies driving change (Section 2)
- › trends in spectrum management (Section 3).

While there are obvious interrelationships between these trends, collectively we expect they will drive future changes in business models, service arrangements along with adaptations to our regulatory frameworks, our planning, allocation and licensing activities.

2 Looking Forward – Technologies Driving Change

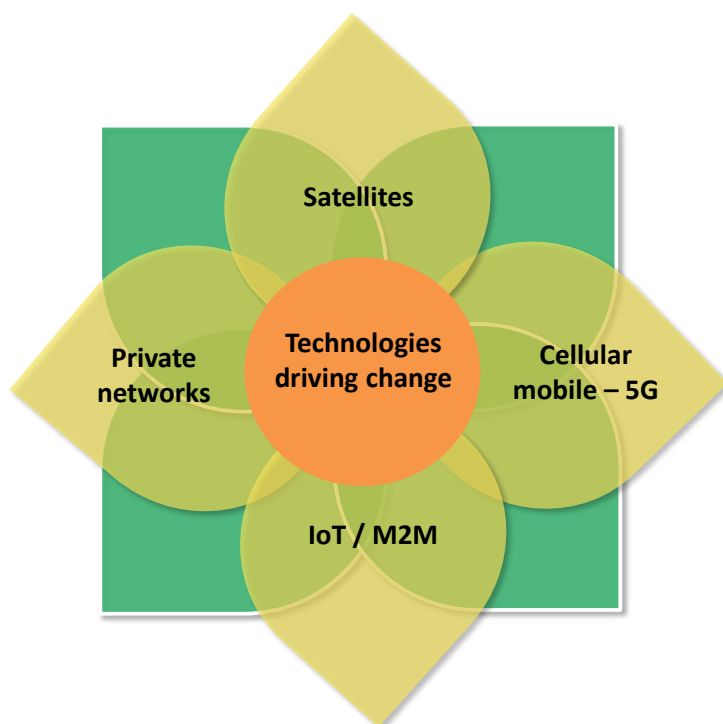
We wish to understand the technology trends driving change in New Zealand and their potential to support digital transformation, while achieving spectrum resource and regulatory objectives.

Each generation of technology brings its challenges. Technological advancements in radiocommunications are no different. The speed of development means regulators, industry and consumers have to constantly navigate a range of complex technological matters. As industry and consumers adapt, regulators need some flexibility to respond.

The roll-out of 5G networks worldwide is an example of a new wave of technological development which has, and will continue to, challenge the ways we think about radio spectrum management. 5G networks will not just influence the provision of cellular mobile services, they will create an environment of digital transformation that will influence many industries. Other examples include developing satellite launch technologies, the miniaturisation of devices and equipment, along with the development of internet of things and private networks.

In this section, we comment on four key trends as shown in Figure 2.

Figure 2 – Technologies driving change



2.1 Satellites and space – evolving technologies and use cases

In the last decade there has been significant investment by governments and the private sector in the space industry which has stimulated development of new satellite technologies. These developments relate to size, function, payload capacity, power storage and launching. This has enabled a degree of mass production that has driven down the price of satellites, and vastly reduced the cost of launching, for example through initiatives of SpaceX and Rocket Labs.

We are seeing the results of these investments through the emergence of Low-Earth-Orbit (LEO) satellites, mega satellite constellations, low-latency satellite networks and short duration satellites. Investment bank Morgan Stanley has predicted that the market for satellite communications is expected to grow from \$24B USD in 2018 to \$128B USD by 2028.

The success of new satellite technologies and the relative explosion of satellite projects is putting pressure on the international frequency coordination regime. It is also influencing application and uptake in non-space sectors. This is stimulating interest in new use cases that satellites can support, such as consumer broadband, particularly to locations not currently well served by traditional service providers (e.g. rural and remote areas). A number of countries (e.g. Malaysia, Canada, and Australia) are, or are proposing to, use satellites for this purpose.

Example box: Mega Satellite Constellations and Satellite Broadband

LEO satellites converged into low-latency satellite networks can provide consumer broadband using phased array antennas and a significant network of ground stations. These low-latency networks are powered by large constellations of LEO satellites. Phased array antennas can be steered electronically to track these satellites, even while moving. This means they can be placed on an aircraft, marine craft or large automobiles, as well as covering areas that are not economically viable to cover with terrestrial infrastructure. Each satellite must be connected to a ground station for the period when it is providing broadband services. These networks have many more LEO satellites in a constellation than you would need geostationary satellites (eg tens of thousands versus less than six).

Such new use cases are challenging traditional business models. For example, it could be necessary to adapt international regulation of satellites to capture these new use cases and to address technical, commercial and regulatory considerations. This will also ensure that international regulation doesn't constrain the development of new use cases.

Implications for New Zealand

Our strategic advantage in the space industry includes our location for launch sites, and for tracking, telemetry and control (TT&C) facilities in the southern hemisphere. This has stimulated a domestic space economy around the launching of small satellites, which will increase the volume of ITU-R satellite filings, coordination requests, notifications and recordings in the master international frequency register. It has also stimulated further investment into the New Zealand space sector.

RSM is responsible for the administration of satellite filings submitted to the ITU-R on behalf of New Zealand businesses. Subject to demand, RSM expects to boost its capabilities in processing filings, coordination requests, notifications and registrations in the space service bands. New Zealand will need to play its part in ITU forums to improve the coordination regime.

In light of the rapid technological development, and the range of satellite services available to industry and consumers, our regulatory responses will need to take into account changing dynamics in markets. New Zealand's Space economy is 'New Space' driven, characterised by a mix of start-up and well-established, small and large entrepreneur-driven and privately funded space

companies which service both government and non-government customers. This is in contrast to 'Traditional Space' economies where large-scale government activity has been a major driver (think US and Russia). International space economies are now expanding from Traditional Space models and developing their New Space activities.

