RADIO SPECTRUM MANAGEMENT

Five year Spectrum Outlook 2017-21

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

0508 RSM INFO (0508 776 463)
info@rsm.govt.nz
rsm.govt.nz

Contents

< Back to contents

Foreword

Hon Simon Bridges
– Minister for Communications

Connectivity is critical to New Zealand's future. Spectrum and radio frequencies play a fundamental role in helping New Zealanders connect with one another and the world. New wireless technologies, ranging from advanced mobile broadband technologies to intelligent ecosystems and wearable technologies are rapidly becoming part of our daily lives. This digital infrastructure is helping our best and brightest to export new ideas, services and products.

The Five Year Outlook provides a framework to accomplish the Government's spectrum infrastructure goals and overcome issues as they emerge. It shows how New Zealand can develop its spectrum management capability and respond to the changes in global technology.

New Zealand's radio spectrum is proactively managed to enable the best national outcomes. This is exemplified by successful national mobile broadband initiatives, for example, making the 700 MHz band available to deploy 4G in 2013. Similarly, we are presently updating our online registrar to provide New Zealanders with even better licensing services and to remain at the leading-edge in the way we facilitate spectrum use.

New Zealand is a world leader in new approaches to spectrum management.

Last year, New Zealand was instrumental in the achievement of important international spectrum decisions during the WRC-15 negotiations. We are now applying the international regulatory changes that we helped create, and are solidifying our reputation as a fast follower of international change.

As a result, New Zealanders will continue to be well positioned to benefit from the mobile revolution and emerging technologies, such as 5G. We are also showing the world that we punch above our weight as a leading, responsive player in global spectrum management.

The Five Year Outlook provides an opportunity for Radio Spectrum Management to share a vision about the future of spectrum management in New Zealand. I am confident that the Outlook will enable Radio Spectrum Management to be responsive to change, and contribute to the economic prosperity of all New Zealanders.

Hon Simon Bridges
Minister for Communications

1. Executive Summary

Radio spectrum is a vital infrastructure resource that enables New Zealand's digital connectivity of its people and businesses. It underlies and supports a vast array of economic activities, contributing to New Zealand's economic growth, innovation and global competitiveness.

In managing the spectrum resource – that is allocating spectrum bands for diverse purposes and minimising radio interference – social, economic and technical dimensions are at play. The fast evolutionary pace of wireless technologies requires the Ministry of Business, Innovation and Employment (MBIE) to undertake a medium-term sector scanning to: a) assess advancements in wireless communications, b) determine probable new demands and, c) identify likely impacts on New Zealand's spectrum allocations and supporting regulation. This is one major objective in this outlook document.

Another objective of this Spectrum Outlook 2017-2021 is to provide an overview of relevant areas of development in spectrum management frameworks. Some of these areas remain as theoretical frameworks being proposed internationally (e.g. licensed-shared access); nevertheless, we explore these emerging frameworks critically in this document.

This outlook document also reviews sector developments (e.g. mobile, broadcasting, and maritime) taking into account advances in wireless technologies for each sector (e.g. conversion to digital). Moreover, the document highlights major regulatory decisions affecting these sectors, arising from the review of international spectrum allocations at the World Radiocommunication Conference 2015 (WRC-15)

In the last section of this document, we discuss some of our major national spectrum management activities during the last Outlook period (2012-2016), and describe the milestones for the 2017-2021 Radio Spectrum Management (RSM) work programme.

< Back to contents

How we contribute

OUR WORK CONTRIBUTES TO MBIE'S OBJECTIVE TO 'GROW NEW ZEALAND FOR ALL'

RADIO SPECTRUM MANAGEMENT

Efficient and effective management of radio spectrum, including allocating rights for the use of the spectrum and enforcing compliance.

Providing policy advice to the government on spectrum issues and administering the allocation of any spectrum the government decides to make available as tradable property rights.

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

More reliable infrastructure and responsible development of natural resources.

Better functioning markets that are more trusted and more competitive.

New Zealand Government

Building the foundations for a stronger economy in which businesses have more confidence to invest and expand and New Zealanders have more opportunity to succeed.

2. Introduction

The objective of this document is to provide an overview of the areas of growth and development in spectrum management, review emerging wireless technologies impacting on the use of the radio spectrum and outline the RSM work programme for 2017-2021.

The document also aims to contextualise the impacts on the use of the radio spectrum, linking the international developments with the relevant national areas of spectrum management activities. Similarly, the document discusses RSM's regular national management functions; it's international engagement and recent policy and planning activities.

The discussion is centred on 5 major areas:

Spectrum trends	Emerging spectrum management approaches and issues
Developing technologies	Evolving wireless services, standards and applications
Sector developments	Demands and issues at sectorial level
Spectrum management activities	Work carried out through our regular national spectrum management functions
RSM work programme 2017-2021	Projects ahead in response to national demands and international developments

The rapid pace of technological change requires continuous monitoring of emerging spectrum issues and the economic, technical and social implications they hold. While this spectrum outlook aims at providing direction in addressing emerging radiocommunication issues, a degree of flexibility is necessary throughout RSM's work program – to benefit from the evolving ICT environment and further advance New Zealand's interests.

Similarly, the growth experienced by major wireless infrastructure areas will undoubtedly result in the development and further evolution of ancillary wireless systems and applications. This outlook document explores these potential areas of development and we welcome feedback and comments from interested parties.

New Zealand Spectrum Management Framework

3. New Zealand Spectrum Management Framework

The electromagnetic spectrum is a highly-valued component of our national communications infrastructure, consisting of the set of radio frequencies that make wireless communications possible. Accessing radio frequencies is useful for government and private users, given the social and commercial needs which are met through radiocommunications (e.g. TV and radio broadcasting, national defence, emergency services and 4G mobile broadband)

Radio spectrum in New Zealand 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 New Zealand is signatory – namely the International Radio Regulations and the International Telecommunication Union (ITU) Convention.

The radio spectrum is administered though the Radiocommunication Regulations 2001 (the Regulations) and national standards. The Act and Regulations establish the spectrum licensing regimes, compliance and enforcement. The Chief Executive of MBIE is responsible for administering the above mentioned radiocommunications legislation.

There is also a set of related legislation relevant to radiocommunications, such as 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.

The regulation of the radio spectrum is oriented at reaching the following objectives:

Achieving the Government's social, cultural and economic outcomes
Maximising the radio spectrum value as input to social and economic development
Meeting the growing demand for wireless services
Promoting healthy competition
Ensuring an environment free of harmful interference for the sustainable development of wireless services and applications

In managing the spectrum, New Zealand has implemented three distinct regimes for assigning the rights to transmit and receive radiocommunications:

a) Management Rights (commercially held and Crown-owned)

b) Radio licensing

c) General user radio licensing

Management rights are used to regard radio frequencies as property rights – tradable and transferable. Spectrum under high commercial demand is generally assigned competitively as Management Rights, for a limited period of time and under a technology flexible approach. Typically, spectrum assigned under Management Rights includes broadcasting (Crown-held, for commercial and non-commercial users) and mobile cellular spectrum bands.

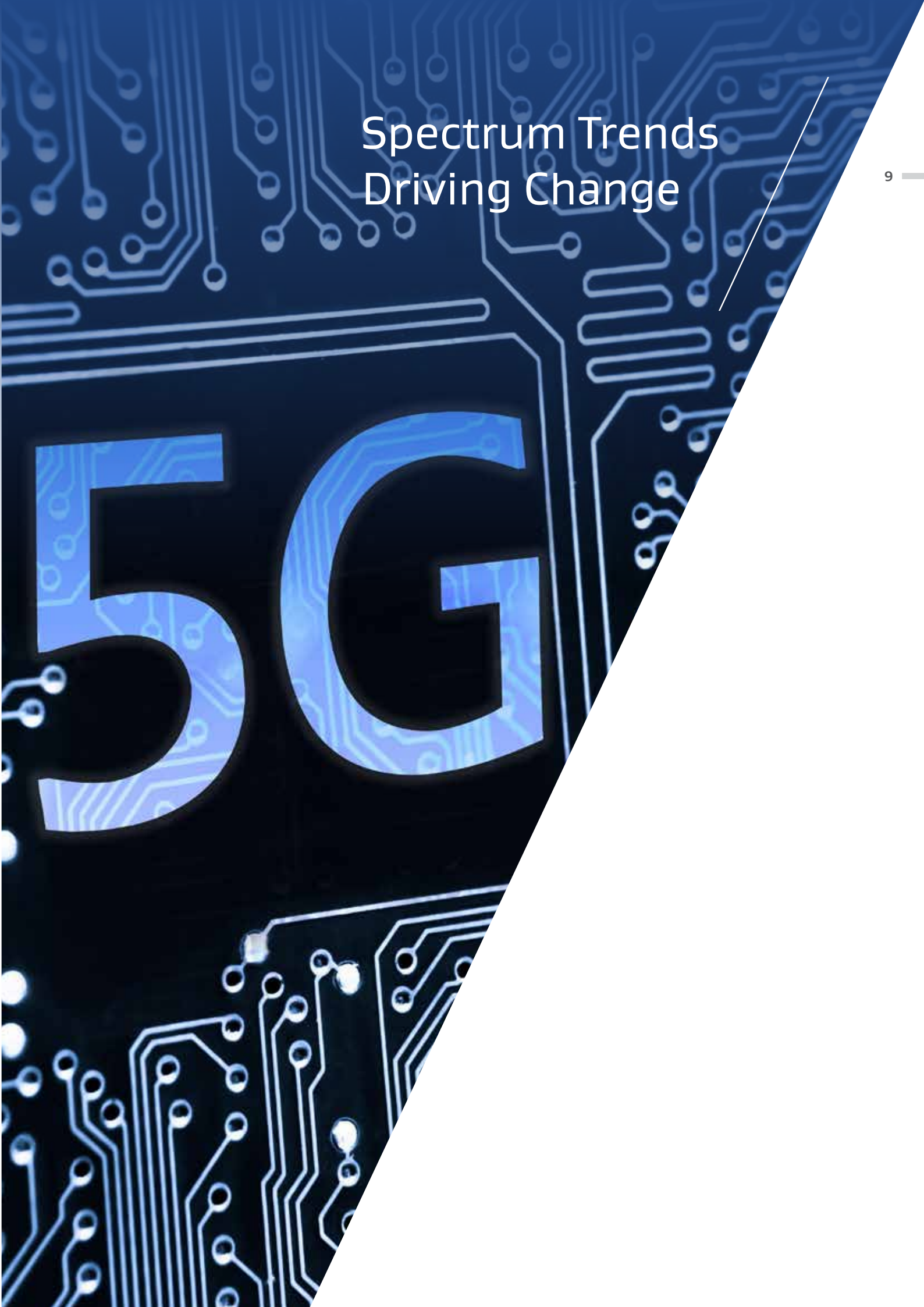
< Back to contents

Radio licensing is a form of administrative assignment, more applicable to commercial radio services where supply is ample enough to meet demand, and to licence services of public interest requiring a high degree of protection (i.e. safety of life and emergency communications)

The General User Licensing (GUL) regime covers lower-power/ ubiquitous radiocommunication applications for mass consumer uses, where individual licensing would be impractical (i.e. short range devices and Wi-Fi). From the GUL model there is also a hybrid licensing approach called “managed parks”, where a limited number of users share a Crown-held spectrum band under rules of operation on a collectively-coordinated approach.

The objective of managing the radio spectrum through these national regimes and under international accords is to enable the productive and reliable use of radiocommunications and avoid harmful interference between radio services and applications. This latter factor is crucial in ensuring the sustainable development of wireless infrastructure, given the rapid growth and diversity of the wireless communications ecosystem and the increasing user demand for mobile connectivity and applications.

Spectrum Trends Driving Change



< Back to contents

4. Spectrum Trends Driving Change

The most noticeable trend in the last decade has been the significant increase in the uptake of wireless broadband, with its dependent mobile applications and services, together with the accelerated increase in mobile data use (see figures 1 and 2 below). The challenge, in spectrum terms, is finding ways to make spectrum available in key bands (and ensure its efficient use), to accommodate new wireless applications while maximising growth and investment in these services.

