Australian Government

Australian Communications and Media Authority

Five-year spectrum outlook 2012–2016

The ACMA's spectrum demand analysis and strategic direction for the next five years

MAY 2012

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Foreword

Welcome to the 2012 edition of the ACMA's *Five-year spectrum outlook 2012–2016*. This Outlook is a new departure for us, into the world of online electronic magazines and I hope you find this e-mag informative and easy to navigate.

The fourth edition of the Outlook brings together information, analysis and work plans in a one-stop shop that aims to give you easy access to information as well as encourage collaboration between all users of spectrum.

The cornerstone of the Outlook remains the same—an overview of spectrum demand drivers, the ACMA's top spectrum projects over the five-year period and specific work plan priorities for the 2012–2013 period. The top spectrum projects include:

- reallocation of the 700 MHz band
- reallocation and conversion of the 2.5 GHz band
- expiring spectrum licences
- smart infrastructure and new thinking about infrastructure parks.

This year's edition also provides an in-depth analysis of WRC-12 outcomes. I attended the conference in Geneva and was encouraged by the vibrancy of discussion and rigour that international spectrum planning undergoes to encourage harmonisation of its use around the world.

The Outlook is an important part of the ACMA's ongoing engagement with all spectrum users about their needs along with being our public assessment of technological developments in the fast-moving communications environment. Your feedback is most welcome as it will assist the ACMA in prioritising our strategic direction and spectrum management work program.

I hope you enjoy this new interactive edition. Please click and tap around the document as it will lead you to further subject specific information on not only the ACMA's websites but on industry and research sites as well.

Chris Chapman
Chairman

Acknowledgements
In developing this edition of the Outlook, the ACMA gratefully acknowledges the input provided by the following organisations, government agencies and their staff:

> Australian Mobile Telecommunications Association
> Australian Subscription Television and Radio Association
> Australian Wireless Audio Group
> Commonwealth Scientific and Industrial Research Organisation
> Corruption and Crime Commission of Western Australia
> Free TV Australia
> Global VSAT Forum
> Inmarsat
> O3b Networks
> Telstra Corporation Limited.

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1. Introduction

The *Five-year spectrum outlook 2012–2016* (the Outlook) is an integral business and planning tool that assists the ACMA to improve its spectrum management functions by:

> providing greater insight and transparency for spectrum users about the demand for spectrum

> setting out the ACMA's strategic direction and priorities for the next five years.

The Outlook is a vital component in the ACMA's consultation and planning framework for spectrum management. It provides information on demand pressures for spectrum which in turn supports consultation on specific spectrum issues, discussion papers and feedback through the ACMA's annual *RadComms* conference and spectrum tune-ups.

Through these targeted mechanisms, the ACMA is working to actively engage all stakeholders in a public discussion on the demands on spectrum, prioritising spectrum projects and possible changes to spectrum access arrangements. This partnership approach is critical in managing the scarce natural resource that is the key communications enabler in modern society.

This edition of the Outlook builds upon the previous four editions by:[1]

> summarising the ACMA's spectrum demand analysis across a range of frequency bands and radiocommunications services

> providing the ACMA's work plan for key spectrum management projects as well as a band-by-band work plan analysis

> supporting the ACMA's goal of efficiency, effectiveness and transparency in regards to all matters pertaining to spectrum management.

The ACMA is an independent statutory authority within the Australian Government's communications portfolio that reports to the Minister for Broadband, Communications and the Digital Economy.

In accordance with the *Australian Communications and Media Authority Act 2005* (the ACMA Act), the *Radiocommunications Act 1992* (the Act) and other relevant legislation, the ACMA's role is to ensure the efficient, effective and transparent management of the Australian radiofrequency spectrum.

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[1] 2009–2014 (draft edition) released 2008; 2009–2013 released 2009; 2010–2014 released 2010; 2011–2015 released 2011.

1.1 Purpose

The purpose of the Outlook is to consolidate the fundamental issues expected to affect the spectrum requirements for key radiocommunications services in the next five years. As well as highlighting spectrum requirements that could arise for radiocommunications services beyond 2016, the Outlook also outlines the ACMA's proposed actions to address these issues

The content of this Outlook, particularly the indicative work programs, is updated annually in response to changing priorities and environmental demands. The indicative work plans outlined in Chapter 6 take into account the current and future spectrum needs resulting from information provided by the 11 submissions from various contributors to the previous edition of the Outlook, as well as the ongoing research and monitoring of the international spectrum environment undertaken by staff of the ACMA.

This Outlook is not intended to be a substitute for separate and targeted industry consultation on specific spectrum management issues. For this reason, any observations on proposed approaches or solutions to emerging problems may only represent the ACMA's preliminary thinking.

The work programs provided in Chapter 6 do not reflect all of the work the ACMA undertakes concerning radiocommunications issues. The ACMA engages in a range of other activities relating to radiocommunications, such as changes to the licensing and allocation frameworks, to reflect incremental changes to the services available within the current bands.

Comments supporting the prioritisation of projects will assist the ACMA in making decisions about the possible future planning, licensing, pricing and allocation arrangements for the radiofrequency spectrum. However, nothing in this Outlook should be taken to bind the ACMA or the government to any particular course of action in the future.

1.2 Methodology

In identifying and discussing spectrum demand it is important to note that 'demand' incorporates both user demand for services as well as submissions from stakeholders, the World Radiocommunication Conference (WRC) outcomes and international markets. The predicted pressure points and the ACMA's proposed initial approaches to managing those pressures have been extracted to form indicative work programs for the next five years.

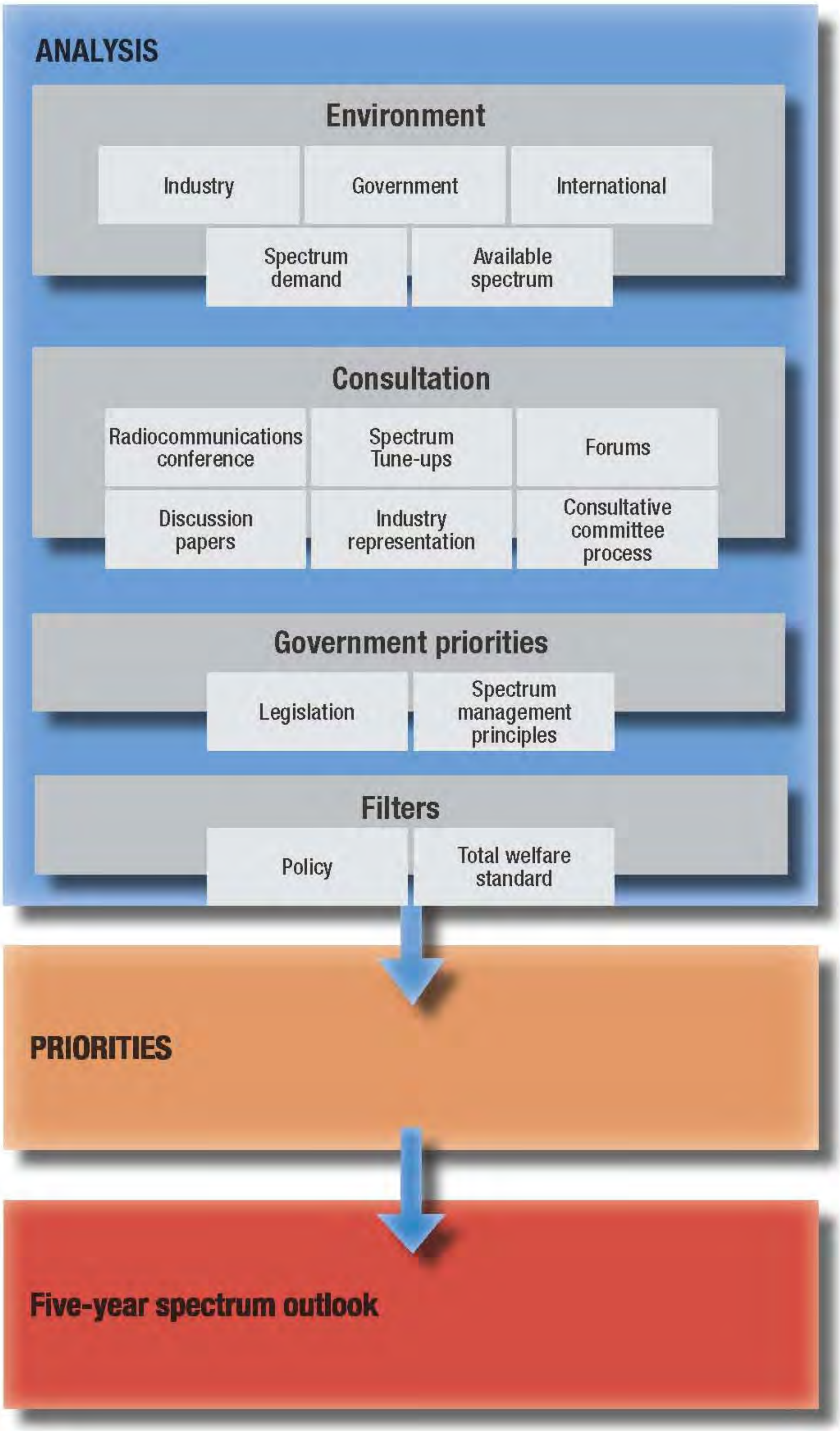
While there is an inherent degree of uncertainty in predicting spectrum requirements over the next five years, consideration in advance of the likely pressure points on spectrum is valuable for two reasons. First, it should mean that the ACMA's work priorities are closely linked to actual emerging demand pressures. Second, it should provide a greater degree of industry certainty about the ACMA's priorities and promote dialogue with spectrum users about these priorities.

1.2.1 Evidence-based approach

In considering whether issues should be included in the Outlook, the ACMA takes a comprehensive approach that is based on the best available evidence. As an evidence-informed communications regulator, the ACMA has an extensive research and reporting program aimed at understanding and identifying the current and potential uses of radiofrequency spectrum. The ACMA's ongoing research program continually examines the communications and media markets, exploring changes in technology, market development and community perceptions.

Our approach is set out in the document *Evidence-informed regulation: The ACMA approach* and outlines the key forms of data, information and research. It describes the role of this diverse evidence base in informing our regulatory development, decision-making and other functions. It also sets out the ways we promote continuous improvement and best practice in evidence-informed regulation. Figure 1.1 depicts how the ACMA uses this evidence to inform its work plans for spectrum management.

Figure 1.1 How evidence informs the five-year spectrum outlook



1.3 Scope and structure

This Outlook considers the range of the radiofrequency spectrum from about 500 kHz to 80 GHz, although the spectrum between 400 MHz and 6 GHz is generally where most of the competing demand exists.

Chapter 1 provides an introduction to the Outlook, outlining the purpose and scope of the document, as well as instructions for parties interested in making submissions.

Chapter 2 contains an overview of the ACMA's spectrum management decision-making framework.

Chapter 3 identifies the principal underlying drivers of spectrum demand, which include international developments, technological change and use of new services.

Chapter 4 outlines the key spectrum management projects that the ACMA is currently undertaking.

Chapter 5 contains an analysis and estimation of spectrum requirements of the nine radiocommunications services over the next five years.

Chapter 6 contains the ACMA's indicative spectrum management work programs for the next five years.

Appendix A lists frequency bands and frequency ranges for easy reference.

Appendix B is a detailed list of the acronyms and abbreviations contained in this Outlook.

Due to outcomes from the World Radiocommunication Conference 2012, the frequency audit table (previously Appendix C) has not been updated for this release of the Outlook. The frequency audit table will be updated to reflect changes to the Australian Radiofrequency Spectrum Plan for the next planned edition of the Outlook. Elements of the frequency audit table have been combined into the Outlook work plan band-by-band analysis in section 6.2.1.

2. Spectrum management decision-making framework

This chapter provides an overview of the ACMA's spectrum management decision-making framework.

It outlines:

> the international framework
> the legislative framework and planning arrangements
> the spectrum management decision-making framework
> the current environment.

2.1 The international spectrum planning framework

In most countries, including Australia, spectrum planning starts at the international level through participation in the International Telecommunication Union (ITU). The ITU is the leading United Nations agency for information and communications technology issues and is the global focal point for governments and the private sector for the development and regulation of networks and services. ITU radiofrequency spectrum planning decisions may need to be incorporated by the ACMA into Australian spectrum arrangements.

The Radiocommunication Sector of the ITU (ITU-R) exists to ensure rational, equitable, efficient and economical use of the radiofrequency spectrum by all radiocommunications services (including those using satellite orbits) and to carry out studies and approve recommendations on radiocommunications matters. The ITU-R also maintains the international *Radio Regulations*, which set out the allocations of bands to various types of services. There are currently six ITU-R study groups and several working parties under each of these study groups assigned to consider specific technical issues as well as develop and maintain ITU-R recommendations and reports.

Australia is a signatory to the ITU Convention, which is a treaty-level legal instrument that obliges Australia to comply with the *Radio Regulations*. In essence, Australian radiocommunications services must not cause interference to the services of other countries where those services operate in accordance with the *Radio Regulations*. Conversely, Australian services are entitled to protection against interference from other countries.

In addition to the ITU, there are numerous organisations that seek to achieve regionally harmonised views on various spectrum planning issues, including those relevant to the ITU-R. Examples of these organisations include:

- the Asia-Pacific Telecommunity (APT), the Asia-Pacific representative body in the ITU
- the Inter-American Telecommunication Commission (CITEL)
- the European Conference of Postal and Telecommunications Administrations (CEPT).

The World Radiocommunication Conference (WRC) was held by the ITU-R in Geneva, Switzerland from 23 January to 17 February 2012. Australia extensively prepared for the World Radiocommunication Conference 2012 (WRC-12) over the past four years with the ACMA overseeing industry and stakeholder consultation through the ACMA’s Preparatory Group for WRC-12. The ACMA led an Australian government delegation that included representatives from both government and industry. Further information on WRC-12 outcomes can be found in Chapter 4.

The next WRC is planned for 2015.

Find out more »

2.2 Legislation for Australian spectrum management

The ACMA is responsible for managing the radiofrequency spectrum in accordance with section 9 of the *Australian Communications and Media Authority Act 2005* (the ACMA Act) and the *Radiocommunications Act 1992* (the Act).

The Act sets out the objectives the ACMA must follow in undertaking this task as well as the tools that are available to it, including frequency planning, licensing, making standards and overseeing compliance with licence conditions to avoid interference with other spectrum users.

The object of the Act is to provide for management of the radiofrequency spectrum in order to:

- maximise, by ensuring the efficient allocation and use of the spectrum, the overall public benefit derived from using the radiofrequency spectrum
- make adequate provision of the spectrum:
  - for use by agencies involved in the defence or national security of Australia, law enforcement or the provision of emergency services
  - for use by other public or community services
- provide a responsive and flexible approach to meeting the needs of users of the spectrum
- encourage the use of efficient radiocommunication technologies so that a wide range of services of an adequate quality can be provided
- provide an efficient, equitable and transparent system of charging for the use of spectrum, taking account of the value of both commercial and non-commercial use of spectrum
- support the communications policy objectives of the Australian Government
- provide a regulatory environment that maximises opportunities for the Australian communications industry in domestic and international markets
- promote Australia's interests concerning international agreements, treaties and conventions relating to radiocommunications or the radiofrequency spectrum.

Find out more »

2.3 Planning instruments made by the ACMA

2.3.1 The Australian Radiofrequency Spectrum Plan

The Australian Radiofrequency Spectrum Plan (spectrum plan) is a legislative instrument administered by the ACMA and is the highest-level spectrum planning document in Australia. It divides the Australian radiofrequency spectrum into a number of frequency bands and specifies the general purpose for which each band may be used. This process is referred to as the allocation of frequency bands to radiocommunication services.

The spectrum plan is drawn from, and kept current with, Article 5 of the ITU *Radio Regulations*, which is revised every few years at the WRC. It is designed to:

> provide a basis for management of the radiofrequency spectrum in Australia

> inform and educate radiocommunication users and the public about the various types of services that can be operated in each frequency band, and the conditions attached to their operation

> reflect Australia's obligations as a member of the ITU

> provide details of international frequency allocations agreed by the ITU for the three world regions.

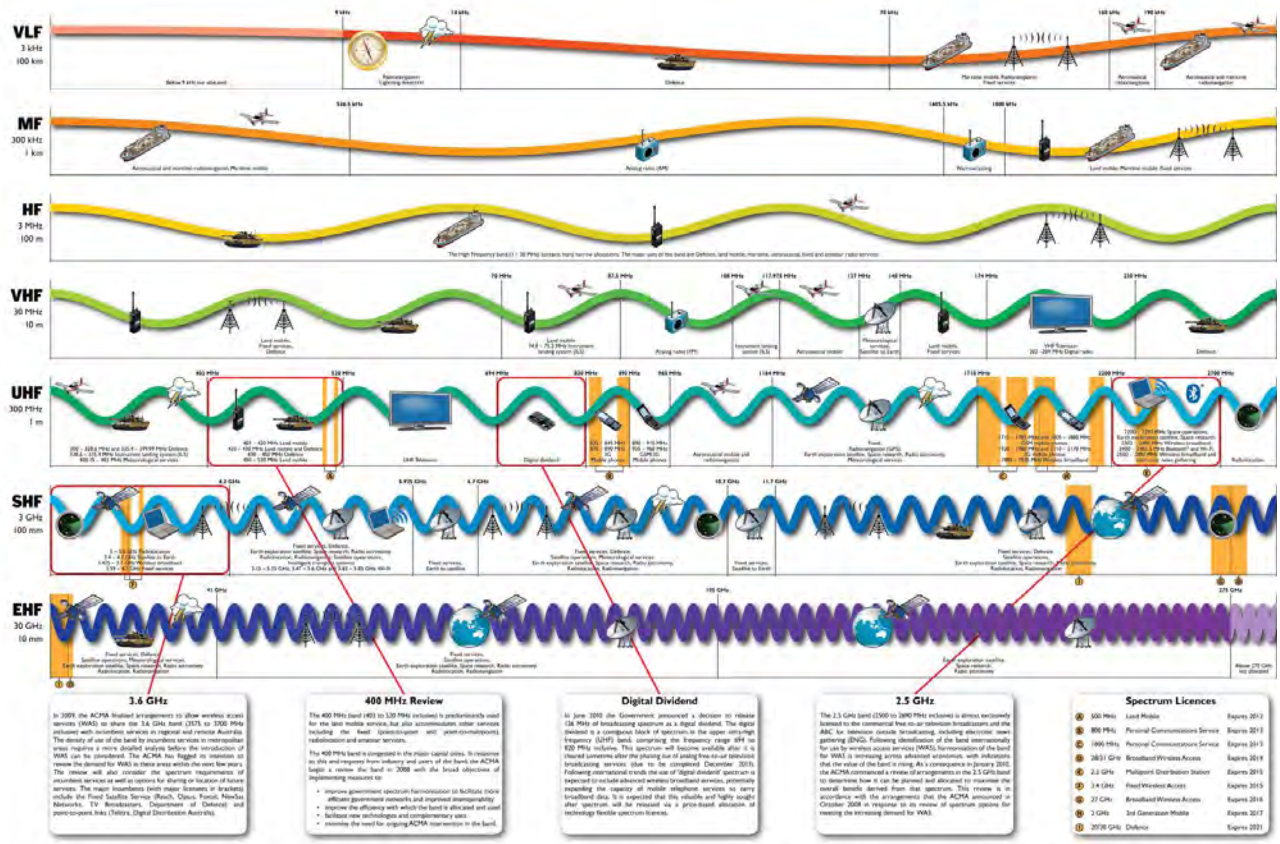
The ACMA is currently reviewing the spectrum plan in response to the latest frequency allocation recommendations from WRC-12. It is planned for release in January 2013.

Find out more »

Figure 2.1 outlines how the radiofrequency has been divided into several broad frequency bands. Each of these bands is divided into sub-bands, which are allocated to particular services such as land mobile, radio, broadcasting, aeronautical, maritime or space services. These services are discussed in detail in Chapter 5.

It also demonstrates where some key spectrum projects sit within the overall spectrum plan and illustrates a visual representation of the change in wavelength as frequency increases (note this does not correspond to the true wavelength).

Figure 2.1 Spectrum illustrated—a guide to major spectrum allocations in Australia



Zoom in for more information

2.3.2 Band plans

Band plans provide detailed instructions on the use of specific parts of the spectrum and there are two types of band plans:

> frequency band plans, which are legislative instruments made under section 32(3) of the Act and which must not be inconsistent with the spectrum plan

> administrative band plans, which serve a similar purpose to frequency band plans but have no statutory obligations.

Frequency band plans specify the purposes for which bands may be used and these are summarised in Table 2.1.

Table 2.1 Frequency band plans

Frequency band	First made
VHF Mid Band Frequency Band Plan (70–87.5 MHz)	1991
VHF High Band Frequency Band Plan (148–174 MHz)	1991
900 MHz Band Plan (820–960 MHz)	1992
1.5 GHz Band Plan (1427–1535 MHz)	1996
1.9 GHz Band Plan (1880–1900 MHz)	1996
Mid-West Radio Quiet Zone Frequency Band Plan	2011
1900–1920 Frequency Band Plan 2012	2012
Television Outside Broadcast Service (19980–2110 MHz and 2170–2300 MHz) Frequency Band Plan 2012	2012

Administrative band plans serve a similar purpose to frequency band plans, but without the latter's statutory obligations. They provide a policy basis for band usage. At present, the only administrative band plan in force is for the 400 MHz band (403–430 MHz and 450–520 MHz).

2.3.3 Radiocommunications Assignment and Licensing Instructions

Radiocommunications Assignment and Licensing Instructions (RALIs) are policy documents that provide detailed guidance on specific spectrum access arrangements, such as permitted frequency channelisation and antenna performance characteristics. RALIs are subject to periodic review and are amended as the ACMA considers necessary. At present, there are 25 RALIs containing intra-service and inter-service frequency assignment requirements.

2.3.4 Spectrum embargoes

Embargoes alert industry to the start of a planning process and are used in conjunction with other administrative and planning tools. An embargo includes details of the frequency band, date of effect, coverage area, time frame, instructions and reasons for the embargo.

The ACMA places spectrum embargoes on identified parts of the radiofrequency spectrum from time to time to provide notice of its intention to restrict the issue of new licences in a band, pending its replanning. Replanning usually results in a change in use or a change in the combination of uses of a band. Embargoes are also necessary to minimise the dislocation of affected services that may otherwise occur and to allow for future developments in a band.

The ACMA considers applications for frequency assignments in embargoed bands on a case-by-case basis. Exceptions may be made to an embargo where there is sufficient justification. RALI MS03: Spectrum Embargoes provides the administrative policy basis for spectrum embargoes and contains a list of all current and withdrawn embargoes. At present, there are 26 active embargoes. The ACMA places a notice about the creation of a new embargo and a link to its contents on its website.

2.4 Radiocommunications standards

The ACMA develops radiocommunications standards to ensure compatibility with, or to limit emissions, from transmitters. To do this, the ACMA requires manufacturers and importers of radiocommunications products and their authorised agents to comply with its supplier-based labelling scheme. The scheme aims to ensure that radiocommunications products meet relevant ACMA mandatory standards before these products are placed on the Australian market.

After consideration of the voluntary industry standards, the ACMA makes mandatory standards under section 162 of the Act. The ACMA's mandatory standards adopt the appropriate voluntary industry standard often with variations that are listed in the mandatory standard. The scheme has separate levels of compliance and is based on a declaration process. The manufacturer, importer or authorised agent (supplier) must also affix a compliance label to their product and hold documents supporting claims of compliance with the standards.

From 2012, the ACMA will introduce a new technical standards compliance program which will allow us to maximise our regulatory reach in a more strategic and resource efficient manner. The ACMA will set and publish Priority Compliance Areas, which will highlight issues of regulatory focus, their treatment and the consequences for those unwilling to participate. Priority areas will be reviewed quarterly to ensure ongoing relevance and will be consistent with the ACMA's graduated compliance and enforcement model. The ACMA will also assist stakeholders to better understand their regulatory responsibilities through targeted education and information programs.

2.5 Decision-making process

The ACMA makes a range of decisions and develops instruments to manage the radiofrequency spectrum. Decisions made by the Authority produce spectrum management outcomes in the form of allocations, pricing, licensing frameworks and licence conditions. Figure 2.2 illustrates the basis for and process behind these decisions. As indicated by the arrows encircling this diagram, spectrum management outcomes affect the environment and the demand for and supply of spectrum and so in this sense the process is iterative.

2.5.1 Principles for spectrum management

The principles provide scope for the ACMA to manage spectrum through a balanced application of both regulatory and market mechanisms. In summary, the principles are as follows:

1. Allocate spectrum to the highest value use or uses.
2. Enable and encourage spectrum to move to its highest value use of uses.
3. Use the least cost and least restrictive approach to achieving policy objectives.
4. To the extent possible, promote both certainty and flexibility.
5. Balance the cost of interference and the benefits of greater spectrum utilisation.

The principles aim to:

> promote consistency, predictability and transparency in the ACMA's decision-making
> provide guidance for major planning and allocation decisions to be made
> increase the ACMA's ability to respond to challenges, including the impact of new technologies and increasing demand for spectrum for advanced services.

The Radiocommunications Consultative Committee (RCC) has recommended that the principles be reviewed for possible updates to:

> provide further explanation or clarification on the language used to describe key concepts in spectrum management, such as 'highest value use' and 'total welfare standard'
> provide a broader consideration of what constitutes value in terms of spectrum use that is not limited to economic considerations.

Further information on this project is outlined in Chapter 6.

2.5.2 Total welfare standard

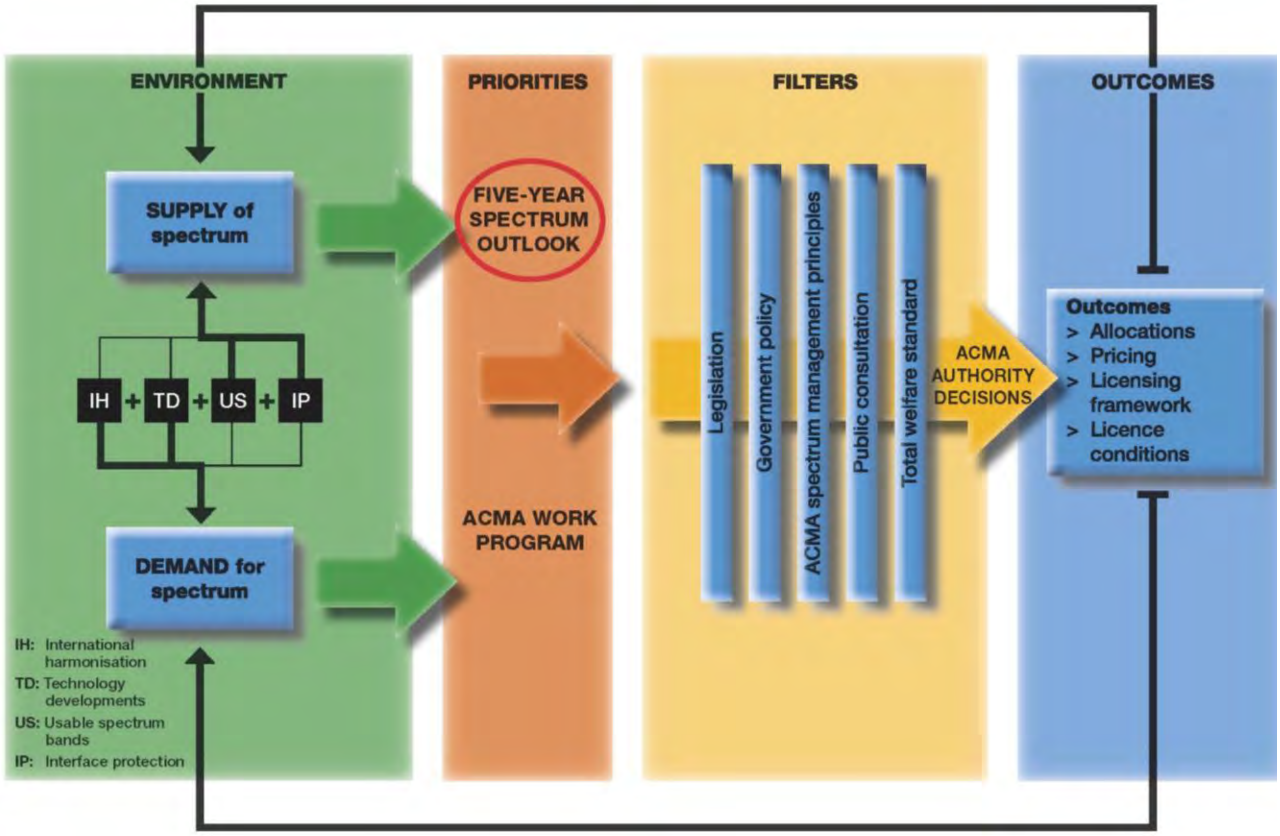
In 2007 the ACMA adopted a total welfare standard for use when:

> the policy and legislative framework provides the ACMA with discretion about the tests it might apply
> a regulatory intervention might have a significant economic impact on consumers, producers or other stakeholders.

In these circumstances, the impact on total welfare is one important factor that the ACMA will take into account.

The ACMA recognises that the assessment of costs and benefits using a total welfare standard will often need to take into account both quantitative and qualitative factors. When the total welfare standard is applied, all significant benefits and costs are taken into account and given the same weight, irrespective of the identity of the recipient.

Figure 2.2 The ACMA's spectrum management decision-making framework



Find out more »

3. Spectrum demand drivers

This chapter identifies the primary underlying drivers of spectrum demand:

> international developments
> government spectrum holdings
> auction processes
> interference management techniques
> facilitating emerging technologies.

A diverse range of factors drives demand for access to the radiofrequency spectrum. The demand from users of technology is in itself generated by a wide range of motives, such as the desire for mobility, networking and access to broadband. Potential users of the spectrum may have conflicting requirements, not all of which can always be accommodated.

Traditional distinctions between telecommunications, broadcasting and radiocommunications are becoming increasingly difficult to regulate, as new technologies and services on the market cut across all sectors. These developments are illustrated by the growth and variety of devices, which are wireless and bandwidth dependent. This phenomenon is a reflection of changing consumer demands, as markets evolve to satisfy the need for anywhere, anytime availability and the convenience of accessing multiple services regardless of the platform or technology used to deliver the service.

To realise the benefits associated with new technologies and services, Australia's various industry sectors leverage from internationally agreed spectrum arrangements and standards. As a result, costs are lower through the development of larger economies of scale and the market place is more competitive and provides benefits for consumers. Other factors that can drive demand for spectrum are outlined below.

3.1 International developments

The ACMA's role is to ensure alignment between global spectrum management policies and objectives with Australia's long-term interests and strategies for greater spectrum utilisation and economic approaches for licensing and allocation activities.

Current international trends indicate an upcoming focus on:

> new approaches to government spectrum holdings
> auction processes
> increasing use of licence exempt spectrum and associate interference management challenges
> facilitating the introduction of emerging 'smart' technologies.

The ACMA recognises that the current international communications environment is evolving at a rapid rate and facing regulatory pressures from new technologies that utilise spectrum in non-traditional ways. Nowhere is this more true than in the move to next generation networks (NGN) and converging services characterised by the increased demand for access to spectrum to support the deployment of mobile broadband infrastructure.

3.1.1 New approaches to government spectrum holdings

Government accounts for a large portion of spectrum use in Australia, with the Department of Defence the largest single user (government or non-government) in terms of bandwidth. Like commercial users of the spectrum, government requirements for spectrum are also growing, to both sustain existing services and provide for new services. As a result, government users influence spectrum demand in general. Importantly, in some cases, government use of the spectrum is substantially different to the broader community, with a strong emphasis on supporting remote-sensing applications, such as radar and passive earth observations.[2]

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[2] Passive services involve only the reception of electromagnetic radiation for their operation, as opposed to active services, which also include stations intended to transmit radiocommunication signals.

3.1.2 Auction processes

Regulators around the globe are increasingly moving towards the use of market-based mechanisms, such as auctions, to allocate high-value spectrum for mobile communications, including mobile broadband services. There are different types of spectrum auctions that have been used by international spectrum regulators over time, but it is important to realise that the use of a particular auction method relies on the characteristics and quantum of the spectrum to be allocated.

The open ascending-bid or English open-outcry auction is a method used by auction houses such as Sotheby's or Christie's or in many suburban real estate auctions. This form of auction is normally considered the most efficient for allocating spectrum at market price where there is one or a small number of lots within a band, none of which are substitutable or complementary for their intended business use.

The simultaneous multi-round ascending (SMRA) auction format is used when there are many spectrum lots to be allocated together across a range of different geographic areas and different band segments.

The combinatorial clock auction (CCA) is a price clock-based auction format used to sell multiple lots for different categories in a single process. It provides bidders with the flexibility to bid on different combinations of lots. The CCA format also creates incentives for bidders to bid their full value for the lots. This format has been used successfully overseas.

The United States Congress has recently given approval to the Federal Communications Commission (FCC) authority to conduct incentive auctions to enable spectrum to move to its highest value use.

An incentive auction is a voluntary, market-based tool used to compensate existing spectrum licensees for relinquishing their licences in order to make spectrum available for innovative new uses or services.

The underlying economic principle of incentive auctions is to provide an incentive to incumbent licensees to relinquish under-utilised spectrum, to enable further economic stimulation by allowing the spectrum to change use and provide the most valuable service to the public, as the highest-value use of the spectrum moves over time. Incentive auctions are seen as an attractive methodology as they may enable this movement to occur without the typically cumbersome regulatory processes which are often necessary to allow for a change in use part-way through the tenure period of a licence. As well they allow the re-purposing or re-farming of spectrum with minimal transaction costs.

3.1.3 Increasing the use of licence-exempt spectrum and associated interference management challenges

Coexistence: The Act was amended in December 2010 to enable class licences to coexist with spectrum licences. These amendments provide a much higher level of flexibility to licensing arrangements and similar coexistence arrangements for apparatus and spectrum licences may be beneficial. The ACMA has not yet applied this provision, and the introduction of coexistence arrangements for class licences to operate under spectrum licences would be subject to consultation with affected spectrum licensees.

Aside from the new coexistence provision of the Act, there is also potential for the ACMA to make greater use of other existing provisions, such as the application of individual licence conditions and tenure periods to reflect the parameters of specific services or applications authorised by the licence. This approach would provide greater flexibility for users in the longer term but may require further investigation by the ACMA, including the need for possible legislative change, before it is brought into use. The three existing licence systems can be used in combination in certain circumstances to facilitate spectrum sharing and increase spectrum utilisation. These combinations are sometimes compared with ‘easement’ rights, which provide a useful analogy for considering primary and secondary access to spectrum.

The following options can be used to configure easements:

- class licences (secondary) with apparatus licences (primary)
- class licences (secondary) with spectrum licences (primary)
- apparatus licences (secondary) with spectrum licences (primary)
- apparatus licences (secondary) with apparatus licences (primary).

Interference management challenges: The ACMA’s compliance and enforcement activities are facing increasing pressure caused by the current legislative framework not easily or readily keeping pace with market and technological changes.

The ACMA is currently researching risk-management approaches to interference management, such as, prioritising interference resolution resources based on the impact and consequences of the interference. The aim of these new approaches would be to encourage the most effective use of the limited resources available for interference management activities.

3.1.4 Facilitating introduction of emerging technologies

The accelerating pace of change in technology and services is continuing to produce scientific innovations that are increasingly dependent on spectrum as an input. While there is an increasing demand to provide spectrum for an expanding range of technologies and applications, technological advancements also offer the potential for more efficient use of the spectrum. Some of the emerging technologies that the ACMA is monitoring include:

Automation, sensing and monitoring: Remote monitoring of weather information, environmental sensing to automation of household appliances and automobile monitoring systems are some examples of such ubiquitous, automatically networked and interconnected devices. Increasingly automation, sensing and monitoring is occurring on a large scale. Mining companies in the Pilbara region of Western Australia, for example, are developing communication systems to automate dump trucks, drill rigs and iron ore trains.

Remote control: While smaller scale applications, such as garage door openers and radio-controlled toys, have also become part of everyday life, larger scale applications are placing an increasing demand on both spectrum and the regulatory frameworks. This includes a variety of applications from unmanned aerial vehicles (UAVs) to requests to enable for the legal use of remote firing and blasting systems for mining, law enforcement and the Australian Defence Force.

Navigation and traffic control: Smaller-scale applications include civilian global positioning systems (GPS) and navigation and automotive radars for intelligent cruise control systems.[3] Larger-scale applications for navigation and surveillance of aircraft and ships include ground-based, airborne and shipborne radars, automatic dependent surveillance broadcast (ADSB) and GPS augmentation systems, including capability for landing guidance.

Ubiquity of broadband: Broadband is recognised as a key economic enabler. For example, it underpins the development of e-commerce and e-health and can provide significant improvements in the delivery of education and government services.

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[3] Global Positioning System, a US satellite positioning system.

Broadband demand is also driven by the desire for people to have greater access to entertainment material.