RSM will continue to monitor developments in satellite technology and use of new satellite bands (including developments on telemetry, short messaging, and low-data-rate IoT satellites) and the evolving market structures. Satellite technologies may support the Government future of connectivity work program which seeks to ensure that New Zealand continues to have world standard connectivity, to meet the current and future needs of Aotearoa, New Zealand's businesses and people, and support the Digital Strategy for Aotearoa themes of trust, growth and inclusion.

We will also continue to assist the NZ Space Agency on issues as they arise and provide information on regulatory settings for satellite operators.

In terms of allocation of spectrum, relevant priorities include implementing decisions made in 2020 regarding the 1700-2300 MHz band and re-planning the 24-30 GHz band.

▶ Work Plan Priorities

Progress implementation of decisions on the 1700-2300 MHz band.

Review and re-plan the 24-30 GHz band including technical consultation.

2.2 Growth in wireless broadband traffic

One of the most significant trends of the last decade is the uptake of fixed wireless and mobile broadband. With a growing range of new mobile applications and services, there has been a dramatic increase in mobile data use. The drivers behind this growth are video usage, device proliferation and application uptake. The growing use of applications to stream content is particularly noteworthy. The worldwide impact of Covid-19 has also been a contributor to this trend.

▶ Figure 3: Drivers of mobile traffic increase 2020-2030
 (source: ITU Report M.2370-0 (07/2015))



The trends that are expected to increase the overall mobile telecommunications traffic over the next decade are shown in Figure 4.

Internationally, the radiocommunications industry is adapting to this growing demand in different ways. New and innovative types of technology are being developed to help manage this demand and allow the uptake of new use-cases from different types of service providers. Services such as fixed wireless and mobile broadband are now part of a wider package that also includes other capabilities and use cases like internet of things (IoT), ultra-reliable services and customised networks to provide services tailored to customer requirements.

The member states of the International Telecommunications Union (ITU) have achieved agreements in the last two decades on international allocations and identifications to support the development of mobile broadband. The last three World Radiocommunication Conferences (WRC-12, 15 and 19) have focused on addressing the growing mobile broadband access requirements through the harmonised identifications of spectrum for International Mobile Telecommunications¹ (IMT).

Various wireless 5G technologies are likely to demonstrate growth in parallel to traditional service providers and network operators. Businesses and sectors which wouldn't normally invest in IMT infrastructure have been looking to build their own networks to provide services that are customised to their needs. In many countries where spectrum has become scarce, this is also driving interest in spectrum sharing models including more advanced methods such as dynamic spectrum access.

Implications for New Zealand

The challenge we face is finding ways to make spectrum available in key bands to accommodate new wireless applications while maximising growth and investment in these services. Spectrum allocations have formed the basis for developing mobile data networks including for 5G (IMT-2020). However, spectrum identified for IMT at an ITU level, almost always has incumbent users. With potential increases in spectrum users and service providers, RSM will need to actively manage challenges such as compatibility and user conflicts and work with the sector to create a positive investment environment for IMT infrastructure and services.

The government is proactively seeking ways to support the roll-out of 5G services, while also investigating impacts on markets and consumers. 5G, and other broadband technologies may support the Government future of connectivity work program by enabling a greater range of options through which greater rural capacity and coverage can be provided, as well as supporting innovation and productivity in urban areas.

For the last five years, the broader outcome sought from government intervention has been to enhance coverage and connectivity. However, with existing government programmes in place or nearing completion, the emphasis will increasingly shift to:

- › Addressing capacity constraints, including ensuring there is sufficient capacity to cater for future growth, and
- › Supporting different use cases (for example for industry verticals), developing capacity, and enabling uptake of new wireless technologies including addressing interoperability needs.

RSM will continue to proactively engage in ITU, APT and international trade matters relating to spectrum including monitoring and responding to developments in the 6.425 – 7.125 GHz band for mobile and Wi-Fi. RSM will also monitor developments in new emerging 6G mobile technology and standards, particularly relating to spectrum sharing, tiered and dynamic access mechanisms for 5G and other allocations.

¹ IMT, IMT-Advanced and IMT-2020 are the ITU-defined technical requirements to be met by 3G, 4G and 5G mobile broadband equipment.

► **Work Plan Priorities**

Detailed consideration of allocation design of spectrum rights: 600 MHz, 3.3-3.4 GHz, 3.4-3.8 GHz, 3.8 -4.2 GHz and 24-30 GHz bands for 5G and associated technologies.

2.3 Massive internet of things

The global growth in connectivity (also driven by global broadband uptake) has encouraged the development of wireless applications for enabling the automated and seamless day-to-day interaction between machines, portable devices, objects, infrastructure and people. These applications range from personal wearable devices such as tracking bands, to automated smart homes, assisted transportation systems and in targeted systems in a “smart city”. A common thread between these use cases is they revolve around large numbers of devices sending low amounts of data.

Internet of Things (IoT) is a concept for connecting objects and appliances to the internet. The definition of IoT is still evolving, but it is widely understood as an application integrating multiple existing technologies rather than a class of radiocommunication. The types of applications and purpose vary widely, and the connectivity aspect of these emerging wireless applications does not point to any specific spectrum band as a sole access solution.

Machine-to-Machine (M2M) applications are widely used for transmitting low bit-rate data between devices and systems.

Use cases for IoT & M2M wireless applications will develop rapidly with the roll out of other wireless technology like 5G services, satellite broadband and generally authorised short-range devices (for example, the increasing connectivity of agricultural machinery for operation and monitoring). The potential of IoT and M2M for health and safety monitoring and sustainability measures has also been widely researched but is yet to be implemented at scale.

The standardisation of wireless technology is creating a trend of convergence around wireless 3GPP and IEEE standardised technologies to replace proprietary technologies and land mobile systems in some sectors.