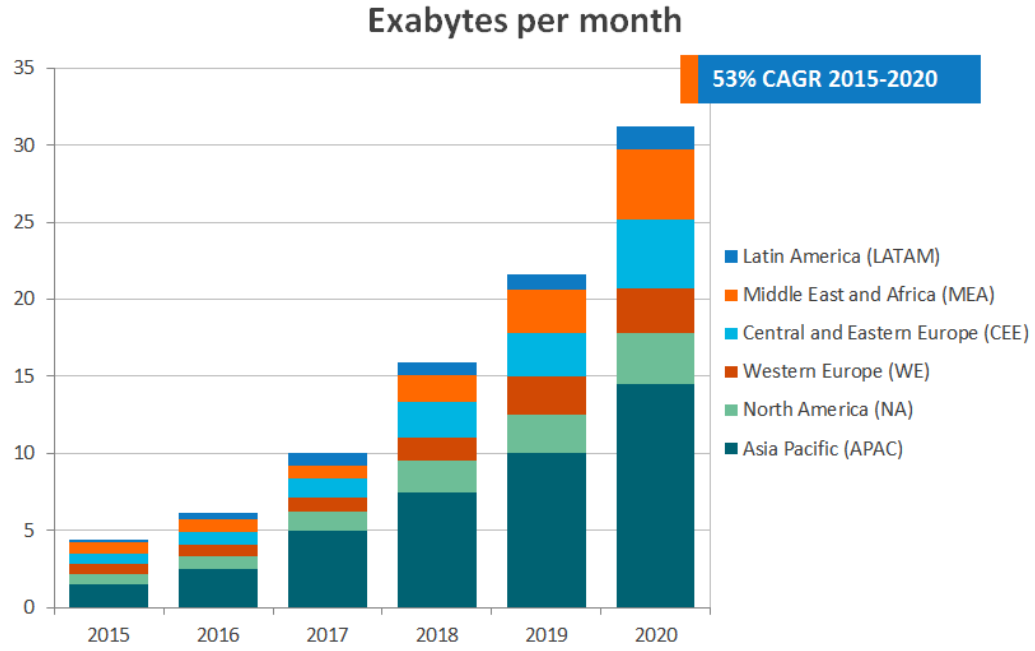


Figure 1. Mobile data traffic forecast worldwide (Cisco VNI 2016)

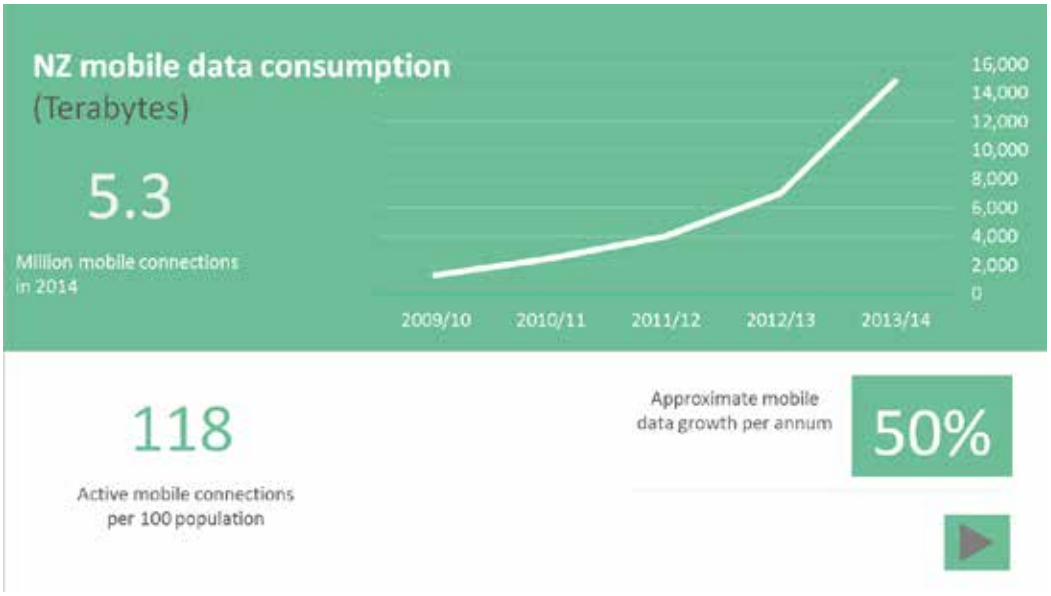


Figure 2. NZ mobile data consumption 2009-2014 (Commerce Commission, 2015)

The high demand for spectrum access in key frequency bands makes interference management vital for ensuring the long-term sustainability of wireless infrastructure. Emerging solutions aiming at balancing spectrum access and manage harmful interference include: a) more efficient and smarter wireless technologies, b) ongoing planning of international allocations and, c) additional flexibility in spectrum authorisation mechanisms in some bands under specific conditions (figure 3).

Figure 3. Key approaches looking for maximising spectrum use and managing interference

Various technical approaches are being implemented to support the growth in spectrum use in congested markets. For instance, more advanced spectrum access techniques such as LTE carrier aggregation, mobile to Wi-Fi offloading and LTE in unlicensed spectrum (LTE-U) are emerging solutions for alleviating capacity constraints and improving the user experience in the mobile broadband environment.

From a spectrum management perspective, the international allocation of spectrum[1], through the work of the Member States of the ITU, is also responding to the growing need for more mobile broadband spectrum. The *World Radiocommunication Conference 2015* (WRC-15) agreed to work towards making available additional spectrum for mobile broadband, including: more spectrum for Wi-Fi in the 5GHz band, further harmonisation of mobile allocations in UHF digital dividend bands, and earmarking spectrum bands for 5G.

These international spectrum allocations expand on the already undertaken international repurposing of the UHF analogue television bands, where countries have been implementing the more efficient digital terrestrial television (digital switch-over), which opened the way to mobile broadband deployment in the 700 MHz[2] and 800 MHz bands.

Meanwhile, some countries have begun reviewing their national frequency authorisation regimes to assess new regulatory mechanisms for maximising spectrum use. The work in this area has been focusing on mechanisms for spectrum sharing between incumbents and new users in some spectrum bands, through more flexible and multi-layered licensing. Some of the frequency authorisation mechanisms being considered are *licensed-shared access, authorised-shared access and dynamic spectrum access*.

The following sections discuss these emerging strategies in spectrum management and the technology developments being devised by manufacturers and operators for maximising spectrum use.

1 International spectrum allocations define a standard frequency range for use by different types of wireless services, in order to ensure an orderly and compatible spectrum access, free of harmful interference.

2 New Zealand has implemented 4G in 700 MHz. Europe implemented 4G in 800 MHz and is now commencing implementation in 700 MHz.

4.1 International spectrum allocations

The use of the radio frequency spectrum is regulated at an international level amongst Member States of the ITU, for the purpose of ensuring its orderly allocation – preventing cross-border interference and striving for globally-standardised equipment use. There are several benefits from this supra-national approach to allocating spectrum:

- International experts work jointly to achieve regionally and globally compatible allocations free of harmful interference, considering the wide variety of radiocommunication services and applications (including safety of life communications, scientific and commercial purposes)
- Standardised international allocations facilitate economies of scale, enabling the mass production of lower-cost communications technology for the benefit of consumers and smaller economies.
- Radiocommunication services and applications become internationally interoperable.
- International decisions on spectrum allocation support long-term certainty for the large investments required for developing telecommunication networks.

Accommodating the growing demand for mobile broadband spectrum has been a clear objective in recent years at the international allocation level.

The Member States of the ITU have achieved agreements in the last two decades on international allocations to support the development of mobile broadband. The last three WRCs (WRC-07, 12 & 15), have focused on addressing the growing mobile broadband access requirements through the harmonised allocation of spectrum for International Mobile Telecommunications[3] (IMT).

IMT spectrum allocations have formed the basis for the development of mobile data networks including 3G (IMT-2000), 4G (IMT-Advanced) and the emerging 5G (IMT-2020). These standard allocations, agreed by the WRCs, have made it possible to accommodate national bandwidth requirements for operators to meet consumer demands – noting that mobile data demands are expected to double by 2020 (as shown in figure 1).

Figure 4 below provides an overview of the additional spectrum made available for mobile broadband (IMT) by WRCs.

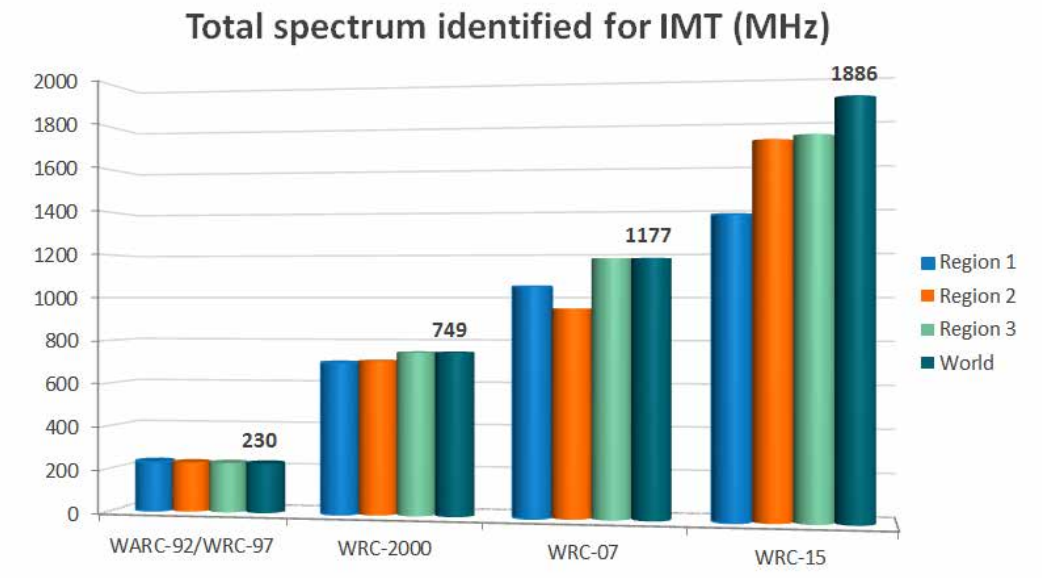


Figure 4. Spectrum allocated by WRCs to mobile broadband (IMT) in response to mobile data demands. New Zealand is part of Region 3 *(source: ITU, Radiocommunication Bureau). The column labelled "world" represents the sum of bandwidths across all regions (both harmonised and non-harmonised spectrum)*

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

Specifically, last November WRC-15 took several steps to ensure spectrum supply continues to meet demand:

- WRC decided to make portions of the L-Band (1427 – 1518 MHz) and part of the C-Band (3.4 – 3.6 GHz) available for IMT mobile broadband on a global basis.
- The digital dividend spectrum in the UHF band (specifically the 700 MHz band in 694 – 790 MHz) has been globally harmonized. This included the initial decisions made at WRC-12 and the follow-up decisions at WRC-15 for its use in Europe, Middle East and Africa.
- Additional spectrum has been identified in some countries for mobile broadband IMT in the bands 470 – 694/698 MHz, 3.3-3.4 GHz, 3.6-3.7 GHz and 4.8 – 4.99 GHz.
- Frequency bands in the range from 24.25 GHz up to 86 GHz will be subject to study for IMT-2020 (5G), providing the basis for the development of next generation 5G services.