In some instances, delivery of fast and reliable broadband relies on the use of terrestrial wireless technology, making access to broadband a strong driver for spectrum demand. In populated areas, 'last-mile' broadband services can be delivered via existing telephone line infrastructure or optical fibre to a large number of customers.[4] The area of service is limited by the performance of the telephone cable, which typically only allows for delivery up to a few kilometres from the exchange. In rural and remote areas, lower population density and the costs of establishing infrastructure can make wireline last-mile delivery unviable. Terrestrial wireless technology, while not able to provide the data rates available using wireline technology, can avoid the high capital costs associated with the installation of fixed wireline and cable and it is potentially faster to deploy. It can serve much larger areas and hence requires far fewer exchanges. It also removes the need to establish specific connections to each user. Satellites can cover much larger areas and therefore can also be an important component of the delivery of broadband services.

3.2 Future demand for mobile broadband

Spectrum capacity is under pressure from the rapid expansion of mobile data applications and the increasing volume of data that is downloaded. Revenue from data traffic is now outpacing revenue generated by voice traffic. Transmission and reception of data relies on a higher amount of bandwidth than traditional voice applications. The ACMA's communications report shows that in 2010–11:

> mobile wireless broadband subscribers[5] increased by 39 per cent

> mobile phone handset internet subscribers grew by 43 per cent

> mobile phone handset services without an internet fell by six per cent.

Smartphones and smart devices are a major driver in mobile data traffic and their users generate approximately 10 times the amount of traffic compared to a non-smartphone user. Demand for increased data rates in turn produces demand for increased bandwidth and increased spectrum occupancy. Demand for spectrum is influenced by growing affordability of mobile broadband, combined with the consumer trend of increased data transmission and or higher bandwidth applications.

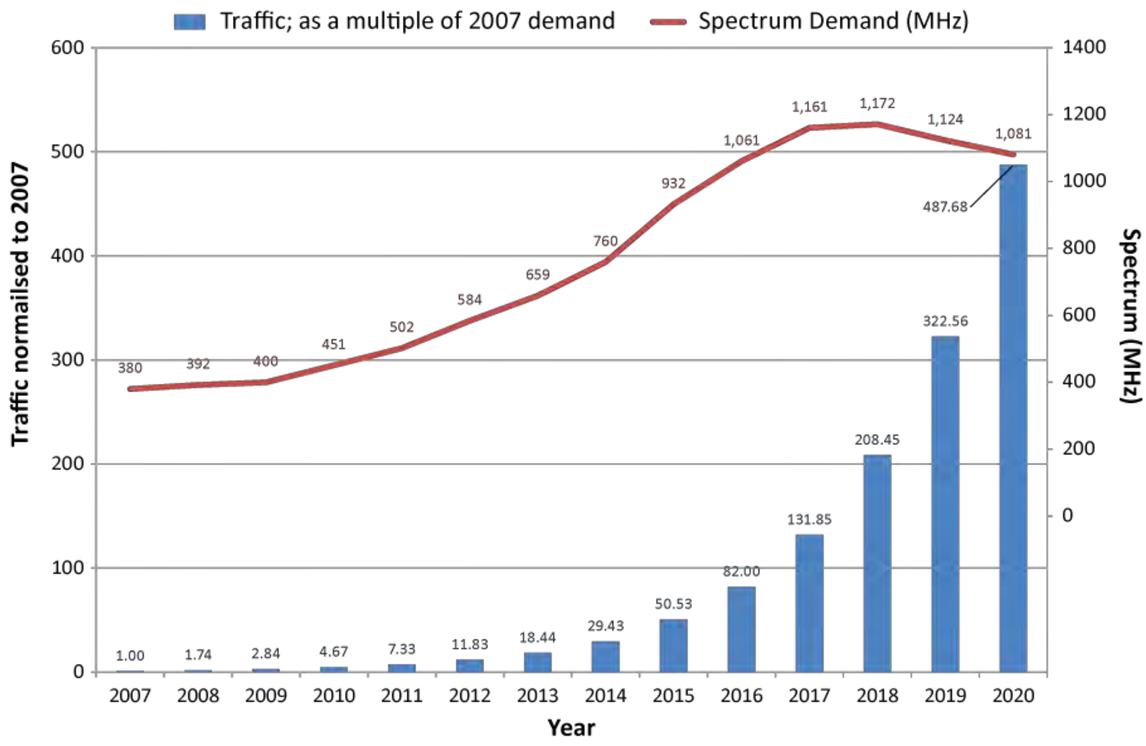
What is not known are the future applications that will derive their data from mobile services and therefore it is likely that this pressure will continue to increase as new technologies appear over time.

In Figure 2.3, the ACMA outlines its expectations for data and spectrum demands through to 2020 as outlined in the ACMA discussion paper *Towards 2020—Future spectrum requirements for mobile broadband*. The blue bar chart represents data demand based on industry assumptions to 2015 and ACMA trending to 2020. The red curve is the ACMA's anticipated level of spectrum demand to meet the needs of mobile broadband.

[4] The 'last mile' is the final link in delivering connectivity from a communications provider (at the local exchange or base station) to the end-user terminal. The term 'last mile' can be misleading, as in some cases wireless access can be provided up to 50 km from the base station.

[5] Refers to services offered via a datacard or dongle. Excludes mobile phone handset internet subscribers.

Figure 2.3 Expectations for spectrum demand and traffic out to 2020



The ACMA expects demand for spectrum to be based on the increasing use of data cards, USB dongles and machine-to-machine applications.

Machine-to-machine

Machine-to-machine (M2M) has been defined in a recent paper by the Organisation for Economic Co-operation and Development (OECD) *as devices that are communicating using wired and wireless networks, are not computers in the traditional sense and are using the Internet in some form or another.*

The ACMA expects that the demand for spectrum to support services such as:

> automated meter reading

> e-health applications and devices to monitor patients

> mobile-connected vehicles

will increase over time in response to the increased proliferation of M2M interactions and a rise in data usage.

M2M is still a relatively new technology and it is expected to grow rapidly with the availability of embedded devices. There have been forecasts of M2M device numbers in orders of magnitude greater than that of today's personal devices, which already exceed 5.0 billion.[6] While there are approximately 75 million cellular M2M connections in the world, this is expected to increase to 225 million by 2014.[7]

Australia is a 'mature' user of mobile technology with a fast uptake of new services and the ACMA expects that data demand will increase exponentially as a result of this trend until about 2018. As demand in mobile technology begins to slow, the ACMA expects an increase in demand for M2M devices to sustain the exponential nature of this demand curve through to 2020.

[6] International Telecommunication Union, Newsroom Press Release, *ITU sees 5 billion mobile subscriptions globally in 2010 – Strong global mobile cellular growth predicted across all regions and all major markets*, 15 February 2010, http://www.itu.int/net/pressoffice/press_releases/2010/06.aspx, retrieved 14 June 2011.

[7] Northstream Strategy and Sourcing, Whitepaper, *The revenue opportunity for mobile connected devices in saturated markets*, February 2010, http://northstream.se/wp-content/uploads/2010/02/The-revenue-opportunity-for-mobile-connected-devices-in-saturated-markets.pdf, retrieved 14 June 2011.

4. Significant spectrum projects

This chapter provides an overview of current high-priority spectrum management projects and has been divided into the following:

> new spectrum licences
> expiring spectrum licences
> current projects
> WRC-12.

One of the key purposes of the Outlook is to provide an indication to stakeholders about where the ACMA is directing its resources and which spectrum projects are considered a high priority therefore receiving primary consideration over other spectrum management issues. This does not assume that the work plans are set in concrete; rather, it provides a starting point for the ACMA with regard to the consideration and status of other spectrum-related work as it arises.

The ACMA has undertaken a considerable amount of work associated with spectrum management processes since the last edition of the Outlook was released. Table 4.1 provides a brief précis of the projects and the outcomes achieved by the ACMA.

Table 4.1 Completed projects

Project	Final outcomes
Technical	> Technical Liaison Groups to consult on new or revised technical frameworks for the 700 MHz, 800 MHz, 1800 MHz and 2.5 GHz bands. > Review of spectrum licence regulatory and technical frameworks. > Taken over 120,000 signal strength measurements of analog and digital television at more than 16,000 locations around Australia.
International delegations	> Hosted International Training Program. > Led Australian delegation to WRC-12.
Stakeholder engagement	> January 2011 to April 2012, the ACMA released 18 consultation papers on spectrum management issues. > Held four tune-ups and the 2011 *RadComms* conference.
Regulatory frameworks	> Variation of the Space Object Class Licence to include an additional 500 MHz of spectrum from 17.7–18.2 GHz for the reception of radio emissions by an Earth station under conditions specified in the class licence. > Consolidated expressions defined in the Radiocommunications Regulations 1993 into the Radiocommunications (Interpretation) Determination 2000. > Implementation of a new model to manage the ongoing interference coordination and regulation of Australian satellite networks. > UHF Citizen Band Radio Service (CBRS) arrangements were amended to increase the available channels from 40 to 80, relax the duty cycle restrictions for telemetry and telecommand transmissions and permit the transmission of identification and position information. > Introduced pricing incentives for apparatus licences fees to assist with 400 MHz transitional arrangements. > Reversion of 500 MHz spectrum licences to apparatus licences.

A number of spectrum licences will be allocated, converted, reissued and reallocated across the 2012–2016 period referred to within this Outlook. In order to prepare for the processes associated with the issue of spectrum licences, a considerable amount of resources are applied by the ACMA. The ACMA also continues to plan and develop technical and regulatory frameworks to support the use of other frequency bands by existing and emerging technologies and services. This section provides an overview of the significant spectrum projects that are both currently underway or ready to begin, as well as providing a summary of the outcomes of the World Radiocommunication Conference 2012 (WRC-12).

4.1 New spectrum licences

4.1.1 Reallocation of the 700 MHz band

In July 2010, the government directed the ACMA to clear 126 MHz of spectrum (the digital dividend) in the upper UHF band and reallocate the spectrum for new uses. During 2010 and 2011, the ACMA released the *Spectrum reallocation in the 700 MHz digital dividend band* discussion paper and hosted a digital dividend auction tune-up.

After considering stakeholder interests, legislative requirements and the potential to optimise public benefit through the most efficient allocation and use of spectrum, in May 2011 the ACMA recommended to the minister that he make a spectrum reallocation declaration for the paired frequency range 703–748 MHz and 758–803 MHz.

4.1.2 New arrangements in the 2.5 GHz band

The ACMA undertook a review of the 2.5 GHz band and in January 2010 released the *Review of the 2.5 GHz band and long-term arrangements for ENG* discussion paper to provide stakeholders with the opportunity to comment on technical and policy issues associated with the future use of the spectrum. This review was completed in October 2010 and the ACMA subsequently announced its decision to replan and reallocate the band by:

> converting existing Television Outside Broadcast (TOB) apparatus licences from 2570–2620 MHz to 15-year spectrum licences (2.5 GHz mid band gap) for TOB use

> reallocate 2500–2570 MHz and 2620–2690 MHz via the allocation of technology-flexible spectrum licences which are optimized for WAS.

4.1.2.1 Conversion process

The ACMA is currently working on the development of:

> the conversion plan, which will set out the procedures and timetable for issuing spectrum licences to replace existing apparatus licences in the 2.5 GHz mid-band gap

> the technical framework which will apply to the converted licences, including a determination setting out unacceptable levels of interference for the purpose of registering transmitters in the mid-band gap and guidelines for the coordination of transmitters and receivers operated in the mid-band gap.

The ACMA expects to undertake public consultation on the conversion plan and the instruments which make up the technical framework in 2012. Following consideration of any submissions received in response to the consultation process, the ACMA will make the final conversion plan and the instruments which comprise the technical framework for the new spectrum licences. Existing apparatus licence-holders will then be invited to comment on the draft spectrum licences.

The ACMA will consider any such representations it receives and may change the draft licence as a result of those considerations. The ACMA will then offer each licensee a spectrum licence to replace the licensee's apparatus licence and advise the licensees of the spectrum access charge—or 'conversion fee'—that is payable for the licence. If the licensee accepts the licence offer and agrees to pay the spectrum access charge, then the ACMA will issue the new spectrum licence. The ACMA expects that this process will occur in 2013.

The new spectrum licences are not expected to commence immediately on issue. The ACMA considers it is desirable that, when possible, all spectrum licences in a band should have a common expiry date. In the case of the 2.5 GHz band, that means that the term of the converted licences in the mid-band gap should align with the term of the spectrum licences in the upper and lower 2.5 GHz bands which are currently planned to be auctioned in late 2012. The auctioned licences are planned to commence at the end of the reallocation period, on 1 October 2014, and expire on 30 September 2029. The ACMA therefore proposes that any converted spectrum licences should also commence on 1 October 2014 and expire on 30 September 2029.

4.1.3 Digital dividend auction

Having considered the ACMA's final recommendations, the minister made declarations on 1 November 2011 to reallocate specified parts in the 700 MHz and 2.5 GHz bands as spectrum licences.

As the characteristics of the 700 MHz and 2.5 GHz bands complement each other, the ACMA has decided to reallocate the spectrum in both bands in a single auction in 2012–13. The auction of spectrum in both bands will be referred to as the digital dividend auction. The ACMA has chosen to use a combinatorial clock auction (CCA) format as the auction method. The CCA is a method used to sell multiple items in a single auction process. The CCA allows the ACMA to offer the spectrum as a series of 'lots' for sale. Bidders can then parcel the lots on which they want to bid into packages. This format provides the opportunity for bidders to purchase specific combinations of spectrum that best suit their business requirements. Following a tender process, the ACMA appointed Power Auctions to provide the online capability services to conduct the auction.

To provide stakeholders with an opportunity to actively engage with the ACMA on its work on preparation for the digital dividend auction, the ACMA hosted the digital dividend auction tune-up in 2011 and two workshops in early 2012.

In order to auction the 700 MHz and 2.5 GHz spectrum, the ACMA must prepare a number of legislative instruments under the Act. These include two Marketing Plans under section 39A, an Allocation Determination under section 60 and the technical framework instruments under sections 145 and 262 of the Act. Submissions closed in early May 2012 for the draft instruments. A webinar was held to inform interested parties in making a submission.

4.1.3.1 *Next steps*

> Release of consultation paper on licence commencement, spectrum availability and auction timing—Q2, 2012.

The ACMA will continue to work with stakeholders in finalising the legislative instruments, rules and related processes for the auction in 2012–13. Updates on the progress of the digital dividend auction can be found on the ACMA's *engage* website or by signing up to the monthly spectrum auction e-Bulletin.

4.2 Expiring spectrum licences

In the late 1990s and early 2000s the Australian Communications Authority issued the first spectrum licences under the Act across nine different bands. These licences are now approaching the end of the 15-year licence term and are part of the ACMA's current project on expiring spectrum licences.

The Act presumes that expiring spectrum licences are to be reallocated by price-based allocation or, if it is in the public interest to do so, to be reissued to the same licensee. The Act provides that expiring spectrum licences may only be reissued to the same licensee under either of two circumstances:

1. The licence was **used in the provision of a service** included in a class of services specified in a Ministerial determination made under subsection 82(3) as a class of services for which reissuing spectrum licences to the same licensees would be in the public interest.
2. The ACMA is satisfied that **special circumstances** exist as a result of which it would be in the **public interest** to reissue the licence to the same licensee.

In February 2012 the minister announced that he had made a 'class of services' determination relating to the reissue of licences to incumbent licensees providing:

- mobile voice and data communications services in the 800 MHz, 1800 MHz and 2 GHz bands
- wireless broadband services in the 2.3 GHz and 3.4 GHz bands
- satellite services in the 27 GHz band.

The minister has also directed the ACMA as to the spectrum access charges—that is, the fee per MHz of spectrum, per capita in the licence area—that should apply to licences reissued in the bands covered by the class of services determination.

The making of these instruments allows the ACMA to commence its licence reissue considerations. Where licences are not reissued to the incumbent licensee, they would usually be subject to a price-based allocation process, for example an auction.

The ACMA's policy is to provide both incumbent and prospective licensees with certainty, where possible, regarding the outcome of expiring spectrum licence processes in each band approximately 18 months before expiry of licences.

Accordingly, the ACMA has developed a forward work plan for expiring spectrum licences that considers each band separately as licence expiry approaches, with a view to considering all the technical and regulatory issues associated with a band at the same time, rather than on a per licence or licensee basis.

To date, the ACMA has commenced its reissue considerations for the 800 MHz, 1800 MHz and 2.3 GHz bands.

Table 4.2 sets out the processes the ACMA will follow as licence expiry approaches in each band.

Find out more »

Table 4.2 Work plan for expiring spectrum licences

Band	Time frame
800 MHz Licence expiry: 17 June 2013	Technical framework > Development complete (Jul 11 – Feb 12) > Public consultation: July 2012 Reissue consideration > Underway: expect completion June 2012 Reallocation process > TBA
1800 MHz Licence expiry: 17 June 2013; 3 May 2015	Technical framework > Development complete (Jul 11 – Feb 12) > Public consultation: July 2012 Reissue consideration—Tranche 1 (2013) > About to commence > Expected completion in July/Aug 2012 Reissue consideration—Tranche 2 (2015) > TBA Reallocation process > TBA
28/31 GHz Licence expiry: 31 January 2014	Review of existing arrangements > Expected consultation process in Q2/3, 2012 Technical framework > Expected commencement Q4, 2012 Reallocation process > TBA
2.3 GHz Licence expiry: 24 July 2015	Technical framework > Expected commencement June/July 2012 > Includes consideration of the potential replanning from 98 MHz to 100 MHz bandwidth Reissue consideration > Expected commencement from Q1, 2013 Reallocation process > TBA
3.4 GHz Licence expiry: 13 December 2015	Technical framework > Expected commencement Aug / Sept 2012 > Includes consideration of planning arrangements Reissue consideration > Expected commencement from Q2, 2013 Reallocation process > TBA
27 GHz Licence expiry: 17 January 2016	Technical framework > Expected commencement 2014 Reissue consideration > Expected commencement 2014 Reallocation process > TBA

2 GHz Licence expiry: 11 October 2017	Technical framework > Expected commencement 2014 Reissue consideration > Expected commencement 2014 Reallocation process > TBA

4.3 Current projects

4.3.1 Digital restack

Since 1998, the ACMA has been planning broadcast spectrum to ensure that digital television and its associated benefits can be made available to viewers across Australia as analog television broadcasts are progressively turned off.

The ACMA is playing a significant role in supporting the switchover to digital television. Key tasks include:

> assessing digital signal coverage under the coverage evaluation program

> planning and licensing digital services

> commencing work on the availability and possible use of spectrum following the switchover to digital television

> providing the minister with an analysis of the technical and other factors which may influence a timetable for the switchover

> undertaking research on the technical impediments to digital television take-up. The research will also look at improved measurement of digital signal coverage and the performance of digital receivers

> registering a conditional access scheme that will allow viewers who do not receive digital commercial free-to-air (terrestrial) services to gain access to the new VAST satellite service.

The ACMA is working with broadcasters to replan the digital channel allotments and clear the digital dividend. The restacking of digital television services by shifting them from the upper end of the UHF television band and concentrating them in the spectrum below channel 52 will clear a contiguous block of spectrum suitable for allocation and re-use.

In February 2011, the ACMA consulted on the planning objectives for restacking digital television channels. Following consideration of submissions, the ACMA published its' decision on the planning principles *Clearing the digital dividend—restacking digital TV* (Document number - RPAG-28). The development of this set of planning principles paved the way for the ACMA to commence planning for the restack of digital services. The restack will be given effect through new television licence area plans (TLAPs) prepared under section 26(1B) of the *Broadcasting Services Act 1992* and, in some instances, by variations to digital channel plans (DCPs) under the digital TV conversion schemes.

4.3.2 Review of the 803–960 MHz band

The review of the 803–960 MHz band commenced in 2011 with the release of *The 900 MHz band—Exploring new opportunities* discussion paper. This paper proposed a number of significant potential improvements to the way the band is currently assigned. These proposals included:

> replan and reallocate the segments currently planned for global system for mobile (GSM) to improve both technical and allocative efficiency

- expand services, such as the 850 MHz spectrum-licensed segments or the adjacent land mobile segments, or enable new services in the 800 MHz band using part of the digital dividend from 805–820 MHz paired with 850–865 MHz
- replan the land mobile segments so that they may reach their highest value use
- make spectrum available for smart infrastructure, or the possible expansion of the industrial, scientific and medical (ISM) segment or other services in the band
- replan a number of segments in the band that are under-utilised or unused due to allocations to outmoded technologies or unrealised applications.

Following analysis of the 63 submissions received to *The 900 MHz band—Exploring new opportunities*, the project has been split into two distinct issues:

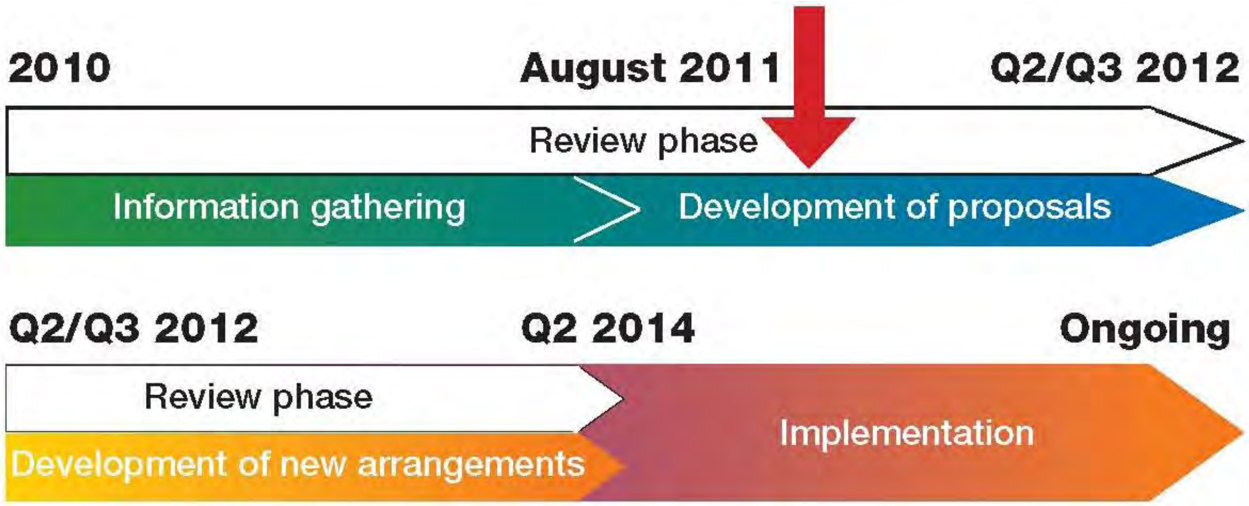
- replan of the digital cellular mobile telephone service (CMTS) segments (890–915 MHz paired with 935–960 MHz)
- replan of the 803–825 MHz, 845–870 MHz and 915–935 MHz band, including consideration of expanding two-frequency services in the 800 MHz band.

These issues have been separated as they encompass different parts of the 803–960 MHz band and can therefore be considered in isolation. Additionally, as part of the project to identify spectrum for public safety agencies (PSA) in section 4.3.3 below, the ACMA is considering an amount of spectrum, if any, that could be identified in the 800 MHz band to support the deployment of mobile broadband networks by these agencies.

Two discussion papers, one on each issue, are scheduled for release in 2012 and will contain proposals on future arrangements in the 803–960 MHz band.

As outlined in Figure 4.1, the review phase is expected to be completed in mid 2014 with implementation ongoing after the completion of the review.

Figure 4.1 Phases and stages of the 803–960 MHz review



4.3.3 Spectrum for public safety agencies (PSAs)

In May 2011, the Attorney-General and the Minister for Broadband, Communications and the Digital Economy established the Public Safety Mobile Broadband Steering Committee to work towards the development of a new nationally interoperable mobile broadband capability for public safety agencies (PSAs). Further information on the Public Safety Mobile Broadband Steering Committee (PSMBSC) is available on the DBCDE website.

Currently, the majority of dedicated public safety radiocommunications services in Australia are narrowband land mobile networks operating in the VHF and UHF bands (including extensive holdings in the 400 MHz band). The ACMA is assisting PSAs to realise a nationally interoperable public safety mobile broadband (PSMB) capability in this band.

As part of its involvement in the PSMBSC, the ACMA is investigating whether a provision of spectrum from the 800 MHz band could be used to assist in realising a mobile broadband capability. This includes the identification of potential models, including options for accessing private and/or commercial mobile broadband networks, and determining whether provision of dedicated spectrum is needed for this and, if so, the quantum of spectrum required.

The ACMA is also in the process of making 50 MHz of spectrum available in the 4.9 GHz band for high-capacity, short-range data transfer (including video, mapping, imagery and other sensor data) for exclusive public safety use. This band will be ideal for setting up multi-agency local area networks in response to an incident or disaster. Preparations for consultation are currently underway and an outcome is expected in 2012/2013.

Public safety radiocommunications needs are wide-ranging and demand for services is highly dynamic and non-homogeneous. Through a combination of the abovementioned provisions, PSAs will have access to a suite of wide area narrowband and broadband communications, with the ability to meet localised ‘spikes’ in demand (such as those resulting from an emergency or disaster), with high capacity, deployable ‘hot spots’. This represents a multi-band ‘system of systems’ type of approach to public safety communications, which is the best way for PSAs to meet their mission and business critical communications needs well into the future.

4.3.4 Infrastructure parks

There is current interest from a variety of infrastructure stakeholders in deploying wireless network devices (such as mobile stations) within a large geographic area. To address this interest, the ACMA is considering the development of an ‘area-style’ licence to support such a cellular mobile network.

The ACMA is yet to determine which licensing arrangements could apply in the longer term to support an ‘area wide’ type of licence. However, the ACMA is proposing a trial ‘private park’ arrangement in a defined geographic area in the Pilbara region with mining, transport and other infrastructure entities. The private park would provide participants with a radiocommunications licence authorising the operation of services in a specified frequency range and geographic area.

It is important to note that although the term ‘private park’ denotes some form of exclusivity, it is the ACMA’s view that an offer to participate in the private park should be extended to a number of industry participants who operate within a specified geographic area. Consequently, the exclusivity suggested by the arrangement would apply to an industry rather than to a single entity.

The purpose of the private park trial is twofold. It would allow participants to undertake the necessary testing of equipment and technologies. It could also assist the ACMA in determining whether spectrum sharing and coordination agreements can be negotiated between industry players in close geographic proximity within the framework of the private park. Some of the reasons supporting this approach include:

- the possibility of shared infrastructure for various operations/services
- synergies in industry operations and communications environments with focus on mobile telephony technologies
- increased demand for larger bandwidths of spectrum to support wireless operations balanced with the availability of mobile spectrum in regional and remote areas
- the development of coordination arrangements that would enable industry to determine its own deployment requirements and interference management techniques
- links into the ACMA's broader project objectives to determine spectrum requirements and arrangements to support smart infrastructure technologies, applications and services.

4.3.5 1.5 GHz mobile band

In the *Towards 2020—Future spectrum requirements for mobile broadband* discussion paper, the ACMA estimated that up to a further 300 MHz of spectrum will be required for mobile broadband services by 2020, with up to 150 MHz of this being required by 2015.

A number of frequency bands below 6 GHz were identified for possible use by mobile broadband services in the discussion paper. This included the 1427.9–1462.9 MHz and 1475.9–1510.9 MHz band segments (the 1.5 GHz mobile band).

The first stage of the review of the 1.5 GHz mobile band will be to release a discussion paper in mid-2012 seeking comment on two potential planning arrangements in the band:

- use of the paired segments 1427.9–1462.9 MHz and 1475.9–1510.9 MHz
- use of the unpaired segment 1452–1492 MHz.

The ACMA notes that the implementation of either of the planning arrangement prevents the use of the other arrangement. The paper also outlines the current use of the 1.5 GHz mobile band and status of planning arrangements in the international environment, along with an assessment of the potential impact on existing services.

4.3.6 400 MHz implementation

The 400 MHz band is used for a diverse range of services, including land mobile and fixed (point-to-point and point-to-multipoint), radiolocation and amateur services. The level of congestion within this band has been steadily increasing for some time and in response to this in conjunction with requests from industry and users of the band, the ACMA commenced a comprehensive review the band in 2008.

A key outcome of the review is the move to implement harmonised spectrum arrangements for government agencies. Work is currently underway to implement the outcomes of the ACMA's review in order to finalise transition to the new arrangements by 31 December 2015 in areas where congestion is defined, and by 31 December 2018 outside of these areas.

The transition process consists of a phased approach, implementing:

- measures to address congestion
- harmonised government spectrum
- new arrangements in 450–470 MHz.

The ACMA recognises that in the short to medium term there will be some disruption caused to licensees by implementing the outcomes of the 400 MHz review. The ACMA believes that these arrangements will improve the efficiency and effectiveness with which services are delivered in the band over the longer term and aims to minimise disruptions as much as possible. The new arrangements will also enable expanded use and flexibility, which will in turn maximise the public benefit arising from use of this spectrum.

4.4 Outcomes from the World Radiocommunication Conference 2012

The ACMA maintains a high profile within the international radiocommunications community, particularly the activities of the International Telecommunication Union Radiocommunication Sector (ITU-R).

The ACMA coordinates Australia's input to the ITU-R in setting international standards for radiocommunications. This input culminates in an ITU treaty level World Radiocommunication Conference (WRC) being conducted every four years with the 2012 WRC (WRC-12) held from 23 January to 17 February 2012 in Geneva, Switzerland.

The ACMA at WRC-12

LEFT: Maureen Cahill, General Manager Communications Infrastructure Division, ACMA with Chris Chapman, Chair, ACMA
RIGHT: Dr Andrew Kerans, Executive Manager, Spectrum Infrastructure Branch, ACMA

4.4.1 Preparation

The ACMA oversees extensive industry and stakeholder consultation in preparation for the WRC. For WRC-12 this was led by the ACMA's Radiocommunications Consultative Committee (RCC) Preparatory Group for WRC-12 (PG WRC-12) and the Australian Radiocommunications Study Groups (ARSGs).

The participation of Australian industry and stakeholders is essential in ensuring that the decisions and future development of international radiocommunications regulations are in Australia's interest. ARSGs are chaired by government or industry representatives and coordinated by the ACMA. Six ARSGs, which mirror the work of the ITU-R Study Groups, were established for WRC-12.

An important part in the WRC preparatory process involves the ACMA working closely with the Asia-Pacific Telecommunity (APT) to achieve a coordinated approach to radiocommunications issues in the Asia-Pacific region. Cooperation within the APT results in Australia's positions and proposals to a WRC being harmonised with those of other countries in the region.

4.4.2 Australian Radiocommunication Study Group (ARSGs)

The ARSGs are subordinate to the RCC and represent a group of experts that form Australian positions on issues considered at the regional and international level and provide input to international meetings.

The ARSGs' responsibilities include:

> study, coordinate and provide expert advice to the RCC and the ACMA to assist in the development of Australian positions and contributions for Australian Delegations to ITU-R Study Groups and subordinate group meetings
> promote and encourage the development of Australian expertise and encourage Australian participation in ITU-R Study Group matters
> report outcomes of ITU-R studies and make recommendations, relevant to WRC Agenda items to the Preparatory Group for WRC
> provide advice and guidance on relevant matters to other ARSGs and the RCC subsidiary groups as necessary.

4.4.3 Outcomes from WRC-12

Table 4.3 lists all the Agenda items discussed at WRC-12. The Agenda items are grouped by radiocommunication service and contain a brief description of the item and précis of the outcomes.

The outcomes from WRC-12 will affect the ACMA's future work plan, which will be reflected in future editions of the Outlook, as Australia's allocations are updated to align with the ITU's requirements for the Asia–Pacific region.

Further information on the ARSG responsible for following WRC-15 Agenda items will become available on the ACMA website as they establish over the following 12 months. Further information on ITU Agenda items for WRC-15 and WRC-18 are available on the ITU-R website on the Conference Preparatory Meeting (CPM).

Find out more »

Table 4.3 Agenda items discussed at WRC-12

WRC-12 Agenda item	Description	Responsible ARSG	Outcome from WRC-12	Services affected
Agenda item 1.3—Unmanned aircraft systems	To consider spectrum requirements and possible regulatory actions, including allocations, in order to support the safe operation of unmanned aircraft systems (UAS), based on the results of ITU-R studies, in accordance with Resolution 421 (WRC-07).	ARSG 5	5 030–5 091 MHz primary allocation for aeronautical mobile (route) service (AM(R)S) and existing aeronautical mobile-satellite (Route) service (AMS(R)S) for unmanned aircraft systems line of sight controls. Restricted to use for safety and regularity of flight. Also a new Agenda item for WRC-15 was developed to consider satellite allocations for UAS.	Maritime and aeronautical
Agenda item 1.4—New AM(R)S in the bands 112–117.975, 960–1 164 and 5 000–5 030 MHz	To consider, based on the results of ITU-R studies, any further regulatory measures to facilitate introduction of new aeronautical mobile (R) service (AM(R)S) systems in the bands 112–117.975 MHz, 960–1 164 MHz and 5 000–5 030 MHz in accordance with Resolutions 413 (Rev.WRC-07), 417 (WRC-07) and 420 (WRC-07).	ARSG 5	Footnote **5.B103** was added, whereby in the frequency bands 5 000–5 030 and 5 091–5 150 MHz, the aeronautical mobile-satellite (R) service is subject to agreement coordination requirements under No. **9.21** of the Radio Regulations. The use of these bands by the AMS(R)S is restricted to use for safety and regularity of flight.	
Agenda item 1.9—Appendix 17—New digital technologies for MMS	To revise frequencies and channelling arrangements of Appendix 17 to the Radio Regulations, in accordance with Resolution 351 (Rev.WRC-07), in order to implement new digital technologies for the maritime mobile service.	ARSG 5	Numerous operational changes to maritime services operating as per Appendix **17** of the Radio regulations. However, no effect to services already allocated.	
Agenda item 1.10—Allocation requirements of safety systems of ships and ports	To examine the frequency allocation requirements with regard to operation of safety systems for ships and ports and associated regulatory provisions, in accordance with Resolution 357 (WRC-07).	ARSG 5	The frequency band 495–505 kHz is allocated to the maritime mobile service on a global basis. The frequency bands 161.9625–161.9875 MHz and 162.0125–162.0375 MHz primary allocation to the maritime mobile service. Numerous other changes not allocation specific have been made.	