Implications for New Zealand

IoT and M2M wireless applications operate currently across generally authorised / licenced spectrum (also known as licence-exempt or unlicensed) as well as licenced mobile spectrum (NR, LTE and GSM), allowing commercial mobile carriers to offer dedicated bandwidth and coverage to M2M and IoT customers.

We are now seeing IoT use cases domestically such as for utilities monitoring (smart meters for example). Having a coherent system for applications in a particular sector (for example, utilities) provides for economies of scale and interoperability of devices nationally.

RSM will continue to monitor IoT business models and use-cases internationally. Many of these business models are integrating IoT with private networks and spectrum sharing to provide customised services that use spectrum efficiently. The extent the Radiocommunications Act 1989 and other legislation that form barriers to the development of these business models is also an ongoing focus.

RSM will also monitor the need for spectrum for critical infrastructure in New Zealand (see ‘Smart transport in New Zealand’ example).

▶ **Work Plan Priorities**

Review and re-plan appropriate spectrum bands, including technical consultation.

Scope issues and develop proposals to modernise the administration of the Radio-communications Act 1989 to keep pace with new technologies and market developments.

▶ **Example box: Smart transport in New Zealand**

Transportation systems are becoming increasingly reliant on wireless connections for essential safety applications to operate. The absence of, or interference to, wireless connections will render some systems inoperable. KiwiRail has systems deployed in Auckland that are capable of running increased safety and signalling features if they have radios connected between the electric train fleet and trackside infrastructure. For its Wellington metro operations, KiwiRail is at the start of a multi-year business case process to procure a new signalling system for the metro network, to enhance its capacity.

In other administrations, dedicated blocks of spectrum have been set aside for rail applications. In New Zealand, we have a number of land mobile (typically 12.5 or 25 KHz wide) channels for rail use. However, the newer systems available employ LTE-based technologies, with bandwidth requirements of 3-5MHz. This is a large increase in the spectrum required. This also reflects the increasing trend of the broader radio sector to move towards standardised cellular based systems.

2.4 Private networks and Industry verticals

There has been increased discussion on private wireless networks for different industry sectors like manufacturing, agriculture, and logistics often referred to as 'verticals'. In general the idea is to improve connectivity for these industries which will lead to greater productivity gains from automation in industrial practices ("Industry 4.0"). While use cases for verticals do not exclusively use mobile spectrum, there are implications for using multiple cellular technologies (eg LTE, New Radio) in terms of licensing models and spectrum sharing.

Private networks are those owned and operated by a business or sector for their exclusive use and are not available for retail services to the public. Private networks feature network infrastructure that is used exclusively by devices authorised by the end user organisation. The roll-out of low-latency 5G networks and developing IoT use cases will lead to further integration of these technologies to create private networks. For example, overseas several manufacturers have applied for licences to develop private networks including Volkswagen/Audi, Bosch and Siemens.

In addition, the evolution of Radio Access Network (RAN) for cellular technologies is bringing enhanced capabilities and more flexibility including supporting more spectrum, additional frequency bands, as well as air interface enhancements in performance and efficiency. One of the major recent developments is the network virtualisation and interoperability between different vendors. The 'Open RAN' is such concept for a more open radio access network architecture. Open RAN intends to create a multi-supplier RAN solution that allows for the separation (or disaggregation) between hardware and software with open interfaces and virtualisation, hosting software that controls and updates networks in the cloud. The promised benefits include supply chain diversity, solution flexibility, and new capabilities leading to increased competition and further innovation. These evolutions and enhancements may bring a wider range of options and benefits to private networks and industry verticals.

Implications for New Zealand

Spectrum for International Mobile Telecommunications (IMT) has generally been allocated on a nation-wide basis to ensure that a cell phone can receive and send data anywhere in the country. Private networks will create high demand in some IMT spectrum bands and may challenge this model. Allocating 5G spectrum across different bands (particularly 3.3-3.4 GHz and 3.8-4.2 GHz) has the potential to provide spectrum to industry sectors to develop private networks. Where there are multiple users in the same band, for example through private networks, interference management can become more complicated and administratively burdensome. Detailed technical criteria or rules may be needed to manage interference risks in some cases (for example, 3GPP technical standards to manage interference including using strict frame structures for transmitting in time division duplex (TDD)).

Different bands are suitable for different use cases, so having spectrum available in high, mid and low frequency bands will allow for a variety of use cases and industry verticals. Significant investment in private infrastructure and the capability to build and operate these sorts of networks will be necessary. Agricultural and horticultural businesses for example, will likely need to source capability or services from existing operators or consulting firms.

The evolution of Radio Access Network (RAN) for cellular technologies including increased flexibility, decreased costs, RAN virtualisation and Open RAN may help drive increasing development and deployments of private networks and industry verticals. We are monitoring these developments.

A related issue is the role of Licencing for such services which is currently restricted by the Radiocommunications Act 1989. This issue will be discussed further in section 4 of this outlook. RSM is also monitoring developments in spectrum sharing models including static, tiered and dynamic access mechanisms for 5G and other allocations (how they might be applied here).