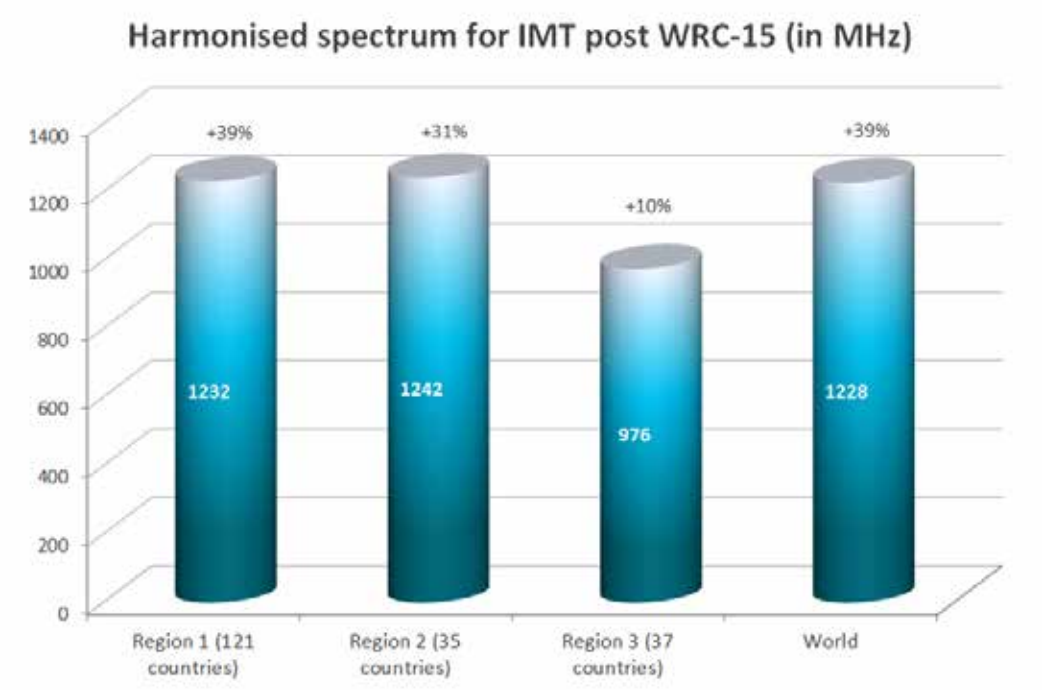


Figure 5. Additional harmonised spectrum (%) made available per region as a result of WRC-15 (Source: ITU Radiocommunication Bureau)

- New Zealand has already allocated and assigned the globally harmonised 700 MHz IMT band. It is currently used by the three national mobile operators to provide 4G mobile services. New Zealand has IMT allocations in 850, 900, 1800, 2100, 2300 and 2500 MHz, which deliver mobile broadband and fixed wireless access.
- In ensuring the availability of adequate spectrum to accommodate the growth in the uptake of mobile broadband services and applications, WRCs have progressively delivered the additional bandwidth required by networks to continue expanding mobile broadband services. RSM has been an active participant in these developments.

WORK PLAN ACTION POINT

RSM will work in the replanning of the additional IMT allocations in the C-band (3.4 – 3.6 GHz). RSM will engage in the international regulatory developments in the L-band (1427-1518 MHz) and the UHF 600 MHz bands in order to assess future options for the New Zealand market.

4.2 Emerging authorisation regimes

The internationally-agreed spectrum allocations, consolidated in the International Radio Regulations (IRRs), form the basis for the orderly national assignment of radio frequencies and interference management. In assigning frequencies to users, regulators have adopted three forms of authorisation:

- administrative licensing,
- flexible rights and,
- licence-exempt (spectrum commons)

One key aspect of authorising spectrum use through exclusive forms of authorisation (administrative licensing and flexible rights) is the legal recognition of authorised radiocommunication services and the security of tenure afforded to secure investment in wireless networks. At the other end of the scale, licence-exempt is a practical solution for low-power mass-consumer applications confined to local areas without strict quality requirements.

In some regions, mixed approaches based on the characteristics of both regimes (licensed and licensed-exempt) are being trialled. These trials aim at enabling more intensive spectrum use by allowing shared access to spectrum between the incumbent and third parties. These concepts are still being developed and remain limited to small portions of spectrum.

These emerging spectrum sharing concepts are discussed in the following sections.

Licensed-shared access

Licensed-shared access (LSA) is an emerging approach seeking to enable access to underutilised incumbent spectrum. The concept authorises licensed access to third party users in some areas where incumbent spectrum rights are not being utilised. The objective is to make this spectrum available for mobile broadband, generally in congested markets. This concept is being explored in Europe, and has been formally defined by Europe's *Radio Spectrum Policy Group (RSPG)* as follows:

"A regulatory approach aiming to facilitate the introduction of radiocommunication systems operated by a limited number of licensees under an individual licensing regime in a frequency band already assigned or expected to be assigned to one or more incumbent users. Under the Licensed Shared Access (LSA) approach, the additional users are authorised to use the spectrum (or part of the spectrum) in accordance with sharing rules included in their rights of use of spectrum, thereby allowing all the authorised users, including incumbents, to provide a certain Quality of Service (QoS)"

In order to ensure an appropriate level of coordination between the sharing parties and the incumbent, a control unit system (LSA database controller) would automatically grant access to licensed but idle spectrum. Access would be granted to the requesting sharing licensees according to spectrum availability and interference limits.

In Europe, the LSA concept is being explored in the 2.3 GHz band, where the incumbents include defence users and some broadcasting applications. The concept has not yet been implemented widely, given technical and regulatory complexities affecting EU countries differently. Moreover, while the 2.3 GHz band has been globally identified for IMT, the level of non-IMT incumbency varies widely across Europe, which adds further challenges for the implementation of LSA.

Authorised-shared access

Authorised-shared access (ASA) is also an authorisation model to provide access to third parties to spectrum held by incumbents, in locations where the incumbent does not fully utilise its spectrum rights. Similar to LSA, the concept aims at sharing spectrum while guaranteeing QoS to the incumbent and the sharing parties. The ASA model adds a third layer of sharing, which allows spectrum access to licence-exempt devices.

The ASA tiered-sharing approach places the incumbent in the highest tier, enjoying full interference protection and full spectrum access. The middle tier is dedicated to licensed-sharing parties, which also enjoy interference protection but can only access spectrum in areas where the incumbent is not fully utilising its spectrum rights. The bottom layer in the sharing framework, for licence-exempt users, can only use the spectrum opportunistically, on non-interference/ non-protected basis.

Similar to LSA, ASA would also require a control unit system (database controller) to coordinate spectrum use and prevent interference. The target uses for the ASA model are mobile broadband implementations, such as small cells, supplementary downlink and spectrum aggregation.

The ASA model is being explored in the US, specifically in the 3.5 GHz band, where the incumbent operates radar systems. Radar systems are scattered throughout the country and their protection would be ensured through the use of exclusion zones, which would restrict sharing parties from using the spectrum at those locations.

Dynamic spectrum access

Dynamic spectrum access (DSA) is a concept that promotes the use of radiofrequencies in an opportunistic fashion (licence-exempt). The concept is being developed as an application that would rely on the developing capabilities of cognitive radio systems and software defined radios – that would be capable of sensing and analysing the spectrum environment they are in before transmitting.

The ability to sense the radio environment would enable DSA devices to search for "gaps in spectrum usage" and deliver wireless services to users using these frequency gaps. If the frequency gaps become utilised by the incumbent, then the DSA device is required to immediately release those frequencies and find another frequency gap to operate.

Naturally, there are technical challenges in the implementation of the concept, especially concerning the timely release of frequencies and the ability to accurately locate frequency gaps, in order to avoid harmful interference. The one application that has partially integrated some of this concept is Television White Space (TVWS). TVWS is being trialled in some regions to deliver wireless internet access, using the UHF television frequency bands.

TVWS devices are not fully cognitive. They employ local frequency-licensing information to program devices with a channel lookup database. The database dictates the available frequency gaps amongst the licensed channels in the UHF TV band (similar concept to the LSA/ASA sharing controller). In addition, TVWS devices use GPS to determine their location in relation to occupied TV channels in their surroundings to avoid interfering with TV reception.

The United States, Singapore and the United Kingdom are the three countries where TVWS devices have been authorised under a low-power/ licence-exempt regime subject to: a) compliance with equipment standards, b) an approved database provider and c) specific operating conditions. New Zealand has provided space for trialling TVWS under licensing rules[4].

While TVWS equipment standards have emerged, slightly diverging approaches in the USA and the UK have impacted on the international harmonisation of hardware, and economies of scale have not been reached. The concept is also being trialled in developing economies, where digital TV switchover has not been completed and a final digital TV channel plan is still pending. This has added further economies of scale uncertainties in terms of the amount of "white space" available after digital TV switchover. Moreover, the future of the UHF TV band in the USA (at the time of writing this document) is subject to the outcomes of the incentive auctions designed for redeploying portions of the UHF spectrum from television to mobile broadband.

The World Radiocommunication Conference 2012 (WRC-12) determined that the international frameworks (Radio Regulations) do not need to be modified to accommodate cognitive radio systems or DSA applications. The implementation and regulatory treatment of DSA devices are to be administered on ad-hoc basis at the national level.

Other regulatory questions are also impacting on the development of the DSA concept:

1) *Competition*: risks of market monopolisation and conflicts of interest between spectrum-sharing controllers (database managers), network and application providers.
2) *Economics*: limits posed by "the tragedy of the commons", where unlimited agents pursue access to a limited resource.
3) *Flexible spectrum rights*: current legal frameworks for commercial spectrum use already provide space for commercial agreements to take place between incumbents and third-party spectrum users (sale, transfer, and lease) if there is such requirement.

4 RSM licensing rules for TVWS can be found at: http://www.rsm.govt.nz/projects-auctions/completed/television-white-space-licensing-rules

4) *Spectrum redeployment*: changes in spectrum use (e.g. moving from broadcasting to mobile) could render the DSA devices incompatible with a new incumbent.

5) *Spectrum demand*: demand for spectrum is relative to population density. While spectrum availability is still ample in New Zealand, existing wireless services will continue to develop in proportion to user demand.

In conclusion, the emerging authorisation mechanisms for spectrum sharing that incorporate a coordinated licensed approach (LSA & ASA) seem to present a lower risk of service degradation to the incumbent and a higher QoS for the sharing parties. The approaches involving opportunistic mechanisms for spectrum access, such as DSA, may pose higher interference risks (including cumulative effects) and less predictable impacts on the use of the spectrum resource.

WORK PLAN ACTION POINT

RSM will monitor the international developments on authorisation models for spectrum sharing. RSM does not consider necessary the implementation of sharing mechanisms in the medium term, taking into account New Zealand's levels of spectrum supply relative to national spectrum demand.

4.3 Increased efficiency in wireless technologies

Recent technical advances are providing new ways to make more intensive and efficient use of the available spectrum. For instance, Carrier Aggregation (CA) is being increasingly employed by mobile networks equipped with IMT-Advanced. CA technology allows for more intensive use of spectrum, since bandwidth can be aggregated and used by combining multiple spectrum lots for achieving higher mobile broadband throughputs. The different demands in the downlink and uplink directions can be managed more efficiently through asymmetric aggregation, accommodating the higher demands usually found in the downlink.

Carrier aggregation is possible via: a) inter-band carriers, b) intra-band adjacent carriers and, c) intra-band non-adjacent carriers. Other benefits, arising from inter-band aggregation, include the ability to deploy sub GHz spectrum (e.g. 700 MHz) to users requiring higher throughput rates at the edge of the cell coverage. CA is also flexible, since it does not require large or contiguous spectrum blocks. The current state of the art allows for a total of 100 MHz of aggregated spectrum.