WRC-12 Agenda item	Description	Responsible ARSG	Outcome from WRC-12	Services affected
Agenda item 1.14—Radiolocation service in the range 30–300 MHz	To consider requirements for new applications in the radiolocation service and review allocations or regulatory provisions for implementation of the radiolocation service in the range 30–300 MHz, in accordance with Resolution 611 (WRC-07).	ARSG 5	Additional allocation to the radiolocation service between 154–156 MHz via a footnote that includes a list of countries. Australia is not included in the footnote therefore the allocation does not apply.	Radiolocation and amateur
Agenda item 1.15—Oceanographic radars 3–50 MHz	To consider possible allocations in the range 3–50 MHz to the radiolocation service for oceanographic radar applications, taking into account the results of ITU-R studies, in accordance with Resolution 612 (WRC-07).	ARSG 5	Allocations relevant to Region 3 are: > 4 438–4 488 kHz (50 kHz) secondary > 5250–5 275 kHz (25 kHz) secondary > 9 305–9 355 kHz (50kHz) secondary > 13 450–13 550 kHz (100kHz) secondary > 16 100–16 200 kHz (100 kHz) secondary > 24 450–24 600 kHz (150 kHz) secondary > 26 200–26 350 kHz (150 kHz) secondary > 39 500–40 000 kHz (500 kHz) primary Revised Resolution 612 specifies 'the peak e.i.r.p. of an oceanographic radar shall not exceed 25 dBW'.	
Agenda item 1.21—Radiolocation service 15.4–15.7 GHz	To consider a primary allocation to the radiolocation service in the band 15.4–15.7 GHz, taking into account the results of ITU-R studies, in accordance with Resolution 614 (WRC-07).	ARSG 5	Worldwide primary allocation to the radiolocation service in the band 15.4–15.7 GHz.	
Agenda item 1.5—ENG spectrum harmonisation	To consider worldwide/regional harmonization of spectrum for electronic news gathering (ENG), taking into account the results of ITU-R studies, in accordance with Resolution 954 (WRC-07).	ARSG 5	No change to allocations.	Fixed, mobile and broadcasting
Agenda item 1.8—Fixed services in bands between	To consider the progress of ITU-R studies concerning the	ARSG 5	Inclusion of recommended emission masks in the Radio Regulations for Fixed	

WRC-12 Agenda item	Description	Responsible ARSG	Outcome from WRC-12	Services affected
71–238 GHz	technical and regulatory issues relative to the fixed service in the bands between 71 GHz and 238 GHz, taking into account Resolutions 731 (WRC-2000) and 732 (WRC-2000).		Services operating in the 81–86 GHz and 92–94 GHz bands.	
Agenda item 1.17—Sharing between MS and other services in the band 790–862 MHz in Regions 1 and 3	To consider results of sharing studies between the mobile service and other services in the band 790–862 MHz in Regions 1 and 3, in accordance with Resolution 749 (WRC-07) to ensure the adequate protection of services to which this frequency band is allocated, and take appropriate action.	ARSG 5 and ARSG 6	No change allocations.	
Agenda item 1.20—HAPS	To consider the results of ITU-R studies and spectrum identification for gateway links for high altitude platform stations (HAPS) in the range 5 850-7 075 MHz in order to support operations in the fixed and mobile services, in accordance with Resolution 734 (Rev.WRC-07).	ARSG 5	Inclusion of Resolution **150**—Use of the bands 6 440–6 520 and 6 560–6 640 MHz by gateway links for high altitude platform stations in the fixed service.	
Agenda item 1.22—Protection of services from short range radio devices	To examine the effect of emissions from short-range devices on radiocommunication services, in accordance with Resolution 953 (WRC-07).	ARSG 1	No change to allocations.	
Agenda item 1.6—Update passive services in the band 275–3 000 GHz	To review No. 5.565 of the Radio Regulations in order to update the spectrum use by the passive services between 275 GHz and 3 000 GHz, in accordance with Resolution 950 (Rev.WRC-07), and to consider possible procedures for free-space optical-links, taking into account the results of ITU-R studies, in accordance with Resolution 955 (WRC-07).	ARSG 1	Modification of Radio Regulation footnote No. 5.565 to identify bands in the range 275–1 000 GHz for use by passive service applications, use of this range by active services and use of frequencies in the range 1 000–3 000 GHz by both active and passive services. Suppression of Resolution 950 (Rev.WRC-07) and Resolution 955 (Rev. WRC-07).	Science

WRC-12 Agenda item	Description	Responsible ARSG	Outcome from WRC-12	Services affected
Agenda item 1.11—SRS (E-s) 22.55–23.15 GHz	To consider a primary allocation to the space research service (Earth-to-space) within the band 22.55–23.15 GHz, taking into account the results of ITU-R studies, in accordance with Resolution 753 (WRC-07).	ARSG 7	A new primary allocation was added to the space research service (Earth-to-space) within the band 22.55–23.15 GHz.	
Agenda item 1.12—Protection of primary services 37–38 GHz	To protect the primary services in the band 37–38 GHz from interference resulting from aeronautical mobile service operations, taking into account the results of ITU-R studies, in accordance with Resolution 754 (WRC-07).	ARSG 7	Exclusion of AMS from the MS allocation in the 37–38 GHz band.	
Agenda item 1.16—Meteorological aids – below 20 kHz	To consider the needs of passive systems for lightning detection in the meteorological aids service, including the possibility of an allocation in the frequency range below 20 kHz, and to take appropriate action, in accordance with Resolution 671 (WRC-07).	ARSG 7	A new primary allocation in frequency range 8.3–11.3 kHz for passive use by Meteorological Aids.	
Agenda item 1.24—Meteorological satellite service in 7 750–7 900 MHz	To consider the existing allocation to the meteorological-satellite service in the band 7 750-7 850 MHz with a view to extending this allocation to the band 7 850–7 900 MHz, limited to non-geostationary meteorological satellites in the space-to-Earth direction, in accordance with Resolution 672 (WRC-07).	ARSG 7	A 50 MHz extension of the 7 750–7 850 allocation to 7 900 MHz for non-geostationary meteorological satellites space-to-Earth allocations.	
Agenda item 1.7—AMS(R)S 1 525–1 559 MHz and 1 626.6–1 660.5 MHz	To consider the results of ITU-R studies in accordance with Resolution 222 (Rev.WRC-07) in order to ensure long-term spectrum availability and access to spectrum necessary to meet requirements for the aeronautical mobile-satellite (R) service, and	ARSG 4	New Resolution **422 (WRC-12)** *Development of methodology to calculate aeronautical mobile-satellite (R) service spectrum requirements within the frequency bands 1 545–1 555 MHz (space-to-Earth) and 1 646.5–1 656.5 MHz (Earth-to-space)*.	Satellite

WRC-12 Agenda item	Description	Responsible ARSG	Outcome from WRC-12	Services affected
	to take appropriate action on this subject, while retaining unchanged the generic allocation to the mobile-satellite service in the bands 1 525–1 559 MHz and 1 626.5–1 660.5 MHz.			
Agenda item 1.13—BSS and feeder links 21.4–22 GHz	To consider the results of ITU-R studies in accordance with Resolution 551 (WRC-07) and decide on the spectrum usage of the 21.4–22 GHz band for the broadcasting-satellite service and the associated feeder-link bands in Regions 1 and 3.	ARSG 4	New provisions, including pfd limits for terrestrial and BSS.	
Agenda item 1.18—Global primary allocation to the radiodetermination satellite service in the band 2 483.5–2 500 MHz	To consider extending the existing primary and secondary radiodetermination-satellite service (space-to-Earth) allocations in the band 2 483.5–2 500 MHz in order to make a global primary allocation, and to determine the necessary regulatory provisions based upon the results of ITU-R studies, in accordance with Resolution 613 (WRC-07).	ARSG 4	A global primary allocation to the radiodetermination-satellite service in the frequency band 2 483.5–2 500 MHz with coordination threshold pfd values of –152 dB(W/m2) in 4 kHz and –128 dB (W/m2) in 1 MHz. Increased p.f.d levels for the MSS.	
Agenda item 1.25—MSS—additional allocations 4 GHz to 16 GHz	Studies of possible bands for new allocations to the mobile-satellite service in the Earth-to-space and space-to-Earth directions, with particular focus on the range 4 GHz to 16 GHz, taking into account sharing and compatibility, without placing undue constraints on existing services in this band, in accordance with Resolution 231 (WRC-07).	ARSG 4	No change.	
Agenda item 7—Satellite procedures	To consider possible changes in response to Resolution 86 (Rev. Marrakesh, 2002) of the Plenipotentiary	ARSG 4	Extensive number of changes—refer to WRC-12 Final Acts for details.	

WRC-12 Agenda item	Description	Responsible ARSG	Outcome from WRC-12	Services affected
	Conference, in accordance with Resolution 86 (Rev.WRC-07).			
Agenda item 1.2—Enhancing the international spectrum regulatory framework	Taking into account the ITU-R studies carried out in accordance with Resolution 951 (Rev.WRC-07), to take appropriate action with a view to enhancing the international regulatory framework.	ARSG 1	No change to Radio Regulations definitions regarding fixed and mobile. New Resolution 957 [PLEN/1] (WRC-12) for *Studies towards review of definitions of fixed service, fixed station and mobile station*. Minor revision to Recommendation 34 on *Principles for the allocation of frequency bands.* No change on satellite convergence issues. Suppression of Resolution 951 *Enhancing the international spectrum regulatory framework.*	Future work program
Agenda item 1.19—Software defined radio and cognitive radio systems	To consider regulatory measures and their relevance, in order to enable the introduction of software-defined radio and cognitive radio systems, based on the results of ITU-R studies, in accordance with Resolution 956 (WRC-07).	ARSG 1	Establishment of Recommendation COM6/1 [76] Deployment and use of cognitive radio systems.	
Agenda item 2—Incorporation by Reference	To examine the revised ITU-R Recommendations incorporated by reference in the Radio Regulations communicated by the Radiocommunication Assembly, in accordance with Resolution 28 (Rev.WRC-03)[8] and to decide whether or not to update the corresponding references in the Radio Regulations, in accordance with principles contained in the Annex to Resolution 27 (Rev.WRC-07).[9]	ACMA	Inclusion in Volume **4** of RRs a cross-reference table between ITU-R Recommendations incorporated by reference and RR provisions and footnotes where they are referenced; Modification of Resolution **27 (Rev.WRC-07)** to implement the Table in Volume **4**; Update of the corresponding texts in the RRs taking into account the new versions of certain ITU-R Recommendations incorporated by reference in the RR which have been revised since WRC-07; and Modification of certain footnotes and provisions containing references to ITU-R Recommendations for the purpose of clarity on whether	

[8] Use of incorporation by reference in the Radio Regulations.

[9] Revision of references to the text of ITU-R Recommendations incorporated by reference in the Radio Regulations.

WRC-12 Agenda item	Description	Responsible ARSG	Outcome from WRC-12	Services affected
			they are mandatory or non-mandatory references.	
Agenda item 4—Review of ITU-R Resolutions and Recommendations	In accordance with Resolution 95 (Rev.WRC-07), to review the Resolutions and Recommendations of previous conferences with a view to their possible revision, replacement or abrogation.	ACMA	Various subsets of the 169 Resolutions and Recommendations in Volume 3 of the Radio Regulations were considered, and various (non substantive) changes were made under this Agenda item. 146 Resolutions and Recommendations were considered related to specific WRC-12 Agenda items (including Agenda item 4), of which 38 were sent to other Committees for consideration and comment. Many Resolutions and Recommendations have been modified or suppressed as a separate result of actions taken under other WRC-12 Agenda items. Details are shown in the Provisional Final Acts WRC-12.	

5. Future spectrum needs

This chapter provides analysis on spectrum usage and demand for different services and outlines the ACMA’s proposed approaches for addressing these issues.

5.1 Aeronautical mobile: The aeronautical mobile service consists of both voice and data communications that are necessary to ensure the safety and efficiency of aviation, both civil and military purposes.

5.2 Broadcasting: Broadcasting involves one-way radiofrequency transmissions intended for direct reception by the general public on AM, FM and digital frequencies.

5.3 Fixed: The fixed service is a radiocommunications service between a fixed transmitter and one or more fixed receivers—point-to-point or point-to-multipoint.

5.4 Land mobile: The land mobile service is a terrestrial service that provides radiocommunications between base stations and land mobile stations, or directly between land mobile stations.

5.5 Maritime: The maritime mobile service consists of both voice and data communications, which is necessary to ensure the safety and efficiency of maritime activities for civil, military and search and rescue purposes.

5.6 Radiodetermination: Radiodetermination is the use of the propagation properties of radio waves to determine the position, velocity or other characteristics of an object, or to obtain information relating to these parameters.

5.7 Satellite: Satellite communications enable applications requiring international communications or large coverage areas and are an important component of the telecommunications industry.

5.8 Science services: The science services (also referred to here as space science services) consist of the communications components connecting the Earth and space stations used to transfer data to the Earth for processing.

5.9 Wireless access services: The term ‘wireless access services’ encompasses the variety of ways that telecommunications carriers, internet service providers or other service providers deliver a radio connection to an end-user from a core network. Although satellite communications are also wireless, this section focuses on the requirements for WAS using terrestrial networks.

5.10 Emerging technologies: The rapid pace of emerging technologies and their adoption will shape and inform our lives at all levels. Understanding their current development will assist in ensuring that all Australians reap the benefits that these technologies can offer to society.

5.1 Aeronautical mobile

Australian allocations are consistent with harmonised ITU allocations to the aeronautical service. The International Civil Aviation Organization (ICAO) is involved in the harmonisation of equipment standards and frequency planning criteria. ICAO's Asia and Pacific Office is responsible for the development of frequency plans for civil aviation member states in this region. It is also responsible for coordinating aeronautical frequency assignments across countries that could be affected by such assignments. Airservices Australia is accredited by the ACMA to endorse all frequency assignments in aeronautical mobile bands.[10] In this report, the aeronautical radionavigation service (ARNS) is included in the radiodetermination service section.

5.1.1 Current spectrum use

The implementation of new developments in the aeronautical industry is typically characterised by long time frames as changes requiring aircraft refit have major overhaul lead times (typically five to seven years). In addition, the bands used for aeronautical purposes are determined at an international level, usually after considerations that extend over one or more WRC cycles. As a result, changes to allocations for aeronautical purposes do not occur rapidly. However, given the roles of Airservices Australia and Civil Aviation Safety Authority (CASA), the ACMA's role in spectrum management for the aeronautical service is more limited when compared to the ACMA's responsibility regarding other radiocommunications services.

The ACMA will continue to work closely with these government agencies to facilitate spectrum requirements for aeronautical operations, especially considering the safety of life aspect that these services entail. The ACMA participates in meetings of the Australian Aviation Spectrum Group (ASG), which is chaired by Airservices Australia and draws membership from government and industry aeronautical stakeholders.

Table 5.1 provides an overview of the various frequency bands and associated use by the aeronautical service. *The information provided in italics suggests possible future use or allocation of frequency bands that may be associated with outcomes from WRC-12.*

[10] Airservices Australia is a government-owned corporation providing air traffic control management and related airside services to the aviation industry.

Table 5.1 Frequency bands used by the aeronautical service

Band	Frequency range	Service allocation	Type of use
HF		Aeronautical Mobile (Route) Service (AM(R)S) Aeronautical Mobile (Off Route) Service (AM(OR)S)	Air-ground-air communications—Civil and Defence aviation
VHF	117.975–137 MHz	AM(R)S Aeronautical Mobile-Satellite Service	Air traffic control (ATC) Aircraft Communications Addressing and Reporting System (ACARS) Search and Rescue (SAR)
VHF/UHF	230–400 MHz	AM(R)S	Unmanned Aerial Vehicle (UAV)—Defence
UHF	420–430 MHz	AM(R)S	Airborne telemetry—Defence
UHF/ L-band	960–1164 MHz 960–1215 MHz	AM(R)S	Universal Access Tracking (UAT) Joint Tactical Information Distribution System (JTIDS)—Defence
L-band	1350–1400 MHz	Aeronautical telemetry	Air combat manoeuvring instrumentation (ACMI) Time space position information (TSPI)
S-band	2.9–3.4 GHz	AM(R)S	UAV—Defence
C-band	4.4–4.5 GHz	AM(R)S	UAV—Defence
C-band	*5000–5150 MHz*	*AM(R)S*	*Possible future use for commercial UAV applications*
C-band	5091–5150 MHz		Airport surface applications *Possible future use for air-ground-air communications*
X-band **Ku-band**	10 GHz 14.4–14.83/ 15.15–15.35 GHz		Common Data Link (CDL)—Defence

5.1.2 2012–2016

Issues affecting spectrum demand

VHF band congestion

Congestion in the VHF aeronautical band has been identified in some parts of the world. This congestion is expected to increase with the anticipated growth in aircraft traffic, which is predicted to more than double over the next 15 years. However, the aeronautical industry is working to transform its operating practices and re-engineer its infrastructure to accommodate the additional demands within existing allocations. Changes include the use of more spectrally efficient technologies (such as migration to digital systems) and reducing channel spacing.[11]

Airservices Australia is implementing a digital ATC radio network to upgrade existing VHF and HF communication systems. This work is expected to mitigate future growth in demand for aeronautical mobile spectrum within the current allocations.

The increase in data rates (generally leading to larger system bandwidths) is a trend which, along with gradual saturation of lower bands, is leading towards the use of higher frequencies, particularly for applications that do not require long propagation distances. An example of this is the AM(R)S allocation added to the 5091–5150 MHz band at WRC-07. Previously, aeronautical mobile allocations were mostly made in VHF spectrum.

The 5091–5150 MHz band is intended for use by airport surface applications transmitting over short distances with high throughput and security applications employing secure and confidential transmissions used in response to interruption of aircraft operations (such as runway incursions). However, ICAO is also studying the feasibility of air-ground aviation communications at 5 GHz with a view to easing congestion in the VHF aeronautical band.

Aeronautical mobile telemetry

At WRC-07, additional spectrum allocations were made for aeronautical mobile telemetry (AMT) for flight test systems in the 4400–4940 MHz and 5091–5150 MHz bands. It is expected that telemetry systems will be used by Defence, especially considering that the *Australian Radiofrequency Spectrum Plan 2009* (the spectrum plan) designates the 4400–4940 MHz band to be used principally for defence purposes. However, when there are similarities in requirements, the ACMA may consider options to permit the sharing of this band with other government agencies for such uses.

Wideband aeronautical mobile systems

Approaches to the ACMA by industry representatives indicate that the use of wideband aeronautical mobile systems is likely to grow significantly in the future. The ability of airborne platforms to provide data to ground-based terminals is rapidly increasing and increased data rates, combined with a proliferation of such systems, will result in increased demand for spectrum. Much of this demand is expected to manifest itself in mission data downlinks and high data rate payloads such as video, which are likely to require large bandwidths.

Planning arrangements for wideband aeronautical mobile systems will be required to accommodate a wide range of applications and operational requirements. Such a range of requirements may be compatible with spectrum sharing between the different applications. For example, the use of wideband AMT systems is likely to be sporadic and occur in geographically isolated areas, while wideband aeronautical

[11] Channel spacing has been reduced from 50 kHz to 25 kHz channels in Australia; 8.33 kHz channels are being used in Europe.

systems in support of emergency service applications are likely to operate more regularly and over more heavily populated areas.

The operational characteristics of airborne platforms usually make sharing with terrestrial services problematic. There is a range of quality of service requirements for these systems, depending on the application. While communications related to air traffic or flight control require a high level of protection, the robustness of other applications, such as payload downlinks, is not so critical and can potentially be afforded less protection.

Ku-band CDL
One family of data link standards (primarily for military use) is the common data link (CDL).[12] CDL is designed to operate over a number of different bands, including those 10 GHz bands currently designated for use for defence purposes. However, Ku-band CDLs that have an uplink in the 15.15–15.35 GHz band and a downlink in the 14.40–14.83 GHz band pose significant spectrum management challenges in Australia because this spectrum is currently used extensively by terrestrial fixed P-P links and by satellite Earth-to-space links.[13]

Defence has had preliminary discussions with the ACMA seeking to establish arrangements in Australia to support Ku-band CDL operations. The ACMA understands that Defence's primary interest in CDL applications is to support a number of existing and planned systems. The ACMA also understands that there are legitimate requirements to provide an appropriate degree of support for Ku-band CDL operations in Australia by other government agencies. Other government agencies may seek to acquire systems using CDLs or will have a requirement to communicate with Defence systems utilising Ku-band CDLs.

Unmanned aircraft systems
An unmanned aircraft systems (UAS) can be controlled remotely or fly autonomously based on pre-programmed flight plans or more complex dynamic automation systems. Defence currently uses UAS, with control communications typically operating in the bands within 230–400 MHz, 2.9–3.4 GHz and 4.4–5 GHz. These bands are designated in the ARSP for use principally for defence purposes. Defence states that these are mission-critical communications that must not suffer harmful interference.

Spectrum demand for UAS is expected to increase significantly over the next decade. UAS use in civilian applications is a developing market and applications such as weather research, crop monitoring and coastal patrols may be introduced in Australia in the future. While some demand may be able to be accommodated in current spectrum allocations. WRC-12 Agenda item 1.3 identified spectrum allocations for UAS operating in non-segregated airspace, taking into consideration the spectrum requirements and regulatory measures required to support remote flight command and control and ATC communications relay. An outcome from WRC-12 was the primary allocation of the frequency range 5030–5091 MHz for AM(R)S and AMS(R)S for UAS-LOS controls. A new Agenda item has been identified for WRC-15 to consider satellite allocations for UAS.

Safety considerations
There are concerns within industry regarding interference to aeronautical communications systems stemming from the susceptibility of digital systems to interference from in-home cable television systems and power line transmissions. This may pose an obstruction to the migration from analog to digital aeronautical

[12] From a spectrum management perspective, the tactical common data link (TCDL) is a very similar system.
[13] Ku-band generally refers to the frequency range 12–18 GHz.

communications. ICAO is continuing to address all regulatory aspects of aeronautical matters through the ITU-R. Its aim is to protect aeronautical spectrum for the radiocommunication and radionavigation systems required for current and future safety-of-flight applications.

5.1.3 The ACMA's proposed approaches

The most significant changes within the 2012–2016 time frame are expected to relate to the additional allocations made to the aeronautical mobile service at WRC-12. It is possible that some VHF and L-band systems may be introduced within the next five years to support air navigation functions, long-range communications and global navigation satellite system (GNSS) correction broadcasts, along with short-range surface applications for the dissemination of systems data at 5 GHz.[14]

Measures to introduce new AM(R)S applications
Following the primary allocations made to the AM(R)S at WRC-07 in the 108–117.975 MHz, 960–1164 MHz and 5091–5150 MHz bands, the ACMA is considering the impact of the introduction of aeronautical mobile systems on existing services.

The introduction of AM(R)S in these bands would typically require consideration and application of such ITU sharing studies, criteria and requirements of the Australian operating environment.

Aeronautical mobile telemetry
Before considering any options for shared use of AUS1 bands within 4.4–5 GHz, the ACMA would consult with interested parties and Defence.

Wideband aeronautical mobile systems
Ku-band CDL
The ACMA will continue to work with Defence and other government users, where necessary, to identify appropriate whole-of-government approaches to support CDL use of the 15 GHz band while maintaining the utility of the band for existing and future fixed and satellite services. As part of this, the ACMA will explore, with Defence, options for customised Ku-band CDL equipment that maintains interoperability with CDL systems of other countries, but is better suited to Australian spectrum management arrangements.

UAVs
Civilian UAV applications are expected to appear in the medium term. In the short to medium term, the ACMA will continue to investigate the demand for such applications as they arise and will consider the primary allocation of 5 030–5 091 MHz for Unmanned aircraft systems (UAS) line of sight controls. WRC-15 Agenda item 1.5 was developed to consider satellite allocations for UAS.

5.1.4 WRC Agenda items

WRC-12
The following WRC-12 Agenda items were relevant to the aeronautical mobile service:

- **Agenda item 1.3**—unmanned aircraft systems (UAS)
- **Agenda item 1.4**—to facilitate introduction of AM(R)S in the bands 112–117.975 MHz, 960–1164 MHz and 5000–5030 MHz
- **Agenda item 1.7**—ITU studies on the spectrum requirements of AMS(R)

[14] L-band refers to the frequency range between 1 GHz and 2 GHz.

- **Agenda item 1.12**—sharing studies between the aeronautical mobile service and other co-primary services in the 37–38 GHz band.[15]

A synopsis of WRC-12 outcomes is available in section 4.4.3.

WRC-15

The following WRC-15 Agenda items are relevant to the aeronautical mobile service:

- **Agenda item 1.5**— to consider the use of frequency bands allocated to the fixed-satellite service not subject to Appendices **30**, **30A** and **30B** for the control and non-payload communications of unmanned aircraft systems (UAS) in non-segregated airspaces, in accordance with Resolution **153 [COM6/13] (WRC-12)**;
- **Agenda item 1.17**—to consider possible spectrum requirements and regulatory actions, including appropriate aeronautical allocations, to support wireless avionics intra-communications (WAIC), in accordance with Resolution **423 [COM6/22] (WRC-12)**.

5.1.5 Beyond 2016

Data intensive ATM networks

Beyond 2016, aeronautical mobile communications are expected to continue to move towards harmonised ATM networks combining ground-to-ground and ground-to-air links, voice and data communications and the integration of data from a wide variety of ground-based sensors.

Taking into consideration the general trend towards increasing data communications relative to voice, the addition of data services in the HF aeronautical bands is also possible within the next decade. However, a corresponding increase in the spectrum required for such purposes is not expected, as it is likely that these services will utilise satellite communications rather than in HF terrestrial transmissions.

[15] Fixed service, mobile service, space research service (space-Earth) and fixed-satellite service (space-Earth).

5.2 Broadcasting

The broadcasting service involves one-way radiofrequency transmissions intended for direct reception by the general public.[16] Currently, the principal uses of the broadcasting service in Australia are in the medium frequency (MF) band for AM radio, in the VHF band for FM radio and in both the VHF and UHF bands for television (subscription television services are considered in the satellite section).[17]

5.2.1 Current spectrum use

MF-AM radio broadcasting

The MF-AM band (526.5–1606.5 kHz) is used for national, community and commercial broadcasting services, as well as high power open narrowcasting (HPON) services.[18] Coverage for these services can be wide area or local, although at MF frequencies, long-range interference (which is exacerbated by night-time sky wave propagation) makes international coordination (particularly with New Zealand and Indonesia) necessary for higher-power transmitters. Long distance propagation makes MF-AM radio effective in Australia's remote regions. However, MF-AM radio has poorer audio quality and is more prone to electrical noise than VHF-FM. The MF-AM band is heavily congested and planning new services and variations to existing services is particularly challenging.

MF and VHF narrowband area services

Narrowband area services (NAS) are broadcasting services licensed to operate in non-broadcasting frequency allocations. Most NAS services have been licensed in the MF range of 1606.5–1705 kHz, immediately above the MF-AM broadcasting band (these are known as MF NAS services). Some licences have also been issued in VHF bands, at 70 MHz, 77 MHz, 151–152 MHz and 173 MHz.

NAS stations are usually used to provide 'narrowcasting' programming.

Narrowcasting services must have reception limited in some way, for example, by being targeted at special interest groups. Such operation is authorised under a class licence in accordance with the *Broadcasting Services Act 1992* (BSA). However, a NAS station licensee who wishes to provide a commercial or community broadcasting service must obtain a non-broadcasting services bands (BSB) licence under Part 4 (commercial broadcasting) or Part 6 (community broadcasting) of the BSA.

In the case of MF NAS licences, the right to provide a commercial broadcasting service is circumscribed by a ministerial direction and resultant apparatus licence condition. Feedback from consultation with industry suggests that many NAS licences are not currently in use.

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[16] In this report, the broadcasting-satellite service is included in the satellite service section and mobile television is included in the WAS section, due to strong technical and/or commercial synergies with these other services.

[17] MF is the frequency range 300–3000 kHz. AM stands for amplitude modulation.

[18] National services are those provided by Australian Broadcasting Corporation (ABC), Special Broadcasting Service (SBS) and the Parliamentary and News Radio Broadcasting Service.

[18] Narrowcasting services are broadcasting services whose reception is limited due to programming of limited appeal or targeted to special interest groups, or limited to certain locations or periods of time (section 18 of the *Broadcasting Services Act 1992*).

HF radio broadcasting
There is very limited use of HF spectrum for domestic broadcasting within Australia. The only significant domestic usage is the ABC's HF Inland Service (some channels in the 2 to 5 MHz range), in addition to a few narrowcasting services. Only three broadcasters are currently using the HF broadcasting bands to provide international broadcasting services from Australia. The ACMA has embargoed the assignment of services other than broadcasting in several HF bands to encourage the introduction of digital broadcasting services in these bands.[19]

VHF-FM radio broadcasting
The VHF-FM band (VHF Band II 87.5–108 MHz) is used for national, commercial and community radio broadcasting services, as well as low power open narrowcasting (LPON) and High Powered Open Narrowcasting (HPON) services. The VHF-FM band is heavily congested in major cities and nearby regional areas, which is demonstrated by the difficulty the ACMA has experienced in planning additional services in metropolitan and many regional areas. The prices obtained for VHF-FM commercial radio broadcasting licences in major metropolitan markets are evidence of demand for additional FM broadcasting channels.[20]

About 30 per cent of the approximately 2,235 broadcasting licences held in the VHF Band II are used for retransmission services.[21] Retransmission services in this band typically serve small population centres in rural and remote areas and are fed via satellite. Despite the large number of retransmission licences, the majority of the Australian population receives VHF-FM services from a small number of high-power transmitting sites.

In addition to national, commercial and community VHF-FM radio broadcasting services, the 87.5–108 MHz band contains significant numbers of LPON and HPON services. Under section 34 of the BSA, three channels (87.6, 87.8 and 88.0 MHz) have been made available to accommodate LPON services until the end of 2013, when the current Determination of Spectrum under the BSA expires.

VHF Band III digital radio broadcasting
VHF Band III (174–230 MHz) spectrum is used in the five metropolitan licence areas of Adelaide, Brisbane, Melbourne, Perth and Sydney to broadcast terrestrial digital radio services, sharing spectrum with digital and analog television services.

The official digital radio start-up day for these areas was 1 July 2009 and from that date digital radio services have been provided using the upgraded version of the Digital Audio Broadcasting (DAB) standard, called DAB+.

Ministerial direction requires the ACMA to make provision for 14 MHz of VHF Band III spectrum in each metropolitan licence area to allow for regional DAB+ rollouts[22];

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[19] For more information please refer to Embargo 46, contained in RALI MS03: Spectrum Embargoes, available at www.acma.gov.au.

[20] Australian Broadcasting Authority, 25 September 2003, *ABA – NR60/2003—Analog commercial radio sector*. The ABA stated that from this date, it did not propose to allocate any further analog commercial radio licences within five years of the last allocation in the ongoing round at that time. The last allocation was made for Melbourne in August 2004 (see '$52 million bid for new Melbourne commercial radio licence', ABA Update, August 2004, Australian Broadcasting Authority, p. 7).

[21] Including commercial, community (both permanent and temporary community broadcast licences), national and retransmission services. Under section 212 of the BSA, in addition to the retransmission of commercial broadcasting (within the licence area), national broadcasting and National Indigenous TV Ltd programming content, commercial broadcasters are permitted to retransmit their program content outside their licence area with special written permission from the ACMA.

[22] 9 July 2010, *Australian Communications and Media Authority (Realising the Digital Dividend) Direction 2010,* paragraph 5 (d)

however, no date has been set for the extension of digital radio into regional areas. Nevertheless, scientific trials of DAB+ digital radio are being conducted in both Canberra and Darwin using available Band III spectrum on an interim basis. Regional areas are considered to be all parts of Australia except for the five metropolitan areas specified above.

In October 2011, the Department of Broadband, Communications and the Digital Economy tabled its report into the review of technologies for digital radio services in regional Australia, which highlighted a number of key findings distilled from 29 public submissions. Paramount among these was the desire of all sectors to see digital radio implemented in regional Australia, together with the importance of high-quality audio, new digital-only services, good quality receivers and good coverage.

VHF/UHF television broadcasting
In Australia, analog and digital television broadcasting services are provided in VHF and UHF bands using 7 MHz-wide channels. Details of current usage are listed below:

> VHF Band I (45–52 MHz and 56–70 MHz): VHF channels 0, 1 and 2 for analog television.
> VHF Band II (85–92 MHz and 94–108 MHz): VHF channels 3, 4 and 5 for analog television (in a limited number of geographic areas; these channels are shared with extensive deployments of VHF-FM radio broadcasting services).
> Television channel 5A (137–144 MHz) for analog television.
> VHF Band III (174–230 MHz): VHF channels 6–9, 9A and 10–12 for analog and digital television services.
> UHF Bands IV and V (520–820 MHz): UHF channels 28–69 for analog and digital television services.[23]

Australia is currently transitioning from analog to digital television. Until the closure of analog television services in each area, television services are delivered through simultaneous transmission of both analog and digital services (known as ‘simulcasting’). Digital television, unlike analog television, permits interference-free adjacent channel transmissions in the same location. For this and other reasons, digital television is far more spectrally efficient than analog television. Digital television allows broadcasters to transmit multiple content streams (known as multi channelling; for example, additional streams of standard definition (SD) or high definition (HD) audiovisual content, or audio only content or data) within a single 7 MHz channel with the use of a multiplexer.

Services ancillary to terrestrial television broadcasting
Before television programming content is broadcast to the general public, various other radiocommunications services are utilised to relay this content. See section 5.3.1 for details of fixed services used by broadcasters (for example, electronic news gathering, television outside broadcast, studio-to-transmitter links and point-to-point fixed links) and section 5.7 for details of satellite broadcasting and satellite links that are used to support terrestrial broadcasting services.

5.2.2 2012–2016

Issues affecting spectrum demand
A feature of both radio and television spectrum demand within the BSB is the importance of regulation in determining spectrum requirements. The development of television and radio services in the BSB is both constrained and driven by legally imposed requirements on the broadcasting sector. Therefore, the highly regulated environment makes ‘demand’ an unreliable guide to future spectrum requirements.

[23] The ACMA’s policy is, where practical, to avoid allocating digital services on channels 68 and 69.

Put another way, future requirements for broadcasting spectrum are likely to depend critically on government decisions about the future development of the sector.

A second distinctive feature of planning for the BSB is that the minister, rather than the ACMA, is responsible for decisions to vary the BSB. This means that the ACMA does not have authority to make planning decisions that involve reviewing the boundaries of the BSB. The ACMA's observations about planning and demand issues affecting the BSB need to be read in the light of these distinctive features of broadcasting planning.

Analog radio broadcasting

The switch-off of analog television services will create some limited opportunities for additional FM radio services, or improved coverage of existing services. This is especially the case in areas currently served by analog television services operating in VHF Band II (channels 3, 4 and 5).[24]

Analog radio is expected to continue well beyond the time frame considered in this edition of the Outlook. The explanatory memorandum to the Broadcasting Legislation Amendment (Digital Radio) Bill 2007 notes that for the near future, digital radio is to be considered a supplementary technology to analog radio and not a replacement technology.

Digital radio broadcasting

There are spectrum availability challenges associated with regional digital radio rollout and the ACMA is working closely with both the government and industry in the development of options for regional Australia.

Based on currently planned and operating digital television channel arrangements and the identification by the minister of 14 MHz of VHF Band III spectrum for digital radio (noted above) it is likely that some significant compromises would need to be made in most regional licence areas if DAB+ is to be accommodated in VHF Band III spectrum.

DAB+ involves multiplex transmitters that combine a large number of different program streams. Such multiplexing is best suited to wide coverage services where several broadcasters share a common coverage area allowing them to use the same multiplex transmitter. In other situations, DAB+ may not be an optimum technical or commercial method for providing digital radio services, notably:

1. For broadcasters in small coverage areas and in small regional markets where there may only be a few broadcasting services in total.

For this reason, there is a need to continue to investigate alternative technologies as a result of the department's review of regional digital radio technologies for regional Australia. At this stage, the most relevant alternatives are Digital Radio Mondiale (DRM) (now known as DRM30), which operates below 30 MHz, and DRM+, which operates in VHF Bands I, II and III.[25]

Another possibility to explore may be the introduction of DRM services in the MF band but, given the current high utilisation of the MF band, the opportunities for doing this would appear to be limited unless a major replanning of that band was to be undertaken.

[24] Notably in Newcastle and Wollongong, NSW, Townsville, Qld, Renmark and Spencer Gulf north, SA, and Bunbury, WA.

[25] The DRM+ system is a development of the DRM system that is designed to operate in frequency bands between 30 and 108 MHz. Trials of this system commenced in Germany in November 2007.

Television
The Australian Government performed a legislative review on various aspects of the television broadcasting regulatory framework. All of the necessary reviews were undertaken and discussion papers were released for public comment.[26] Although limited changes were made as a result of submissions received (mostly from industry), the information was considered in the formulation of government media reforms.

Simulcasting of analog and digital television services are expected to be maintained in current VHF and UHF television spectrum until the switchover to digital-only television is completed in 2013.

5.2.3 The ACMA's proposed approaches

Radio broadcasting
Given the current high usage levels in both the MF-AM and VHF-FM bands, there is limited opportunity to introduce new radio services. The ACMA will monitor technical developments and usage levels but no significant changes in analog radio are foreseen in the 2012–2016 time frame.

The most significant development for radio may be the expansion of digital radio services into regional areas. The deployment of DAB+, or other digital radio technologies, in regional areas is an issue that requires further consideration by the ACMA and other areas of government. Part of that process will be to support scientific trials of new technology.[27]

There is some uncertainty faced by LPON licensees with regard to the future of these services. This is because the current section 34 Determination that gives effect to the three LPON channels (87.6,87.8 and 88.0 MHz) expiring at the end of 2013. The ACMA will commence consultation with industry on the future of the LPON planning and regulatory arrangements in 2012. Further information on this project is in section 6.2.3.

Television
The ACMA is assisting the government in its digital switchover activities in a number of ways by:

> evaluating digital television coverage to assess whether analog and digital services achieve the same level of coverage and reception quality
> monitoring the nationwide rollout of digital television infrastructure
> working with the government and broadcasters to complete the digital rollout process and to plan new digital only gap filler sites and the digital conversion of self-help retransmission sites.

Following the switch-off of the analog television services by 31 December 2013, the channels previously used to transmit those services will become vacant:

> Digital services will continue to operate in channels 52–69 (as well as the eight channels in VHF Band III).
> The services in channel 52 and above will need to be shifted in order to clear a contiguous block of spectrum (694–820 MHz) suitable for allocation and re-use as the digital dividend.

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[26] Reports on the results of the consultation process were completed for all of the reviews, except the review of the duration of the analog/digital television simulcast period.
[27] *Digital Radio Trials using the Broadcasting Services Bands – Policy Guidelines*, available at: www.acma.gov.au/webwr/_assets/main/lib100535/dig%20radio%20trials%20pol%20march06.pdf.

The ACMA has commenced the replanning of digital television services to clear digital television services from digital dividend band. This 'restack' process will see digital television services operating on television channels 52–69 moved to alternative channels below channel 52. This restack process will also require some digital television services operating on channels below 52 to change channels in order to make room for services moving from higher channels. Further information on the 'restack' process is provided in section 4.3.1.

The ACMA is working in consultation with broadcasters to replan the digital channel allotments following the ACMA's decision on the planning principles. The restack will be given effect through new television licence area plans (TLAPs) prepared under s26(1B) of the BSA and, in part, by variations to digital channel plans (DCPs) under the Commercial Television Conversion Scheme 1999 (CTCS) and the National Television Conversion Scheme 1999 (NTCS).