▶ Work Plan Priorities

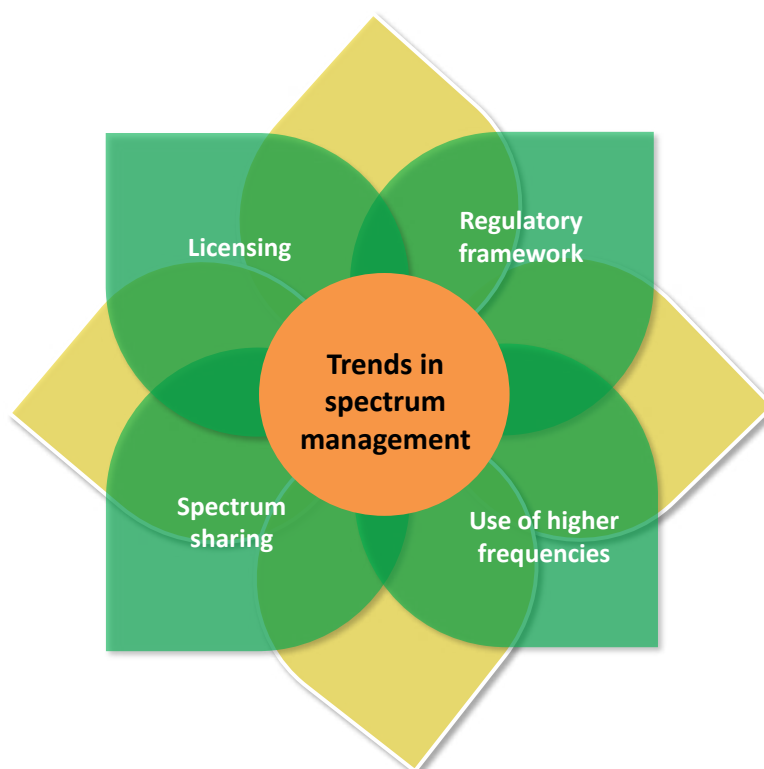
Review and re-plan 600 MHz, 3.3-3.4 GHz, 3.4-3.8 GHz and 3.8-4.2 GHz bands, including technical consultation.

Develop and implement revised operational approach to small cell network licensing.

3 Looking Forward - Trends in Spectrum Management

Spectrum management approaches are changing to adapt to technological developments. Internationally, regulators are considering different and new approaches in spectrum management. We expect that industry's approach to commercial structures and operating models will also change.

► **Figure 4 - Trends in spectrum management**



With reference to four aspects shown in Figure 4, this section highlights the trends that we have identified that we think will be influential in how we regulate radio spectrum in New Zealand.

We are seeing an ever growing number of technologies and proliferation of devices driving increasing demands for access to spectrum. This will require tighter spectrum management and technologies will need to use the spectrum more efficiently. Regulators will have to continue to look for ways to get more and more use out of the radio spectrum to enable sustained improvements in efficiency over time. Generally radio frequency spectrum is managed with respect to three technical dimensions:

1. **Frequency** (different users / applications on separate frequencies).
2. **Spatial** (different users / applications separated by distance, geography / obstructions).
3. **Time** (different users / applications access the spectrum at different times).

Traditionally, spectrum management has been based on conservative approaches, primarily on frequency where frequency ranges have been allocated to a single service (such as fixed, mobile, broadcasting, satellite) and assignment to exclusive use for one particular purpose or technology in a particular frequency range ('spectrum silo' approach). In addition, frequency separation (guard bands) have also been used to compensate for transmitter and receiver performance. There is a growing need for regulators, to minimise guard-bands and make more use of spatial and time dimensions to enable more spectrum use.

Policy and planning interventions, market forces and technological development are three aspects that regulators in many jurisdictions are considering. Policy and planning levers to increase efficiency could include tighter co-existence analysis and setting of tighter rules based on better equipment performance, spectrum sharing among different types of users, and using different authorisation mechanisms, spectrum re-farming and recycling, and use of higher frequency ranges.

Use of market mechanisms to incentivise the highest benefit and most efficient use of spectrum will continue to be important. This may require spectrum regulators to identify opportunities to take action where required and appropriate to support these outcomes. It would be necessary to have the appropriate tools and data to enable an analysis of this type. There are also a range of technologies that will help to achieve greater efficiency including the use of more spectrally efficient equipment that achieves more data through a given bandwidth (bits per second per Hertz) and greater frequency reuse. Also, use of equipment that is more tolerant to interference and changing expectation of spectrum users where they have to live in an environment with other users and some level of degradation (no longer a noise limited environment).

3.1 Spectrum re-farming, recycling and sharing

3.1.1 Re-farming and recycling

Spectrum re-farming is a tool that could increase the efficient use of spectrum. Spectrum re-farming and recycling allows the use of existing spectrum to support newer generation technologies. Often the transition from one technology to another technology can be complex and requires detailed technical management so that old and new networks can continue to operate un-interrupted. We have seen examples of this through the transition from analogue to digital television in New Zealand and through the transition through 1st, 2nd, 3rd and 4th generation cellular technologies. Transition from existing cellular technologies to 5th generation is now starting. With 5G there are technology options to ease transition allowing coexistence with 4G in the same band such as using dedicated carriers or Dynamic Spectrum Sharing. In the case of cellular, this transition has happened with limited regulatory intervention as the radio frequency spectrum was in private management rights, where the MNOs who had the right could manage their own transition.

Implications for New Zealand

Investigations into the efficient use of spectrum are largely due to a growing number of technologies and the proliferation of devices. The dwindling availability of spectrum in key frequency bands is also a factor, vital to ensuring the long-term sustainability of wireless infrastructure. While this has not yet become a significant issue for New Zealand, RSM maintains a watching brief on developments in this area.

Historically, we've taken a band-by-band approach, requiring use of licencing and technical conditions to fulfil regulatory and wider government outcomes. We see a need for a technology neutral approach to support flexibility in equipment upgrades as technology evolves. However, many factors will shape this approach moving forward. When we undertake spectrum planning there is always a band plan involved (for example duplex spacing, uplink and down link frequencies) which is inevitably suitable to particular technologies. With growing spectrum use and the need for tighter spectrum management, this may require specific technical details.

Where possible we will continue to use a technology-neutral approach with least restrictive technical conditions as this provides flexibility for spectrum users. We have been using this approach when assigning spectrum to MNOs to enable a transition to different technologies over time. While we will continue to apply this as a principle, tighter management of the radio frequency spectrum may require RSM to be more specific in some areas to enable new use while managing interference risks.