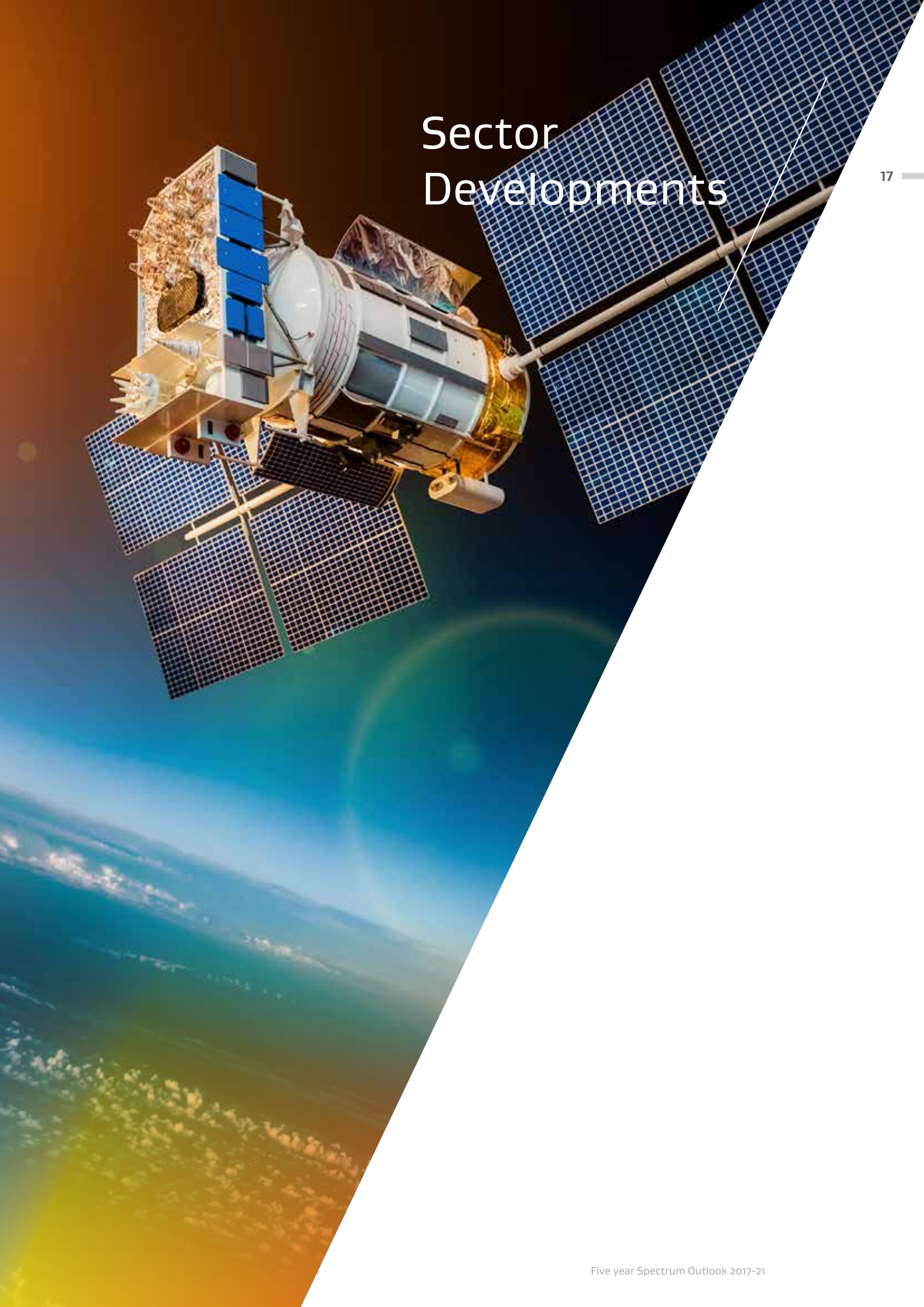
Recent developments are also enabling the use of wireless LANs (Wi-Fi) for balancing download capacity, by offloading traffic onto nearby available Wi-Fi channels. In terms of spectrum management, this approach represents a novel interaction between licensed spectrum rights and licensed-exempt spectrum under a "commons" approach. Similarly, another approach that uses license-exempt spectrum to deliver higher mobile capacity is emerging, under the set of standards for LTE[5] technology – LTE Unlicensed or LTE-U.

Carrier aggregation, LTE-U and mobile offloading are emerging techniques which can offer advantages to operators in circumstances where IMT ecosystems are constrained in capacity. For markets with ample spectrum resources such as New Zealand, regulatory planning of spectrum would certainly be carried out in response to market demands. In New Zealand, LTE-U in the 5 GHz is required to observe the current General User Licence prescriptions for wireless LANs.

WORK PLAN ACTION POINT

RSM will review the feasibility of additional spectrum for IMT carriers subject to international harmonisation outcomes, in the L, S and C bands.

5 LTE (Long Term Evolution) is the set of mobile broadband standards developed by the 3rd Generation Partnership Project (3GPP). The LTE standards provide broadband speeds beyond 3G



Sector Developments

5. Sector Developments

5.1 Mobile broadband

RSM is aware that 5G connectivity (IMT-2020) will become increasingly important as a next step in personal and machine communications. Both, spectrum and equipment standardisation, are currently being developed internationally.

Ensuring that New Zealand is ready for 5G uptake will put us in a good place to maximise the expected benefits from this new technology. Within New Zealand, as well as internationally, the efforts in the area of wireless broadband connectivity have largely been targeting the supply side of the spectrum resource, with an emphasis on expanding and standardising IMT spectrum allocations.

5G is the common term for what industry expects to have as the next generation of mobile communication networks. Currently, mobile broadband connections account for 40% of the world total broadband connections, with an expected increase to 70% by 2020. By 2020[6], approximately one third of the world population will have access to 4G services. In New Zealand, mobile data demands have increased by 50% annually since 2013[7], given the rapid growth and uptake of smartphone applications, especially media and video applications. New Zealand will continue experiencing this growth, following the worldwide trend of ever increasing demand for mobile data services as shown in figure 7. 5G would enable higher-speed mobile broadband in congested environments, real time video and tactile internet.

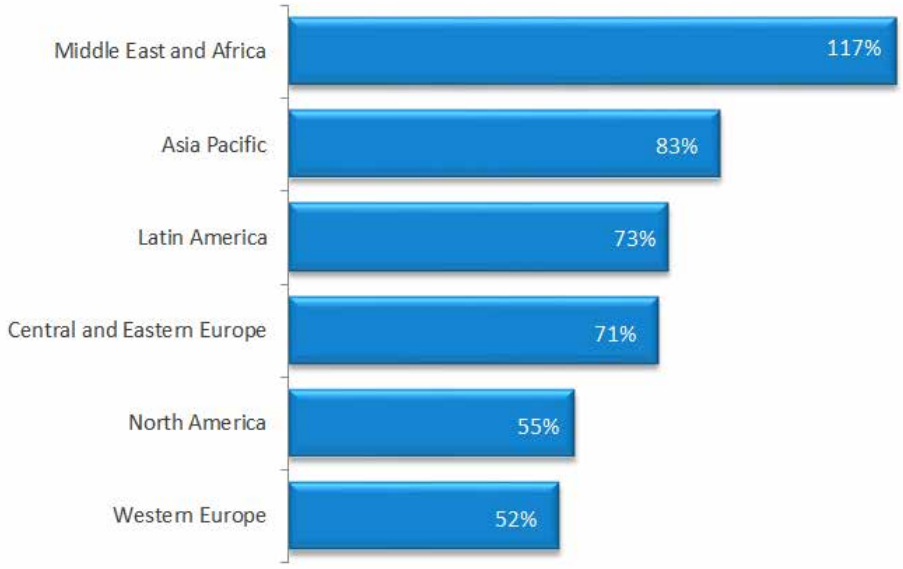


Figure 6. Mobile data traffic growth in 2015 (Source: Cisco VNI 2016)

6 According to GSMA: http://www.gsma.com/newsroom/press-release/4g-networks-to-cover-more-third-of-global-pop-this-year/

7 NZ Commerce Commission annual telecommunications monitoring report: http://www.comcom.govt.nz/regulated-industries/telecommunications/monitoring-reports-and-studies/monitoring-reports/

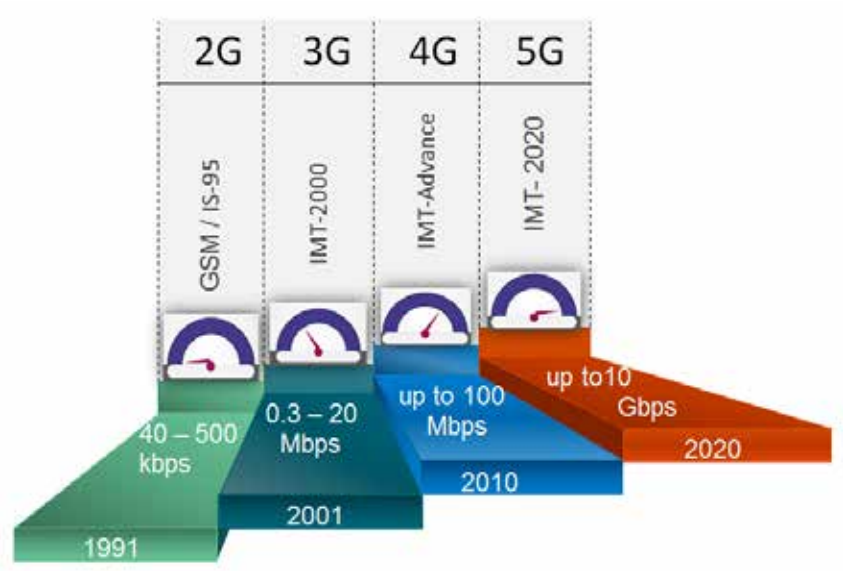


*Figure 7. Mobile data progression by year of emergence, standard and approximate practical speed (*IMT-2020 expected date). In New Zealand, the spectrum bands being used by mobile broadband services are 700/850/900 MHz and 1800/2100 MHz.*

As users continue to access bandwidth-intensive mobile applications, and uptake of mobile data services grows even more, RSM envisions there will be more pressure on mobile spectrum in the medium and long term. Mobile spectrum is a key resource for enabling the delivery of 3G/4G services and beyond. In view of the growing demand, the international community has commenced developing new technical requirements and frequency band specifications to develop IMT-2020 (5G), which would alleviate future bandwidth constraints.

RSM understands that it is important for New Zealand to engage with emerging advances in mobile broadband technologies as they become available. In order to do this, RSM has dedicated resources to participate in the international work for the development of IMT-2020 (under ITU-R working party 5D). The objective of this participation is to develop a regional approach for IMT-2020 (within Asia Pacific) to leverage economies of scale for the benefit of the small New Zealand market.

WORK PLAN ACTION POINT

RSM will participate in the ITU studies (Working Party 5D) related to IMT-2020 (5G) leading to the spectrum allocation decisions expected at WRC-19.

5.2 Broadcasting

Internationally, the broadcasting industry continues to evolve in the context of convergence and the digitalisation of media. While significant progress continues to be made in enhancing video technologies (e.g. HD and Ultra-High Definition), the role of the internet in delivering digital multimedia content is increasingly shaping consumer behaviour.

In addition, large investments in high-capacity broadband networks, the rapid uptake of smart mobile devices and the rise of content streaming markets are increasingly influencing change in media broadcasting business models. New Zealand is seeing the benefits of these developments in broadcasting. RSM continues to work on spectrum issues which facilitate development in both television and audio broadcasting.

Television broadcasting

A major area of progress in television broadcasting has been the phase-out of analogue TV, which opened the way to the more efficient and higher quality digital terrestrial television (DTT). New Zealand switched off the last analogue TV transmissions in December of 2013, replacing it with a nationwide digital free-to-air service made up of a national DTT network, plus a Direct-to-Home (DTH) satellite television service reaching out to the most isolated areas.

New Zealand uses DVB-T technology (similar to Europe) for delivering digital TV, and the video compression technology currently available (MPEG4) delivers standard definition (SDTV) and high definition (HDTV) programmes. Most broadcasters in New Zealand employ a mix of SDTV and HDTV in their programming.

DTT provides higher video quality and a larger number of programmes can be delivered (one 8-MHz channel can deliver approximately 12 SDTV or 4 HDTV programmes depending on the selected compression bit rate) – where analogue TV could only deliver one programme in the same channel space.

The widespread implementation and uptake of digital television has been followed by further developments in television formats, building on the progress made in terms of video compression technology and more efficient spectrum use. In 2012, the ITU approved the international standard for Ultra High Definition TV (UHD TV)

While user and production equipment is available to support UHD TV, content production in this format is still limited, making SD and HDTV the most popular formats. In terms of DTT spectrum use, the higher video resolutions currently emerging (such as UHD) would require a more intensive use of the available bandwidth.