Draft TLAPs and DCPs are available on the ACMA website for comment. Further background and other documents related to restack channel planning can be found on the ACMA website.

5.2.4 WRC Agenda items

WRC-12

The following WRC-12 Agenda items were relevant to broadcasting services:

> **Agenda item 1.4**—to facilitate introduction of AM(R)S systems in the bands 112–117.975 MHz, 960–1164 MHz and 5000–5030 MHz

> **Agenda item 1.17**—sharing studies between the mobile service and other services in the band 790–862 MHz in Regions 1 and 3.

A synopsis of WRC-12 outcomes is available in section 4.4.3.

WRC-15

The following WRC-15 Agenda items are relevant to the broadcasting service:

> **Agenda item 1.1**—to consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution **233 [COM6/8] (WRC-12)**.

5.2.5 Beyond 2016

Digital radio broadcasting

The extension of digital radio services into regional licence areas is likely to depend on the success of DAB+ in the five metropolitan licence areas, the availability of suitable spectrum in either VHF Band III or L-Band, and the adequacy of alternative technologies (such as DRM or DRM+). Digital radio will remain as a complement rather than a replacement for existing analog radio services for the foreseeable future, and discontinuation of analog radio is unlikely within the time frame of this report.

It appears that new digital-only radio services, rather than performance enhancements, are more likely to drive DAB+ take-up. For example, commercial and national radio broadcasters have been providing a wide range of digital-only radio content, including short-term services relevant to particular touring artists and festivals.

VHF-FM transmission is expected to continue to be an attractive option well into the future, especially considering the relatively low cost of establishing and operating FM stations. However, if DAB+ services are commercially successful, some metropolitan MF-AM radio broadcasters may wish to vacate the MF band because of the cost and inefficiency of maintaining duplicate transmissions. Such a migration would only occur if there was a high audience penetration of DAB+ digital receivers and any audience loss was commercially insignificant.

Based on an assumed longer-term growth in the number of DAB+ services, especially in the metropolitan licence areas, DAB+ spectrum requirements may increase beyond current allocations. After the switch-off of analog television, VHF Band III is the preferred spectrum to accommodate additional DAB+ demand, while making L-band spectrum available would require a strategy to clear incumbent services.

Other radio broadcasting technologies and planning issues

Demand for spectrum for alternative digital radio technologies beyond 2016 will require the ACMA to review and consider its policies on:

> the availability of HF broadcasting spectrum
> potential for replanning the MF-AM band should incumbent broadcasters wish to vacate the band
> the future use of vacated VHF Band I and II television spectrum should DRM+ technology become viable.

Some alleviation of VHF-FM band congestion may be possible after digital television switchover in areas that are currently covered by analog VHF Band II television services.

Digital television and planning issues

The digital switch off will release the channel capacity currently occupied by analog services in each area. Once the restack of digital television services has been completed, it is expected that there will be minimal scope for new services beyond the six services to be planned as part of the restack. There may be scope for additional in-fill sites for existing networks depending on the location or whether the site can be operated as part of a single frequency network.

In addition to the digital dividend in the UHF bands, a further VHF digital dividend is also likely to arise following the closure of Band I and II and Channel 5A analog television services. A process to consider future use of these bands will need to take place.

Future television broadcasting standards

Developments in broadcast technology standards have the potential to enhance future delivery of digital terrestrial television services. Enhancements can offer better or different services for consumers (e.g. HDTV and 3DTV) whilst achieving greater spectral efficiency. New broadcast technology standards such as MPEG-4 AVC[28] and DVB-T2 have been developed and deployed in other countries. These two standards allow more services or program streams to be transmitted in each television channel and are only two of a number of standards under ongoing development.

In recognition of the importance of these and other new technologies to future digital terrestrial services the ACMA has started a discussion with industry. The first stage of the ACMA discussion was the issue of a discussion paper *Beyond switchover—the future technical evolution of digital terrestrial television in Australia*. The paper sought comment on technical migration issues for digital terrestrial television

[28] Also known as MPEG-4 Part 10 or H.264. (AVC stands for Advanced Video Coding).

broadcasting (DTTB) services and uses MPEG 4 and DVB-T2 as examples of potential future technologies.

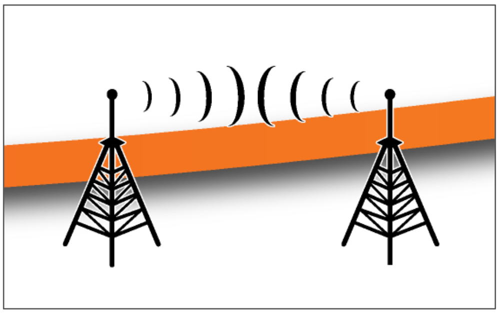
MPEG-4 is a more efficient video compression standard, potentially allowing the same content to be delivered with almost half the bit rate of an equivalent MPEG-2 service. Alternatively, the same bit rate can be used for improved video quality.

DVB-T2 is a later generation standard similar to DVB-T. Compared to DVB-T it allows increased efficiencies of around 30–50 per cent for a given transmission power and coverage level. Alternatively, the same transmission rates and coverage can be achieved with reduced transmission power offering broadcast cost savings.

The availability of digital television receivers that are capable of using these new technologies is limited. ACMA acknowledges that government does not propose any move to new standards before switchover is completed, The ACMA also recognises that no action should be taken that would have a negative impact on the digital conversion and restack; for example, any action that would discourage the uptake of existing digital receivers, which is expected to be completed by 2015. However, steps to facilitate technical evolution in future may be taken by the ACMA if it is clear they do not affect the switchover.

Further into the future, consideration may be given to emerging television broadcasting technological advancements such as successor standards to MPEG 4 in H.265 HEVC or the standards for Ultra High Definition Television (UHDTV). Such developments and any potential spectrum benefits arising from their adoption will be monitored by the ACMA. The potential implementation of these would need to consider their merit relative to other competing uses of the spectrum, and the practicalities of any future migration strategies.

5.3 Fixed



Fixed links are a fundamental communications delivery technology for numerous spectrum users (including government networks, emergency services, utilities and mining operators) and act as a backhaul enabler for other radiocommunications networks (including mobile telephony and satellite). The fixed-satellite service is included in the satellite service section at 5.7 and fixed wireless access (FWA) is included in the wireless access services (WAS) section at 5.9.

5.3.1 Current spectrum use

The fixed service has allocations across the entire radiofrequency spectrum, from very low frequency (VLF) to extremely high frequency (EHF).[29] The usage considered here is at UHF (400 MHz and 800/900 MHz bands) and the bands from 1.5 GHz to 58 GHz (often referred to as the microwave bands). Another band that is considered noteworthy is the VHF high band for fixed telephony services to remote homesteads. In addition, a primary band for Defence operations is the 230-399.9 MHz band, which is used for tactical radio relay systems and other services.

The fixed service in the UHF bands is predominantly used by narrowband applications including those that link land mobile base stations, referred to as point to point links (P-P), and those that perform telecommand and telemetry functions referred to as point to multipoint services (P-MP). The bands also include wideband fixed services at 403–420 MHz (P-P) and 500–520 MHz (P-MP). The 800 MHz band is also used for some studio to transmitter links (STLs) and sound outside broadcasting for the broadcasting service.

At 400 MHz and 800/900 MHz, P-MP systems are typically those in which a single central master station communicates with a number of outlying remote fixed stations. The predominant use of these systems is for data transmission with typical applications including telemetry, supervisory control and data acquisition (SCADA) systems, computer networking and alarm systems. Specific segments have been set aside in band plans for these systems, but there are now limited opportunities for new frequency assignments.[30] Provision has been made for these systems to access 400 MHz band spectrum allocated for the land mobile service. Demand for spectrum for P-MP systems appears to be strong in the 400 MHz and 800/900 MHz bands.

The microwave fixed bands that are used in Australia are specified mostly in the ACMA's Radiocommunications Assignment and Licensing Instruction (RALI) FX3—Microwave Fixed Services Frequency Coordination.

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[29] VLF is notionally the frequency range 3–30 kHz and EHF is notionally the frequency range 30–300 GHz.

[30] The administrative band plan RALI: MS 22 – 400 MHz Plan is available at www.acma.gov.au/WEB/STANDARD..PC/pc=PC_2571, while the legislative radiocommunications *900 MHz Band Plan 1992* is available at www.comlaw.gov.au/comlaw/Legislation/LegislativeInstrument1.nsf/0/9D52513538D665BACA256FF000063209?OpenDocument.

These bands can be classified into four major categories of use:

1. low-capacity long-haul links—1.5, 1.8, 2.1 and 2.2 GHz bands
2. high-capacity long-haul links—3.8, 6, 6.7 and 8 GHz bands
3. medium-capacity medium-haul links—7.5, 10 and 13 GHz bands
4. backhaul and urban networks—15, 18, 22, 38, 50 and 58 GHz bands.

In rural and remote areas, the 1.5 GHz band is used for Digital Radio Concentrator System/High Capacity Radio Concentrator (DRCS/HCRC), which provides telephone services to these areas, as well as for the provision of broadband wireless access (BWA) services.[31] The 1.5 GHz band is also used for non-DRCS/HCRC P-P links across Australia. Although the *1.5 GHz Band Plan* prohibits new assignments in the frequency ranges 1452–1492 MHz and 1525–1530 MHz, fixed P-MP services for the delivery of telecommunications services in a rural or remote area are still permitted.[32] This constraint was made to preserve options in the 1452–1492 MHz band for the deployment of DSB transmitters in and around metropolitan areas and the deployment of MSS in the 1525–1530 MHz band.

Other microwave bands not listed above are used for television outside broadcast (TOB) services (2.5, 7.2 and 8.3 GHz) or temporary links (49 GHz), or are spectrum-licensed (3.4 and 31 GHz).[33] The 3.4 GHz band (outside spectrum-licensed areas) also provides rural communities with fixed telephony and data communications services.

Some channels in the 13 and 22 GHz bands are also designated for TOB services.

The 5 GHz band (4400–5000 MHz) is Defence’s main band for microwave fixed services, although it is also used for other services. Defence uses this band for tropospheric scatter systems and microwave fixed P-P links. Microwave assignment numbers from 1 January 2002 to 1 January 2012 as shown in Figure 5.1.

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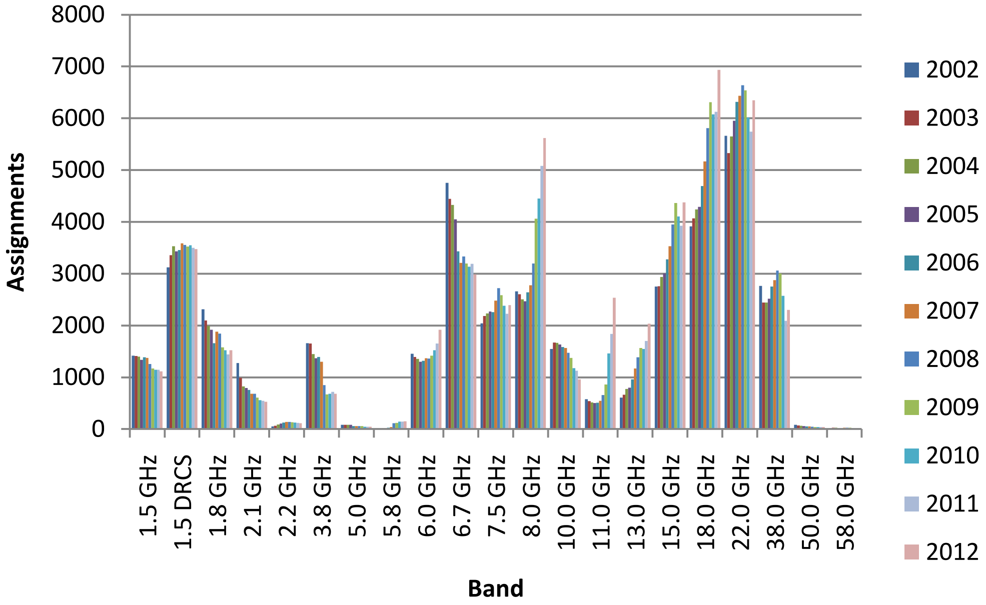
[31] DRCS is Digital Radio Concentrator System; HCRC is High Capacity Digital Radio Concentrator System. The DRCS system is a microwave point to multipoint system which concentrates the telecommunication traffic of many users. A typical system comprises a central exchange which connects to the wireline network, repeater stations and remote stations. Subscribers are connected either to the repeater or a remote station, with a typical transmission link length between two stations of approximately 40-50km. DRCS is an ageing technology that is being replaced by HCRC.

[32] *1.5 GHz Band Plan*, available at www.comlaw.gov.au/comlaw/Legislation/LegislativeInstrument1.nsf/0/D9FD9C61C81A64F4CA256FF6001CBA62/$file/1.5bandplan.pdf.

[33] TOB involves the use of temporary fixed links for broadcast coverage of an event remotely located from the broadcasting studio.

Figure 5.1 Fixed link assignment trends



5.3.2 2012–2016

Issues affecting spectrum demand

Microwave bands

The ACMA expects growth in the fixed service to be driven mainly by the backhaul needed to support the creation and expansion of mobile carrier networks. However, an increase in the spectral efficiency of technology may offset this to some degree. The demand for broadband communications services in rural and remote areas is likely to have implications for backhaul spectrum in the low-capacity bands to support fixed wireless broadband services.

The ACMA has considered the current and estimated future requirements of these services and mechanisms to minimise potential sharing issues while planning arrangements for future P-P fixed-link services. However, the increasing demands for access to spectrum to accommodate technological advances and other demands will almost certainly require the ACMA to periodically revisit the planning arrangements for P-P fixed-link bands.

Other factors that may affect future spectrum demand (such as the possible replacement of high-capacity long-haul trunks with optical fibre) are discussed in the following subsections.

Prospective users need to recognise that use of the limited spectrum resource will increasingly need to be shared and that future availability will inevitably decrease.

400 MHz and 800/900 MHz bands

High demand for narrowband fixed links in the 400 MHz band has exceeded the available spectrum in certain areas, both metropolitan and regional. Parts of the 800/900 MHz band are also heavily used and there is increasing difficulty in finding available spectrum for P-MP links in particular. Industry has requested that the ACMA provide additional opportunities to operate in these bands, particularly for telecommand and telemetry applications and STLs. Figures 5.2 and 5.3 show the distribution of fixed P-P links and fixed P-MP transmitters in the 400 MHz and 800/900 MHz bands respectively.

Figure 5.2 Distribution of fixed P-P links (blue lines) and fixed P-MP transmitters (red dots) in the 400 MHz band

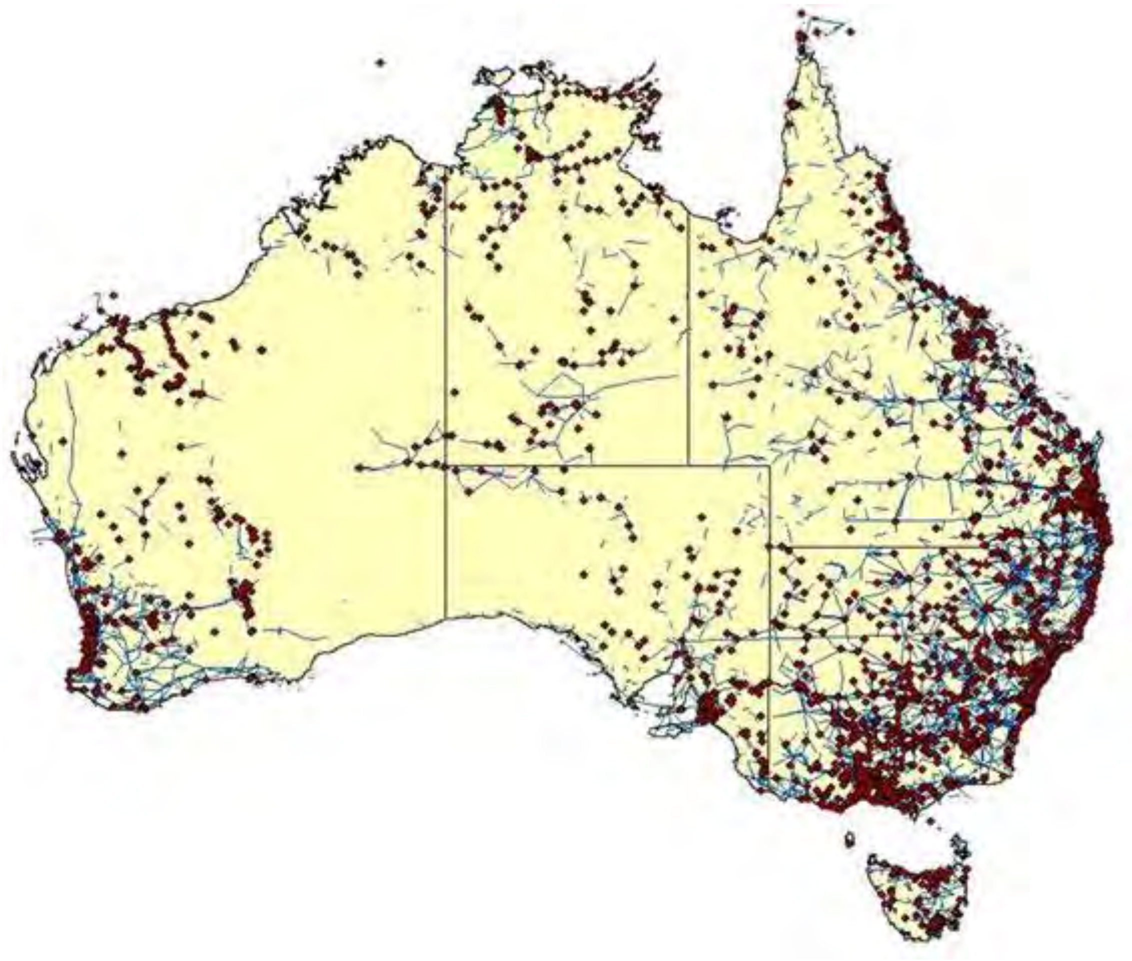
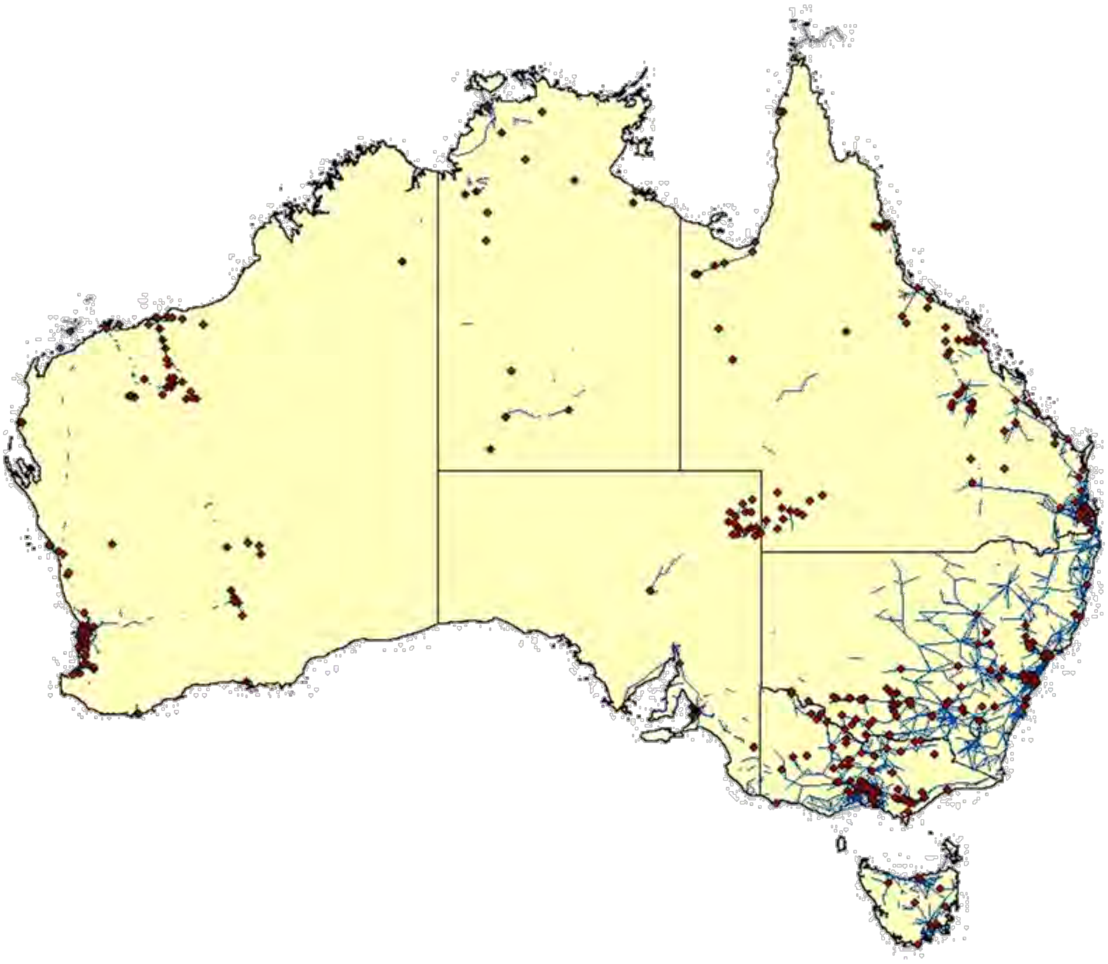


Figure 5.3 Distribution of fixed P-P links (blue lines) and fixed P-MP transmitters (red dots) in the 800/900 MHz band



A number of issues affecting the fixed service will require consideration over the next five years, in particular, sharing issues between the fixed service and other services. The identification of the 790–806 MHz and 806–960 MHz frequency ranges for IMT includes the entire 800/900 MHz fixed service band. Also the introduction of WAS applications and expansion of public telecommunications services has further reduced spectrum availability in the lower microwave bands and increased the requirement for services to operate in shared bands.

Low-capacity long-haul links (1.5, 1.8, 2.1 and 2.2 GHz)

The limited availability of spectrum in the 1.5 GHz band is due in part to the existing heavy use of some channels. It is also due to the restrictions imposed by the 1.5 GHz Band Plan to reserve part of the spectrum for the introduction of other services, such as Digital Sound Broadcasting (DSB). The ACMA expects that pressure for access to this band is likely to increase over time.

Most of the 1.8 GHz band is spectrum-licensed in major city areas (1710–1785 MHz/1805–1880 MHz) with 2 x 15 MHz in the lower segment of the band spectrum-licensed in regional areas (1710–1725 MHz/1805–1820 MHz). Spectrum licences in this band are typically used for third generation (3G) and GSM mobile telephone services. In addition to this, part of the 1.8 GHz band is embargoed to support possible future replanning for WAS (see section 5.9.1).[34]

[34] Embargo 38, contained in RALI MS03, www.acma.gov.au.

Most of the 2.1 and 2.2 GHz bands in low-, medium- and high-density areas are either spectrum-licensed or embargoed to facilitate the introduction of the Mobile Satellite Service (MSS) or to preserve options for future planning.[35] Apparatus licences issued in these and several other bands are subject to apparatus licence advisory note BL, which states:

> This frequency band is currently under review to accommodate changes in technology and may lead to a requirement to change frequency or cease transmissions. In this case, the bands are under review for the possible accommodation of WAS.

In recent years, there has been a decline in the number of low-capacity long-haul links, which could be due to parts of the 1.8, 2.1 and 2.2 GHz bands being embargoed and the spectrum licensing of large portions of the bands in populated areas. These bands are under increasing pressure from other services to share or release their spectrum, which could result in operators being reluctant to roll out links in these bands due to the uncertainty surrounding their future.

One outcome of the 2.5 GHz band review is to replan the 2.1 and 2.2 GHz bands to support the introduction of television outside broadcast services. An outcome of this approach is that the availability of the 2.1 and 2.2 GHz bands is likely to be reduced.

There is also increased interest in use of the 1.8 GHz band in regional areas for mobile broadband applications. Prospective users need to recognise that use of these bands will increasingly need to be shared and that future availability will inevitably decrease. However, in the short term, there is some opportunity for access to these bands in regional and remote areas to provide some backhaul capacity.

High-capacity long-haul links (3.8, 6, 6.7 and 8 GHz)

The continued pressure on the lower microwave bands (1.5, 1.8, 2.1, 2.2, and 3.8 GHz) by wireless access has resulted in a shift of links from these bands to the 6, 6.7, 7.5 and 8 GHz bands. The latter group of bands are mostly used along trunk routes that link major towns and cities across Australia and spectrum is highly utilised along these major routes.

It is anticipated that the deployment of the National Broadband Network (NBN Co) and other fibre networks will replace some of the capacity currently carried by fixed links and relieve congestion on major trunk routes and other high-density areas.

Considering the cost of installing new trunk routes and the increased capacity that alternatives such as fibre offer the use of these bands is likely to increase slightly over the next few years.

Figure 5.4 shows the distribution of low-capacity and high-capacity long-haul fixed links across Australia.

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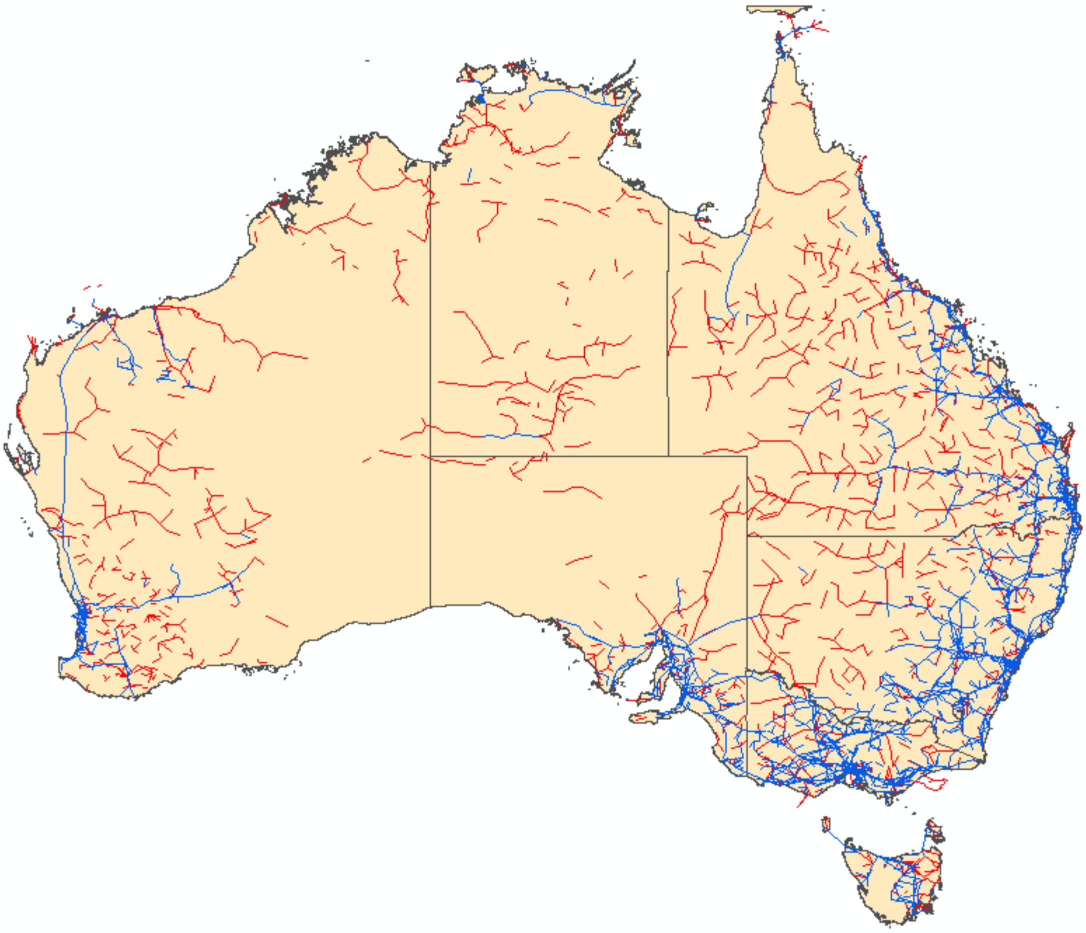
[35] See Embargo 23, contained in RALI MS03, www.acma.gov.au, and the Spectrum Management Agency, *1.9 GHz Band Plan*, 1996, www.comlaw.gov.au/ComLaw/legislation/LegislativeInstrument1.nsf/0/4B5FF06D93A21416CA256FEB00083741?OpenDocument prohibits new fixed point-to-point services in 1880–1900 MHz, while Embargo 23 (see above) applies to 2025–2110/2200–2300 MHz.

Figure 5.4 Distribution of low-capacity (red lines) and high-capacity (blue lines) long-haul links



Bands above 7 GHz (7.5, 10, 11, 13, 15, 18, 22, 38, 49 and 50 GHz)
All these bands, with the exception of 18 and 22 GHz, are moderately utilised at present and the projected growth of recent frequency assignment rates indicates that there is sufficient spectrum to accommodate demand in the short to medium term.

The deployment of future technologies may have an impact on spectrum requirements. For example, future growth in the bands above 15 GHz in urban areas is expected to be driven by backhaul requirements supporting the expansion of wireless access services (particularly mobile broadband such as those provided by mobile carrier networks) in areas where the use of optical fibre is not considered cost effective. However, future growth in the 18 and 22 GHz bands may be limited as they are already heavily used in some high-density areas.

The 50 MHz channels of the 22 GHz band may be reviewed with a view to accommodating future satellite broadcast of high definition television (HDTV) in the 21.4–22 GHz band (see section 5.7.2). These channels are lightly used by fixed P-P links.

The 50 and 58 GHz bands were made available for fixed services; however, due to slow take-up within industry they are currently very lightly utilised. Based on international trends, the ACMA believes that these bands may see a large increase in use in the future if envisioned technological improvements and increased affordability are realised. The broadband wireless technology known variously as millimetre-wave, pencil beam or gigabit wireless spectrum is designed to operate in the 71–76 GHz and 81–86 GHz bands. Due to the relatively small re-use distance characteristics of the bands, the ACMA expects that additional spectrum requirements for fixed services operating in these bands are unlikely during the next 15 years.

Transmissions at these higher frequencies allow communication paths of up to three kilometres and with this technology, full duplex data rates of up to 10 gigabits per second can be achieved.[36] At these frequencies, antennas can have much narrower beamwidths than antennas at lower frequencies. This means that millimetre-wave technology has a relatively low potential to cause interference to other nearby links and can provide high-level frequency re-use. Therefore, the ACMA does not expect spectrum shortage in these bands within the next five years, despite the expectation that the use of this technology will become more widespread.

The viable use of increasingly higher frequencies is a common trend in radiocommunications that is facilitated by technological advancements. The use of active services (services that generate their own electromagnetic emissions for the purposes of radiocommunications) is expected to continue above 71 GHz. For this reason, WRC-12 agenda item 1.8 considered the results of ITU studies into sharing arrangements between passive and active services (Resolution **731**) and between multiple, different co-primary active services (Resolution **732**). The outcome from WRC-12 recommended the inclusion of emission masks in the Radio Regulations for Fixed Services operating in the 81–86 GHz and 92–94 GHz bands.

Coordination of fixed services with Earth stations

There are a number of frequency bands that have shared allocation with the fixed satellite service. There are established performance and availability objectives reflected in coordination arrangements in RALI FX3, providing a benchmark for spectrum use of these bands. However, interference coordination with Earth stations is more problematic.

It is often the case for Earth station receivers that receiver bandwidths greatly exceed the emission bandwidth they are licensed to receive. This results in commensurately greater susceptibility to interference and related spectrum denial to other services. The ACMA cannot consider this larger bandwidth in its coordination decisions for fixed links and assumes that Earth station receivers are fitted with filters that limit their spectrum use to that of their licensed bandwidth.

To this end, the ACMA is currently developing a new RALI for coordination between fixed-satellite service (FSS) and space research (deep space) service (SRS) Earth stations and terrestrial microwave fixed services between 2–30 GHz. A draft of the RALI is expected to be released for comment shortly.

5.3.3 The ACMA's proposed approaches

The ACMA will consider the need for consistency with international practices when developing arrangements for use of the fixed service bands. The ACMA plans to maintain support for P-P links and does not intend to make major changes to fixed service band usage without appropriate consultation. The ACMA will also monitor utilisation levels in the relevant bands. If it appears they are becoming congested, the ACMA will investigate strategies such as facilitating the use of more spectrally efficient technology.

Technological advances, including the use of high-order modulation mechanisms, are resulting in increasing carriage data capacity for the same bandwidths. There may be potentially greater susceptibility to interference for new technologies

[36] With four-level frequency shift keying (FSK) modulation.

compared with current technologies. RALI FX3 provides coordination criteria that include specification of target interference protection ratios. These ratios provide certainty of service availability for current technologies but may not be consistent with the target performance limits of these developing technologies. While some of these technologies are capable of adjusting their data capacities to cope with interference, it is not clear where the optimum balance is between coordination for data capacity, maximum number of services and achievement of spectrum efficiency for the overall public benefit. The ACMA is considering how to manage these developments and achieve the necessary balance.

Spectrum users may also consider the use of new trunk routes or the use of optical fibre if the bands become congested, although these options would involve a significant financial consideration.

The ACMA periodically conducts trending studies of fixed-service licensing and makes adjustments to the licensing framework. A progressive review of protection criteria and planning arrangements for microwave services is planned to continue over the next five years, which may lead to a consequential update of RALI FX3.

400 MHz and 800/900 MHz bands

The ACMA has undertaken extensive consultation of the overall use of the 400 MHz band to find ways of increasing access to it (see Appendix A). Among other things, this is intended to improve access for the fixed service (mainly P-MP) in the medium term. The ACMA received feedback from several stakeholders seeking continued access to 25 kHz channels for fixed P-P services in the 400 MHz band. One consequence is that increased size and interoperability of land mobile networks, as sought by government organisations (see 5.4.2), would correspondingly require an increase in base station backhaul fixed-link capacity. In response, the ACMA has assured access to 25 kHz channels in the 400 MHz band and is encouraging the use of more efficient technologies to accommodate increased capacity demands.

Arrangements in the 803–960 MHz band are currently under review by the ACMA. The first discussion paper in the review, *The 900 MHz band—Exploring new opportunities*, was released in May 2011 and outlines some potential changes to the fixed service allocation in the band. The ACMA has put in place Embargo 64 to support replanning of this band. The review of the 803–960 MHz band will continue throughout 2012.

Low-capacity long-haul links (1.5, 1.8, 2.1 and 2.2 GHz)

The future use of the 1.5 GHz band is under consideration in the ACMA discussion paper *Towards 2020—Future spectrum requirements for mobile broadband*. The ACMA intends to release a discussion paper to further explore the potential use of the 1.5 GHz band by mobile broadband services in mid-2012. Accordingly, pressure on fixed services in the 1.5 GHz band will continue.

The ACMA is considering longer term licensing and planning issues associated with the 1.8 GHz band. With increasing pressure for the ACMA to provide access to this band for mobile services from a wide range of industry sectors, sharing arrangements with existing fixed services also needs to be taken into account. Any changes to the access and coordination arrangements for this band will be subject to consultation with affected stakeholders, including existing and prospective licensees in the band.

The ACMA is continuing work on the development of arrangements to facilitate the introduction of television outside broadcasting services in the 2.1 and 2.2 GHz bands. The decision to implement these arrangements was the outcome of the ACMA's review of the 2.5 GHz band.

Bands over 7 GHz (7.5, 10, 11, 13, 15, 18, 22, 38, 49 and 50 GHz)

A trend of increasing use of wider channels across the bands by operators has been noted by the ACMA. The ACMA will monitor utilisation levels in these bands. If it is evident that the bands are becoming congested, the ACMA may consider replanning these bands.

Consideration of changes to arrangements in the 10 GHz band for the protection of the EESS (see section 5.8.2) may be undertaken as part of a general review or as a separate project. In order to protect future options for the use of the 11 GHz band by the fixed service and other terrestrial services, the ACMA policy does not support the ubiquitous, uncoordinated deployment of Earth station receivers in the 10.7–11.7 GHz band (see section 5.7.2) or any planned fixed band.

If growth increases in the bands above 13 GHz to the extent that there may be unmet demand, the ACMA may consider making alternative bands available to relieve the pressure.

The ACMA may consider the possible introduction of the satellite broadcast of HDTV in the band 21.4–22 GHz (see section 5.7.2). Generally, incremental improvements to planning arrangements will be made and measures such as incentive pricing may be utilised to encourage the use of less congested bands and the relinquishment of unused licences.

For example, the 25 GHz band (24.5–26.5 GHz) has been embargoed for potential future use by the fixed service.[37] Other bands, including the 32 GHz band (31.8–33.4 GHz), have been identified by the ITU for high-density applications in the fixed service.[38]

Review of RALI FX3

The ACMA is conducting an extensive review of P-P arrangements specified in RALI FX3. This review will analyse and amend, where necessary, the microwave bands in RALI FX3 to ensure the arrangements address community and industry needs. The project has been broken down into two main sections:

> bands below 5 GHz

> bands above 5 GHz.