Work Plan Priorities

Investigate ways to get more use out of radio frequency spectrum and adopt tighter spectrum practices.

Consider the effect of spectrum sharing frameworks on market dynamics and competition and if the current regulatory framework enables or constrains access arrangements and spectrum sharing.

Consider sharing models when developing future spectrum bands.

3.1.2 Spectrum sharing

Spectrum sharing is where a radio frequency spectrum band can be authorised and used by multiple different users that may be operating different technologies. Regulators are now finding it increasingly challenging to give different users their own frequency bands (spectrum silo approach) and have to look at different users in the same band. Regulators are also finding that many existing bands are not used ubiquitously over an entire country and there are often frequencies or location gaps where another use can be enabled.

The spectrum sharing discussion gained momentum during the debate over TV white space in the 2010s (white space being the gaps between TV channel frequencies). This was first driven by an industry group (including Microsoft and Google) and the development of a framework by the Federal Communications Commission (FCC) in the United States. Other countries then followed (including the United Kingdom, Canada and New Zealand) with their own regimes. TV white space focused on complex mechanisms such as dynamic spectrum access, which uses a database to automatically find unused frequencies and occupy them with mixed success. Dynamic spectrum access is not widely used except in the United States (with mixed success). Static forms of sharing are more common globally. Despite this, spectrum sharing is maturing and is starting to form a part of strategic thinking for many regulators who are starting to see such methods able to drive more efficient spectrum use in the long term.

Implications for New Zealand

Along with other regulators, we are changing the way we are thinking about how we can make spectrum available. Traditionally management rights have included long-term exclusive rights on a frequency band, with a set of accompanying commercial terms, technical requirements and sometimes implementation obligations. Responding to changing business models and technological developments, and competing demands for spectrum rights, we need to look more closely at the merits of sharing methods and what might work in New Zealand.

Spectrum sharing can be implemented through both of the traditional static licensing mechanisms (radio licensing and general user licensing). This already happens in some cases through prescribed licensing rules but is normally for particular technology types (for example fixed to fixed, land mobile to land mobile). We have implemented a static licensing mechanism that allows the use of TV white-space in the 500 MHz band, provided it works around existing Digital Television use.² However, there is scope to expand this approach and look at the management rights regime and whether tiered access models and dynamic sharing could be used effectively (for example that are being developed in the United States).

² See Public Information Brochure (PIB) 39 www.rsm.govt.nz/about/publications/pibs/pib-39/, section 4.5.

We will continue to monitor the demand for different tools and levers to allow more innovative approaches to spectrum sharing. This includes developments in sharing arrangements in the 3 800 – 4 200 MHz band, and developments in tiered and dynamic access mechanisms specifically for 5G allocations.

► **Work Plan Priorities**

Consider the effect of spectrum sharing frameworks on market dynamics and competition and if the current regulatory framework enables or constrains access arrangements and spectrum sharing.

Consider sharing models when developing future spectrum bands (as a result of the review the current Managed Spectrum Parks rules).

3.2 Use of higher frequencies

As technology advances, higher and higher frequency ranges become feasible and more equipment becomes available. Higher frequencies offer higher bandwidths but come with increased propagation losses. Frequency ranges that did not seem feasible decades ago now have widespread use. This includes the frequency ranges recently identified for mmWave 5G in the 26 GHz, 40 GHz and 66-71 GHz bands.

There is growing interest in the use of even higher frequency ranges (eg above 100 GHz) with the latest technological advancements. Higher frequency ranges can offer very wide bandwidths, much higher data throughput and network capacity for fixed and mobile applications. These high bandwidths can also offer high resolution to radio determination applications.

International work and investigations have started on the next evolution from 5G to 6G cellular technologies. While work is still in its early stages, the 100 – 1000 GHz frequency range is being considered as a possibility for providing large bandwidths to provide very high data rates.

Other regulators have recognised the potential for technology innovations in higher frequency bands. Both the US and the UK have provided frameworks to increase access to frequencies above 100 GHz to promote technological innovations.

Higher frequency ranges can be shared more readily than lower frequency ranges, mainly due to their propagation characteristics. In addition technologies can utilise spectrum access techniques to minimise the risk of interference to other users. How spectrum is made available in these higher frequency ranges may need further investigation.

Implications for New Zealand

We will need to consider the most appropriate time to make higher frequencies available, noting that this will be driven through development of international activities and available equipment. Because higher frequency ranges can be shared more readily this could favour non-exclusive licensing approaches that maximise the number of users that can access spectrum. There are models of spectrum sharing that RSM currently uses that could be applied to higher frequency ranges, such as General User Licences (GUL). RSM is also monitoring developments in tiered and dynamic access mechanisms for establishing allocations of higher frequencies and monitors international developments on 40 GHz mmWave, particularly 40.5 -43.5 GHz.

► **Work Plan Priorities**

Monitor use of multigigabit wireless systems in the 66 -71 GHz range.

Review and re-plan the 24-30 GHz band including technical consultation.

3.3 Licensing approaches enabling new technologies

With the development of new technologies, commercial models are changing and more complex service arrangements are emerging. Regulators will need to look at the merits of licensing approaches and the extent that they constrain or incentivise use of new technologies and applications. In some cases, a new approach to allocation and licensing will be necessary.

Regulators are looking more closely at new licensing approaches including spectrum sharing, small cells and short range devices (SRDs). Currently, where individual licensing would be impractical (like for SRDs and Wi-Fi connectivity), most regulators use licence exempt or unlicensed approaches (for example, Ofcom in the UK or the FCC for the US). With the proliferation of such devices and continuing development of technologies, we are likely to see a reassessment of technical conditions and other regulatory requirements. This is because traditional licensing approaches did not anticipate the current and emerging commercial models, which means traditional licensing approaches may prevent the uptake or success of new technologies. In future, there is likely to be a greater emphasis on more flexible spectrum sharing techniques.