However, video compression and signal processing technologies continue to improve also, with the expectation of reaching even higher spectrum efficiencies in the future (higher modulation schemes). One example of this has been the evolution of video compression from MPEG2 to MPEG4, where MPG4 achieved a 50% improvement (the same 8 MHz channel can now accommodate double the number of HD programmes)

Moreover, the UHF spectrum allocations designated to broadcasting (traditionally used for television) have been continuously reviewed. In 2015, Europe, Middle East and Africa confirmed their new primary mobile allocation in the band 694-790 MHz to enable IMT 4G networks, as the next step to redeploy their legacy broadcasting use of the band. Furthermore, a number of countries are planning to free up the 600 MHz band for future IMT use, with national plans already underway in North America.

RSM notes that if future changes are proposed in the use of the 600 MHz band, as a result of the ongoing international review of the UHF band, there will be a requirement to consider the situation of wireless microphones currently sharing this band.

WORK PLAN ACTION POINT

RSM will monitor the developments on the ongoing international review of the UHF band, especially in relation to emerging proposals for IMT use. Should these proposals materialise, RSM will need to review the impact on the use of wireless microphones sharing the UHF band with DTT.

Audio broadcasting

In audio broadcasting, international digitalization of audio programming continues to move at a slower pace in comparison to digital television broadcasting (USA and Europe have the largest implementations of digital audio programming). While digital audio offers higher audio quality, the main factor preventing a faster transition and uptake worldwide is the less evident benefit for consumers from investment in digital audio equipment.

Audio broadcasting takes place in various bands, including MF, HF and VHF bands. The most popular band is the VHF band (88-108 MHz), where analogue FM radio is still the predominant form of audio broadcasting for listeners globally. There is also AM radio in the MF band, which has been used for many decades despite its lower audio quality in comparison to FM radio.

AM broadcasting remains in use given its ability to provide service across large coverage areas with only few transmitter stations. This has made AM radio a practical option for servicing large rural areas, and hence it's continuing use.

There is ongoing competition in the commercial FM radio segment, which is still very profitable in high population density markets. Such markets make intense use of the commercial FM radio channels, often reaching maximum band capacity. The ability to provide additional capacity may be the catalyst for accelerating digital audio uptake in highly competitive markets. Europe and the USA have implemented their own digital audio platforms (DAB and IBOC respectively), which have contributed in meeting the demand for wider diversity in content programming.

Both solutions provide for a more efficient use of the spectrum, delivering higher quality digital audio content. The US solution (IBOC system) uses the same frequency band as FM radio, transmitting digitally compressed audio signals alongside with the FM analogue carriers.

Meanwhile, Europe has preferred to adopt Digital Audio Broadcasting (DAB), which uses a frequency band different to that of FM radio (174 – 230 MHz is the most commonly used). The USA and Europe currently simulcast analogue FM radio and digital audio.

While, internationally, there is not a strong move towards analogue audio switch-off, some countries have committed to switch-off analogue FM in the near future. For example, Norway (where the number of DAB programmes has largely surpassed the number of FM programmes) announced in 2015 its plans to achieve analogue FM switch-off by 2017.

The expanding deployment of broadband networks and the growing uptake of mobile data services has enabled consumers to receive global audio content in digital form directly via mobile devices connected to the internet, an international trend now visible in New Zealand. This capability has resulted in new digital audio markets, targeting users who seek on-demand audio content, provided via mobile applications, adding another layer of competition in content delivery to listeners.

In New Zealand, commercial FM analogue broadcasting remains the most popular form of audio broadcasting, especially in the main urban areas. Similar to other markets, the use of the additional programme capacity provided by digital broadcasting systems (such as DAB) may become an attractive alternative, especially in urban areas where FM channels are currently fully utilised. Some DAB trials have been carried out in New Zealand in recent years, and RSM is currently evaluating the outcomes of the industry consultation on the future use of VHF band III (174 – 230 MHz).

WORK PLAN ACTION POINT

RSM will assess, inform and implement the outcomes of the consultation on the future use of the VHF band III (174-230 MHz) in relation to the market demands for digital audio broadcasting.

5.3 Public safety communications

Currently, emergency services rely largely on land mobile radio (LMR) to support mission critical mobile communications. The uptake of digital LMR has been the predominant trend amongst public safety agencies worldwide (implementing either the TETRA or the APCO P25 standards), for the purpose of deploying secure/ encrypted voice and narrowband data communications.

These systems are likely to continue delivering the services they provide today, in addition to mobile broadband solutions (such as 4G LTE) integrated as complementary data services. New Zealand is considering the use of portions of the 800 MHz band for PPDR[8] mobile broadband, depending on the outcomes of government decisions.

WORK PLAN ACTION POINT

RSM will implement any Cabinet decisions on a Whole of Government Radio Network for PPDR.

5.4 Connected ecosystem: Internet of Things, Machine-to-Machine Communications and Intelligent Transportation Systems

The widespread international uptake of broadband connectivity 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 (e.g. tracking bands) to automated smart homes, assisted transportation systems and the concept of smart cities.

Applications of this kind make use of multiple existing wireless technologies and frequency bands, and are largely suited for operating under a low-power/ licence-exempt regime (e.g. short range devices). Emerging uses include wireless sensors, telemetry and control, and Radio Frequency Identification (RFIDs), interacting with internet access via wireless LANs and mobile broadband networks.

Internet of Things (IoT) is an emerging concept for connecting objects and appliances to the internet. The definition of IoT is still vague, 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. For example the remote wireless reading of household power consumption ("smart meters") and remotely-controlled utilities (e.g. operation of water pumping stations and electricity grids) form part of the M2M concept.

IoT and M2M wireless applications operate currently across licence-exempt spectrum as well as licenced mobile spectrum (LTE and GSM), allowing commercial mobile carriers to offer dedicated bandwidth and coverage to M2M and IoT customers. IoT has also been implemented for automotive applications. Mobile operators in United States reported in 2015 a significant increase in the uptake of IoT for vehicles, surpassing one million new mobile broadband connections. In New Zealand, a few implementations of IoT have emerged, especially for the remote reading of utilities (electricity and water).

8 PPDR (Public Protection and Disaster Relief) is the term commonly used to refer to public safety communication networks.

Spectrum for the operation of short-range/ high-resolution automotive radar has been allocated in the 79 GHz frequency band. This globally harmonized frequency band for automotive radars is used for vehicular safety technology to prevent collisions. This spectrum complements other Intelligent Transportation Systems (ITS) applications operating in the 5 GHz band. An agenda item has been agreed for WRC-19 on allocation studies for ITS in the 5.875 – 5.925 GHz band (competing with Wi-Fi for spectrum access in this band).

WORK PLAN ACTION POINT

RSM will engage in the international studies on narrowband and broadband machine communications for IoT under the agenda issue set for WRC-19.

RSM has temporarily reserved the band 5.875 – 5.925 GHz, subject to the international studies and WRC-19 decisions.

5.5 Science and space

New Zealand is currently in the process of implementing a regulatory framework to support the development of a national space industry; including the launching of small satellites (Outer Space and High Altitude Activities Bill[9]). MBIE is leading this work[10] and RSM has contributed in a number of issues concerning policy and regulation of space radiocommunications.

The emergence of a national space economy around the launching of small satellites is likely to increase the volume of ITU satellite frequency registration and technical coordination. Subject to demand, RSM expects to boost its capabilities in processing technical coordination and registration in the space service bands.

New global spectrum allocations have recently been decided for use by space radiocommunications. Spectrum in the 7 - 8 GHz frequency range has been allocated for *Earth-Exploration Satellite Services* (EESS) for the uplink of data required for space operations.

Spectrum allocations have also been agreed in the 9 - 10 GHz frequency range for sensing technologies for use in earth exploration. These space radiocommunication applications support scientific and earth information activities including enhanced weather monitoring and land information, used in humanitarian aid and terrain surveying.

Additional global allocations for the land-based segment of space communications have also been agreed, to include allocations for the global deployment of Earth Stations in Motion (ESIM) in the 19.7 - 20.2 and 29.5 - 30.0 GHz bands in the *Fixed-Satellite Service* (FSS)

These new ESIM allocations will support the deployment of satellite systems capable of delivering tailored broadband access solutions for the transportation sector. These mobile earth stations will be located on-board trains, aircraft and vessels, enabling high data rate internet access on the go via spot-beam satellites.

WORK PLAN ACTION POINT

RSM will implement modifications to the General User Radio Licences for the satellite, maritime and aeronautical services to accommodate the implementation of ESIM. RSM notes that it will monitor the international studies for the expansion of ESIM to the bands 17.7 – 19.7 GHz and 27.5 – 29.5 GHz.

9 Outer Space and High Altitude Activities Bill: http://www.mbie.govt.nz/info-services/sectors-industries/space/pdf-library/Outer%20Space%20and%20High%20Altitude%20Activities%20Bill.pdf

10 MBIE, lead agency for space policy: http://www.mbie.govt.nz/info-services/sectors-industries/space/nz-space-agency#3

5.6 Land mobile

Land mobile radio (LMR) is used in New Zealand for commercial and private applications. The use of LMR in New Zealand is evolving in step with international practice by transitioning from the wider-channel allocations used by legacy analogue land mobile radios to modern and more efficient narrow-band LMR (including digital narrow-band LMR)

RSM has been phasing-out the 25 kHz LMR channels to promote the more efficient use of land mobile bands in order to reduce congestion, enhance interoperability and harmonise New Zealand with digital technologies available across international markets.

The phase-out has already been applied to all 25 kHz LMR licences operating in frequencies below 470 MHz (E, C and D bands[11]), where congestion was significant, except for licences used for SCADA and data services in C and D bands. Frequencies above 470 MHz (F band and TS band[12]) are expected to be phased-out by 2019.

RSM is currently reviewing the outcomes of the consultation on VHF band III (174-230 MHz) to assess the potential use of this band for land mobile. RSM is aware that in some countries, LMR service providers have shown interest in spectrum allocations used for LTE mobile broadband, as a future alternative for offering high-speed mobile data to LMR customers.

WORK PLAN ACTION POINT

RSM will assess and report the outcomes of the industry consultation on future uses for the band 174- 230 MHz (VHF band III) in relation to the potential use of land mobile in this band.

5.7 Fixed services

Fixed service bands provide point-to-point and point-to-multipoint links in the frequency ranges 162.2 MHz to 86 GHz. They are widely used for backhaul, studio-to-transmitter links (used in broadcasting), and other line-of-sight wireless data transmissions.

RSM undertook a review of the fixed services bands in 2012 and carried out a consultation in 2015, resulting in refinements to some fixed service channel plans. The technical guidelines outlined in the RSM's Public Information Brochures (PIBs) reflect these changes. The consultation outcomes have been fully implemented and all related documentation updated.

International developments in the fixed service across L band (1427 -1518 MHz) are pointing at some possible changes in this international allocation to accommodate mobile broadband. Should these international decisions materialise, then RSM will need to assess options for implementing these changes, including possible alternative allocations for the fixed service in higher frequency bands.

WORK PLAN ACTION POINT

RSM will review the outcomes of international decisions in the L band (1427 -1518 MHz) for IMT, with a view to develop options for incumbent fixed links services should this allocation change.

11 E Band: 150-156 MHz, C Band: 449-458 MHz, D Band: 458-470 MHz

12 F Band: 470-494 MHz, TS Band: 813-819/858-864 MHz

5.8 Aeronautical & maritime

The ITU and the International Civil Aviation Organization (ICAO) paved the way for worldwide standards for unmanned aircraft systems (UAS), and identified the regulatory conditions to be applied to such systems. WRC-15 agreed to allocate spectrum for wireless avionics intra-communications (WAIC), which would facilitate the use of wireless connectivity to minimise the use of cumbersome wiring in aircrafts.