The review is based on the outcomes of a 2006 report by Spectrum Engineering Australia to determine the long-term aspirations of fixed P-P users in microwave frequency bands below 5 GHz and comments received in 2010 from stakeholders on proposed changes to channel arrangements for fixed point-to-point links in the lower microwave frequency bands.

The update to RALI FX3 is expected to occur in 2012, once decisions are made on arrangements supporting the introduction of television outside broadcast services (relevant to 2.1 and 2.2 GHz bands).

[37] Embargo 24, contained in RALI MS03, available at www.acma.gov.au.

[38] See Article 5.547 in the ITU *Radio Regulations*.

5.3.4 WRC Agenda items

WRC-12

The following WRC-12 Agenda items were relevant to fixed services:

- **Agenda item 1.5**—worldwide/regional harmonisation of spectrum for ENG
- **Agenda item 1.8**—technical and regulatory issues relating to the fixed service in the bands between 71 GHz and 238 GHz
- **Agenda item 1.15**—possible allocations in the range 3–50 MHz to the radiolocation service for oceanographic radar applications
- **Agenda item 1.13**—spectrum usage of the 21.4–22 GHz band for the broadcasting-satellite service and the associated feeder-link bands in Regions 1 and 3
- **Agenda item 1.16**—passive systems for lightning detection in the meteorological aids service, including the possibility of an allocation in the frequency range below 20 kHz
- **Agenda item 1.18**—extending the existing primary and secondary radiodetermination-satellite service (space-to-Earth) allocations in the 2483.5–2500 MHz band
- **Agenda item 1.20**—spectrum identification for gateway links for high altitude platform stations (HAPS) in the range 5850–7075 MHz in order to support operations in the fixed and mobile services
- **Agenda item 1.24**—existing allocation to the meteorological-satellite service in the 7750–7850 MHz band with a view to extending this allocation to the 7850–7900 MHz band
- **Agenda item 1.25**—possible additional allocations to the mobile-satellite service.

A synopsis of WRC-12 outcomes is available in section 4.4.3.

The following WRC-15 Agenda items are relevant to the fixed service:

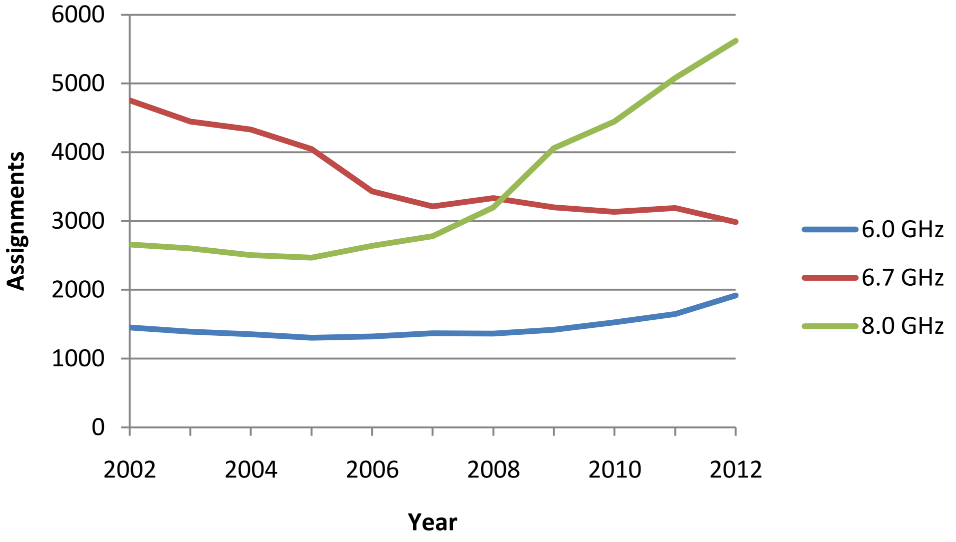
- **Agenda item 1.1**—to consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution **233 [COM6/8] (WRC-12)**.
- **Agenda item 1.4**—to consider possible new allocation to the amateur service on a secondary basis within the band 5 250–5 450 kHz in accordance with Resolution **649 [COM6/12] (WRC-12)**.

5.3.5 Beyond 2016

High-capacity long-haul links (3.8, 6, 6.7 and 8 GHz)

Based on current growth in frequency assignment rates (Figure 5.5), the 8 GHz band may experience more growth than the other high-capacity long-haul bands beyond 2016. Despite the international trend towards the replacement of high-capacity long-haul radio links with optical fibre systems, the feasibility of this in Australia is somewhat limited by rough terrain, a small dispersed population, large distances between population centres and higher costs. Consequently, the high utilisation of these bands is expected to continue.

Figure 5.5 Licence trends for the high-capacity long-haul bands of the fixed service



Bands above 7 GHz

It is also expected that fixed-service usage will extend up to frequencies above 100 GHz within the next 15 years. The use of such high frequencies will be influenced by the results of agenda item 1.8 at WRC-12, particularly if inter-service sharing criteria are determined.

High altitude technologies

The ACMA supports the future deployment of High Altitude Platform Stations (HAPS) with the proviso that work, including detailed sharing studies, is undertaken to ensure the successful coexistence of HAPS with other systems. HAPS base stations are intended to be fitted to aircraft or airships for the wireless transmission of both narrowband and broadband telecommunications services to user terminals over a wide area.

The paired bands 47.2–47.5/47.9–48.2 GHz and 6440–6520/6560–6640 MHz are available for the use of HAPS in Australia. The use of these bands by HAPS is subject to coordination arrangements to protect other services operating in the same or adjacent frequency bands. This includes limits on power flux density (pfd) and equivalently isotropically radiated power (EIRP) to protect fixed and fixed satellite services, and implementation of minimum separation distances and antenna beam pattern constraints to protect earth exploration satellite and radioastronomy services.[39,40]

Other bands have been identified at the international level including the 27.5–28.5 GHz (28 GHz) and 31–31.3 GHz (31 GHz) bands. For both of these HAPS bands, interference mitigation techniques and protection criteria will be needed to minimise interference to the terrestrial fixed and mobile services. Both the 28 GHz and 31 GHz bands are spectrum-licensed and lightly used in Australia. They were intended for systems optimised for BWA.

[39] Provisional Final Acts of WRC-12, Resolution COM5/3 – Use of the bands 6440-6520 MHz by gateway links for high-altitude platform stations in the fixed service.

[40] ITU Radio Regulations, Resolution 122 – Use of the bands 47.2-47.5 GHz and 47.9-48.2 GHz by high altitude platform stations in the fixed service and by other services.

5.4 Land mobile

The land mobile service is a terrestrial service that provides radiocommunications between base stations and land mobile stations, or directly between land mobile stations. Land mobile stations typically provide one-to-many or one-to-one communication services to law enforcement, defence, security and emergency services organisations, transportation, rail and utilities industry sectors. These stations also provide communications services to couriers, private companies with large vehicle fleets, and field staff and others from industry sectors including agriculture, construction, hospitality, mining, manufacturing, tourism and telecommunications service providers.

The land mobile service comprises the following licensing options:

> land mobile systems
> ambulatory stations
> citizen band radio service (CBRS) repeaters
> paging systems.

Land mobile systems usually comprise a fixed base station communicating with one or more mobile units, which can be handheld or vehicle mounted. Coverage is typically metropolitan in scale.

Ambulatory stations are similar to land mobile systems, but they do not have base stations. Communication is between handheld units, which typically have lower power than land mobile systems and therefore a comparatively smaller coverage area.

The CBRS is a two-way, short-distance voice communications service that can be used by any person in Australia. A CBRS repeater is established at a fixed location for the reception and automatic retransmission of radio signals from citizen band (CB) stations.

Paging systems comprise a base station and portable receiving devices used to contact individuals or convey messages to them. Paging systems can be used in either indoor or outdoor applications.

5.4.1 Current spectrum use

There are six frequency bands generally used for the land mobile service:

1. HF band (3–30 MHz)
2. VHF low band (29.7–45 MHz)
3. VHF mid band (70–87.5 MHz)
4. VHF high band (148–174 MHz)
5. 400 MHz UHF band (403–430 MHz and 450–520 MHz)
6. 800 MHz UHF band (820–825 MHz and 865–870 MHz).

In addition to some of these bands, Defence deploys land mobile systems in other parts of the spectrum; in particular, 230–399.9 MHz. Defence has specified its use of HF for long-distance communications and VHF low band for land-force communications, including joint and allied interoperable communications.

This Outlook focuses on the 400 MHz and 800 MHz bands, as these are the prime land mobile bands for non-defence users. However, the ACMA does not ignore the value of lower-frequency bands for land mobile radio users. The superior coverage of these bands makes them useful for communications in regional and remote areas. For example, in the VHF high band, the Victorian Government uses the StateNet Mobile Radio (SMR) network and Telstra operates its commercial Fleetcoms trunked land mobile network. The Queensland Government uses the VHF mid band for emergency services communications.

400 MHz band

The 400 MHz band caters for land mobile and fixed services with a mix of 12.5 and 25 kHz channelling, with 6.25 kHz available through splitting of 12.5 kHz channels. Both single- and two-frequency operation is supported, as well as trunked land mobile services. The 400 MHz Plan details planning arrangements for the 400 MHz band.[41] Industry feedback indicates that users of the 400 MHz band agree that current spectrum arrangements, technology availability and frequency characteristics make 400 MHz the ideal band for wide-area land mobile radiocommunications. VHF is suitable for regional areas but requires larger antennas and is more susceptible to man-made noise. On the other hand, 900 MHz is optimal for urban areas, but lesser coverage makes infrastructure rollout to regional areas very expensive.

800 MHz band

The majority of this band is used for second 2G and 3G public mobile telecommunications services using GSM and wideband CDMA (WCDMA) technologies.[42] Land mobile services in this band are for trunked systems restricted to one paired segment: 820–825 MHz (base receive)/865–870 MHz (base transmit). All land mobile assignments in this paired segment authorise 25 kHz systems. The *900 MHz Band Plan* details planning arrangements for the 800 and 900 MHz bands.[43] As discussed in section 4.2.2, the 803–960 MHz band is currently under review.

Trends

Analysis shows steady growth in the number of land mobile assignments. Traditionally used mostly for voice communications, the operation of land mobile radio for data services is increasing rapidly and becoming very important to users. Apparatus licence data only gives an indication of the growth of base station or repeater station numbers, not the actual number or growth of mobile stations.

There is evidence to suggest that growth has been tempered by congestion in some metropolitan areas. In congested areas, new systems are often accommodated by splitting 25 kHz channels into 12.5 kHz channels or by deploying low-power systems. The growth of land mobile assignments in the 400 MHz and 800 MHz bands is charted in figures 5.6 and 5.7.

[41] The *400 MHz Plan*, available at: www.acma.gov.au/WEB/STANDARD/pc=PC_2571.

[42] Code division multiple access.

[43] The *900 MHz Band Plan*, available at: http://legislation.gov.au/comlaw/Legislation/LegislativeInstrumentCompilation1.nsf/0/FFAC85B8A5C4FB5FCA25703B0015B33F?OpenDocument.

Figure 5.6 Total land mobile assignments in Australia in the 400 MHz band

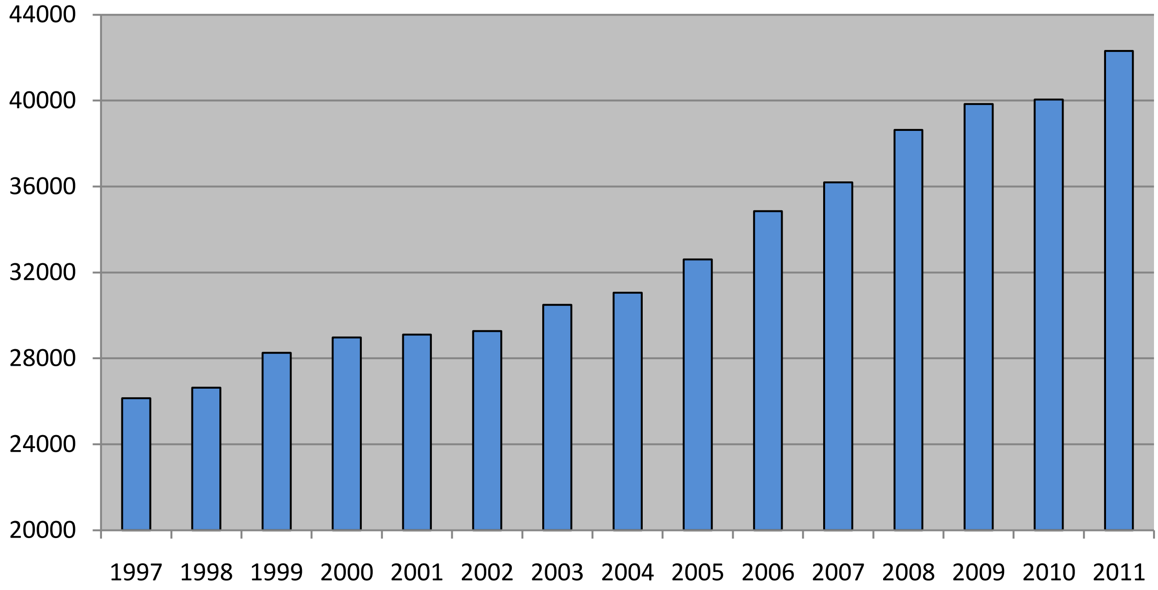
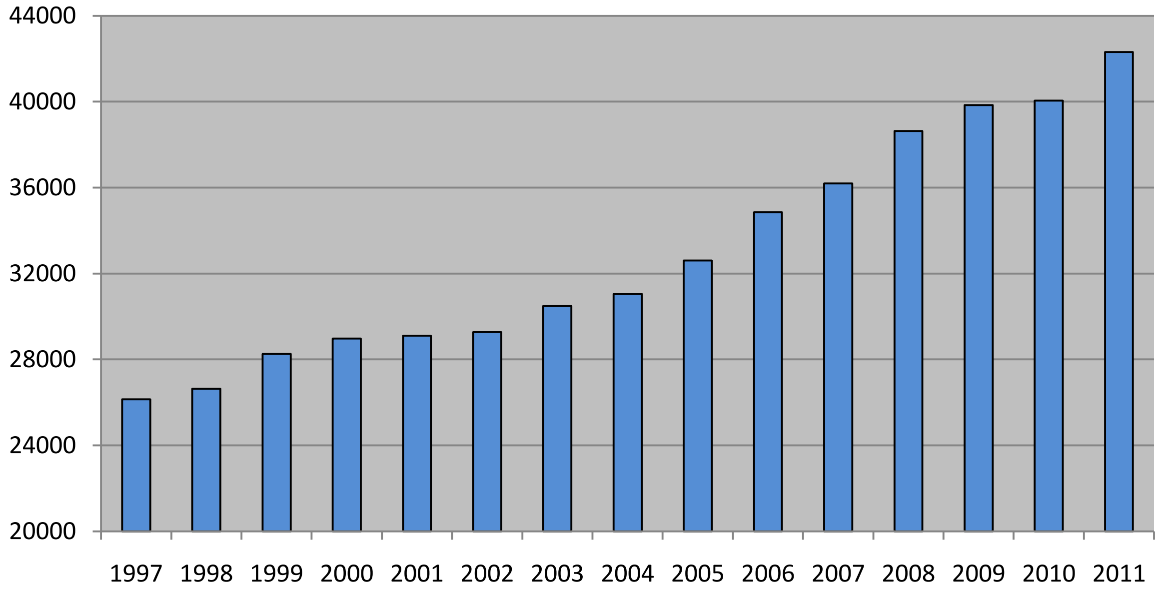
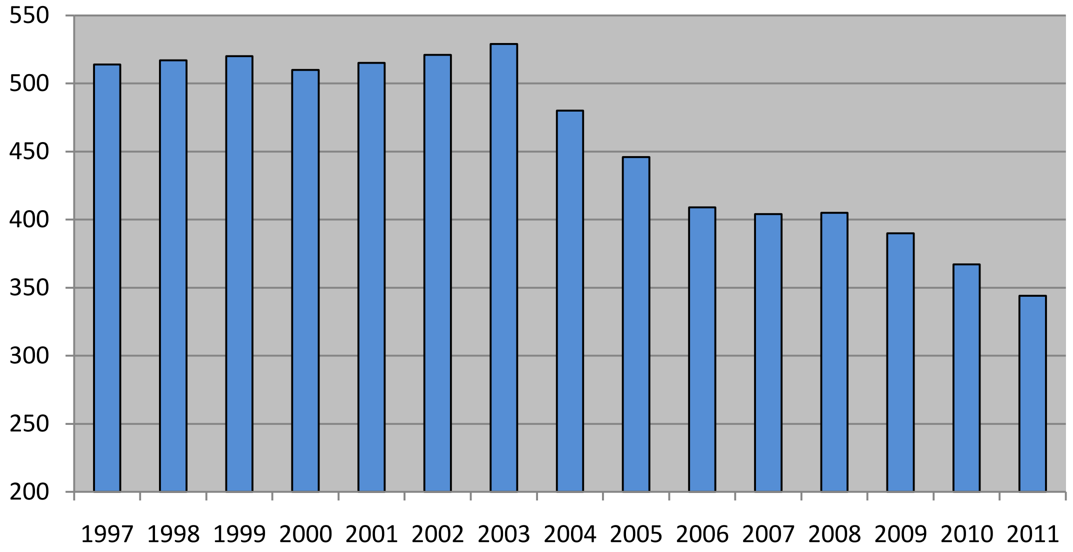


Figure 5.7 Total land mobile assignments in Australia in the 800 MHz band



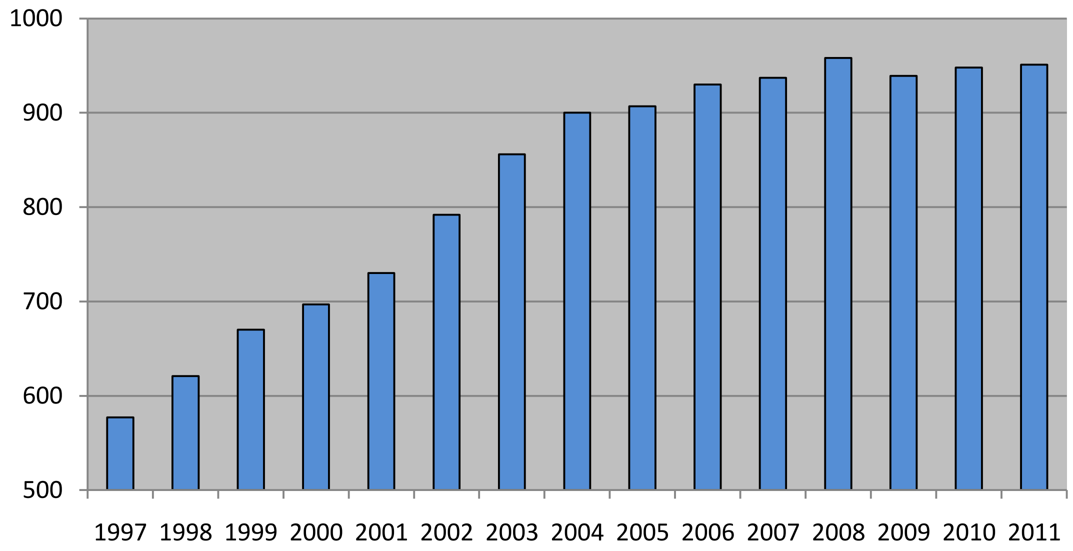
There has been a gradual decline in the number of paging assignments over the past four years, which is largely attributable to the growth of the short message service (SMS) provided by mobile telephony services. This decline can be seen in Figure 5.8.

Figure 5.8 Paging assignments



The operation of CB radios is authorised under a class licence, which means that stations are not recorded individually.[44] Growth in the use of the CBRS can be inferred from the growth in CBRS repeater assignments over the last decade, as shown in Figure 5.9.

Figure 5.9 CBRS repeater assignments



[44] Australian Communications Authority, 2002, Radiocommunications (Citizen Band Radio Stations) Class Licence 2002, www.comlaw.gov.au/ComLaw/legislation/LegislativeInstrument1.nsf/0/9C9C576BDCCEBF70CA256F8C007DAC72?OpenDocument.

5.4.2 2012–2016

Issues affecting spectrum demand

Congestion and the availability of spectrum to facilitate new technologies are key issues for the land mobile service. Industry has expressed the view that land mobile radio services provide essential features that in most cases cannot be provided by other services (such as public mobile telephony and satellite) including group calling, one-to-many communications, accessibility and reliability. Such features make land mobile radio a continuing requirement for a variety of commercial and government users.

Fragmented government land mobile spectrum holdings

To date, spectrum use by government agencies, including those involved in law enforcement, defence, security and emergency services, is fragmented across various segments of the 400 MHz band.[45] Driven by the ACMA's review of the 400 MHz band, federal, state and territory governments are developing strategies for using 400 MHz band spectrum for land mobile systems, including whole-of-government or most-of-government networks, which could exploit trunking efficiencies and potentially use less spectrum. The various government jurisdictions, with the assistance of the ACMA, are working towards a national strategy for the consolidation of government land mobile spectrum holdings to achieve inter-jurisdictional interoperability.

The ACMA notes that the requirements of the commercial sector must also be accommodated and some industry commentary has argued that the level of interoperability and, consequently, the quantum of contiguous, common spectrum, being sought by government agencies is excessive.

Congestion

Congestion, especially in high-demand markets such as Sydney and Melbourne, is currently the most significant issue affecting the land mobile service. Survey results from frequency assigners indicate that in high-demand markets it is almost impossible to find available 25 kHz channels. Consequently, frequency assigners have resorted to splitting 25 kHz channels and/or using low-power assignments to meet the demand.

Industry feedback reveals that digital radio technologies employing 6.25 kHz channel bandwidths are readily available and the ACMA has made provision for these systems in the 400 MHz band.

Under-utilisation of channels

There is evidence to suggest that the abovementioned 'congestion' is better described as a lack of channel availability. Assignments in a number of channels in the 400 MHz band are lightly used. Spectrum monitoring by the ACMA indicates that there is a significant quantity of spectrum occupied by such assignments. There may be a number of reasons why the assignments are not used or only lightly used, and this situation could be further examined with a view to using these channels more productively.

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[45] 403–420 MHz—used by SA, as well as the NSW Government for its government radio network (GRN). 420–430 MHz—Victorian metropolitan mobile radio (MMR) and NSW mobile data radio service (MDRS) networks used by police and emergency services; NT has expressed interest in moving its trunked radio network to this band. 458.3375–459.9375/467.8375–469.4375 MHz—law enforcement and public safety (LEPS) spectrum—used by most jurisdictions (principally police) for voice communications; this band has some capacity for cross-jurisdictional operations and interoperability. 470–490 MHz—used by law enforcement and security agencies for radiocommunications in counter-terrorism operations. 500–520 MHz—includes systems deployed by Motorola—trunked radio network for Western Australian police and the mobile data network (MDN) and the Victorian MMR network.

The ACMA notes that government agencies involved in law enforcement, defence, national security, emergency services, and the rail industry, have said that their communications cannot be subject to unacceptable delay or interference because their operations involve the preservation of public safety. Consequently, they are strongly opposed to the principle of sharing their land mobile channels.

Although emergency services acknowledge the low average temporal utilisation of their radiocommunications networks, they argue that sufficient capacity is necessary to support the simultaneous peak demand of all law enforcement, defence, security and emergency services agencies in the case of major events and emergencies.

Support for new technologies

New technologies employing digital modulation schemes, particularly those employing trunking techniques, can improve the spectral efficiency and quality of land mobile services. For example, the Terrestrial Trunked Radio (TETRA) system enables four-time divided communications channels in 25 kHz of bandwidth.[46] The Association of Public Safety Communications Officials (APCO) Project 25 (P25) system supports both 12.5 kHz and 6.25 kHz bandwidths.[47] Both systems were designed to support the operations of government agencies.

To support such technologies, new arrangements were put in place in the 400 MHz band in February 2011 (i.e. compatible, contiguous blocks of spectrum and compatible frequency splits).[48] Despite the large amount of work required by both the ACMA and radiocommunications users, users supported changes to spectrum arrangements within the 400 MHz band to enhance the efficiency of spectrum use, including reduced bandwidths and trunked radio technologies. However, trunked systems are not optimised for some services, such as those delivering communications to rural areas, and use of conventional land mobile radio systems is expected to continue in those circumstances.

Future developments

Various Australian defence and security agencies, and organisations involved in law enforcement and emergency services, have expressed interest in accessing spectrum for medium-speed broadband data communications.

A similar development to meet the increasing need of such government agencies for broadband data communications was the identification of the 4940–4990 MHz band for use by public protection and disaster relief (PPDR) organisations (at WRC-03). Various Australian organisations involved in PPDR-type operations have expressed interest in using the 4.9 GHz band for deployable, high-speed data systems.

The band 450–470 MHz was identified for the implementation of IMT (see 5.9.2) particularly in developing countries where the use of lower frequencies can significantly reduce infrastructure costs. A primary candidate technology for WAS in this band is CDMA450. Due to the favourable propagation characteristics of the band and broadband communications capability, CDMA450 is seen by some industry members as a potential solution for the provision of wireless in rural areas. The feasibility of using this band for WAS in Australia appears low in high- and medium-density areas. Prospective users are examining the viability of CDMA450 in other areas.

[46] For further information on TETRA see www.etsi.org/website/technologies/tetra.aspx.

[47] For further information on APCO P25, see www.apcointl.org/.

[48] Paired spectrum blocks of 5 MHz each, with 10 MHz splits, are sought by law enforcement, security and emergency services agencies.

5.4.3 The ACMA's proposed approaches

400 MHz band

From April 2008 to December 2010 the ACMA conducted a review of the 400 MHz band. The key outcomes of the review are:

- harmonised spectrum for government use, to assist in radiocommunications interoperability objectives and the development of efficient government networks
- new and improved frequency assigning and licensing mechanisms (including band plans, licensing instructions, licensing options and pricing) that increase the allocative, technical and dynamic efficiency with which spectrum in the band is allocated and used
- support for new technologies and possible complementary uses of the band
- support for arrangements that take advantage of the different spectrum management requirements and challenges between different geographic areas.

To support these outcomes and the migration to the new arrangements in the 400 MHz band the ACMA has put in place spectrum embargoes 50, 51, 53–56 and 60. Further information on the implementation process is discussed in section 4.2.6.

803–960 MHz band

In May 2011, the ACMA commenced a review of the 803–960 MHz band. The review is exploring alternative uses of the 803–820 MHz band and opportunities for combining use with the 820–960 MHz band. It is also considering rationalisation, redesignation and concatenation of existing allocations to maximise the overall public benefit derived from its use.

In response to the first discussion paper, *The 900 MHz band—Exploring new opportunities*, industry has indicated an interest in expanding the 850 MHz PMTS bands (currently 825–845 MHz paired with 870–890 MHz), identifying spectrum for public safety mobile broadband services, reconsideration of arrangements for the fixed service and harmonisation with international markets within the 803–960 MHz band. Other stakeholders have expressed an interest in expanding the trunked land mobile segments in the band.

The ACMA is aware of concerns in the community and industry at the pace and scope of its many other band replanning activities and accommodation of new technologies. These activities reflect the increasing demands on the radiofrequency spectrum and for global harmonisation of spectrum use which the ACMA is obliged to consider. The ACMA is conducting its review with these concerns in mind and with appropriate public consultation. As discussed in section 4.2.2, a second round of consultation in the review of the 803–960 MHz band is expected to occur in 2012.

Data communications requirements

The ACMA will undertake consultation to assist in developing appropriate spectrum management processes to support use of the 4.9 GHz band by PPDR applications as discussed in section 4.2.3. This will involve liaison with Defence and various other government agencies. Any future spectrum arrangements should provide flexibility and interoperability between PPDR organisations. As with the 400 MHz and 700 MHz band, the identification and specification of which organisations and agencies will have access to this band will be crucial.

5.4.4 WRC Agenda items

WRC-12

The following WRC-12 agenda items were relevant to land mobile services:

- **Agenda item 1.17**—sharing studies between the mobile service and other services in the 790–862 MHz band in Regions 1 and 3.

- **Agenda item 1.20**—spectrum identification for gateway links for high altitude platform stations (HAPS) in the range 5850–7075 MHz in order to support operations in the fixed and mobile services.
- **Agenda item 1.24**—existing allocation to the meteorological-satellite service in the 7750–7850 MHz band with a view to extending this allocation to the 7850–7900 MHz band.

A synopsis of WRC-12 outcomes is available in section 4.4.3.

WRC-15

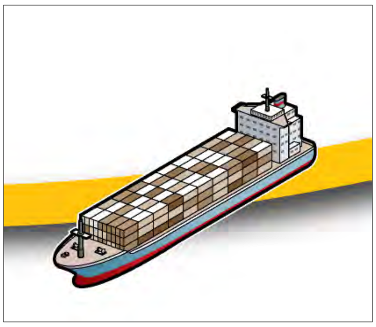
The following WRC-15 Agenda items are relevant to the land mobile service:

- **Agenda item 1.1**—to consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution **233 [COM6/8] (WRC-12)**.
- **Agenda item 1.3**—to review and revise Resolution **646 (Rev.WRC-12)** for broadband public protection and disaster relief (PPDR), in accordance with Resolution **648 [COM6/11] (WRC-12)**.
- **Agenda item 1.4**—to consider possible new allocation to the amateur service on a secondary basis within the band 5 250–5 450 kHz in accordance with Resolution **649 [COM6/12] (WRC-12)**.

5.4.5 Beyond 2016

Currently, the land mobile landscape generally consists of small, land mobile radio networks serving individual client groups. Based on an international trend towards larger, more integrated networks, it is expected in the future that land mobile radio networks in Australia will expand in size to accommodate many client groups and the number of smaller single client networks will decline. This will require the wider use of trunking and thereby improve spectrum usage, with these networks ideally residing in contiguous blocks of spectrum where trunking efficiencies could be fully realised.

5.5 Maritime



The maritime mobile service (MMS) forms an important part of Australia's radiocommunications infrastructure.[49] A wide range of organisations and individuals use the spectrum allocated to the MMS including:

> the Royal Australian Navy
> the Royal Life Saving Society
> search and rescue (SAR) organisations
> coastal patrol stations
> competing commercial entities
> recreational boating enthusiasts
> the fishing industry.

In addition to its usual roles of spectrum management and interference investigation, the ACMA also assists Australian Search and Rescue (AusSAR) in locating emergency position indicating radio beacons (EPIRBs).

Just as for the aeronautical service, the international nature of maritime operations means that Australian allocations are consistent with harmonised ITU allocations to the maritime mobile service, with much of the planning work being driven and overseen by the International Maritime Organisation (IMO). The IMO is responsible for ensuring the safety and security of shipping activities.

5.5.1 Current spectrum use

The majority of spectrum usage in the maritime mobile service occurs in the HF and VHF maritime mobile bands. Above these bands, there is only one maritime mobile allocation for six frequencies, which are used for on-board communications. There are also several maritime mobile bands in the VLF to MF spectrum, with the most significant of these being the MF bands 415–526.5 kHz and 2000–2495 kHz. Especially important are the 490 and 518 kHz channels for maritime safety information (MSI) and the 2174.5, 2182 and 2187.5 kHz channels used for distress, urgency and safety communications.

HF maritime mobile bands

Appendix 17 of the ITU Radio Regulations specifies the frequencies allocated to the maritime mobile service in the HF bands. Currently, there are eight HF maritime mobile bands, ranging from 4 MHz to 26 MHz. Australia also allocates the 27.5–28 MHz band for maritime use. WRC-12 made operational changes to maritime services, with no change to services currently allocated under Appendix 17.

Appendix 17 allocates channels in the HF bands for transmissions using:

> radiotelephony (voice communications)
> Morse telegraphy
> narrowband direct printing (NBDP)
> wideband and direct printing telegraphy, facsimile and data transmission;
> facsimile
> digital selective calling (DSC).

[49] In this Outlook, the maritime mobile-satellite service is included in the satellite service section, and the maritime radionavigation service is included in the radiodetermination service section.

Radiotelephony, NBDP and DSC can all be used in distress situations, on designated channels specified in Appendix 15. A few radiotelephony and NBDP channels are also designated for the transmission of maritime safety information (MSI). In Australia, the state and territory governments operate a safety communications service that includes a listening watch on 4, 6 and 8 MHz distress frequencies and the broadcast of MSI on 8176 kHz. Radiotelephony and NBDP channels can also be used for public correspondence in Australia. The telegraphy and data channels are mainly used by Defence in Australia for both command and control via formal messaging and for tactical data beyond LOS communications.[50]

VHF maritime mobile band

Appendix 18 of the ITU *Radio Regulations* specifies the frequencies of the VHF maritime mobile band (59 channels in the range 156–162 MHz). Currently, two channels in this band (161.975 MHz and 162.025 MHz) are reserved for use by the automatic identification system (AIS), which is required by the IMO to be fitted on all cargo ships over 300 gross tonnage (GT) on international voyages, cargo ships of over 500 GT not on international voyages and all passenger vessels.[51]

The National Standard for commercial vessels (NSCV) now includes carriage requirements for AIS for most commercial vessels in most operational areas.[52] AIS is increasingly being fitted to small recreational vessels for safety purposes.

The Radiocommunications Licence Conditions (Maritime Coast Licence) Determination 2002, Radiocommunications Licence Conditions (Maritime Ship Licence) Determination 2002[53] and the Radiocommunications (Maritime Ship Station – 27 MHz and VHF) Class Licence 2001 specify the permitted uses and conditions applicable to the use of VHF maritime mobile spectrum in Australia.

5.5.2 2012–2016

Issues affecting spectrum demand

Consultation with AMSA has indicated that current maritime spectrum arrangements are largely sufficient to meet the requirements of existing applications and technologies. There appears to be no shortage of spectrum for distress communications and provisions for NBDP are adequate.

Interference

Interference poses a threat to all radiocommunications services, but the impact of malicious and illegal operations and poor radio equipment are becoming important considerations for the ACMA, particularly in the VHF band. As aural telephony distress alerts are replaced with automated DSC alerts, this raises an additional risk that undecoded interference may go unnoticed preventing the reception of distress alerts.

Digital technologies

The safety of life nature of maritime mobile communications makes it important to have numerous communications technologies providing redundancy in the case of

[50] Telegraphy involves the transmission of low-rate data and text messages for both distress situations and working for commercial and non-commercial operations.

[51] AIS provides information about the ship (including identity, type, position, course and speed) to other ships and coastal authorities.

[52] Further information can be found on the NMSC website at www.nmsc.gov.au.

[53] See Radiocommunications Licence Conditions (Maritime Coast Licence) Determination 2002, www.comlaw.gov.au/ComLaw/Legislation/LegislativeInstrumentCompilation1.nsf/all/search/6F188ABFCE7A90A1CA2575390022BE89 and Radiocommunications Licence Conditions (Maritime Ship Licence) Determination 2002, www.comlaw.gov.au/ComLaw/Legislation/LegislativeInstrumentCompilation1.nsf/all/search/B456B37B6531036ECA25753D00067FF5.

emergencies. The transition of vessels to the GMDSS has been a major focus of the ITU and IMO for many years, but so far, the process has been very slow. A major consideration is to maintain a communications environment that will continue to accommodate non-SOLAS vessels and support interoperability with SOLAS vessels.

The ITU has specified the need to enhance spectrum efficiency with the use of new digital technology in order for both the HF and VHF maritime mobile bands to better respond to future spectrum demand.[54] Digital HF technologies have already been developed and are in use.

It is likely that in the long term, NBDP may be replaced by more advanced digital HF data exchange technologies, for which the IMO considers it important to identify additional spectrum allocations for the future, particularly in the range 9–18 MHz.[55]

Changes were made to Appendix 17 at WRC-12. Agenda item 1.9 revised the frequencies and channelling arrangements of Appendix 17 to accommodate new digital technologies for the maritime mobile service. Several administrations have proposed using channels allocated to NBDP transmission to accommodate digital data systems, but some NBDP allocations (at least those for MSI and distress and safety communications) may need to be preserved globally for some years due to the unavailability of satellite-based alternatives in polar regions.

While digital HF data transfer protocols using 3 kHz channel widths have been proposed, additional spectrum may be required if the potential advent of higher speed services (akin to email) are implemented. However, the use of commercial and personal HF data services may be declining (certainly those using NBDP) due to an increasing preference for satellite-based solutions.

Growth in spectrum usage

In Australia, trends in maritime coast frequency assignments indicate that the NBDP channels in the 8 MHz band may become congested, if the current growth rate is maintained. The ACMA does not anticipate that additional spectrum will be required for NBDP within the next five years as the growth can be attributed to a single licensee and because of the decline in commercial HF data services.

Security, safety, tracking and surveillance

The increasing need for systems enhancing ship identification, tracking and surveillance, as well as ship and port security and safety, is an issue that was addressed under Agenda item 1.10 at WRC-12. The frequency band 495–505 kHz is now allocated to the maritime mobile service on a global basis. Refer to section 4.4.3 for further information on WRC-12 outcomes.