Implications for New Zealand

RSM is actively considering ways to address issues from the regulator and operator perspectives. There are a range of potential approaches such as in the current GUL regime (traditionally used in New Zealand for spectrum sharing), radio licensing and management rights. Finding a balance between protecting consumers and supporting innovation is an ongoing focus.

We are also keen to explore ways the licensing framework might work better for the deployment of indoor small-cells for private networks and will be monitoring international developments to consider if GULs are appropriate when developing future spectrum bands (for example higher frequency bands like mm wave bands).

In 2021, we commenced a review of rules for the 2575 MHz – 2620 MHz Managed Spectrum Park for the seven years remaining on the management rights. This process is expected to provide opportunities to consider how such models could be applied in high demand and higher bandwidth spectrum on a non-national basis.

In terms of management rights, several are due to expire in the next seven to ten years.³ While the next expiry of rights is not until 2028 (mobile cellular rights and the Crown Managed Spectrum Park in the 2600 MHz band), considerable planning effort is needed in this Outlook period. It will be important to ensure sufficient lead in time can be provided to transition to new arrangements across multiple bands during the next Outlook period (ie from 2026).

▶ Work Plan Priorities

Consider updates to General User Licences, particularly for short-range devices and monitor developments in the use of 6 GHz for Wi-Fi 6E.

Consider a General User Licencing regime when developing higher frequency bands.

Commence planning work for spectrum bands where management rights are due to expire from 2028.

Review the current Managed Spectrum Park rules and the suitability for use in other bands.

³ This includes management rights: 600 MHz, 700 MHz, 850-900 MHz, 2300 MHz and 2600 MHz bands; plus AM and FM sound broadcasting and digital terrestrial television rights.

3.4 Regulatory frameworks

We have identified three priority work programme areas needed to enable our regulatory framework to respond to technology trends and innovations in spectrum management. These relate to:

- › our regulatory settings under the Radiocommunications Act
- › how we fund spectrum management services
- › how we sustain the pool of engineering expertise needed to support spectrum use.

3.4.1 Adapting the New Zealand Spectrum Management Framework

The Radiocommunications Act has not been substantially amended since its introduction in 1989. Many provisions are outdated and are affecting administration of the Act. In addition, specific provisions are unnecessarily constraining new technologies from being authorised within the regime. This is preventing deployment of key tools for law enforcement and border controls by government agencies.

Operational workarounds have progressively been used for some law enforcement activities and in administering rights to spectrum. For example, some methods for measuring interference made by radiocommunications equipment are not recognised by the Act and therefore compliance cannot easily be verified – compromising monitoring and enforcement activities. If this continues, it will significantly impact spectrum management in the medium and long-term in two areas: allocation of spectrum, particularly spectrum for 5G technologies; and inhibit developing innovative forms of licencing to reflect changing commercial models, as highlighted throughout this outlook.

Each of these broader issues have more specific implications for items of work that are planned for the 2022-2026 period or have an effect on the levers that are available to RSM in authorising new technologies.

- › The Act was drafted at a time when systems were paper based and online transactions were not envisaged. Modernising the provisions will ensure the Act reflects changes in trade, technology, equipment and industry best practice.
- › There are inconsistencies in how technical requirements and reference standards are authorised under the Act and regulations. This is apparent for both radio and spectrum licensing regimes, and has led to constraints over adapting and responding to new technologies (including responding to the ITU Radio Regulations, changing business models and network evolution). This creates serious implications for compliance monitoring and enforcement.
- › The current approach to competition in the Act creates duplication, uncertainty and may not always result in outcomes that are in the public interest. Reliance on deeds and commercial contracts to impose conditions on spectrum use and holdings creates uncertainties for spectrum right holders and difficulties for enforcement.
- › The radiocommunications regime was originally designed with the intent that all spectrum would be transferred to the management rights regime, and spectrum use and allocation decided by the market – very little regulatory role for government was anticipated. However, current practice and the outcomes sought from spectrum management do not reflect the initial regime design.

Implications for New Zealand spectrum management framework

We are considering ways in which to support law enforcement by providing for approved agencies to deal effectively with security and safety threats that cause potential or actual harm such as those arising from drones or improvised explosive devices (IEDs). Law enforcement should be able, in appropriate circumstances, to use wireless technologies to detect, monitor, disrupt, use, intervene and prevent communications.

RSM will seek to continue to modernise the approach to and administration of the radiocommunications regime under the Radiocommunications Act 1989 so that it is fit-for-purpose for current and future needs. This includes ensuring the regulatory framework can meet desired objectives including:

- › Supporting public policy objectives, including providing for Te Reo Māori and public broadcasting
- › Supporting economic growth by enabling information and communications technology innovation, and competitive broadcasting and communications sectors
- › Meeting the growing demand for wireless services
- › Facilitating non-commercial spectrum uses that benefit New Zealand, including public safety and defence communications, and industrial, scientific and medicinal applications.

We will also need to ensure that there are adequate tools available across government agencies to manage security threats (for example, ability to deploy a range of devices to monitor, intercept and disrupt telecommunications). Any changes to the regulatory frameworks will need to ensure New Zealand can meet obligations under international agreements, treaties and conventions relating to radiocommunications and the radio spectrum.

 **Work Plan Priority**

Investigate issues and develop proposals to modernise the Radiocommunications Act 1989 covering: reflecting agreements on Māori spectrum, supporting law enforcement, keeping pace with new technologies and market developments, streamlining consideration of competition issues in spectrum allocations, modernising Radiocommunications administration.