Agreement was reached on the allocation of radio-frequency spectrum for global flight tracking in civil aviation for improved safety. The frequency band 1087.7 - 1092.3 MHz was allocated to the aeronautical mobile-satellite service (Earth-to-space) for reception by satellites of Automatic Dependent Surveillance-Broadcast (ADS-B) signals, transmitted by aircrafts. This will enable reporting the geographic location of aircraft fitted with ADS-B equipment on a global basis.

New Zealand played a key role in influencing the outcomes of this decision by backing the New Zealand position at WRC-15 based on the prospects of the New Southern Skies initiative, led by the Civil Aviation Authority, for improved flight safety.

In another aeronautical area, RSM is currently assessing the technical and operational viability of allowing wireless microphones in certain unused portions of the aeronautical bands allocated for DME aviation applications (Distance Measurement Equipment). This initiative has been considered by other countries (e.g. United Kingdom[13]) as an option to alleviate the demands of wireless microphone users who became spectrum-constrained after the transition from analogue to digital television.

New Zealand has been required to change some maritime VHF repeater channels to make space for newly allocated Automatic Identification System (AIS) for ship tracking and data services. These applications are intended to improve safety of navigation. RSM is currently undertaking the final implementation stages of these changes and is engaging with Coastguard and Maritime New Zealand to communicate and materialise this change.

WORK PLAN ACTION POINT

RSM will implement modifications to the aeronautical General User Radio Licence to accommodate the WRC-15 outcomes on WAIC systems as well as the GURL for maritime services, to implement the decisions on allocations for AIS in the maritime service bands.

13 Ofcom consultation on the use of PMSE in aeronautical radionavigation bands

Summary of action points from sector developments

6. Summary of action points from sector developments

RSM will work in the replanning of the additional IMT allocations in the C-band (3.4 – 3.6 GHz). RSM will engage in the international regulatory developments in the L-band (1427-1518 MHz) and the UHF 600 MHz bands in order to assess future options for the New Zealand market.

RSM will monitor the international developments on authorisation models for spectrum sharing. RSM does not consider necessary the implementation of sharing mechanisms in the medium term, taking into account New Zealand's levels of spectrum supply relative to national spectrum demand.

RSM will review the feasibility of additional spectrum for IMT carriers subject to international harmonisation outcomes, in the L, S and C bands.

RSM will participate in the ITU studies (Working Party 5D) related to IMT-2020 (5G) leading to the spectrum allocation decisions expected at WRC-19.

RSM will monitor the developments on the ongoing international review of the UHF band, especially in relation to emerging proposals for IMT use. Should these proposals materialise, RSM will need to review the impact on the use of wireless microphones sharing the UHF band with DTT.

RSM will assess, inform and implement the outcomes of the consultation on the future use of the VHF band III (174-230 MHz) in relation to the market demands for digital audio broadcasting.

RSM will implement any Cabinet decisions on a Whole of Government Radio Network for PPDR.

RSM will engage in the international studies on narrowband and broadband machine communications for IoT under the agenda issue set for WRC-19. RSM has temporarily reserved the band 5.875 – 5.925 GHz, subject to the international studies and WRC-19 decisions.

RSM will implement modifications to the General User Radio Licences for the satellite, maritime and aeronautical services to accommodate the implementation of ESIM. RSM notes that it will monitor the international studies for the expansion of ESIM to the bands 17.7 – 19.7 GHz and 27.5 – 29.5 GHz.

RSM will assess and report the outcomes of the industry consultation on future uses for the band 174- 230 MHz (VHF band III) in relation to the potential use of land mobile in this band.

RSM will review the outcomes of international decisions in the L band (1427 -1518 MHz) for IMT, with a view to develop options for incumbent fixed links services should this allocation change.

RSM will implement modifications to the aeronautical General User Radio Licence to accommodate the WRC-15 outcomes on WAIC systems as well as the GURL for maritime services, to implement the decisions on allocations for AIS in the maritime service bands.

RSM Activities

7 Radio Spectrum Management activities

Radio Spectrum Management is responsible for efficiently and effectively managing the radio spectrum in New Zealand. Part of this responsibility is allocating rights for the use of the spectrum and enforcing compliance.

Another aspect is providing policy advice to the government on spectrum issues and administering the allocation of any spectrum the government decides to make available as tradeable property rights.

In achieving these objectives, RSM is organised in three teams; licensing, compliance, and policy and planning. The day to day activities of the teams include creating licences, carrying out compliance checks on licences, resolving interference problems, and generating policy which supports Government decisions and objectives on spectrum use.

7.1 Policy and Planning: Recent Projects

RSM's policy and planning has been implementing a number of radiocommunication projects, including spectrum rights renewals, fees review and technical consultations on the future uses of spectrum bands. The following sections provide an overview of these recent projects[14].

Licence fees review

RSM consulted on a number of administrative changes, with the most notable proposal being a shift to a single licence fee for all classes (set below cost-recovery levels). We also proposed to set fees at a reduced level to lower the total amount collected from licensing fees, over a six year period (with a subsequent return to cost-recovery levels at the end of this period). Submissions on the proposals have been analysed following the release of the consultation document, and final proposals are expected to be released during the first half of 2017.

Radiocommunications Act Review

The last review of our Act was conducted almost ten years ago. The current review of the Radiocommunications Act 1989 provides an opportunity to fine-tune and revise legal prescriptions that may have become obsolete (e.g. provisions related to legacy television broadcasting) or expanding clauses to allow more flexibility of the regime.

Following the release of a discussion document, analysis of submissions was completed. A series of workshops with industry were held to discuss selected topics, including interference management processes. Some of the areas identified as requiring expansion included: options for more support of Approved Engineers and Certifiers, exploring alternative options for assessing competition aspects in sales of Management Rights and refinements in the technical definitions coined in the Act. RSM is now finalizing its recommendations and outcomes analysis.

VHF band III consultation

The future use of the VHF band III (174 – 230 MHz) is being reviewed, as this band has become vacant after transitioning from analogue to digital television. Worldwide, this band is not fully harmonised, hence standardised use of the band and potential economies of scale are somewhat unclear.

RSM released a discussion document to consult with industry on emerging and future alternatives for its use. Following the consultation, RSM completed an analysis of submissions. RSM is now finalizing recommendations on the future use of the band and will be reporting on outcomes to industry after final decisions have been made.

14 RSM Policy and Planning projects are also published on our website: http://www.rsm.govt.nz/projects-auctions/current-projects

Review of the management rights in 1800 and 2100 MHz (cellular mobile)

Management Rights in the ranges 1800 and 2100 MHz are expiring on a common expiry date in 2021. These Management Rights are used by the three mobile operators to deliver 3G and 4G services to New Zealand consumers. RSM has initiated a formal consultation with the incumbents of these bands and is currently analysing the submissions and considering options for the renewal.

Management Right Renewals in the band 2300 – 2370 MHz

The expiry dates for Management Rights in 2300 - 2335 MHz and 2335 - 2370 MHz were extended to 31 December 2016. The Management Right holders have a contractual right to extend these Rights with a new subsequent term ending in November 2030, provided that implementation requirements are met.

The previous Management Right in 2370 - 2395 MHz was reserved by the Crown for Hautaki. As this Management Right expired on 31 December 2014, the frequencies in 2370- 2395 MHz have been reverted to *administrative radio licensing* since 1 January 2015.

This spectrum could be retained on short-term basis for usages such as outside broadcast (e.g. special and large sporting events) or aeronautical mobile telemetry. This band has been reserved under the Statement of Government Policy and Directions, pending allocation decisions for appropriate uses.

Renewal of rights for Local Commercial Broadcasters

Local Commercial FM licences are due to expire in July 2018 (13 licences). LCFM licences were intended to fill the gap between community licences and full commercial licences, whereby licensees are permitted to operate in a commercial manner but must provide local programming of interest to local communities.

The government has engaged incumbents in a consultation, outlining a renewal mechanism which provides flexibility for licensees to either remain as a local commercial broadcaster or to transition to a full commercial licence. RSM is currently considering the submissions and will proceed to inform the outcomes following the decisions by the Minister for Communications.

Inter-agency engagement on space matters

RSM has been actively participating in the development of government policy and supporting regulation in anticipation of the development of a space economy in New Zealand around space rocket launching and the commissioning of small satellites in space.

The emergence of RocketLab's business operations in New Zealand initiated this process and relevant government agencies are now working together in making sure New Zealand's use of space is conducted safely and in accordance with international obligations.

MBIE has been given the role of space agency and is leading the national inter-agency work on space matters and the international engagement with relevant space related organisations. RSM hosted the first New Zealand space industry forum, through a 2-day symposium on small satellite regulation and space governance, held in Auckland. The event was attended by international speakers from the ITU, overseas academics, government agencies and national research institutions.

International engagement

RSM has continued to engage with our trading partners, regional groups and relevant international organisations on a wide variety of radio spectrum issues. In preparation for the World Radiocommunications Conference 2015 (WRC-15), RSM developed the New Zealand positions, in consultation with local industry and other government agencies.

New Zealand sent a number of representatives, led by RSM, to WRC-15 held in Geneva in late 2015. RSM is currently working on the implementation of WRC-15 decisions on spectrum allocations relevant to the New Zealand table of frequency allocations and supporting regulations.

RSM has now commenced its international regulatory work in preparation for WRC-19 to promote New Zealand's positions within the Asia-Pacific region through the various Asia Pacific Telecommunity (APT) preparatory meetings and ITU study group meetings.

The focus of this work is ensuring New Zealand has access to economically and technically viable leading-edge wireless technologies, which can be smoothly incorporated into our national infrastructure for the benefit of the New Zealand economy.

RSM will be focusing on the development of next-generation mobile broadband technology (e.g. 5G). This will be achieved through active participation in WRC-19 Conference Preparatory meetings, specifically those covering agenda items concerning allocations for mobile broadband technology.

RSM also collaborates with our partner regulators on spectrum related matters. Since 2004, RSM has been participating in an international engagement group (Spectrum Regulators Forum), formed by the spectrum agencies of New Zealand, Canada, United Kingdom, USA, Australia and Hong Kong.

Every two years, this group gets together to share insights and developments on spectrum management in their jurisdictions, with a view to learn from each other and collaborate on finding alternatives to emerging spectrum issues. This year, the forum was hosted by the spectrum regulator of Canada (Industry Canada) and was held in Ottawa.

Update of General User Licences

There is ongoing implementation of GURL adjustments to incorporate decisions made at WRC-15. RSM will continue to release updated GURLs to align the technical parameters required for Aeronautical Purposes, Maritime Purposes, Satellite Service, and Short Range Devices in order to align these services with international prescriptions.

7.2 RSM Licensing and Registry

Where the facility to trade spectrum rights is not seen as appropriate, and the demand for spectrum does not exceed supply, government directly allocates licences under the radio licensing regime.

The licensing team continues to meet their registry obligations and radio licence audit functions, as well as undertaking proactive technical planning to improve licensing tools. Licensing also provides training to external Approved Radio Engineers and Certifiers in the application of engineering rules and licensing processes to accurately integrate radio licences into the national Register.

Maintaining a high standard of the information entered in the national Register is extremely important, since the successful management of harmful interference relies on the integrity of the data provided by the users of the Register.