VHF communications

The possible reduction in channel spacing, combined with the overall reduction of Australian maritime coast stations over the past eight years, suggests that spectrum demand will not exceed current VHF maritime mobile allocations in the 2012–2016 time frame.

Despite this, there are some service degradation concerns for the VHF maritime mobile bands with regard to inappropriate use of the international distress, safety and calling channel 16. The usability of the band may degrade further in the future due to the low cost and class licensing of VHF equipment, which could make detecting the source of misuse difficult.

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[54] ITU *Radio Regulations*, Resolutions 342 and 351.

[55] International Maritime Organisation, *IMO position on WRC-12 agenda items concerning matters relating to maritime services*, 2011.

5.5.3 The ACMA's proposed approaches

Digital technologies

The introduction of a new digital HF data exchange technology will increase spectrum efficiency. However, it may also present an opportunity to implement higher data rate services, which could require additional spectrum. On the other hand, channels for NBDP are not heavily utilised at present (supported by discussions at WRC-03 and WRC-07) and HF data services for commercial and personal purposes are becoming less attractive in comparison to satellite-based solutions.

If required, the ACMA will update the maritime licence conditions determinations and class licences in response to changes made to Appendix 17 as a result of WRC-12. The ACMA will consider possible frequencies that would be suitable for use or, conversely, which frequencies would be undesirable for Australian users.

VHF communications

The ACMA is reviewing the regulatory arrangements for VHF marine radio used by recreational boat operators and released a discussion paper entitled *A new approach for recreational boaters who operate VHF marine radios*. Comments closed in February 2011. Discussions are continuing with interested marine stakeholders on the most appropriate regulatory approach to take in this sector. An outcome is expected by 30 June 2012.

5.5.4 WRC Agenda items

WRC-12

The following WRC agenda items were relevant to the maritime mobile service:

- **Agenda item 1.9**—Appendix 17—New digital technologies for the MMS.
- **Agenda item 1.10**—Allocation requirements of safety systems for ships and ports.
- **Agenda item 1.14**—Radiolocation service 30–300 MHz Res 611.
- **Agenda item 1.16**—Meteorological aids.
- **Agenda item 1.23**—Amateur service secondary allocation.

A synopsis of WRC-12 outcomes is available in section 4.4.3.

WRC-15

The following WRC-15 Agenda items are relevant to the maritime mobile service:

- **Agenda item 1.15**—to consider spectrum demands for on-board communication stations in the maritime mobile service in accordance with Resolution **358 [COM6/3] (WRC-12)**.
- **Agenda item 1.16**—to consider regulatory provisions and spectrum allocations to enable possible new Automatic Identification System (AIS) technology applications and possible new applications to improve maritime radiocommunication in accordance with Resolution **360 [COM6/21] (WRC-12)**.

5.5.5 Beyond 2016

Growth in spectrum usage

While the ACMA expects no additional spectrum requirements for the maritime mobile service, current growth in the number of apparatus-licensed coast stations operating in the HF channels for NBDP suggests that additional spectrum may be required in the 4, 6, 8, 12 and 18/19 MHz bands by 2023.

Digital technologies

The ACMA will continue to monitor the progress of HF data services and relevant technological developments and will assess options for planning arrangements when more is known about spectrum requirements.

e-Navigation

Additional spectrum may be needed for a proposed network known as e-Navigation. Current maritime mobile bands, especially the HF and VHF bands and UHF satellite frequencies, are expected to play a major part in e-Navigation. It is intended to provide a globally harmonised navigation system using a wide variety of current technologies, enabling the transmission, processing and display of navigational information to increase the level of safety and efficiency of maritime voyages. Information will be transmitted to and from coast stations and to other ships for efficient vessel tracking and management.

e-Navigation is envisioned to provide global broadband communications via satellite and terrestrial networks. Based on those of similar broadband navigation systems and systems recognised for high bandwidth use of the VHF maritime mobile band, its VHF spectrum requirements could be in the vicinity of 150 kHz.

5.6 Radiodetermination

Radar and radionavigation beacons are the best-known examples of radiodetermination systems. Radiodetermination systems operate under a number of different spectrum service allocations including radiodetermination, radiodetermination satellite, radionavigation, radionavigation satellite, radiolocation and radiolocation satellite services.

5.6.1 Current spectrum use

Current spectrum usage by the radiodetermination service occurs across the radiofrequency spectrum. There are, however, only a relatively small number of systems that currently make use of the frequency bands below 300 MHz. The most notable of these are non-directional beacons (NDBs) in the low frequency (LF) and medium frequency (MF) bands and the instrument landing system (ILS) and VHF omnidirectional range (VOR) system in the very high frequency (VHF) band, all of which are used for civil air navigation. The greater number of systems can be found spread across the ultra high frequency (UHF) and microwave frequency bands with most being radar systems.

There are relatively few licensees in this service with the most significant being the Department of Defence, Airservices Australia and the Bureau of Meteorology (BoM). About half of all the bands with radionavigation and radiolocation allocations in the spectrum plan are designated principally for defence purposes, primarily for military radar for surveillance and tracking of both aircraft and ships.

The main non-Defence uses of spectrum for the radiodetermination service are listed in Table 5.2.

Table 5.2 Main uses of spectrum for the radiodetermination service

Frequency band	Use
328.6–335.4 MHz	ILS (Airservices Australia)
400.15–403 MHz	Weather monitoring using radiosondes—meteorological sensors on weather balloons (the BoM)
420–430 MHz	Vehicular tracking and monitoring (QuikTrak)
915–928 MHz	Automatic identification systems (Australian Rail Track Corporation—ARTC, RailCorp NSW and Pacific National)
960–1215 MHz	Distance measuring equipment, secondary surveillance radar (SSR), airborne collision avoidance system, ADS-B for air traffic control purposes and landing approach guidance (Airservices Australia)
1164–1350 MHz and 1559–1610 MHz	Allocations to the radionavigation satellite service (RNSS)—currently used by global navigational satellite systems (GNSS) such as the USA's Global Positioning System (GPS) and the Russian Federation's Global Navigation Satellite System (GLONASS)
1270–1295 MHz	Wind profiler radar
2700–2900 MHz	Primary surveillance radar—PSR (Airservices Australia) S-band weather radars (the BoM)[56]
2900–3100 MHz	Maritime radar beacons (AMSA) and associated shipborne S-band radars
5010–5030 MHz	RNSS allocation (Galileo)
5600–5650 MHz	C-band weather radars (the BoM)[57]

[56] S-band refers to the microwave frequency range between 2 GHz and 4 GHz.

[57] C-band refers to the microwave frequency range between 4 GHz and 8 GHz.

9000–9500 MHz	Maritime radar beacons (AMSA), harbour surveillance radar, SARTs, airport surface movement radar and airborne weather radars
9500–9800 MHz	Slope stability radar GroundProbe
22–26.5 GHz	UWB short range vehicle radar
24.05–24.25 GHz & 34.7–35.2 GHz	Traffic speed radar (police)

The number of frequency assignments authorising the uses listed in this table has been steady or only slightly increased over the past decade. The most significant growth in assignments has occurred for automatic dependent surveillance-broadcast (ADS-B), C-band weather radars, radar beacons and 35 GHz police traffic speed radars. Growth has also occurred in the use of S- and X-band maritime radar and SARTs, as well as weather radars (5350–5470 MHz and 9300–9500 MHz) and Doppler radars (8750–8850 MHz and 13.25–13.4 GHz).[58]

Defence radiodetermination usage includes:

> the use of the HF spectrum for the operation of the Jindalee Operational Radar Network (JORN), which consists of two over-the-horizon radars for air and surface object detection

> UHF spectrum used for military radar systems like identity friend or foe (IFF—included as part of the JTIDS platform) and tactical air navigation (TACAN)

> L-band systems include airborne early warning and control (AEW&C) surveillance radar

> airfield radar and ground-based air defence radars. Defence also uses a variety of X-band radar systems.

5.6.2 2012–2016

Issues affecting spectrum demand

Civil air navigation, surveillance and landing systems

Developments in navigation and landing systems have been very much towards the adoption and use of GNSS augmentation systems over terrestrial-based navigation systems. However, the use of ILS and distance-measuring equipment are expected to remain important though their role may be reduced. This is to avoid an over-reliance on GPS-based systems that could present a single point of failure which would be unacceptable for the safety-of-life nature of the aeronautical radionavigation service (ARNS). ILS facilities in Australia are currently being upgraded by Airservices Australia and the installation of new sites is also possible.

Microwave landing systems (MLS) are not currently used in Australia and, despite its planned phasing out in the US, spectrum in the MLS band (5030–5091 MHz) is not likely to become available in the near future because of increased implementation in Europe and the UK and strong support from ICAO to protect the spectrum.

Until recently, Australia's surveillance infrastructure has depended primarily on PSR and SSR, but this is expected to change with the current deployment of the Australia-wide ADS-B network. ADS-B and GNSS-based navigation, surveillance and landing systems are expected to expand and possibly replace some ground-based surveillance systems within the next decade. The primary objective of the proposed wider application of ADS-B for air traffic surveillance and GNSS-based navigation for aircraft navigation is to enhance safety and increase efficiency of air traffic management.

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[58] X-band refers to the microwave frequency range between 8 GHz and 12 GHz.
The Australian Communications and Media Authority, Radiocommunications (Aircraft and Aeronautical Mobile Stations) Class Licence 2006, is available from www.comlaw.gov.au/ComLaw.

The use of class-licensed airborne radars (radio altimeters) is expected to increase in proportion to the increase in aircraft traffic, which is expected to at least double over the next 15 years.

GNSS

GNSS ground-based augmentation systems (GBAS) combine received GPS signals and the surveyed positions of ground stations to compute corrections for signal errors (for example, timing and ionospheric delay). This achieves far greater positioning accuracy than stand-alone GPS. Differential GPS (DGPS) is a terrestrial GPS augmentation system currently used in Australia to facilitate coastal marine navigation (at LF and MF), as well as in land surveying and navigation (typically VHF high band and UHF).

GBAS has been introduced at Sydney Airport by Airservices Australia for trialling and qualification. The ground-based regional augmentation system (GRAS) may be selected for en-route and regional approach navigation. In both cases, GPS signal corrections are broadcast to aircraft at VHF in the 108–117.975 MHz band. Airservices Australia will consider expanding the GBAS service to other airports in Australia. There are, however, no new radiodetermination spectrum implications from this project.

Industry has expressed some concern about the potential for interference to Galileo L-band systems (to be introduced after 2014) operating at 1164–1350 MHz and 1559–1591 MHz from Defence's JTIDS and airborne warning and control systems (AWACS). AWACS are aircraft that use radar technology and can be used to collect intelligence and coordinate Defence activities.

Current co-channel operation between GPS, GLONASS and Defence radar in the L-band suggests that no significant sharing problems will be encountered in the future. However, further use of L-band GNSS frequencies by other services has been identified as a concern by industry. This is because the operations of the current GNSS elements are entirely based on the availability of the 1559–1610 MHz band. Several regulatory and representative bodies (including the ACMA) and industry continue to hold the position that the use of this spectrum by GNSS should not be constrained by other services.

UHF radar

Defence considers the 430–450 MHz band critical to its operations due to its suitability for long-range air surveillance radars and foliage penetration radar.

S-band radar

The primary users of the 2700–2900 MHz band are Defence, Airservices Australia and the BoM, which operate a number of fixed and mobile radar systems. As shown in Table 5.2, Airservices Australia operates PSR and the BoM operates part of its S-band 'Weather Watch' system and wind-finding radars in the band. Existing radar system operators in this band have identified a number of assignment coordination difficulties. These difficulties have been resolved by discussions between operators, however in the future it may be necessary to develop more formal coordination requirements.

Proposed new Defence radar systems, such as advanced phased array 3D radars for air and missile defence systems (particularly aboard naval vessels), are currently under development. These technologies are designed for the 2900–3400 MHz band and are likely to increase demand for spectrum.

C-band weather radars and RLANs

C-band weather radars are widely deployed and are critical to the BoM's operations. The BoM has indicated that it may have a future spectrum requirement, depending on the extent to which it introduces rural area weather radar coverage. The BoM has also expressed concern about the introduction of class-licensed radio local area networks (RLANs) in the 5600–5650 MHz band.

The frequency range 5600–5650 MHz, used by C-band weather radars in Australia, is currently excluded from Australian class licensing arrangements for 5 GHz RLANs. Sharing arrangements for the compatible operation of RLANs and weather radars in this band, and the wider 5470–5725 MHz frequency range, have been defined in ITU Recommendation ITU-R M.1652. RLANs and C-band weather radars currently operate in this shared spectrum in Canada, the US and Europe. The ACMA will continue to monitor changes in standards for RLANs to protect weather radar systems operating in this band.

Airport surface detection equipment

The use of advanced surface movement guidance and control systems (A-SMGCS) utilising surface movement radar commenced in Australia in 2008 operating in the 9.0–9.2 GHz band and is currently in use at several major airports. Airport surface detection equipment (ASDE) performs a very similar role to A-SMGCS, providing surface movement tracking and control of aircraft and vehicles. ASDE systems are currently deployed in smaller overseas airports, where they use the 9.0–9.2 GHz band.[59] ASDE109 is used in a growing number of overseas airports in the 15.7–16.6 GHz radiolocation band.[60] For this reason, a potential increase in spectrum demand has been identified for ASDE in the 15.7–16.6 GHz frequency range.

While the deployment of ASDE is not currently planned for Australia, any future introduction of this equipment would need to be made in consultation with Defence because spectrum in this range is designated to be used principally for defence purposes.[61]

Automotive radar systems

The operation of two different types of automotive radar systems are currently authorised by the Radiocommunications (Low Interference Potential Devices) Class Licence 2000 (LIPD class licence) in the 22–26.5 GHz (24 GHz band) and 76-77 GHz frequency ranges.[62] The 24 GHz short-range radar (SRR) technology is used for low-power collision avoidance applications (at the front, back and sides of the vehicle), while the 76–77 GHz long-range radar technology is used in longer-range intelligent cruise control applications (observing traffic on the road ahead of the vehicle).

The use of automotive radar systems is expected to increase in the future, as these systems move from limited use in luxury cars to becoming a common safety system in many vehicles. It is expected that new collision-avoidance radars operating in the 77–81 GHz band (79 GHz band) will eventually replace those in the 24 GHz band. The European Commission (EC) decided that 24 GHz ultra wideband (UWB) SRRs were only a temporary solution for anti-collision automotive radar and that these systems would be installed only until June 2013, after which new systems would be limited to other bands. Europe is exploring the feasibility of using other frequency bands as the 79 GHz radars are considered to be expensive.

The likely future proliferation of automotive radar is of concern to operators in the radioastronomy services (RAS) that also operate in the 24 GHz, 76–77 GHz and

[59] ASDE-X is used in the 9.0–9.2 GHz band, and utilises two to four frequencies.

[60] ASDE-3 is used in the 15.7–16.2 GHz band, and has a 16-frequency hopset, with two assignable hopping patterns.

[61] As per footnote AUS1 of the Spectrum Plan.

[62] Available at www.comlaw.gov.au.

79 GHz bands. However, careful planning to provide adequate protection through separation distances and terrain shielding can minimise the risk of interference.

Members of the scientific community have also expressed concerns about the risk of harmful interference to the Earth exploration-satellite service (EESS). Compatibility analyses performed by the ACMA show that for UWB SRRs to cause harmful interference to EESS passive sensors operating in the 23.6–24 GHz band, a significantly large number of vehicles would have to be equipped with SRR within the coverage area of the sensors.[63] Such vehicle densities are unlikely to occur in Australia and would require substantial growth in the use of 24 GHz SRRs.

5.6.3 The ACMA's proposed approaches

Civil air navigation, surveillance and landing systems

Airservices Australia has indicated that additional spectrum requirements for aeronautical radionavigation are unlikely to arise within 2012–2016. Nevertheless the ACMA will continue to liaise with Airservices Australia and monitor developments in spectrum requirements for navigation, surveillance and landing systems.

GNSS

International GNSS systems operate on frequencies allocated by the ITU and the introduction of new GNSS constellations, satellites and signals generally has little impact on the ACMA's spectrum management activities. Despite this, the ACMA monitors international policy and technological developments and will continue to do so.

The ACMA is aware of concerns that JTIDS and AWACS may cause interference to Galileo L-band systems. The ACMA is also aware of technical specifications associated with Galileo and is working to facilitate communications between Defence and the EC to resolve potential interference issues.

The ACMA supports and encourages industry involvement in services associated with GNSS by facilitating access to spectrum for GNSS, including the proposed introduction of Galileo and the QZSS. The ACMA also assists in matters related to GNSS through its involvement with the Galileo Inter-Departmental Committee and the Australian Government Space Forum.

S-band radar

The ACMA will work with stakeholders to establish spectrum-sharing agreements. The ACMA will also investigate the need to develop further spectrum planning guidance on future use of the band by radar systems.

C-band weather radars and RLANs

The ACMA will monitor the outcomes of sharing between weather radars and RLANs in the 5470–5725 MHz band overseas. The ACMA believes that sharing is possible, based on international arrangements set out in the Recommendations and Annex of ITU-R M.1652. The ACMA will proceed carefully with any implementation of RLANs sharing the 5600–5650 MHz and will aim to align developments with the finalisation of the relevant ETSI standard.

ASDE

The ACMA will continue to monitor ASDE developments and its possible future introduction in Australia.

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[63] Australian Communications and Media Authority, *Ultra-wideband short-range radars for automotive applications*, Radiofrequency Planning Branch, Australian Communications and Media Authority, Canberra, 2005, www.acma.gov.au/webwr/radcomm/frequency_planning/spps/0502spp.pdf.

Automotive radar systems
The ACMA believes that the density of operational UWB SRRs required to cause harmful interference to satellites of the EESS will not be realised given that European cars which constitute a significant proportion of the automobile market, (especially among luxury cars with the most advanced features), are likely to phase out the use of 24 GHz UWB SRRs. The ACMA will monitor developments in existing automotive radar systems, through consultation with peak groups such as the Federal Chamber of Automotive Industries and liaise with potentially affected users.

WRC-12 radiolocation allocations
The ACMA will continue to facilitate the use of HF surface wave radars through temporary arrangements. The development of permanent arrangements is dependent on WRC-12 outcomes.

The ACMA will monitor demand and analyse outcomes from other WRC-12 agenda items for VHF space detection applications, the 15.4–15.7 GHz radiolocation allocation and any future allocations in support of UAS operations.

5.6.4 WRC Agenda items

WRC-12
The following WRC-12 agenda items were relevant to the radiodetermination services:

> **Agenda item 1.3**—unmanned aircraft systems (UAS).

> **Agenda item 1.14**—new applications in the radiolocation service and review allocations or regulatory provisions for implementation of the radiolocation service in the range 30–300 MHz.

> **Agenda item 1.15**—possible allocations in the range 3–50 MHz to the radiolocation service for oceanographic radar applications.

> **Agenda item 1.18**—extending the existing primary and secondary radiodetermination-satellite service (space-to-Earth) allocations in the band 2 483.5–2 500 MHz.

A synopsis of WRC-12 outcomes is available in section 4.4.3.

WRC-15
The following WRC-15 Agenda items are relevant to the radiodetermination service:

> **Agenda item 1.18**—to consider a primary allocation to the radiolocation service for automotive applications in the 77.5–78.0 GHz frequency band in accordance with Resolution **654 [COM6/23] (WRC-12)**.

5.6.5 Beyond 2016

Civil air navigation, surveillance and landing systems
As mentioned earlier, aeronautical navigation and landing systems are evolving towards GNSS-based systems. For this reason, the use of some current systems is planned to decline within the next five years following the implementation of GPS-based navigation and landing systems on aircraft. As early as 2010, there were plans in the US to phase-down non-directional beacon (NDB), VHF omnidirectional range (VOR) and microwave landing system (MLS) to a minimum operational network, based on projected satellite navigation program milestones.[64] No spectrum is expected to become available from such activity within the near future.

[64] US Department of Defence, Department of Homeland Security, Department of Transportation, 2005 Federal Radionavigation Plan, http://www.navcen.uscg.gov/.

Airborne weather radars are under development in the 15.4–16.6 GHz band. They are currently very lightly utilised, but there is interest in their use for defence purposes.

Wind profiler radar
Wind profiler radars that operate in the 448–450 MHz range are currently not used in Australia. However, the BoM does use wind profiler radars that operate in other bands and expects its use of these radars to increase generally. The BoM may commence using 450 MHz wind profiler radars and, consequently, anticipates an increase in the need for 450 MHz spectrum allocations at some locations, currently limited to 448–450 MHz. The ACMA will liaise with the BoM on its future requirements for in this area.

GNSS
The passive reception of GPS is expected to increase, but this should not impact on spectrum demand in the next 10 years. The ACMA will instead focus on adjacent band issues to ensure the functionality of GPS.

Spectrum demand will most likely increase for terrestrial augmentation systems. The use of VHF spectrum for the broadcast of GPS corrections indicates that other future systems may also require additional spectrum allocations, but at this time, there is insufficient information to quantify such demand. It is likely that spectrum requirements for GNSS (in particular GPS) augmentation systems will be quantifiable after terrestrial tracking applications are more widely introduced in Australia. The ACMA will continue to observe the deployment of GNSS augmentation systems over the next five years.

Shipborne maritime radar
The use of S- and X-band maritime radars is expected to increase well into the future. Spectrum demand for these radars may therefore increase, but a spectrum shortage is not anticipated in the near future. The ACMA will continue to monitor the deployment of S- and X-band maritime radars and reassess whether additional spectrum may be needed if there are indications of growing spectrum usage.

Maritime radar beacons (racons) are widely used. Their increasing use over the past decade should continue in the future. However, consultation with AMSA has revealed concerns that new technology non-magnetron radar may not be compatible with existing racons. In addition, there is the possibility that they will not be replaceable at the end of their lifetimes and alternative technologies with different spectrum requirements may be introduced after 10 years. The ACMA will monitor the developments of non-magnetron radars and consult with AMSA on the continuation of S- and X-band racons after 2013.

Automatic rail identification systems
The rapidly increasing general use of RFID systems worldwide suggests that the use of rail identification systems will also increase. Despite the limited deployment and growth of this application to rail networks in Australia, increased use for suburban rail transport routes may be a possibility. However, international developments indicate that tracking systems for terrestrial transport may instead use GNSS augmentation systems. The ACMA will continue to monitor the use of the 915–928 MHz band for rail identification systems, but at this stage does not anticipate additional spectrum requirements for this purpose.

Radiodetermination in support of UAS
Agenda item 1.3 of WRC-12 identified spectrum allocations for communications in support of UAS operations in the 5030–5091 MHz. In addition to the mobile communications mentioned in that section, the safe operation of a UAS will require technologies enabling the detection and tracking of other aircraft, terrain and

obstacles, for which spectrum requirements also need to be considered. WRC-15 Agenda item 1.5 was developed to consider satellite allocations for UAS.

A synopsis of WRC-12 outcomes is available in section 4.4.3.

5.7 Satellite

Satellite systems have coverage areas referred to as 'footprints' that can cover up to one-third of the Earth. As a result, these services cannot be considered solely on a national basis. For this reason, the ITU provides a process for the coordination of satellite systems that is outlined in the ITU Radio Regulations.

Satellite communications have enabled applications requiring international communications or large coverage areas and are an important component of the telecommunications industry. In particular, satellite communications are often the preferred or only solution for the provision of communications to remote and rural areas, especially in developing countries. It also provides an important backup for undersea cables that are vulnerable to being cut as a result of geological movements. The main categories of satellite communications are as follows:

> fixed-satellite service (FSS)—satellites communicating with Earth stations located at fixed, specified locations on the Earth

> mobile-satellite service (MSS)—satellites communicating with Earth stations that move across the Earth's surface

> broadcasting-satellite service (BSS)—satellites transmitting signals intended for direct reception by the general public.[65]

5.7.1 Current spectrum use

Satellite services operate in a number of different frequency bands making the development of spectrum sharing and coordination arrangements both appropriate and necessary.

Internationally, the major satellite operators of the fixed-satellite service (FSS) and broadcasting-satellite service (BSS) are Intelsat, SES Global and Eutelsat, which operate primarily in the C-, Ku- and Ka- bands.[66] Most Australian coverage comes from footprints of geostationary satellites serving the Asia-Pacific region operated by Intelsat and Optus and, to a lesser extent, others including ASIASAT, APT Group and SES New Skies. In the FSS and BSS markets, television distribution and broadcasting is the dominant service with much of the recent growth in satellite usage attributable to the development of digital television.

Broadcasting to the public generally uses Ku-band spectrum, with utilisation of C- and Ku-band for contribution feeds. C-band satellite communications currently facilitate important applications including distance learning, telemedicine, universal access and disaster recovery. C-band is also used for feeder links for the MSS. The Ku-band is also used heavily for very small aperture terminal (VSAT) applications and some satellite news gathering (SNG) and digital terrestrial television broadcasting (DTTB) distribution.

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[65] In this report, the radiodetermination-satellite service and the RNSS are included in the radiodetermination service section, and the meteorological-satellite and Earth exploration-satellite services are included in the space science services section. The space operations service is also included in the space science services section, since it is concerned with the operation of spacecraft and not limited to the tracking, telemetry and control of satellites.

[66] When discussing satellite services, these band names generally refer to different frequency ranges than those for other services. For the frequency ranges of satellite services corresponding to these band names, refer to Table 5.2.

The paired FSS allocations 7250–7750 MHz and 7900–8400 MHz are designated to be used principally for the purposes of defence and Defence holds space licences in these bands.

C-band also provides the sole means of international communications for several developing countries, including some of Australia's neighbouring Pacific island territories. Australia hosts several teleport Earth stations providing feeder links to major Earth stations on these islands.

The ACMA is aware of unlicensed Earth receive stations operating in the C-band. To investigate this issue of non-compliance, the ACMA released the discussion paper *Licensing for Earth receive stations* in September 2011. This discussion paper presented a number of options for addressing this issue and sought comment from the satellite community. The submissions made to this consultation process will inform the ACMA's next steps. This issue will be considered further in 2012.

The MSS is more of a niche market based on the needs of specific communities (for example, maritime, aeronautical and transport industries) that require services in regions without alternative infrastructure. The major satellite operators of the MSS in Australia are Inmarsat, Iridium, Globalstar, Orbcomm, Optus and Thuraya. These services primarily use L- and S-band spectrum. Table 5.3 shows the main bands used to provide satellite services in Australia.

Table 5.3 Main satellite spectrum usage in Australia

Band	Service	Comments
<1 GHz	MSS	Shared with RNSS and science services; the only exclusive MSS band is for the use of EPIRBs. Generally used for low data rate and messaging requirements.
L-band (1–1.98 GHz)	MSS	1525–1559 MHz (downlink) paired with 1626.5–1660.5 MHz (uplink), 1610–1626.5 MHz (uplink) paired with 2483.5 MHz–2500 MHz (downlink)—global or near global coverage by Inmarsat, Iridium, Thuraya and Globalstar services, such as voice, data, fax, paging and digital messaging. Earth stations are class licensed in these bands where the space object apparatus is otherwise licensed.[67] The 1525–1530 MHz and 1660–1660.5 MHz bands are shared with the fixed and radioastronomy services, respectively. Inmarsat commenced operation of its aeronautical Broadband Global Area Network (BGAN) service in 2007. Optus MobileSat (1545–1559 MHz (downlink)/1646.5–1660.5 MHz (uplink) on B-series Optus satellites) provides mobile phone coverage for voice, fax and data across Australia and 200 km out to sea. No new fixed assignments are permitted in the 1525–1530 MHz band to preserve options for the MSS.[68]
L-band (1–1.98 GHz)	BSS	1452–1492 MHz—shared with broadcasting, mobile and fixed services (DRCS/HCRC).[69] No new assignments are permitted in order to preserve options for government policy on the introduction of DAB.

[67] Radiocommunications (Communication with Space Object) Class Licence 1998, Available: www.comlaw.gov.au/ComLaw/Legislation/LegislativeInstrument1.nsf/0/F19B53DD2D4DA6F8CA256FD9000555FA?OpenDocument.

[68] This is specified in the 1.5 GHz Band Plan; however, fixed P-MP services for the delivery of telecommunications services in rural or remote areas (such as DRCS) are still permitted.

S-band (1.98–3.4 GHz)	MSS	1980–2010 MHz (uplink)/2170–2200 MHz (downlink) —clearance of these bands to facilitate introduction of the MSS, which have also been identified for the satellite component of IMT). Earth stations can operate under class licence. Few fixed P-P links still operating. 2483.5–2500 MHz (downlink paired with 1610–1626.5 MHz)—used, for example, by Globalstar service downlinks. Earth receivers are authorised to operate under class licence where the space object apparatus is otherwise licensed. 2500–2690 MHz identified for terrestrial component of IMT. Shared with ENG at 2.5 GHz.
C-band (3.4–7.25 GHz)	FSS	C-band was the first band to be used for commercial satellite communications, and there are many extant legacy systems. C-band also has the largest number of satellites. Currently shared with the terrestrial fixed service, use of C-band is authorised by apparatus licences in Australia. 3600–4200 MHz (downlink)/5850–6725 MHz (uplink). This band is used for content delivery for commercial/subscription television and critical communications and mission support for government agencies. The principal usage is in 'standard' C-band (3700–4200/5925–6425 MHz), although some satellite services also use parts of 'extended' C-band (3550–3700/5850–5925 and/or 6425–6725 MHz), which is secondary in Australia in the range 3400–3600 MHz. 5091–5250 MHz (uplink)/6700–7075 MHz (downlink) bands—limited to feeder links for non-geostationary satellite systems of the MSS.
X-band	FSS	6725–7075 MHz (uplink)—used by AsiaSpace for TCR to ASIABSS satellites; also licensed to SKY Channel and Lockheed Martin. 7250–7750 (uplink)/7900–8400 (downlink)—satellite bands used by Defence—communication with AUSSAT C 156E GOV satellite is class licensed.[70]

[69] Under Resolution 528, new BSS systems may only be introduced in the upper 25 MHz of the band (i.e. 1467–1492 MHz).

[70] Radiocommunications (Communication with AUSSAT C 156E GOV Satellite Network) Class Licence 2005, available www.comlaw.gov.au/ComLaw/legislation/LegislativeInstrument1.nsf/0/3AA5BADC5AF7B80DCA25709A000AEEC3?OpenDocument.

Ku-band (10.7–18.4 GHz)	FSS	10.7–11.7 GHz (downlink)—used by iPSTAR in Australia for the provision of broadband connectivity in regional areas, and LBF Australia (French digital TV). Several Earth receive assignments held by NewSat Networks, as well as Lockheed Martin, Pacific Teleports and Soul Pattinson Telecommunications. This band is shared with terrestrial services. 12.2–12.75 GHz (downlink)/14–14.5 GHz (uplink)—Earth stations are class licensed in these bands where the space object is apparatus licensed. These bands are used for direct-to-home (DTH) television services (including Foxtel services on the Optus C1 satellite), SNG, VSAT services including IP broadband and private networks, DTTB distribution and international teleport services. The bands are used by all Optus satellites. There are many Earth receive/space assignments, held by several licensees including Defence, iPSTAR, Lockheed Martin, NewSat Networks, Optus and Telstra. 13.75–14 GHz (uplink)—apparatus licensed due to sharing requirements with radiolocation and space sciences services. Only a few satellites serve Australia using this band. 17.3–18.4 GHz (uplink)—use by geostationary satellites is limited to feeder links for the BSS. Optus uplinks to Optus D3 BSS satellite use 17.3 to 17.8 GHz with Fixed Earth Licences. Australian fixed Earth assignments are held by Stratos Global, Lockheed Martin and Optus for TT&C operations for BSS satellites.
Ku-band (10.7–18.4 GHz)	BSS	11.7–12.2 GHz—Optus D3, uses this band. Further usage of this band at is expected in the medium term.
Ka-band (17.7–37.5 GHz)	FSS	Increasing international use for national and regional broadband connections. 17.7–21.2 GHz (downlink)/27–31 GHz (uplink)—only the 19.7–20.2 GHz and 29.5–31 GHz bands are not shared with fixed and mobile services, even though Earth stations are class licensed in the 18.8–19.3 GHz / 28.6–29.1 GHz bands. There are also MSS allocations. Iridium feeder links use a portion of these bands, Thaicom (formerly Shin Satellite), also operates in these bands under a 27 GHz spectrum licence. Defence has exclusive access to spectrum-licensed bands 20.2–21.2 GHz/30–31 GHz, via of the Optus C1 satellite. 24.75–25.25 GHz (uplink)—shared with the fixed and mobile services, but currently preserved under Embargo 24[71] pending further planning and satellite service developments.
	BSS	21.4–22 GHz—not considered compatible with existing terrestrial fixed links.[72]

[71] Australian Communications and Media Authority, 2007, RALI MS03—Embargo 24, www.acma.gov.au.

[72] This portion of the 22 GHz band is occupied by a relatively low number of microwave fixed links. Licences in this band are subject to advisory note BL, which states that the band is currently under review to accommodate changes in technology, which may lead to a requirement to change frequency or to cease transmission.

5.7.2 2012–2016

Issues affecting spectrum demand

Spectrum demands

It is important to consider the type of growth expected for services and applications supplied by the satellite industry, as this will directly influence the demand on spectrum resources. Factors expected to drive demand for satellite spectrum include increasing consumer demand for higher data rates and flexibility to accommodate various uses and increasing government demand and investment in technology.

The highest levels of growth within the satellite industry are expected for handheld and mobile multimedia applications (for the MSS), along with television distribution and broadcasting and the VSAT market (for the FSS and BSS). Despite these drivers, there are no expected requirements for additional MSS, FSS or BSS allocations or additional class-licensing arrangements within the next five years. There is a general agreement by industry that service providers can continue operations within existing spectrum allocations.

There is interest in the international environment to deploy MSS/ATC systems. Should these networks prove successful, it may drive interest in the Australian market. If this occurs, consideration will need to be given to the effects of such a system on co- and adjacent-band services.

The growth that the satellite communications industry has experienced over the past decade (for example, a 38 per cent increase in revenue from 2000 to 2005) is expected to continue for at least the next decade. Satellite communications usually involve a long investment cycle that can average between 15 to 25 years, meaning that long-term strategic planning is necessary so the industry can respond to spectrum allocation changes.

In February 2012, NBN Co announced that Space Systems/Loral (SS/L) was commissioned to build two next-general Ka-band satellites. These satellites will be designed to provide high-speed broadband coverage and are scheduled for launch in 2015. The provision of satellite services by NBN Co is one of the mechanisms, along with fixed wireless technologies, expected to provide approximately seven per cent of premises with access to broadband services.

MSS in the L- and S-bands

While for now MSS usage is primarily in L- and S-bands, WRC-15 Agenda item 1.10 is to consider possible additional MSS allocations, principally in the range 22 GHz to 26 GHz. This is unlikely to have a significant effect on the Australian radiocommunications environment within the next five years.

Potential future S-band MSS systems in Australia

The ACMA has identified the S-band (1980–2010 MHz and 2170–2200 MHz) as an alternative band for interim use by ENG services as they transition out of the 2.5 GHz band. Australia also has NGSO MSS satellite networks file with the ITU in this frequency range. The ACMA will continue to monitor international activities in this band in relation to the development of MSS/ATC systems.

L-band congestion and sharing issues

The L-band is the primary band used by the MSS and the ACMA notes that the existing allocation are congested. Additional spectrum allocations were identified at WRC-03 and WRC-07 but have not yet been fully implemented in Australia. The congestion issues referred to above are further intensified by sharing issues with other services. This may hinder the use of extension bands identified at previous WRCs.

For example, the ACMA applies sharing and coordination rules to protect the following services sharing with MSS:

- DRCS/HCRC
- passive space research
- RAS.

In light of these factors, future MSS growth is likely to rely on spectrum allocations in the S-band (essentially unused in Australia) and the identified extension bands.

There appears to be little scope for the future expansion of existing networks or the introduction of new networks within existing L-band allocations. Despite the possible introduction of mobile television within the next five to 10 years, along with increased MSS subscriber numbers, additional spectrum requirements for the MSS are not expected within the 2012–2016 time frame.

FSS and BSS in the C-band and higher frequencies

With the MSS spectrum congestion and the identification of the 2500–2690 MHz band for the possible future terrestrial IMT use, the FSS and BSS are expected, for the most part, to continue to be limited to frequencies above 3 GHz.[73]

C-band

Moderate growth of C-band usage is expected to continue in Australia.
The continued improvement in satellite beam-forming technologies would be expected to result in a gradual migration of some C-band services to Ku-band in the longer term. However, the significant investments in existing C-band Earth station infrastructure would be likely to limit the rate of any such migration. Given this and the fact that certain satellite applications and services require high levels of service availability offered by the C-band, this band is expected to continue to play and ongoing role in international communications, including Australia.[74]

There is industry concern about the possibility of interference from future use of the C-band downlink for IMT, particularly for WiMAX and LTE, and the constraint on future FSS deployments that could result.[75] EC decision 2008/411/EC identifies usage of the 3.6–3.8 GHz band for BWA services from 2012 onwards. Part or all of the 'extended' C-band (3400–3600 MHz) was also identified for use by IMT in many countries at WRC-07. While the list of countries does not include Australia, part of the band has already been made available for WAS in regional and remote areas of Australia (3575–3700 MHz). In addition, parts of the extended C-band are already used for WAS under apparatus and spectrum licences.[76]

X-band

Defence expects its use of this band to increase with its involvement in the Wideband Global System satellite communications program. Defence has expressed a concern over the interference potential of current sharing arrangements between satellite and terrestrial fixed services in the band and is seeking long-term protection for anchor stations, training areas, and possible protection in areas of higher density use in the future.