3.4.2 Radio Spectrum Fees Review

Holders of radio and spectrum licences must pay an annual fee to cover the administrative costs of registering their licences. This fee covers the costs of technical planning, licence registration and compliance activities to protect the rights of licence holders. Spectrum policy work is funded by the tax-payer. Revenue from spectrum sales goes to the Crown account and is not used for administrative costs. A memorandum account is used to hold fee revenue and pay relevant expenses. This means that fee revenue can be held to the credit of fee payers over multiple years and allows for the smoothing of fees over time.

Treasury guidelines require that government-imposed fees, such as those for radio and spectrum licences, be reviewed every three years. Radio licence fees are mandated by the Radiocommunications Regulations – Schedule 6: Annual Admin Fees. Following the 2017 review, the vast majority of users pay a fee of \$150 (including GST) per licence.

We are currently in a phase of planned under-recovery of fees to reduce the positive balance in the memorandum account. The aim of the 2017 review was to reduce the memorandum account gradually so that a sudden, large reversal in fees is not required. A high-level fees review was also conducted in 2020 which found that a more detailed review was unnecessary. Ongoing monitoring would be prudent but, based on the review, it appeared that the next regular fees review in the calendar year 2023 would be the appropriate time for a fees reset.

 **Work Plan Priority**

Review the radio spectrum licensing fees regime in 2023.

3.4.3 Building Certification Capability

Approved Radio Engineers (AREs) and Approved Radio Certifiers (ARCs) are a critical component of the radio licensing regime in New Zealand. The effectiveness of the radiocommunications regulatory regime is reliant on the expertise of these authorised experts.

The Radiocommunications Act 1989 and the Radiocommunications Regulations 2001 were updated in 2004 and 2005 to provide processes and certification of authorised persons. Authorised persons include Radio Engineers, Radio Certifiers and Radio Examiners. The amendments were specifically to allow people that are not employed by the Ministry to certify radio and spectrum licences and issue certificates of competency.

Since 2006, MBIE and industry sectors have progressively increased their reliance on authorised persons to provide efficient and technically compatible assignment of radio spectrum. This is particularly apparent in key industries where there is growing demand for radio spectrum such as the telecommunications, maritime and aeronautical industry sectors, as well as the growing space industry. These industry sectors are vital for New Zealand's economic prosperity.

Implications for New Zealand

We have mapped the environment to understand the demand versus the availability of ARE's and ARC's. This work points to the lack of radio engineering training and qualifications in New Zealand. We expect that within five years, there will be a significant shortage of skills and capability in the radio sector.

To sustain the pool of expertise to adequately service key industries, an increase in support of the authorised persons regime is needed to meet current and future projected industry demands.

▶ Work Plan Priority

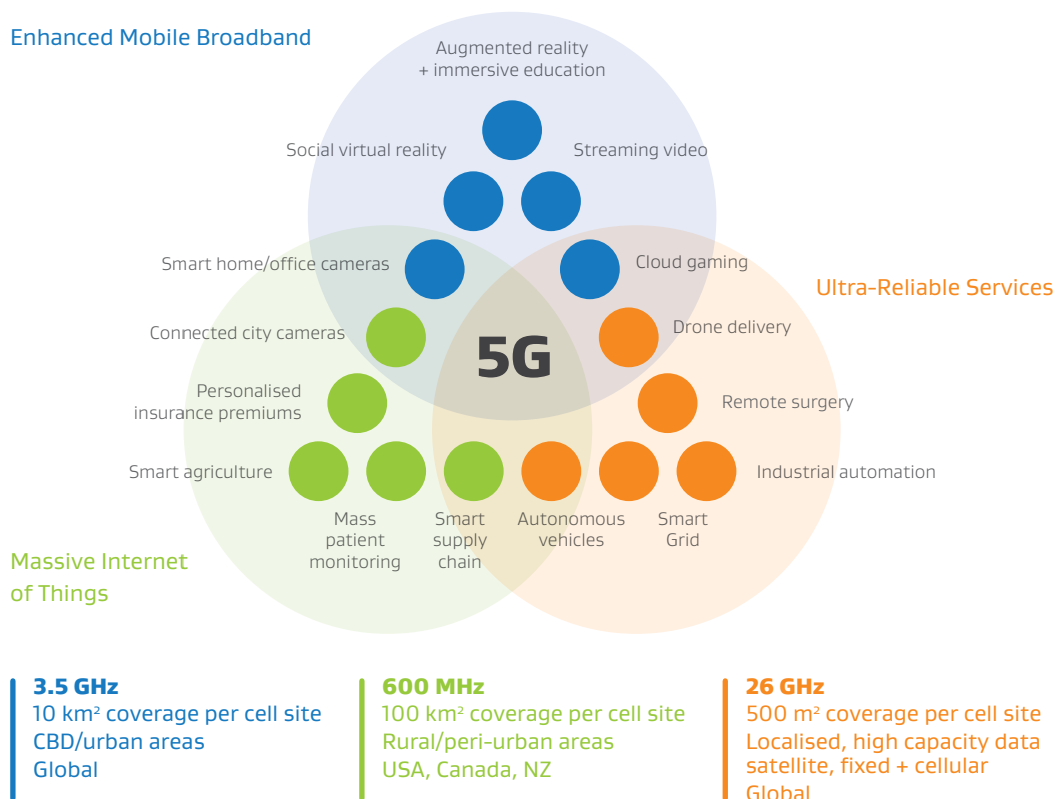
Monitor sector needs, training and qualifications for radio spectrum management specialists.

4 Our Priorities 2022 – 2026

The RSM work programme for 2022-2026 has been developed in response to ongoing regulatory responsibilities and the action points arising from industry trends and sector developments outlined in Section 3.