While the total number of licences has remained at a similar level since 2008, the composition of licences that make up this total has changed. Figure 9 below provides an overview of these composition trends in licensing:

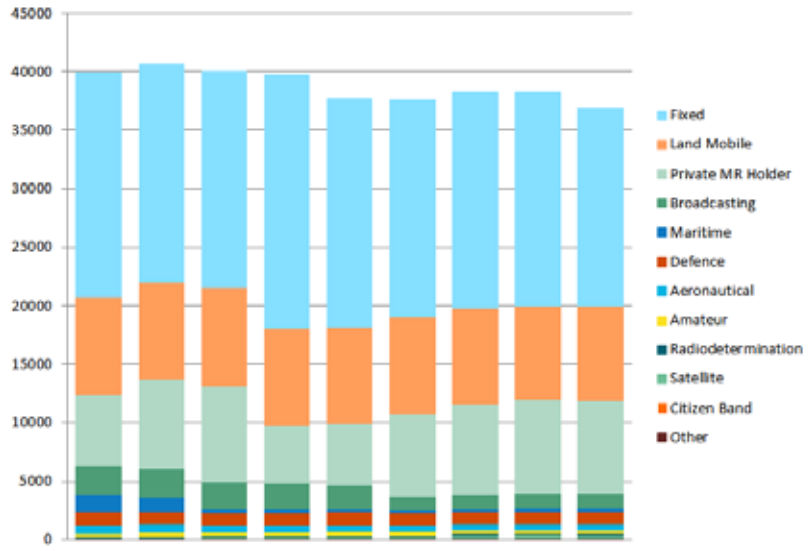


Figure 8. Total number of licences (2008 - 2016)

Given the high number of licences in the top four categories (fixed, land mobile, management rights and broadcasting), trends in categories of licences with smaller totals are harder to identify. For this reason, figures 9 and 10 below provide a more in depth view of the trends over time in these licence categories.

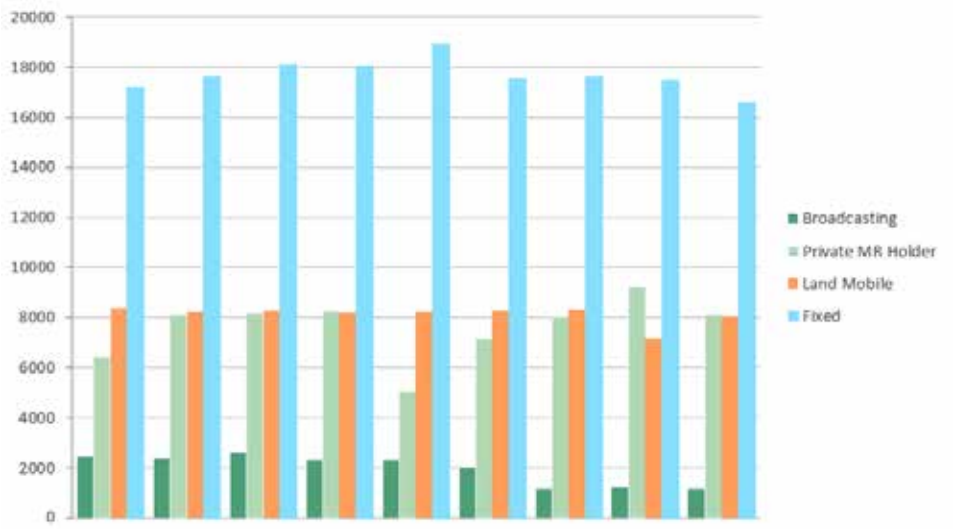


Figure 9. Trends, licensing by major groups (2008 – 2016)

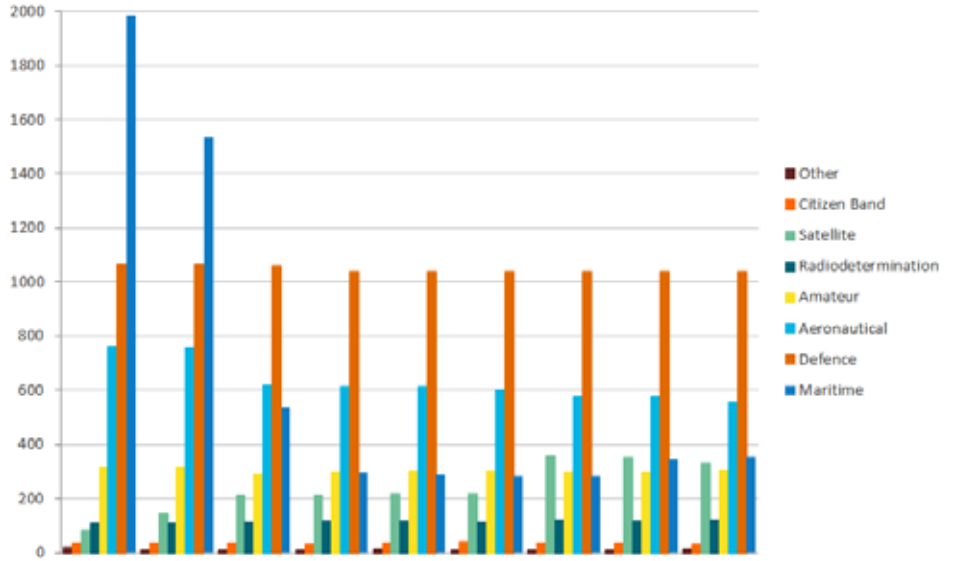


Figure 10. Trends, licence types 2008 - 2016 (detail)

A small number of categories saw a significant change in the number of licences between 2008 and 2016. Most notably, the number of maritime licences has dropped considerably, with nearly 2000 licences issued in 2008, to only 354 in 2016. This has been caused by the move from individually-licensed private coast stations to an open-access framework in 2007, through the implementation of a maritime GURL to cover this type of station.

Broadcasting licences, which include both television and sound licences, have decreased in number by just over 50%, with 2440 licences in year 2008 and 1163 licences in year 2016. This can be partially explained by the digital switch-over which occurred in New Zealand in 2005 and culminated in late 2013, with the final analogue television 'switch-off'.

The number of fixed licences is consistently higher than other licence types, beginning at 17,186 licences in 2008 and remaining at 16,620 licences in 2016. This high number is largely due to the wide range of applications that fixed licences are used for, including backhaul applications by mobile network operators (linking numerous cellular base stations).

However, an emerging trend can be seen in the small decrease in fixed licences, which may signal the move towards fibre replacement for increased capacity. Linked to the high number of fixed licences is an increase of approximately 20% in licences under Private Management Rights. This can be partially explained by mobile intensification by cellular operators.

Licensing by external engineers

RSM continues to support the external licence engineering work by AREs and ARCs in an effort to increase efficiency in the processing of licences to benefit the users of the radio spectrum. The uptake of external services continues to rise, reaching 98.7% in the 2014/2015 year.

The trend in this area is positive for both RSM and the AREs/ARCs, who work in this relatively new market and it indicates that RSM's regulatory tools are working well and are accessible to external technicians. The small percentage of licences engineered internally covers specific licensing needs, for more tailored and technically complex user requirements.

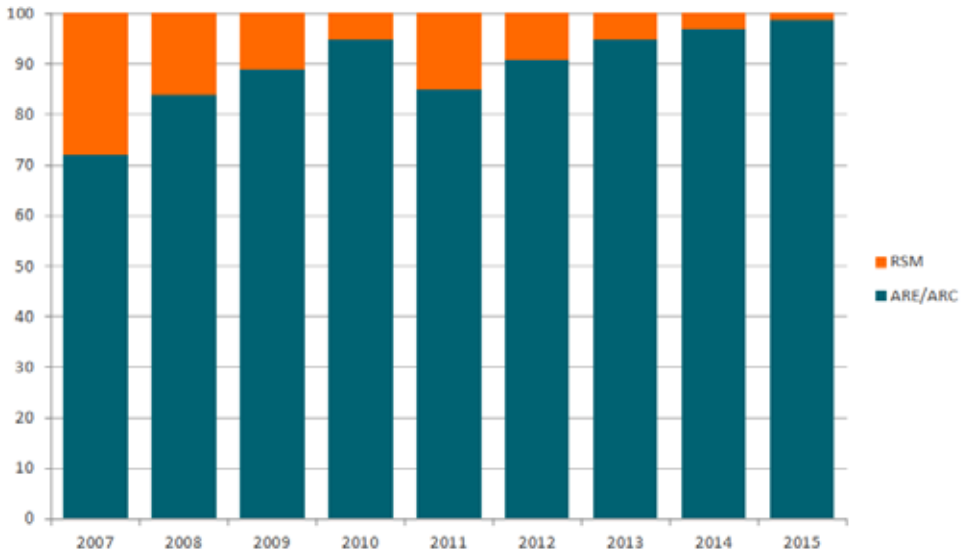


Figure 11. Percentage of licences engineered by AREs and RSM

The licensing team has been working to encourage the use of more spectrally efficient radio technologies. Actions undertaken to achieve this goal have been the phase-out of 25 kHz land mobile channels. The phase-out of 25 kHz channels in LMR bands promotes more efficient use of land mobile spectrum, reduces congestion, and aligns New Zealand with international practice.

Use of the RSM licensing web portal and online tools

RSM licensing tools, licensing information and engineering guidelines provided through the RSM's web portal have a significant use not only by national users but also by overseas parties.

This encourages the continuing provision of high quality information and online tools for spectrum management, as well as providing an easy navigation through the regulatory information and our web-based licensing tools. Figure 12 below provides an overview of the international use of the RSM web portal:

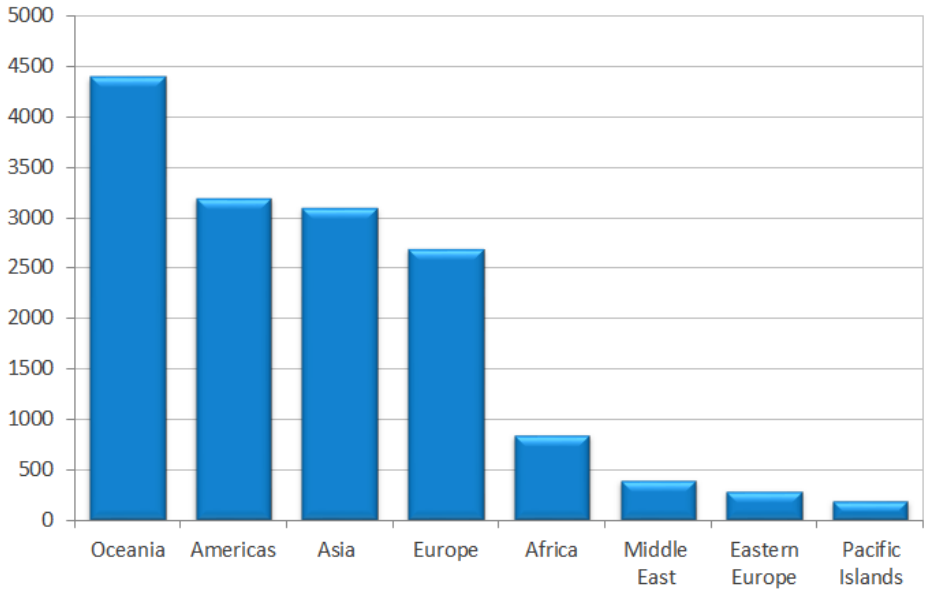


Figure 12. RSM licensing web: visits per world region (2015)

Future work by Licensing and Registry

The licensing team will commence the implementation of a new Register, beginning in January 2017 to replace the existing Register of Radio Frequencies. The Register is a public online repository of radio licences, spectrum licences and management rights and is crucial for effective spectrum management.

The existing Register has been in use for over ten years, and now requires upgrades to respond to user demands and to continue delivering a robust service. The project to replace the online Register will be led by the Market Services Transformation Team (part of MBIE).

The development of the new database will ensure that information about spectrum use in New Zealand is easily accessible, accurate and informative for those making decisions regarding licensing and spectrum use.

7.3 RSM Compliance

The compliance team is responsible for much of the day-to-day work of RSM in the field. The team assists businesses in understanding how to comply with regulations, and to ensure that there are no unnecessary burdens on businesses wishing to use spectrum.

The team also investigates and resolves interference complaints and actively monitors the radio spectrum environment to ensure it is kept free of harmful interference.