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[73] S-band FSS (2500–2535/2655–2690 MHz) and BSS (2520–2670 MHz) allocations are not used in Australia, and satellite applications are not considered feasible here.

[74] The C-band is the only FSS band commonly used for commercial (non-government/military) purposes below 10 GHz. Above 10 GHz, rain attenuation becomes significant. This makes the C-band critical for communications in tropical areas.

[75] WiMAX stands for worldwide interoperability for microwave access.

[76] Since 2000, the 3425–3492.5 MHz and 3542.5–3575 MHz bands have been allocated for spectrum licensing. Seven entities currently hold licences in different geographical areas around Australia.

Ku- and Ka-bands

The Ku-band is currently experiencing the fastest growth in satellite communications and this is expected to continue well into the future. The widespread use of several communications solutions is expected in this band, including:

> television distribution and broadcasting

> Satellite News Gathering

> broadband

> VSAT data communications, including IP broadband and private networks, and international teleport services

> mobile television—satellite downlinks are being considered in both the S- and Ku-bands and terrestrial retransmission in the S-band.

Television distribution and broadcasting is the dominant service in the FSS and BSS allocations in the Ku- and Ka-bands and growth in these markets is expected in Australia. The expansion of the Optus satellite fleet, intended to support Foxtel's HDTV and other satellite broadcasting services, is an example of industry anticipating the expected growth in demand. The Optus D3 satellite uses 11.7–12.2 GHz for television broadcasts and 17.3–17.8 GHz for BSS feeder links. The 14.5–14.8 GHz is also limited to feeder links for the BSS, but since the band is designated to be used principally for defence purposes, it is complicated to introduce commercial satellite services within it.

Footnotes 5.502 and 5.503 of the ITU *Radio Regulations* outline sharing criteria between FSS Earth station transmitters and radiolocation/space research services in the 13.75–14.0 GHz band. Currently, Earth stations must be individually apparatus licensed to facilitate coordination. Industry feedback indicates that, due to the imbalance between FSS uplink and downlink allocations, congestion in 14.0–14.5 GHz is starting to occur in Australia. As new Ku-band satellites are capable of serving Australia in the 13.75 to 14.0 GHz band, there is some interest in a simplified licensing approach that still satisfies the international sharing arrangements.

Internationally, there is increasing interest in satellite broadcasting at Ka-band frequencies. Agenda item 1.13 of WRC-12 considered the future spectrum usage of the 21.4–22 GHz band for HDTV in the BSS and associated feeder link bands, based on technical and regulatory studies on the harmonisation of spectrum usage and BSS technologies. Under current arrangements, such BSS usage of the band is not considered compatible with existing fixed P-P links in the 22 GHz band. Further information on the fixed service operating in the 22 GHz band is in section 5.3.2.

From 1995 to 2005, the spectrum efficiency of satellite communications technologies tripled and it is expected to double again over the next 10 years. Technologies that can enhance the efficiency of spectrum used for satellite services include:

1. video encoding and modulation standards such as:
    > MPEG 4, a video compression format standardised by the Moving Picture Experts Group
    > digital video broadcasting-satellite-second generation (DVB-S2), a forward error coding and modulation standard that has enhanced performance over the digital video broadcasting-satellite (DVB-S) standard
    > digital video broadcasting return channel via satellite (DVB RCS), which provides a return channel to enable internet access and other data services over satellite
2. other technologies and efficiencies such as the use of phased array antennas, spot beam-forming technologies, multi-band antennas and adaptive array antennas.

5.7.3 The ACMA's proposed approaches

Earth station siting

In August 2011, the ACMA released a discussion paper, *Earth Station Siting*, outlining the factors that may impact the future viability of satellite Earth stations and space communications facilities in different geographical areas and frequency bands. The purpose of the discussion paper and broader consultation process was to openly discuss some of the factors relevant to current and prospective operators when they consider the geographical and frequency location of Earth stations. Through this discussion, the ACMA intends to provide options for long-term certainty of operations to the satellite and space science industries. See section 5.8.2 for further discussion.

MSS in the L- and S-bands

Within the 2012–2016 time frame, the ACMA expects to maintain current L-band and S-band class-licensing arrangements for MSS services. The ACMA will also monitor any MSS requirements for WRC-03 extension band applications in Australia, including class-licensing arrangements for these bands, and will consider sharing arrangements between MSS and fixed DRCS/HCRC services. The ACMA is unaware of any current plans for the use of MSS systems in these bands in Australia, however, recognise that the coverage of such international services may extend to Australia.

The ACMA will continue to protect DRCS/HCRC in the 1518–1525 MHz band by imposing pfd thresholds on the MSS in this band. Though the current limit was negotiated to ensure that MSS development would not be severely constrained, future sharing arrangements for the potential introduction of MSS services in this extension band may lead to a need to reconsider the pfd limit in more depth. There are currently no MSS systems operating in the 1668–1675 MHz band in Australia. Potential future use of the band for the MSS may require a study into the feasibility of sharing with RAS facilities at Parkes and Narrabri. In particular, protection of RAS stations at 1660–1670 MHz will need to be considered. This may require the use of separation distances and mobile Earth station output power limits for co-band 1668–1670 MHz MSS systems and adjacent band 1670–1675 MHz MSS systems.[77]

FSS and BSS in the C-band and higher frequencies

For the ACMA's proposed approaches to L-band BSS, see section 5.2.2. From 2012 to 2016, the ACMA's apparatus licensing arrangements will maintain current access arrangements to the C-band for satellite Earth stations. As outlined in section 5.7.1, the ACMA has identified non-compliant Earth receive stations operating in the C-band and will be considering this matter further in 2012. In addition, the ACMA expects to maintain its policy not to support the ubiquitous, uncoordinated deployment of Earth station receivers in bands shared with terrestrial services, particularly the 3.4–4.2 GHz frequency range (standard and extended C-band) and the 10.7–11.7 GHz band.

The ACMA will continue to work with Defence to balance its operational requirements in the X-band with those of the broader community and radiocommunications industry.

The ACMA will maintain Ku-band class-licensing arrangements in the 11.7–12.75 GHz and 14.0–14.5 GHz bands, as strong continued growth is expected in the Ku-band for DTH broadcasting and VSAT applications. Current class-licensing arrangements in the Ku-band are expected to be sufficient to support satellite applications, including HDTV, within the 2012–2016 time frame. However, the ACMA notes some industry interest in revised licensing arrangements in the 13.75–

[77] As specified in Article 5.379C of the ITU *Radio Regulations*.

14.0 GHz band. Any consideration of such a revision would require consultation with interested and affected stakeholders in the band.

The ACMA will monitor any international technological and regulatory developments for HDTV services broadcast at 21.4–22.0 GHz. The ACMA will also monitor demands for HDTV BSS systems in Australia, which may involve public and industry consultation.

Ka-band class-licensing arrangements in the 18.8–19.3 GHz and 28.6–29.1 GHz bands will also be maintained, with the expectation that demand for Ka-band DTH broadband applications may arise within the 2012–2016 time frame.

5.7.4 WRC Agenda items

WRC-12

The following WRC-12 agenda items were relevant to satellite services:

> **Agenda item 1.8**—fixed service in the bands between 71 GHz and 238 GHz.
> **Agenda item 1.13**—spectrum usage of the 21.4–22 GHz band for the broadcasting-satellite service and the associated feeder-link bands in Regions 1 and 3.
> **Agenda item 1.18**—primary and secondary radiodetermination-satellite service (space-to-Earth) allocations in the 2 483.5–2 500 MHz band.
> **Agenda item 1.21**—radiolocation service in the 15.4–15.7 GHz band.
> **Agenda item 1.24**—meteorological-satellite service in the 7 750–7 850 MHz band with a view to extending this allocation to the 7 850–7 900 MHz band.
> **Agenda item 1.25**—mobile-satellite service.
> **Agenda item 7**—advance publication, coordination, notification and recording procedures for frequency assignments for satellite networks.

A synopsis of WRC-12 outcomes is available in section 4.4.3.

WRC-15

The following WRC-15 Agenda items are relevant to satellite services:

> **Agenda item 1.1**—to consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution **233 [COM6/8] (WRC-12)**.
> **Agenda item 1.6**—to consider possible additional primary allocations:
>> **Agenda item 1.6.1**—to the fixed-satellite service (Earth-to-space and space-to-Earth) of 250 MHz in the range between 10 GHz and 17 GHz in Region 1
>> **Agenda item 1.6.2**—to the fixed-satellite service (Earth-to-space) of 250 MHz in Region 2 and 300 MHz in Region 3 within the range 13–17 GHz
>>> and review the regulatory provisions on the current allocations to the fixed-satellite service within each range, taking into account the results of ITU-R studies, in accordance with Resolutions **151 [COM6/4] (WRC-12)** and **152 [COM6/5] (WRC-12)**, respectively.
> **Agenda item 1.7**—to review the use of the band 5 091–5 150 MHz by the fixed-satellite service (Earth-to-space) (limited to feeder links of the non-geostationary mobile-satellite systems in the mobile-satellite service) in accordance with Resolution **114 (Rev.WRC-12)**.

- **Agenda item 1.8**—to review the provisions relating to earth stations located on board vessels (ESVs), based on studies conducted in accordance with Resolution **909 [COM6/14] (WRC-12)**.
- **Agenda item 1.9**—to consider, in accordance with Resolution **758 [COM6/15] (WRC-12)**.
  - **Agenda item 1.9.1**—possible new allocations to the fixed-satellite service in the frequency bands 7 150–7 250 MHz (space-to-Earth) and 8 400–8 500 MHz (Earth-to-space), subject to appropriate sharing conditions.
  - **Agenda item 1.9.2**—the possibility of allocating the bands 7 375–7 750 MHz and 8 025–8 400 MHz to the maritime-mobile satellite service and additional regulatory measures, depending on the results of appropriate studies.
- **Agenda item 1.10**—to consider spectrum requirements and possible additional spectrum allocations for the mobile-satellite service in the Earth-to-space and space-to-Earth directions, including the satellite component for broadband applications, including International Mobile Telecommunications (IMT), within the frequency range from 22 GHz to 26 GHz, in accordance with Resolution **234 [COM6/16] (WRC-12)**.
- **Agenda item 7**—to consider possible changes, and other options, in response to Resolution 86 (Rev. Marrakesh, 2002) of the Plenipotentiary Conference, an advance publication, coordination, notification and recording procedures for frequency assignments pertaining to satellite networks, in accordance with Resolution **86 (Rev.WRC-07)** to facilitate rational, efficient, and economical use of radio frequencies and any associated orbits, including the geostationary-satellite orbit.

5.7.5 Beyond 2016

Potential future deployments and spectrum demand pressures in Australia

It is likely that insufficient spectrum allocations for MSS under 3 GHz will be available for deployment of a MSS/ATC system and mobile television, if subscriber numbers continue to increase. Therefore, additional allocations in L- and S-band spectrum may be required by about 2018. Moreover, the introduction of a MSS/ATC system operating at 1.6 GHz and 2.5 GHz would require the consideration of the RAS at 1610–1613.5 MHz and ENG services, and possible future WAS applications within the 2500–2690 MHz frequency range.

There is concern within the satellite industry that WAS may impact on satellite usage in the standard C-band (3700–4200 MHz). The ACMA is monitoring international developments in this band and will canvass the possible use for mobile broadband in its service planning for the mobile broadband.

Ku-band growth

Growth in the number of satellite television channels will increase spectrum demand, as will the increased proportion of HD transmissions and the expected growth of VSAT deployment numbers and data rates. There is a possibility that this may lead to congestion of Ku-band spectrum allocated to the FSS within the next 10 years, despite considerable portions of unencumbered spectrum. While it is likely that spectrum demand will exceed current satellite capacity within the next 15 years, there are several vacant orbital locations over Australia that could satisfy the estimated demand within current spectrum allocations. Spectrum demand for the BSS is not expected to exceed current spectrum allocations.

Growth in higher frequency bands

The use of Ka-band permits the use of more complex satellite antennas, allowing for a cellular approach to spectrum re-use, which subsequently increases throughput through a satellite. Industry feedback indicates that Ka-band satellite communications may be considered as a means of extending broadband to regional and remote areas. It is already being used in the US and may be relevant to Australia in the future, particularly in the context of NBN.

V- and W-band satellite technology (50–75 GHz and 75–110 GHz) is currently immature and significant utilisation of this spectrum is not expected to materialise within the next 15 years.

5.8 Science services

The science services (also referred to here as space science services) consist of the:

> radio astronomy service (RAS)
> Earth exploration-satellite service (EESS)
> space research service (SRS)
> space operation service (SOS)
> meteorological-satellite service (MetSat)
> meteorological aids service (MetAids).

Frequency allocations for these services are made on a global basis due to their use of space and, in some cases, their dependence on naturally occurring emissions referred to as 'fingerprints of nature'.

5.8.1 Current spectrum use

The EESS involves the reception of the radio waves originating on or reflected from the Earth. The measurements of interest are made on satellite-based platforms and are processed to obtain information relating to the characteristics of the Earth and its natural phenomena; for example, soil moisture, sea surface temperature, snow cover, rainfall and atmospheric temperature and water vapour content. Both the EESS and SRS have communications components connecting the Earth and space stations that comprise these services in order to transfer data to the Earth for processing.

MetSat is a subset of the EESS specifically for meteorological purposes and MetAids involves the transmission of meteorological information from airborne or terrestrial sensor platforms to ground stations. The environmental measurements obtained through MetAids and the EESS are characterised by the strength and frequency of signals received by the passive and active sensors employed. Since the naturally emitted or reflected electromagnetic signals with characteristics fundamental to these space science services have fixed frequencies (apart from some shifting due to anomalous phenomena), their protection is crucial to the operation of these services.

The RAS, on the other hand, involves the study of celestial bodies by way of the reception of radio waves of cosmic origin at a terrestrial station. The SRS (passive) is similar, however operates by the way of reception of cosmic radio waves by spacecraft-borne instruments. These instruments may be carried on a wide range of scientific spacecraft that explore our solar system, collecting data through sensors, video systems and other devices.

There is a significant radioastronomy presence in Australia, with RAS facilities at:

> Narrabri, Parkes and Mopra, operated by the Commonwealth Scientific and Industrial Research Organisation (CSIRO)
> Mt Pleasant, Yarragadee (WA), Katherine (NT) and Ceduna, operated by the University of Tasmania
> the Canberra Deep Space Communication Complex (CDSCC), which is part of the National Aeronautics and Space Administration (NASA) Deep Space Network
> the Mid West Radio Quiet Zone (RQZ) located in the Murchison Shire near the Boolardy Station with the Murchison Radioastronomy Observatory (MRO) operating at the centre of the Mid West RQZ.

Australia has Earth stations that receive environmental and scientific data from sensing instruments aboard foreign satellites and provide TT&C to others. Most of the Earth stations associated with these satellites are operated by the BoM, CSIRO (including the CDSCC), Stratos Global and Geoscience Australia (GA).

The implementation of new developments in the science services industry is typically characterised by long time frame s as the bands used for these purposes are determined at an international level, usually after considerations that extend over one or more WRC cycles. As a result, changes to allocations do not occur rapidly.

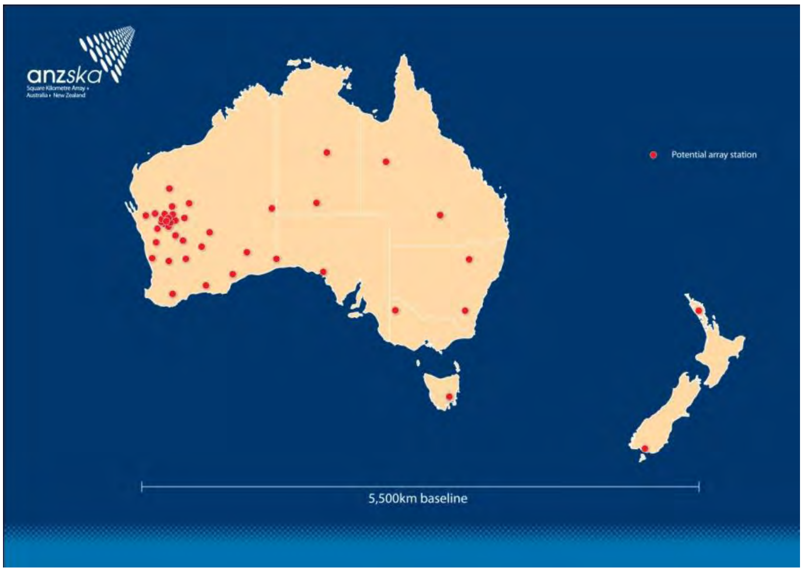
The ACMA will continue to work closely with agencies involved in science services to facilitate spectrum requirements for operations, especially considering the public benefit that these services provide.

The table below provides an overview of the various frequency bands and associated use by the science service.

Square Kilometre Array

The Square Kilometre Array (SKA) is a planned radio telescope made up of an array of parabolic antennas and dipoles with a combined collecting area of one square km. It will operate between 70 MHz and 25.25 GHz.

Figure 5.10 Potential SKA array station placement in Australia and New Zealand



Picture courtesy anzSKA

Australia, together with New Zealand and South Africa have been short-listed to host the SKA and both are building technology demonstrators at their proposed sites. The decision is expected to be announced in 2012. It is essential that the SKA be located in an area of radio quietness to protect the highly sensitive receivers required for such an instrument.

The joint Australian/New Zealand proposed anzSKA site is in a remote area which provides a naturally radio quiet environment. To further support the bid, a radio quiet zone (RQZ) has been established in Western Australia. In July 2011, the ACMA implemented the *Radiocommunications (Mid West Radio Quiet Zone) Frequency Band Plan* in 2011. The purpose of the band plan is to protect the operation of radioastronomy services within the identified geographic area.

The Frequency Band Plan arrangements allow for the operation of other services in the area, provided the services are able to coexist and do not cause interference to the SKA. The CSIRO has developed consultation mechanisms and processes that interested applicants can use to approach the CSIRO with their intended applications, before submission with the ACMA. In addition, key class licences have been revised to provide protection for radioastronomy within the Mid West Radio Quiet Zone.

Within the RQZ, the Murchison Radioastronomy Observatory presently hosts the SKA Pathfinder (ASKAP) radio telescope (operated by the CSIRO), the Murchison Widefield Array radio telescope (operated by a consortium of national and international institutions) and EDGES radio telescope (operated by an international consortium). In addition to undertaking cutting-edge radioastronomy observations in their own right, these demonstrate the suitability of the proposed SKA site in Western Australia. The introduction of the SKA, if hosted by Australia, is the most significant foreseeable change in radioastronomy and spectrum requirements for the RAS.

Table 5.3 Main frequency bands used by science services

KEY:
* d—downlink
** u—uplink
† a—active
†† S—secondary allocation
‡ p—passive

Frequency band	Service	Main Australian licensee	Usage
VHF	MetSat (d*)	BoM	137–138 MHz—meteorological image downlink from polar-orbiting satellites (NOAA POES[78] and FengYun-1).
UHF	MetAids	BoM	400.15–401 MHz—radiosonde[79] data downlink.
	MetSat (d/u**)	AAD[80] AMSA	401–403 MHz—uplink for meteorological data sensed at data collection platforms. 460–470 MHz—interrogation downlink for data collection platforms.
		GA	401.25 MHz—ionospheric correction signal for the DORIS[81] system for position tracking.
L-band	EESS (a†)		1215–1300 MHz—L-band synthetic aperture radars (SAR) on Japan's ALOS and Argentina's SAOCOM satellites.
	RAS	CSIRO	1400–1427 MHz & 1610.6–1613.8 MHz—Parkes, Narrabri and Tidbinbilla stations.
	MetSat (d)	BoM GA CSIRO	1670–1710 MHz—meteorological satellite data downlink (NOAA POES, FengYun, GOES, Meteosat and MTSAT and OrbView-2 satellites).

[78] Polar Operational Environmental Satellites (POES) of the US's National Oceanic and Atmospheric Administration (NOAA).
[79] Radiosondes are meteorological sensors mounted on weather balloons.
[80] Australian Antarctic Division.
[81] Doppler Orbitography and Radiopositioning Integrated by Satellite, used by Jason-2, SPOT-2 and Envisat.

S-band	EESS (u/d) SRS (u/d) SOS (u/d)	2025–2110/2200–2290 MHz—primary TT&C uplink/downlink, used by almost all satellites in the EESS and SRS.	
		Stratos Global (Xantic B.V.)	European Space Agency's (ESA's) ESTRACK stations support: Perth—XMM-Newton and Cluster II missions New Norcia—Mars Express, Rosetta and Venus Express Both stations—LEOP support for several ESA missions.
		CSIRO	Deep-space stations at CDSCC, which communicate with many spacecraft in the SRS and EESS.
		USN	Provides TT&C from Yatharagga, WA under PrioraNet network (various clients).
		GA	2036.25 MHz—main Doppler signal for DORIS.
	SRS (deep space) (u/d)	Stratos Global CSIRO	2110–2120/2290–2300 MHz—deep-space uplink/downlinks to the tracking stations at New Norcia, and Canberra.
S-band	RAS	CSIRO	2690–2700 MHz—Parkes and Narrabri stations.
C-band	EESS (aS††)		3100–3300 MHz—Envisat's Radar Altimeter (RA-2).
	FSS (d)		4033–4042 MHz—meteorological data dissemination service (GEONetCast).
	RAS	CSIRO	4800–5000 MHz—Parkes and Narrabri stations.
	EESS (a)		5250–5570 MHz—radar altimeters, SARs and scatterometers for the determination of wind speed.
	EESS (p‡)		6700–7075 MHz—advanced microwave scanning radiometer (AMSR) and the Windsat radiometer.
X-band	SRS (u)	Stratos Global (Xantic B.V.) CSIRO	7145–7235 MHz—X-band command uplinks from tracking stations at Perth, New Norcia and Canberra. Deep-space missions operate in the 7145–7190 MHz band.
	MetSat (d)		7450–7550 and 7750–7850 MHz—limited current use.
	EESS (d)	GA USN	8025–8400 MHz—primary data downlink for EESS satellites (data from Terra, Aqua, Landsat-5 and -7, ALOS, EO-1, Radarsat-1, Resourcesat-1 and ERS-1 and -2 are received in Australia).
	SRS (d)	Stratos Global (Xantic BV) CSIRO	8400–8500 MHz—primary SRS data downlink, used by Perth, New Norcia and Canberra tracking stations. Deep-space missions in the 8400–8450 MHz band.
	EESS (a)		9500–9800 MHz—SAR on TerraSAR-X.
	ESS (p)		10.6–10.7 GHz—AMSR, the Tropical Rainfall Measuring Mission (TRMM) microwave imager (TMI) and the Windsat radiometer.
Ku-band	EESS (a)		13.25–14.3 & 17.2–17.3 GHz—radar altimeters, the SeaWinds scatterometer, the TRMM precipitation radar and the Jason Microwave Radiometer.
	SRS (d/u)	CSIRO	13.75–15.35 GHz—spacecraft tracking from Perth and Canberra.

Ka-band	EESS (d/u) SRS (d/u)	Stratos Global (Xantic BV) CSIRO	25.5–27 GHz—Ka-band downlink—at Canberra and New Norcia. 28.5–30 GHz—MTSAT Ka uplink (not in Australia).
	SRS (d/u)	Stratos Global (Xantic BV) CSIRO	31.8–32.3 GHz / 34.2–34.7 GHz—communications to/from Canberra deep space station and New Norcia.
	SRS (d/u)		37–38/40–40.5 GHz—planned links to/from Canberra and New Norcia.
	EESS (p)		Various bands between 18.6 and 24 GHz, and 36–40 GHz—AMSR, TMI, advanced microwave sounding unit (AMSU), special sensor microwave imager (SSM/I), and other microwave radiometers.
	EESS (p)		50.2–59.3 GHz and 86–92 GHz—AMSU, TMI, SSM/I and AMSR. 100 GHz—AMSU.
> 50 GHz	EESS (a)		94–94.1 GHz—cloud-profiling radar (Cloudsat).

5.8.2 2012–2016

Issues affecting spectrum demand

The general issues of most concern for the science services are:

> the protection of passive sensors operating at naturally emitted/reflected frequencies for Earth, atmosphere and space observations from harmful interference
> the future increase in bandwidth requirements, in particular, wideband data downlinks to accommodate an increase in scientific data being collected by current and future exploratory missions
> additional spectrum allocated for SRS uplink spectrum near 23 GHz to support mission SRS downlinks allocated in the 25.5–27 GHz band
> the protection of sensitive passive receivers in the frequency range 70 MHz to 25.25 GHz at the Mid West RQZ.

Passive services

For passive reception in the RAS, EESS and SRS, the extremely weak levels of the wanted signals—and hence the high sensitivity of receivers—makes these services particularly susceptible to harmful interference. This is compounded by the fact that, because passive services do not transmit radiocommunications signals, techniques like dynamic frequency selection being developed to sense and avoid other services cannot be used for detection and avoidance of interference to passive services. This is a challenge in implementing dynamic spectrum access (see section 5.9.3).

Protection of passive services up to now has relied on regulatory measures, such as separate frequency allocations or exclusion zones, requiring prior knowledge of fixed passive stations by potential interferers.

While some of these services are protected by Article 5.340 of the ITU *Radio Regulations*, other space science allocations are not.[82] Various members of the scientific community, including the BoM, have expressed concerns about reported interference to passive satellite measurements from fixed P-P links in the 10.6–10.68 GHz band. With recognition of this issue at international level, a resolution was

[82] All emissions are prohibited in the bands specified in Article 5.340 of the ITU *Radio Regulations*.

created to specify new sharing criteria between passive sensors in the EESS and fixed P-P links.[83]

The scientific community has also expressed concern about potential interference in the 23.6–24 GHz passive band[84] due to the class licensing of automotive UWB SRR at 22–26.5 GHz, particularly for the EESS and RAS. The analysis at section 5.6.2 demonstrates that the use of this band for UWB SRR is likely to decline which may alleviate some of this concern.

Recognition of science services

There is concern within the space science sector that because scientific usage of the spectrum generates benefits that are generally difficult to gauge financially, such usage is likely to experience pressure from commercial users. For example, the ACMA recognises that the communications components of space science services involve very sensitive reception, which in some cases within the SRS extends to distances exceeding 16 billion kilometres. Therefore, it is desirable that incompatible services do not operate in close proximity to highly sensitive RAS and SRS facilities.

To reduce the consequent spectrum denial as much as possible, the ACMA has actively encouraged the location of proposed new stations, along with EESS and meteorological satellite Earth stations, in areas where spectrum demand is likely to be low. This may impose additional costs on the operator of the Earth station, including large capital investments that may reduce the operator’s ability to provide scientific services that could be of great value to the community. Feedback from these operators highlights claims that the costs of relocating equipment, establishing and maintaining the associated high-speed data communications to data collection facilities and power supply to remote locations may be prohibitive.

The ACMA must balance these costs with the benefits of making spectrum available for services that must be locally based to the community in those areas where demand is likely to be strongest, in addition to meeting its obligations to protect existing services operating under co-primary allocations. The ACMA recognises that even in remote locations demand for spectrum may exist and coordination between science services and other uses may be necessary.

Bandwidth requirements

It is expected that the communication components of the EESS, SRS and MetSat will use higher frequencies and wider channel bandwidths in the future. This is driven by the ongoing demand for higher data rates, which are expected to increase rapidly over the target period of this Outlook. Meteorological satellites, in particular, most of which currently use L-band[85] downlinks, are moving towards X-band data downlinks (already used by many EESS satellites).

An example of the higher frequency, wider bandwidth trend is the extension of the Ka-band MetSat downlink allocation to 300 MHz (18.1–18.4 GHz). WRC-12 agenda item 1.24 allocated an extension of the 7750–7850 MHz space-to-Earth MetSat allocation by 50 MHz (up to 7900 MHz), limited to non-geostationary satellites. Use of higher frequencies and wider bandwidths will also apply to the SRS and SOS, with plans to upgrade the facilities at New Norcia (European Space Agency) and CDSCC (Canberra) to commence and improve Ka-band reception at 37–38 GHz and 25.5–27 GHz. Uplink assignments at 40.0–41.5 GHz at New Norcia and CDSCC will also be an operational requirement. These Earth stations support many scientific

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[83] Resolutions 751 (10.6–10.68 GHz) and 752 (36–37 GHz) of the ITU *Radio Regulations* outline sharing criteria specifying incidence angle, spatial resolution and main-beam efficiency limits for passive sensors in the EESS, and elevation angle and transmit power limits for P-P and P-MP links in the fixed service.

[84] ITU Radio Regulations Article 5.340.

[85] L-band refers to the microwave frequency range between 1 GHz and 2 GHz.

spacecraft missions, which include exploration of the solar system utilising remote sensors, video and robotic techniques.

Both NASA and the European Space Agency (ESA) are increasing their solar system exploratory activities and Ka-band frequencies for radio links to lunar and planetary missions via data relay satellites and direct-to-Earth stations are proposed. At WRC-12, an additional primary uplink was allocated to the SRS in the band 22.55–23.15 GHz. This allocation is intended to be used in the future to support lunar and planetary missions. Data relay satellites are already using this band in the existing inter-satellite service allocation and would be paired with the 25.5–27.0 GHz band. As missions venture further into space, the longer links further complicate coordination due to the need for higher protection ratios and bandwidths. In turn, the higher potential for interference may slow technological development.

5.8.3 The ACMA's proposed approaches

Passive services

Existing coordination arrangements are in place to protect passive services in the 10.6–10.7 GHz band from harmful interference caused by fixed P-P links. However, further work is likely to be undertaken to document and formalise these arrangements in the future, following the additional formal consultation required to implement the changes.

The ACMA has established notification zones around the RAS facilities listed in section 5.8.1.[86] Under these arrangements, the CSIRO is informed of new frequency assignments within these zones so that if they are likely to cause interference to the operation of RAS stations, negotiations with the new licensee can be undertaken. However, only the Parkes and Narrabri RAS stations hold Earth-receive licences. If other stations seek protection within the RAS allocations, then appropriate licences should be obtained.

Earth station siting

Due to competing demands between satellite and terrestrial radiocommunications services, the ACMA has identified spectrum management issues associated with the siting of some satellite Earth stations and other space communications facilities. In certain bands, satellite services are coming under pressure from the increasing demands for spectrum for terrestrial services, especially in areas of high spectrum demand, such as urban areas.

While it is acknowledged that some satellite Earth stations need to operate in urban areas, in at least some cases there may be satellite dependent services that can be successfully provided by Earth stations located in less populated areas where spectrum demand is low.

[86] These notification zones are specified in RALI MS 31 – *Notification Zones for Apparatus Licensed Services around Radio Astronomy Facilities*; available at: www.acma.gov.au/webwr/radcomm/frequency_planning/frequency_assignment/docs/ms31.pdf

Figure 5.11 The Tidbinbilla Dish

Picture Courtesy CSIA/ASA 2012

In August 2011, ACMA released a discussion paper, *Earth station siting,* which outlined the factors that may impact the future viability of satellite Earth stations and space communications facilities in different geographical areas and frequency bands. The purpose of the discussion paper and broader consultation process was to discuss publically some of the factors relevant to current and prospective operators when they consider the geographical and frequency location of Earth stations. Through this ongoing discussion, the ACMA intends to provide options for long-term certainty of operations to the satellite and space science industries.

The ACMA recognises that it must balance the costs to Earth station operators of locating their station in these areas, with the benefits of making spectrum available for other services to the community. Where spectrum demand for terrestrial services is highest, the possibility of siting of Earth stations in less populated areas may make spectrum available in urban areas (for which it would otherwise be denied).

This is a complex issue and will require extensive consultation with stakeholders over the coming years.

Recognition of space science services

The ACMA must assess additional costs to Earth station operators of locating their stations in areas where spectrum demand is likely to be low, taking into consideration the benefits of making spectrum available for services to the community in the areas where demand is likely to be strongest. Typically, high-demand services must be located close to end users, whereas Earth stations can be operated as effectively, or more so, in more remote areas.

Stakeholders in the science services have indicated a level of concern that the ACMA considers the economic or monetary value of a service with regard to the development of its regulatory and planning arrangements. The ACMA's regulatory frameworks take into account a wide range of factors, including the *Principles for spectrum management* and the total welfare standard. These policy frameworks require the ACMA to consider the overall impact to all stakeholders of potential regulatory or technical frameworks, including the overall public benefit that can be attained. Public benefit does not necessarily imply a monetary incentive.

The ACMA has indicated via its Radiocommunications Consultative Committee processes that it will undertake a review of the *Principles for spectrum management*, and this project is included in the workplan provided at section 6.2.3.

Bandwidth requirements
The ACMA considers that the current trends towards the use of higher frequencies when the planning of future satellite systems in space science services may simplify possible competing demand issues.

The ACMA will continue to monitor the development of radiocommunications technologies for Earth-observing and deep-space missions, with a particular focus on NASA and ESA. Such missions may be the driving force behind expansion of frequency allocations for space science services, as seen in the 18 GHz MetSat and the X-band EESS and SRS (active) allocations.

5.8.4 WRC Agenda items

WRC-12
The following WRC-12 Agenda items were relevant to science services:

> **Agenda item 1.6**—update the spectrum use by the passive services between 275 GHz and 3 000 GHz.
> **Agenda item 1.11**—to consider primary allocation to the space research service (Earth-to-space) within the band 22.55–23.15 GHz.
> **Agenda item 1.12**—protection of primary services in the 37–38 GHz band from interference resulting from aeronautical mobile service operations.
> **Agenda item 1.16**—to consider the need for passive systems for lightning detection in the meteorological aids service, including the possibility of an allocation in the frequency range below 20 kHz.
> **Agenda item 1.24**—to consider the existing allocation to the meteorological-satellite service in the 7 750–7 850 MHz band with a view to extending this allocation to the 7 850–7 900 MHz band.

A synopsis of WRC-12 outcomes is available in section 4.4.3.

WRC-15
The following WRC-15 Agenda items are relevant to science services:

> **Agenda item 1.1**—to consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution **233 [COM6/8] (WRC-12)**.
> **Agenda item 1.11**—to consider a primary allocation for the Earth exploration-satellite service (Earth-to-space) in the 7–8 GHz range, in accordance with Resolution **650 [COM6/17] (WRC-12)**.
> **Agenda item 1.12**—to consider an extension of the current worldwide allocation to the Earth exploration-satellite (active) service in the frequency band 9 300–9 900 MHz by up to 600 MHz within the frequency bands 8 700–9 300 MHz and/or 9 900–10 500 MHz, in accordance with Resolution **651 [COM6/18] (WRC-12)**.
> **Agenda item 1.13**—to review No. **5.268** with a view to examining the possibility for increasing the 5 km distance limitation and allowing space research service (space-to-space) use for proximity operations by space vehicles communicating with an orbiting manned space vehicle, in accordance with Resolution **652 [COM6/19] (WRC-12)**.
> **Agenda item 1.14**—to consider the feasibility of achieving a continuous reference time-scale, whether by the modification of coordinated universal time (UTC) or some other method, and take appropriate action, in accordance with Resolution **653 [COM6/20] (WRC-12)**.

5.8.5 Beyond 2016

The trend towards use of higher frequencies is expected to continue and allocations may be made for passive observations in the RAS and EESS above 300 GHz.

Use of the L- and S-bands for communications is expected to continue (especially S-band TT&C), but most of the growth is expected in the X- and Ka-bands. It is anticipated that the Ka-band could possibly surpass the X-band as the primary data downlink band within the next 10 to 20 years. Given the long life spans of EESS satellites, the X-band is expected to remain the primary data downlink for some time.

The SKA, designed for a 50-year lifetime, is expected to become operational around 2019, although at this stage it is not known whether the SKA will be built in Australia or South Africa. In any case, the radio-quiet environment established by the development of the RQZ in Australia will ensure that it continues to remain an appropriate place for the deployment and future development of radioastronomy activities.

5.9 Wireless Access Services

In February 2006 the ACMA began a dialogue with stakeholders in order to stimulate discussion and collect information to gauge the demand for future Wireless Access Services (WAS) and the associated spectrum support requirements. The WAS consultation process identified a need for more spectrum, and as a result, the 2.5 GHz and 3.6 GHz were identified as bands that could be made available in the short to medium term.