There are two overriding factors influencing the next five-year period that are geared towards leveraging the radiocommunications sector and the digital economy to grow New Zealand for all: enabling nationwide roll-out of 5G services and securing an enduring agreement between Māori and the Crown regarding spectrum interests.

Figure 5 - 5G Spectrum Strategy



4.1 Enabling the nationwide roll-out of 5G services

Digital technologies are evolving rapidly and have wide-ranging impacts across economic, social and public sector domains. It is therefore important for government to respond in a proactive and coordinated way in order to create an environment for digital transformation. Spectrum bands identified for IMT 5G services are a critical element to achieve this, supporting the Government Future of Connectivity work program, as shown in Figure 5.

4.2 Working towards an enduring agreement between Māori and the Crown

As noted in Section 1, a Māori Spectrum Working Group was established in 2019 to work with the Crown to address Māori interests in radio spectrum. This work is currently progressing well. The immediate objective is to agree a Memorandum of Understanding that will form the basis for an enduring agreement between the Māori and the Crown on spectrum issues; and lead to a step-change in Māori participation in spectrum-related industries and the digital economy.

4.3 Our Work Programme 2022-2026

Taking the work plan priorities from Section 3, Table 2 outlines our major activities and projects over the upcoming outlook period. A brief description of each activity and how it relates to each of the trends identified this Spectrum Outlook.

We note that flexibility is required in responding to emerging issues in radio spectrum as new technologies and issues emerge. Hence, this indicative work programme is designed to be flexible and responsive to issues over time.

Table 2: Summary of RSM's Work Plan Priorities

	Satellites and space	Mobile data traffic	Massive IoT	Private networks + and industry verticals	Use of higher frequencies	Spectrum sharing + efficient use of spectrum	General user licensing	Spectrum management and administration
Priority RSM Work Programme Items								
Band planning and technical studies (eg use, technical requirements)								
Review and re-plan the 24-30 GHz band including technical consultation	●	●			●			●
Review and re-plan 600 MHz spectrum, including technical consultation		●	●					●
Review and re-plan 600 MHz, 3.3-3.4 GHz, 3.4-3.8 GHz and potentially 3.8-4.2 GHz bands, including technical consultation		●		●		●		●
Investigate use of 6 GHz for Wi-Fi 6E		●					●	●
Investigate multigigabit wireless systems in the 66 -71 GHz range		●			●		●	●
Commence planning work for spectrum bands where management rights are due to expire from 2028.		●	●	●	●	●	●	●
Allocation design and implementation								
5G spectrum - detailed consideration of allocation of spectrum rights: 3.3-3.41 GHz, 3.5 GHz, 3.8 -4.2 GHz and 24-30 GHz bands for 5G and associated technologies	●	●	●	●	●	●		●

	Satellites and space	Mobile data traffic	Massive IoT	Private networks + and industry verticals	Use of higher frequencies	Spectrum sharing + efficient use of spectrum	General user licensing	Spectrum management and administration
Priority RSM Work Programme Items								
Investigate ways to get more use out of the radio spectrum and adopt tighter spectrum practices	●	●	●	●	●	●	●	●
Consider spectrum sharing, tiered and dynamic access mechanisms for 5G and other allocations	●	●	●	●	●	●	●	●
Consider the effect of spectrum sharing frameworks on market dynamics and competition		●		●		●		●
Consider if the Radio Communications Act enables or constrains access arrangements and spectrum sharing								●
Progress implementation of decisions on the 1700-2300 MHz band.	●	●					●	●
Review the rules for the 22575 MHz – 2620 MHz Managed Spectrum Park for the remaining 7 years		●			●	●		●
Review use of Managed Spectrum Park concepts in general, and for regionally-based operators and how such models (and other sharing models) could be applied in high demand and higher bandwidth spectrum		●			●	●		●
Regulatory management and administration								
Assisting New Zealand Space Agency on issues as they arise.	●	●			●			●
Providing information on New Zealand regulatory settings to satellite service providers.	●	●			●		●	●
Continue to run the ITU-R Satellite Co-ordination process and keep PIBs up to date (eg PIB 60)	●							●
Scope issues and develop proposals to modernise the Radiocommunications Act 1989	●	●	●	●	●	●	●	●
Continue to proactively engage in ITU and international trade issues relating to spectrum.	●	●	●	●	●	●	●	●
Develop and implement revised operational approach to small cell network licensing		●	●	●		●	●	●
Develop options for law enforcement agencies regarding use of wireless electronic counter measures and associated technologies	●	●		●				●
Update government policy statement for radio licencing	●	●		●		●	●	●
Consider updates to General User Licences, particularly for short-range devices							●	●
Review the Radio Spectrum Licensing Fees regime in 2023								●
Investigate ways to build capability in the Radiocommunications sector including through the training of Approved Radio Engineers and Certifiers								●

	Satellites and space	Mobile data traffic	Massive IoT	Private networks + and industry verticals	Use of higher frequencies	Spectrum sharing + efficient use of spectrum	General user licensing	Spectrum management and administration
Priority RSM Work Programme Items								
Monitoring priorities								
Monitor developments in satellite technology and use of new satellite bands (eg Q&V bands)	●							●
Monitor international developments on telemetry, short messaging, and low-data-rate IoT satellites	●							●
Monitor international developments on 40 GHz mmWave, particularly 40.5 -43.5 GHz					●			●
Monitor developments and sharing arrangements in 3800 – 4200 MHz						●		●
Monitor developments in 1 427-1 518 MHz and consider how this could be made available						●		●
Monitor developments in 6 425 - 7 125 GHz mobile/wi-fi		●					●	●
Monitor developments in new 6G mobile technology and next generation technologies and standards		●				●		●
Monitor international developments in spectrum sharing, tiered and dynamic access mechanisms for 5G and other allocations						●		●
Monitoring sector needs, training and qualifications for radio specialists						●		●