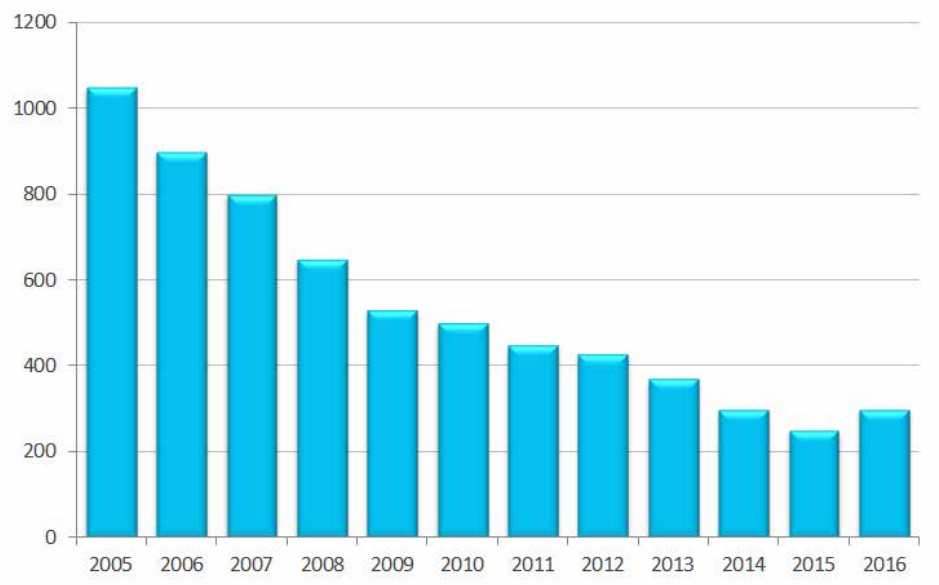


Figure 13. Interference cases in NZ, 2005 - 2016 (2016 reflects an extrapolated figure)*

Interference complaints are a large part of the work of the compliance team; however since 2005 the number and complexity of these complaints have been changing. While the number of cases has decreased quite dramatically, as can be seen in Figure 13 above, the complexity of the cases has increased. Interference cases in the past were typically broadcast reception problems to radio or TV, from easily identifiable in-home or neighbouring property sources.

However, the problems are now more likely to affect services at much lower signal levels as the number of connected wireless devices increases and broadband technologies evolve. This requires more sophisticated investigation equipment and techniques, and generally takes considerably longer to resolve– particularly when dealing with systems deployed in multi-storey metropolitan buildings, hosting multiple wireless technologies.

Because of this, the proportion of the radio inspector's time spent on interference investigations remains at around a third of their time.

The compliance team also continues to take a proactive approach in supplier auditing, focusing on *electromagnetic-compatibility compliance* and *performance standards* applicable to wireless equipment likely to represent a risk of harmful radio interference.

Recently, New Zealand has completed the transition to use the RCM and R-NZ marks to indicate a device's compliance.

Challenges arising in the compliance area

Problems arising from un-harmonised spectrum allocations internationally may become more pronounced in the future as a result of individuals importing equipment without consulting local standards for frequency use.

Radio equipment designed for other countries or regions with different spectrum allocations to New Zealand present a high risk of harmful interference for local wireless networks and systems. Greater global standardisation will reduce this risk.

The combined use of switch-mode power supplies and wireless communication systems in devices is a fast growing trend that may cause future problems for the compliance team. These new technologies increase the potential for interference to existing spectrum technologies and users.

For example, incandescent lightbulbs are now being replaced in many homes by LED lights that have a built-in switch-mode power supply and a Wi-Fi module to control brightness and colour. These devices are far more likely to produce harmful radio noise than incandescent lightbulbs.

7.4 Crown-held spectrum activities

The Crown has management rights in a number of bands, enabling the Crown to issue specific spectrum licences, and ensure their efficient use through competitive allocation, or alternatively, to undertake administrative allocation to non-commercial users. All television and radio broadcasting licences are allocated in Crown-managed spectrum, and commercial licences were initially allocated through competitive processes.

Broadcasting

In New Zealand, the digital television switch off was a major change to television broadcasting and had flow on effects for wider spectrum management. Spectrum was freed up in the 700MHz band, which was then converted into management rights and sold by the government in 'Auction 12' in 2013, generating $270 million.

The management rights are now privately held by Spark, Vodafone and Trilogy. Licences are steadily being granted by the managers of this spectrum providing enhanced cellular mobile coverage and broadband speeds.

While most broadcasting licences are now allocated, there have been two auctions in the Crown's AM and FM broadcast spectrum management rights in the recent past. An auction of AM and FM sound broadcasting licences took place between 27 November and 3 December 2014.

124 licences were sold from the 172 available in the auction for a total of $17.2 million. Licences that were not sold in this auction were then offered to parties who expressed interest via a closed allocation process. Nine licences were sold for a total of $110, 000.

The government has introduced a new methodology, whereby short-term licences pending auction are no longer issued, and the minimum resource value charged by the Crown for FM licences has been reassessed to be put on a national basis (similar to AM radio and television licences).

Lower-value FM licences are no longer issued. All licence applications are now being publicly notified for expressions of interest and a competitive allocation process undertaken where multiple parties express interest.

Managed spectrum park and 3.5GHz regional allocations

In the previous spectrum outlook, we noted that changes to the managed spectrum park (MSP) framework would be focused on efficiency and reducing administrative burden. MSP rules were altered in 2015 to provide more certainty in terms of the specification of licences and to shorten the allocation process timeframe.

Within the Crown's four 3.5 GHz Management Rights, licensees have been permitted to migrate from FDD to TDD transmissions, where this is practicable. The temporary use of short term licences below the management rights was also permitted to facilitate the testing and migration of the 3.5GHz spectrum licences from FDD to TDD. Four licensees took up the use of the short term facility.

In 2017, MBIE will commence planning the renewal process for the 3.5 GHz Management Rights spectrum, and also the four Management Rights held by the Crown. All the 3.5 GHz Management Rights and spectrum licences expire in 2022.

Indicative RSM Work Programme 2017-2021

8. Radio Spectrum Management indicative work programme 2017 – 2021

The RSM indicative work programme for 2017-2021 has been devised in response to the ongoing regulatory responsibilities outlined in section 7, and the action points arising from the industry trends and sector developments in section 5.

The table below outlines the major activities and projects over the upcoming outlook period and provides a brief description of each activity. RSM notes that flexibility is required in responding to emerging issues in radio spectrum as new technologies and issues emerge. Hence, our indicative work programme is not designed to be a rigid work plan.

Work Programme	Description	Status
Fees review	Review and consultation on spectrum fees structure.	Underway
Radiocommunications Act 1989 Review	Review and consultation of interference management, competition aspects and certification.	Underway
Renewal of spectrum rights 1710 – 2170 MHz	Review and consultation on management rights use coming to expiry in 2021. Begun review and consultation of 1800 and 2100 MHz management bands.	Underway
VHF band III review (174 -230 MHz)	Consultation on potential band uses. Review of submissions and crafting of recommendations.	Underway
Provide advice on spectrum matters related to legislation of NZ's space activities	As part of an inter-agency work stream, RSM will continue to contribute in the development of the NZ space regulatory regime, with a focus on space radiocommunication matters.	Underway
Implementation of changes to maritime mobile VHF channels	Adoption of amendments made to the International Radio Regulations to enable data services in the VHF maritime mobile band. Changes are being implemented and going through final stages.	Underway
Reporting on the NZ participation at WRC-15	Represented NZ in spectrum matters, promoting and advancing NZ interests at WRC-15. Reported back to industry on developments.	Completed
Implementation of WRC-15 outcomes	Update of national spectrum allocations resulting from changes to the International Radio Regulations as a result of the Conference. Application of amendments to the national table of allocations and statutory instruments.	Underway
General User Licence updates	Implementing WRC-15 decisions impacting on maritime, aeronautical and satellite GURLs.	Completed

Renewal of rights in 1785 – 1805 MHz (expiring in 2021)	Review and consultation of future management rights use.	Upcoming
Renewal of rights in 2010 – 2110 MHz (expiring in 2021)	Review and consultation of future management rights use.	Upcoming
Renewal of rights in 2200 – 2300 MHz (expiring in 2021)	Review and consultation of future management rights use.	Upcoming
Renewal of rights in 3500 MHz (expiring in 2022)	Review and consultation of future management rights use.	Upcoming
Renewal of rights in 28 GHz (expiring in 2018)	Reallocation work as a result of cabinet decisions not to renew MRs in this band.	Upcoming
Renewal of rights in 26 GHz (expiring in 2022)	Review and consultation of future management rights use.	Upcoming
Implementation of outcomes arising from the Radiocommunications Act 1989 review	Industry consultation completed. Currently crafting advice to Government. RSM is required to carry out and implement the resulting decisions on the Act review.	Underway
Represent NZ interests as signatory Member State to the ITU Treaty and Convention at the ITU Plenipotentiary Conference 2018	Part of New Zealand's' Treaty international obligations. Review of the ITU Convention and election of ITU officials.	Upcoming
Develop national and regional positions to represent the NZ interests at WRC-19	Regional engagement at APT and relevant ITU-R study groups (especially but not exclusively in agenda items related to Working Party 5D) and engagement within the NZ radio sector.	Underway
Implementation of action points arising from Outlook review of industry trends and sector developments	RSM will carry out the implementation of the action points identified in section 5 of this outlook, in response to industry trends and sector developments.	Underway
Update of the national Register database	RSM licensing will commence the work on the update of the online register.	Upcoming
Development of a 5G spectrum agenda	To provide a vision on the expected timelines and resources required for the development of 5G spectrum allocations in New Zealand. This agenda will aim to serve as the "RSM view on New Zealand's 5G spectrum readiness"	Upcoming
Spectrum options for wireless microphones – ongoing studies	Some of the current spectrum allocations, where wireless microphones operate, are likely to change due to international developments on mobile broadband technology. MBIE will continue to engage planning resources to undertake ongoing studies for the assessment of spectrum access alternatives in light of these developments.	Underway

< Back to contents

Concluding remarks

The RSM Spectrum Outlook 2017-2021 represents an opportunity for the New Zealand wireless industry to take a look at the emerging developments on spectrum management and the technological changes likely to arrive to our shores. RSM will continue to proactively engage nationally and internationally, making sure New Zealand's wireless ICT infrastructure continues to grow strong and in-tune with the global interconnected economy.

We expect to continue working together and collaboratively with industry, extracting the greatest benefit from the use of the radio spectrum for the benefit of consumers, businesses and users who rely on a well-managed wireless ecosystem.

This Outlook period is an exciting one. We are witnessing the fastest ever growth in ICT uptake. We are now more connected than ever before and new forms of connectivity are rapidly emerging and changing how we live.

The challenge is to effectively and efficiently accommodate new innovations and the increased demand for spectrum use while, at the same time, protecting existing investments and maintaining a sustainable wireless ecosystem.

Achieving this balance will deliver significant opportunities and benefits for the New Zealand economy. The team at RSM are confident that we can address these challenges.

9. List of acronyms

ACRONYM	ABBREVIATION
AIS	Automatic Identification Systems
ADS-B	Automatic Dependent Surveillance-Broadcast
ESIM	Earth Stations in Motion
FDD	Frequency-Division Duplex
GURL	General User Radio Licence
ICAO	International Civil Aviation Organisation
IMT	International Mobile Telecommunications
IoT	Internet of Things
ISM	Industrial, Scientific and Medical
ITS	Intelligent Transport Systems
ITU	International Telecommunication Union
LMR	Land Mobile Radio
LTE	Long Term Evolution – a set of mobile standards
M2M	Machine to Machine communications
MBIE	Ministry of Business, Innovation and Employment
MSP	Managed Spectrum Parks
PPDR	Public Protection and Disaster Relief
PSME	Programme Making and Special Events
RSM	Radio Spectrum Management
TDD	Time-Division Duplex
WAIC	Wireless Avionics Intra-Communications
WRC	World Radiocommunication Conference

Contacts

Website	www.rsm.govt.nz
Email	info@rsm.govt.nz
Phone	0508 RSM INFO (0508 776 463)
	+64 3 962 2603 (outside New Zealand)
Fax	+64 4 978 3162
Post	PO Box 2847 Wellington 6140 New Zealand

ISSN: 978-0-947524-80-7 (online)

Published December 2016

New Zealand Government

MB14150