The term 'wireless access services' (WAS) encompasses the variety of ways that telecommunications carriers, internet service providers or other service providers deliver a radio connection to an end-user from a core network. This is usually a public network such as a public switched telephone network, the internet or a local/wide area network. WAS covers a range of other terms such as:

> fixed wireless access (FWA)

> mobile wireless access (MWA)

> nomadic wireless access (NWA).

Stakeholder demand for access to spectrum for WAS is increasing as the level of government, business and consumer access to ubiquitous high speed information gains greater momentum at both the domestic and international level. New and emerging technologies offer improved data rates and spectral efficiency. However, the success of these new and emerging technologies will largely depend on the availability of spectrum.

This puts the ACMA in a complex position. Despite the use of improved spectrum utilisation techniques or new technologies, it is likely that more spectrum will need to be made available to meet increasing demand. This demand will also need to take into account legislative expectation to ensure that spectrum is allocated to its highest value use and is used efficiently. To this end, the ACMA is continuously reviewing spectrum trends to ensure that spectrum use delivers maximum benefits to industry and the community.

The ACMA continued this dialogue in 2011 by embarking on the mobile broadband project. The first discussion paper, *Towards 2020—Future spectrum requirements for mobile broadband*, focused on the need to identify the baseline spectrum requirements for future mobile broadband services while taking into account the needs of incumbent services, and as well as the need to consider strategies that could be deployed to reduce the pressure on other bands.

Due to the ever-changing nature of WAS, the ACMA has undertaken to continue to keep stakeholders updated on the progress of making additional spectrum available for WAS, including mobile, nomadic and fixed, through this chapter of the Outlook.

5.9.1 Current spectrum use

A total of 890 MHz of spectrum is allocated, or planned to be allocated, to WAS services in Australia, though not available in all regions and the spectrum used is limited to below 4 GHz. Frequency bands up to 4 GHz are in high demand for WAS applications because they offer advantages that cannot be achieved at higher frequencies such as coverage, power and form factor.

Table 5.4 details the spectrum bands that have been designated or allocated providing mobile, nomadic and fixed services in a mixture of apparatus and spectrum licensing.

Table 5.4 Spectrum bands that provide for WAS services

Band	Spectrum	Type	Current usage
694–820 MHz[87]	2 x 45 MHz	Spectrum licence	Analog/digital TV to be cleared to realise digital dividend
825–845 and 870–890 MHz	2 x 20 MHz	Spectrum licence	Mobile telephony (3G—WCDMA/HSPA)
890–915 and 935–960 MHz	2 x 25 MHz	Apparatus	Mobile telephony (2G—GSM900 and 3G—WCDMA/HSPA)
1710–1785 and 1805–1880 MHz	2 x 75 MHz	Spectrum licence	Mobile telephony (GSM1800). Licensed for Australia-wide use (restricted to the lower 2x15 MHz in regional areas)
1900–1920 MHz	20 MHz 20 MHz	Spectrum licence Apparatus	3G services—licensed in capital cities only Broadband—licensed in regional and remote areas only
1920–1980 and 2110–2170 MHz	2 x 60 MHz 2 x 40 MHz/ 2 x 60 MHz	Spectrum licence Apparatus	3G mobile telephony and broadband. Licensed in capital cities and regional areas (restricted to the upper 20 MHz) 3G mobile telephony and broadband. Licensed in regional (2 x 40 MHz) and remote areas (2 x 60 MHz)
2302–2400 MHz	98 MHz	Spectrum licence	Broadband—licensed in capital cities and regional areas.
2500–2690 MHz[88]	2 x 70 MHz 50 MHz	Spectrum licence Spectrum licence	Band currently under review to allow for new services such as mobile telephony and wireless broadband in 2 x 70 MHz. Technical framework underpinning ENG operation in 50 MHz.
3425–3442.5 and 3475–3492.5 MHz	2 x 17.5 MHz	Spectrum licence	Fixed wireless access, broadband. Licensed in capital cities and major regional centres.
3442.5–3475 and 3542.5–3575 MHz	2 x 33.5 MHz	Spectrum licence	Broadband—licensed in capital cities and regional areas.
3575–3700 MHz	Up to 30 MHz	Apparatus	Fixed wireless access, broadband to coordinate with fixed links and Earth stations. Licensed in regional and remote areas.

[87] This spectrum is commonly referred to as the digital dividend.

[88] This band is planned for FDD technologies to support IMT services. The mid-band gap will be converted to a spectrum licence for broadcasting purposes.

5.9.2 2012–2016

Issues affecting spectrum demand

The next five years in the WAS space will be important for securing spectrum for the future for mobile, nomadic and fixed networks as congestion continues. The ACMA is working closely with our international partners in the ITU and APG, operators and equipment vendors and engaging with stakeholders to ensure that the ACMA can make spectrum available as quickly and as feasibly as possible. It should be noted that Australia is a technology adopter and traditionally relies on economies of scale for the deployment of large scale networks and equipment.

International planning activities for wireless access services

The consideration of possible bands to support future WAS is being undertaken on a worldwide basis by international regulatory agencies. Current allocation activities show that the focus is on allocation of spectrum associated with the digital dividend provided in respective countries and the reallocation of spectrum to support the deployment of national broadband infrastructure.

A number of regulatory authorities have released consultation papers and plans indicating that they will seek to make further spectrum available for WAS after the allocation of the digital dividend. A common theme is the need to identify additional globally harmonised spectrum for mobile and will be a key focus of WRC-15 under Agenda Item 1.1.

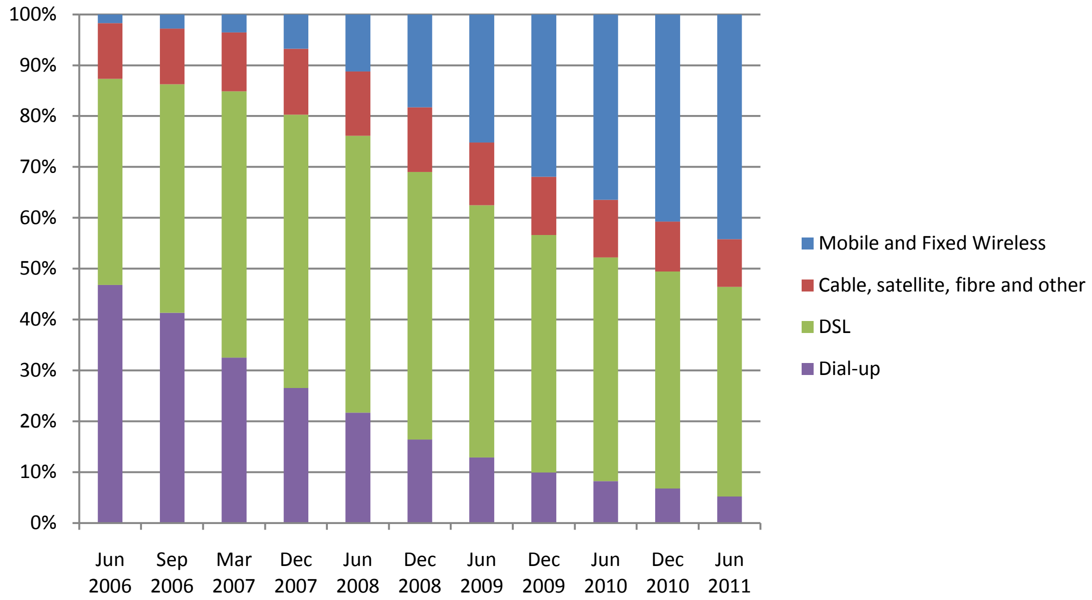
Consultation on mobile broadband

The ACMA's mobile broadband project identified the first in a series of consultation papers aimed at recognising the increasing demand for mobile broadband services and applications. As a result, the *Towards 2020* paper released in May 2011 considered the total quantum of spectrum required and the frequency bands where this spectrum may be available. Further details are available in section 5.9.3.

Baseline demand for wireless access services spectrum in Australia

The demand for mobile, nomadic and fixed wireless access service spectrum in Australia is continuing to grow, as witnessed in Figure 5.11 showing the take up of internet services by technology type based on the Internet Activity Survey conducted by the Australian Bureau of Statistics (ABS) for June 2011. In fact, WAS for internet service makes up 44.19 per cent of all connections for the June 2011 period, compared with 11.19 per cent in the June 2008 period, and has now overtaken digital subscriber line services as the main technology for accessing the internet.

Figure 5.11 Internet activity survey



As a result, demand for additional spectrum in the market to support WAS has been increasing, but this is tempered somewhat by the evolution of technologies including HSPA and LTE. For example, additional efficiencies are now being realised in the 1800 MHz band with the transition from GSM to LTE and aggregation of spectrum into larger contiguous bandwidths.

ACMA analysis shows that by 2015, an additional 130–150 MHz of spectrum is required to support mobile access services, and by 2020, an additional 150 MHz beyond that identified for 2015 will be needed. This totals 300 MHz of spectrum that needs to be identified and released prior to 2020.

The ACMA's ability to make further spectrum available is constrained by the international environment. Because Australia is a traditionally an early-adopter of technology, it is common for the ACMA to make planning and regulatory arrangements for bands that are being accepted and implemented in larger markets such as Europe, Asia and the Americas.

For this reason, the ACMA is actively involved in the ITU and APG decision making process, especially when it comes to the identification of WAS spectrum. This was evident in the ACMA's involvement in achieving consensus in the Asia-Pacific Telecommunity Wireless Group (AWG) for a Region 3 700 MHz band plan and among broadcasters and the mobile industry with respect to the technical framework and development of emission masks for the digital dividend spectrum in Australia.

5.9.3 The ACMA's proposed approaches

The ACMA is continuing its dialogue with stakeholders to release additional spectrum for WAS where demand outstrips supply, but is cognisant of the needs of incumbent services and must often satisfy their requirements, either by identifying alternative bands or other measures.

The responses and information received in response to the mobile broadband paper regarding emerging technologies is assisting the ACMA in its consideration of issues regarding spectrum utilisation and efficiency generally.

Candidate bands
The ACMA identified several candidate bands in the *Towards 2020* paper that it views as bands suitable for future mobile allocation. Stakeholder comments to the *Towards 2020* paper provided some consensus for some bands, but noted that many bands will be difficult to share with, or clear for, mobile services. The following paragraphs briefly detail those bands where some consensus among stakeholders was identified.

850 MHz 'expansion' band—FDD spectrum from the range 806–825 MHz paired with 851–870 MHz could potentially be released to support mobile broadband services. This would expand the existing allocation at 825–845 MHz paired with 870–890 MHz used to provide mobile telephony services. Parts of the 850 MHz 'expansion' band are heavily utilised by services including land mobile and fixed services. This issue is being considered as part of the ACMA's review of the 803–960 MHz band discussed in section 4.2.2.

1.5 GHz mobile band—the ACMA believe that 2x35 MHz (1427.9–1462.9 MHz and 1475.9–1510.9 MHz) of FDD spectrum, or 40 MHz (1452–1492 MHz) of unpaired mobile downlink (UMD) spectrum, could potentially be released from the 1.5 GHz mobile band (1427.9–1510.9 MHz). Stakeholders noted that the impact on incumbent fixed services could be significant and alternative options and a transition plan would need to be developed before this band could be reallocated for different services. The ACMA intends to undertake preliminary work to determine the impact on aeronautical telemetry services and the DRCS. The outcomes of this work are necessary considerations for the future planning arrangements for this band.

The ACMA will release a discussion paper in mid-2012 to gather further information on these and other issues related to the potential use of the 1.5 GHz mobile band for mobile broadband services.

3.3 GHz band (3300–3400 MHz)—This band has been highlighted by the IEEE for use by IMT-Advanced technologies. Currently the band is identified as AUS11 spectrum and will be used by Defence to support next generation naval radar systems. For this reason, the ACMA believe that this band may be able to support fixed or nomadic access services in regional and remote areas, as well as some metropolitan areas given appropriate sharing studies are conducted with Defence.

3.4 GHz band (3400–3600 MHz)—The current arrangements in this band support the operation of apparatus and spectrum licensing arrangements for a number of services including:

> fixed point-to-point services
> fixed point-to-multipoint services
> Earth receive
> spectrum-licensed services.

The ACMA intends to review the current licensing and technical arrangements underpinning this band. For example, proposed FDD technologies require a 100 MHz duplex split in order to operate in this band, but the 3425–3442.5/3475–3492.5 MHz sub-band imposes a 50 MHz duplex split on FDD equipment.

Bands above 4.2 GHz—Frequency bands above 4.2 GHz are viewed as being unsuitable for mobile services. These bands may be useful for high bandwidth mobile applications if spread spectrum and diversity techniques are used as well as some fixed and nomadic applications. Ultra wide-band (UWB) devices are a key example of technologies that are well suited to frequencies above 4.2 GHz.

The primary benefit of considering bands greater than 4.2 GHz is to support the rollout of infrastructure which has the potential to increase spectral efficiency by offloading capacity from macro network environments to personal networks. Femtocells are examples of these types of technologies. The ACMA has not yet identified any bands above 4.2 GHz for mobile broadband services or technologies, but recommends operators and industry work together with the ACMA to identify globally harmonised bands in the lead up to WRC-15.

5.9.4 WRC Agenda items

WRC-12

The following WRC-12 Agenda items were relevant to wireless access services:

> **Agenda item 1.5**—worldwide/regional harmonisation of spectrum for ENG.
> **Agenda item 1.17**—sharing studies between the mobile service and other services in the band 790–862 MHz in Regions 1 and 3.
> **Agenda item 8.2**—development of future agenda items.

A synopsis of WRC-12 outcomes is available in section 4.4.3.

WRC-15

The following WRC-15 Agenda items are relevant to wireless access services:

> **Agenda item 1.1**—to consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution **233 [COM6/8] (WRC-12)**.
> **Agenda item 1.3**—to review and revise Resolution **646 (Rev.WRC-12)** for broadband public protection and disaster relief (PPDR), in accordance with Resolution **648 [COM6/11] (WRC-12)**.

5.9.5 Beyond 2016

The ACMA will continue its dialogue with stakeholders aimed at releasing additional spectrum to market in order to support mobile services. But the ACMA notes that incumbent services, as well as the fixed and nomadic WAS, need to be considered.

In 2012, the ACMA will release its response paper to the *Towards 2020* discussion paper where it will also propose a forward work plan and identification of bands that stakeholders and the ACMA recognise could be released in the 2015 and 2020 time frame s. Additionally, discussion papers on specific candidate bands identified in the *Towards 2020* paper will be released in 2012, including the 1.5 GHz band and the 850 MHz 'expansion' band.

The outcomes of the WRC-15 will underlie the future direction of WAS globally, with a focus on harmonisation leading to greater economies of scale in all regions. The ACMA will work closely with stakeholders and with the wider regulatory community to ensure that Australia's interests are satisfied.

5.10 Emerging technologies

Beyond 2015

The ACMA actively monitors and researches emerging technologies that have potential to significantly enhance the lives of Australians. As a result, the ACMA actively maintains awareness of international spectrum developments and other allocational spectrum management issues. In some circumstances, the ACMA has the opportunity to provide access to spectrum for trial purposes.

Identifying emerging technologies that utilise spectrum in new and innovative ways will be a challenge over the next decade. Advances in smart radio design, smart antennas, new digital signal processing and modulation techniques, software defined radios (SDR) and cognitive radio systems (CRS) are likely to broaden the capabilities and flexibility with which new wireless systems can be designed. Associated with this, the ACMA will also need to consider issues associated with the existing regulatory framework to determine whether current arrangements will suit proposed deployment of likely future emerging technologies.

5.10.1 Dynamic spectrum access technologies

Dynamic Spectrum Access (DSA) describes technologies that are designed to operate in spectrum that is not being used in a particular area or at a particular point in time. While these technologies operate at power levels that have the potential to cause interference to primary users, the constant monitoring of the DSA device's environment allows it to dynamically move its transmission to other 'unused' frequencies to minimise the interference.

At present, the only mature devices operate in television broadcast spectrum at locations where channels are not being used for television or other authorised services. This is known as 'TV white space'. However, white-space devices could be developed to use white space in other bands, for example, to provide broadband services especially in rural and remote areas where spectrum is generally less congested. DSA technologies can significantly increase the efficiency of spectrum use by enabling radios to access and share available spectrum.

Arrangements to address spectrum management issues associated with these technologies will be the subject of further work by the ACMA. DSA technologies are likely to challenge traditional views of spectrum regulation but they present opportunities to facilitate access to the spectrum to gain the most benefit. The ACMA is also mindful of these technologies when designing technical frameworks for new and expiring spectrum licences.

Internationally, WRC-12 Agenda item 1.19 was to consider regulatory measures that will be required to enable the introduction of SDR and cognitive radio. Studies led to the development of ITU-R Resolution 58 on studies on the implementation and use of cognitive radio systems. Therefore, further studies on CRS and its implementation will occur in the ITU-R over the coming years.

5.10.2 Ultra wideband

Ultra wideband (UWB) technologies use extremely wide bandwidths (typically >500MHz) to improve the communication of data in high noise, high interference or low signal strength environments. UWB technologies can be used to provide a range of services including short-range, high-capacity wireless data transfer; high-precision, short-range radar for motor vehicles; precision location RFIDs; and ground- or wall-penetrating radar systems.

Most UWB systems operate at very low signal levels and because of their wideband nature, their emissions often look like the noise floor to narrower bandwidth radiocommunications systems. UWB systems have been described as noise floor or underlay systems implying that they are capable of being operated underneath existing services; that is, on the same frequency and in the same area. Their use has the potential to significantly increase the number of systems operating in currently used spectrum.

However, many operators of existing radiocommunications services see the widespread use of UWB technologies as likely to cause a rise in the overall noise floor experienced by their systems. The rising man-made noise floor is slowly reducing available margins of existing radiocommunications services. This loss of margin can lead to a potential loss of reliability for these existing services or alternatively lead to a need to replace existing equipment or install additional equipment to counteract the effect.

The concerns expressed by operators of existing radiocommunications services led to significant work in the ITU-R to update the protection requirements for existing services and to develop a framework for the introduction of UWB technologies that would protect existing services. Australia is putting in place arrangements to support the indoor use of low-power UWB devices to allow the introduction of this new technology while protecting existing services.

The ACMA intends to review existing arrangements to allow UWB technologies to be deployed in various bands while providing adequate protection to existing services. This work will be done through consultation with industry.

5.10.3 Smart infrastructure

Smart infrastructure is technology based, adaptive infrastructure that combines two-way communication systems with infrastructure. The systems gather real-time data and use the information to improve efficiency, report and dynamically fix problems and adapt to meet requirements. Smart infrastructure is recognised as a major development that will modernise the transport, resource, mining, electricity, gas and water sectors over the coming decades.

Due to the anticipated ubiquitous nature of smart devices in the future, wireless communication will likely be a major component of the operation of smart infrastructure systems. Therefore, radiofrequency spectrum will be required to facilitate area-wide and state-wide smart infrastructure networks.

While a number of countries have allocated spectrum for a particular infrastructure sector (for example, to smart electricity grids), the ACMA is taking a unique, holistic approach to spectrum for smart infrastructure. The ACMA hopes to encourage spectrum sharing within and across different infrastructure sectors which will result in greater spectrum efficiency than ad hoc, single-sector solutions.

The ACMA believes that the greatest spectrum efficiency and overall public benefit is likely to be achieved by a nationally harmonised approach to spectrum for smart infrastructure. The ACMA's smart infrastructure project team is working across various sectors to determine the spectrum needs for smart infrastructure and promote a nationally harmonised approach across various smart infrastructure projects. These projects include, smart electricity grids, intelligent transport systems, and monitoring of water resources. The ACMA project team will continue to work with the various smart infrastructure sectors in 2012 and beyond.

5.10.4 Home network

The home network is an example of smart infrastructure that is used to interconnect a wide variety of digital devices predominantly designed for use by consumers. The home network environment includes entertainment, telecommunications and home automation systems, and provides connectivity between system devices and associated services.

A variety of fixed and wireless technology solutions is available to provide the infrastructure within the home environment. The ITU Telecommunication Standardization Sector (ITU-T) has set a global wired home networking standard (G.hn) to ensure higher data rates over legacy cabling systems.

Wifi technology is increasingly used in the provision for accessing the internet, streaming music, video and data content around the networked home. With the release of the IEEE 802.11n standard, home users can achieve wireless data rates of 300 Mbps using a 40 MHz wide channel in the 2.4 GHz and 5 GHz class-licensed bands.[89]

With the exponential demand for wireless communications, researchers are looking to an alternate fraction of the electronic magnetic spectrum which has 10,000 times more available capacity than the radiofrequency spectrum; visible light spectrum.[90] Light-emitting diodes (LEDs) provide researchers with a technique to manipulate the optical signals by rapidly changing the intensity of a LED that is imperceptible to the human eye, yet still providing illumination. The fluctuation in intensity creates a high speed data stream which can be detected by devices such as computers or smartphones in and around the home or office. This technique, coined Li-Fi, can potentially transmit data at 100 Mbps and has gained the attention of the IEEE.[91]

The ACMA recognises the emerging role and importance that home networks have in the digital home and will continue to monitor existing and proposed technologies that utilise spectrum for device interconnection and the delivery of services.

5.10.5 Near Field Communications

Near Field Communications (NFC) is a short range connection technique that enables communication between devices that are within approximately 40 mm[92] of each other. Advances in miniaturisation of components along with the increase in e-commerce are driving a wider adoption by Australian retailers and banks as a payment process for goods and services. This is likely to continue as the inclusion of NFC capabilities becomes a regular feature on mobile phones. Trials have been conducted by some major financial institutions in Australia.

NFC reduces the time and costs involved in transactions. The process of bringing a card or a smartphone close to the NFC terminal can be used for entry, payment or the exchange of information. The process is being marketed with a number of terms that include ‘tap’, ‘wave’ and ‘wallet’.

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[89] Network World, *Toward a Gigabit Wi-Fi Nirvana: 802.11ac and 802.11ad*, viewed 26 September 2011, www.networkworld.com/news/tech/2011/021411-gigabit-wifi.html.

[90] TED, Harald Haas: Wireless data from every light bulb, viewed 14 October 2011, www.ted.com/talks/harald_haas_wireless_data_from_every_light_bulb.html.

[91] IEEE 802.15 WPAN Task Group 7 (TG7) Visible Light Communication, viewed 14 October 2011, www.ieee802.org/15/pub/TG7.html.

[92] Page 19 appendix to Mobile NFC Technical Guidelines Version 2 Nov 2007 from the GSMA (GSM Association).

There are a number of planned uses[93] of the NFC technique that include:

- mobile payments and store vouchers
- authentication, access control—store electronic keys, loading data on NFC phones
- data transfer between different NFC-units (peer-to-peer data exchange) like NFC smartphones, digital cameras, notebooks
- 'unlocking' another service (such as opening a Wifi or Bluetooth link for data transfer)
- ticketing.

Other uses are likely to emerge as the NFC ecosystem continues to develop.

5.10.6 WRC Agenda items

WRC-12

The following WRC-12 Agenda items were relevant to emerging technologies:

- **Agenda item 1.19**—enable the introduction of software-defined radio and cognitive radio systems.
- **Agenda item 1.20**—spectrum identification for gateway links for high altitude platform stations (HAPS) in the range 5 850–7 075 MHz.
- **Agenda item 1.22**—effect of emissions from short-range devices on radiocommunication services.

A synopsis of WRC-12 outcomes is available in section 4.4.3.

WRC-15

The following WRC-15 Agenda item is relevant to the emerging technologies:

- **Agenda item 1.18**—to consider a primary allocation to the radiolocation service for automotive applications in the 77.5–78.0 GHz frequency band in accordance with Resolution **654 [COM6/23] (WRC-12)**.

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[93] See Near Field Communication (NFC) Technology and Measurements: A White Paper from Rohde & Schwarz available at www2.rohde-schwarz.com/en/service_and_support/Downloads/Application_Notes/?type=20&downid=7019 and the December 2008, National Smartcard Framework, Smartcard Framework from AGIMO, DEFR.

6. 2012–2016 work programs

This chapter contains the ACMA's indicative spectrum management work programs for the 2012–2016 time frame. They are:

1. **Work priorities for 2012–2013:** This work program contains the ACMA's significant spectrum management projects that are scheduled to be completed within the next five years (Table 6.1).
2. **The Outlook 2012–2016 work program:** This work program is based on the assessment of future spectrum requirements of services contained in Chapter 5, and also includes the ACMA's current spectrum management projects. These projects that have medium- to long-term time frames and have been divided up into the following:

   6.2.1 Projects listed band-by-band

   6.2.2 Projects by service planning—not band-specific

   6.2.3 Regulatory framework projects.

These work programs are living documents that are reviewed annually to ensure their relevance to current trends in radiocommunications. This will included regular updates of the time frames and priorities for each task and project to ensure they reflect current demand.

Project prioritisation

The prioritisation of spectrum management projects aims to encourage a two-way conversation between the ACMA and stakeholders about planned spectrum management activity. The ACMA stresses that consultation with interested parties about planned spectrum management work and related changes will be an ongoing feature of all individual projects.

Effective prioritisation of these projects aims to ensure that the ACMA can efficiently allocate work and resources to meet its main spectrum management objective; that is, to maximise the overall public benefit derived from using radiofrequency spectrum.

Work programs, and the priorities are based on the available evidence at the time the Outlook is updated each year. In making decisions about changing priorities for its spectrum management work, the ACMA commits to undertaking work in those areas that will best enable it to fulfil government policy, its legislative objectives and its *Principles for spectrum management*, in the broader public interest.

The ACMA aims to:

> improve the transparency of the ACMA's decision-making when prioritising projects

> assist stakeholder involvement in regulatory issues and decisions

> contribute to effective and appropriate regulatory outcomes.

6.1 Work priorities for 2012–2013

Frequency range	Project		Priority
45–52 MHz and 56–70 MHz (VHF Band I) **87.5–108 MHz (VHF Band II)** **174–230 MHz (VHF Band III)** **520–820 MHz (UHF Band IV and Band V)**	Digital switchover	Tasks to assist the government's switch-off of analog television in VHF Bands I and II, as part of transition to digital television broadcasting in Australia. The ACMA is currently involved in assessing digital coverage to ensure an equivalent level of service post switchover and is monitoring the nationwide rollout of digital television infrastructure.	High
694–820 MHz	Reallocation of 700 MHz	The decision to allocate the 700 MHz (or 'digital dividend') band comes after the Australian Government directed the ACMA in July 2010 to clear 126 MHz of digital dividend spectrum (694–820 MHz) and reallocate this spectrum for new uses.	High
403–520 MHz	Implementation of 400 MHz band arrangements	Outcomes of the 400 MHz band review announced in April 2010 and implementation began in early 2011. Project is due for completion by 2018.	High
803–960 MHz	Review of the 803–960 MHz band	The ACMA commenced a review of band in 2011 with the release of *The 900 MHz band—Exploring new opportunities* discussion paper. A number of significant potential improvements to the way the band is assigned appear to be possible.	High
825–845 MHz/ **870–890 MHz**	**ESL—**800 MHz band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences.	High
1.5 GHz	1.5 GHz mobile band	The first stage of the review of the 1427.9–1510.9 MHz band segment (the 1.5 GHz mobile band) will be to release a discussion paper in mid-2012.	High
1710–1755 MHz **1805–1850 MHz (paired)**	**ESL—**1800 MHz band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences. Longer term planning arrangements for the band in regional and remote areas.	High

Frequency range	Project		Priority
1980–2110 MHz/ 2170–2300 MHz	Introduction of TOB services	Introduction of arrangements supporting TOB services in the bands 2010–2110 MHz and 21270–2300 MHz. To support the introduction of TOB services the *Outside Broadcast (1980–2110 MHz and 2170–2300 MHz) Frequency Band Plan 2012* was made in March 2012. Development of coordination arrangements between TOB services and service operating in and adjacent to the bands 2010–2110 MHz and 21270–2300 MHz in consultation with stakeholders.	High
2302–2400 MHz	**ESL—**2.3 GHz band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences. Review options to expand the band from 98 MHz to 100 MHz bandwidth.	High
2570–2620 MHz	Conversion of 2.5 GHz	Conversion existing 2.5 GHz Television Outside Broadcast Network (TOBN) apparatus licences to spectrum licences in the mid-band gap.	High
2500–2570 GHz **and** **2620–2690 GHz**	Reallocation of 2.5 GHz band	On 1 November 2011, the minister made a Spectrum Reallocation Declaration, declaring that parts of 700 MHz and 2.5 GHz band are to be reallocated as spectrum licences.	High
3425–3442.5 MHz **3475–3492.5 MHz (unpaired)** **3442.5–3475 MHz** **3542.5–3575 MHz (unpaired)**	**ESL—**3.4 GHz Band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences. Replanning options to provide greater spectrum and technology efficiencies.	High
4940–4990 MHz (4.9 GHz band)	Potential use by public protection and disaster relief (PPDR) organisations for broadband data applications.	The ACMA will consult to assist the development of the appropriate spectrum management processes, in order to support use of the band by public safety applications. Consultation with Defence and other stakeholders. Band channelling arrangement options for PPDR.	High
26.5–27.5 GHz	**ESL—**27 GHz band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences.	High

Frequency range	Project		Priority
27.5–28.35 GHz	**ESL—**28 GHz band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences.	High
31.0–31.36 GHz	**ESL—**31 GHz band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences.	High

6.2 Outlook work program 2012–2016

6.2.1 Band-by-band

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
MF	526.5–1606.5 kHz (MF-AM band)	Band congestion	The ACMA supports digital radio trials to assess the potential for DRM digital radio to alleviate congestion in this band. If successful, the ACMA may replan this channel to accommodate DRM services. The ACMA will monitor digital radio technologies and the development of markets for their deployment.	LONG Low *Monitoring*
HF	5900–5950 kHz 7300–7350 kHz 9400–9500 kHz 11600–11650 kHz 13570–13600 kHz 13800–13870 kHz 15600–15800 kHz 17480–17550 kHz 18900–19020 kHz	Support introduction of digitally modulated broadcasting transmissions	Embargo 46	MEDIUM Low *Monitoring*
HF	5950–6200 kHz 7100–7300 kHz 9500–9900 kHz 11650–12050 kHz 13600–13800 kHz 15100–15600 kHz 17550–17900 kHz 21450–21850 kHz 25670–26100 kHz	Industry proposals to introduce DRM into this band	Spectrum Embargo 44 is intended to preserve planning options. The ACMA will consult with industry to canvass interest in the possible use of DRM technology in 25670–26100 kHz. The ACMA will monitor digital radio technologies and the development of markets for their deployment.	MEDIUM Low *Monitoring*
HF		Projected increases in the use of digital maritime HF data services may require additional spectrum allocations for future use	The ACMA will continue to monitor the progress of HF data services and relevant technology developments. Options for planning arrangements will be assessed when spectrum requirements are known. This issue will be influenced	MEDIUM Low *Monitoring*

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
			by outcomes of WRC-12 Agenda item: 1.9.	
VHF	45–52 MHz and 56–70 MHz (VHF Band I) 85–92 MHz 87.5–108 MHz (VHF Band II)	Introduction of digital radio broadcasting in VHF Bands I or II 45–52 MHz Switch-off of analog television transmissions on VHF Band I and II will not be used for digital television broadcasting transmissions The ACMA will assist the government in its digital switchover activities	Although congestion may be alleviated as a result of the digital switchover, the ACMA is monitoring the development of related issues that are likely to impact demand for this band, such as the introduction of digital radio (DAB+) services in other bands. Consideration is also being given to the future reduction of channel spacing. The ACMA will continue to support digital radio trials and assist government where appropriate on the formulation of policy relating to future use of this spectrum. Some VHF channels may become available for non-broadcasting applications at the end of the simulcast period; the introduction of digital radio broadcasting is also a possibility. The ACMA will continue to monitor demand for non-commercial and regional radio broadcasting services and the development of different digital radio technologies.	MEDIUM Medium *Monitoring*
VHF	108–117.975 MHz	This band was allocated to the aeronautical mobile service (AM(R)S) on a primary basis at WRC-07 for LOS applications, including RNSS signal corrections. This affects	The ACMA will continue to consider the impact of the introduction of AM(R)S on existing services by: > sharing studies between AM(R)S and VHF-FM band radio broadcasting services > assessing compatibility between GBAS/GRAS correction signals and	LONG Low *Monitoring*

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
		existing services in this band	FM broadcasting. This band is also undergoing work as part of the digital switch-off	
VHF	117.975–137 MHz	Congestion experienced in VHF aeronautical mobile bands at the international level	Additional primary allocations made to the AM(R)S at WRC-07 are intended to alleviate congestion. However, the ACMA first needs to consider the impact of the introduction of AM(R)S on existing services.	LONG Low *Monitoring the international environment.* *Sharing studies underway.* *Deploying technology*.
VHF	121.5 MHz–121.5/243.0 MHz	EPIRBs phased out of this frequency range and moved to 406 MHz	121.5 MHz may continue to be used for homing signals to be received by aircraft and rescue craft. The COSPAS-SARSAT satellite system no longer receives distress signals from distress beacons on 121.5 MHz.	MEDIUM Medium *Monitoring*
VHF	137–144 MHz	Channel 5A will not be used for broadcasting services after the switch-off of analog television	Switch off of analog television.	SHORT High *Monitoring*
VHF	156–174 MHz	Maximise the efficiency of the VHF maritime mobile band	to encourage the use of single-channel operations and 12.5 kHz channel spacing, as well as the introduction of new digital technologies.	LONG Low *Monitoring*
VHF	168–174 MHz	No new assignments for fixed or mobile services near sites that could be used for the transmission of digital television broadcasting on VHF television Channel 6	Embargo 32	LONG Low *Monitoring*
VHF	174–230 MHz (VHF Band III)	Spectrum availability to Support the	Clearance of the digital dividend at 700 MHz will	SHORT

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
		introduction of DAB+ Digital dividend—spectrum vacated following the analog TV switch-off and restack	require additional use of this VHF band for digital television services. VHF channel 9A is available for DAB+ digital radio in mainland state capital cities, but there is limited spectrum availability for regional areas, particularly those close to capital cities. Digital radio broadcasting services commenced in mainland state capital cities on 1 July 2009. No new commercial digital radio licences will be issued in these areas for six years after this date. No start-up date has been announced for digital radio services in regional Australia. The ACMA will continue to facilitate DAB+ trials. Deployment of DAB+ in regional areas requires further consideration by the ACMA and the government.	High *Monitoring*
VHF	230–240 MHz	Improving digital radio broadcasting system coverage in metropolitan areas	Potential use for improving digital radio broadcasting system coverage in metropolitan areas—on a short-term basis pending the closure of VHF Band III analog television services.	MEDIUM Medium *Monitoring*
VHF	230–399.9 MHz 380–399.9 MHZ	Defence band	230–399.9 MHz—identified by Defence as a future operational band for NCW. 380–399.9 MHz—interest from government agencies in sharing this spectrum with Defence.	LONG Low *Monitoring*
VHF	380–400 MHz	Review of band usage	Defence has exclusive use under footnote AUS1. Competing demands for access to spectrum from government users and incumbent users. Review the existing	MEDIUM Medium *Monitoring*

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
			arrangements in the 380–400 MHz band as part of the ongoing monitoring of government spectrum use and mobile issues in the 400 MHz band. Review the 380–400 MHz band with a view to determine effective sharing/coordination arrangements.	
UHF	403–520 MHz	400 MHz implementation 430–450 MHz—Possible future Defence radar includes development of foliage penetration radar	The ACMA is implementing new arrangements in this band, as per the outcomes the 400 MHz band review. Embargo 19—no new assignments to the TLMRS outside a 100 km radius of state capitals (except Hobart) and Canberra (for which fewer channels are embargoed) in order to protect wideband fixed services in regional/remote areas. Embargo 45—no new assignments in order to support expansion of UHF TV Channel 27 and to preserve planning options for adjacent channel sharing. Embargo 50—no new assignments to support the review of arrangements for harmonised government spectrum primarily to support national security, law enforcement and emergency services. Embargo 51—no new land mobile assignments requiring channel bandwidths greater than 12.5 kHz to support measures to address congestion in HDAs and MDAs. Embargo 53—no new assignments to be made to	MEDIUM Medium *Ongoing work plan*

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME **Priority** ***Status***
			national security, law enforcement and emergency services to harmonise government spectrum. Embargo 60—no new frequency assignments to support formalising arrangements for the rail industry.	
UHF	406–406.1 MHz	Support search and rescue	Introduction of the Galileo GNSS expected for around 2014—search and rescue uplink. Embargo 53	MEDIUM Low *Monitoring*
UHF	448–450 MHz	Indication of BoM plans for increased use of wind profiler radars	The ACMA will liaise with the BoM on future requirements for wind profiler radars.	LONG Low *Monitoring*
UHF	450–470 MHz	Support 450–470 MHz band	Embargo 54—no new frequency assignments to support change to 10 MHz duplex frequency split in part of the band Embargo 55—no new frequency assignments to support change to 10 MHz duplex frequency split in part of the band Embargo 56—no new frequency assignments to support change to 10 MHz duplex frequency split in part of the 450–470 MHz band.	
UHF	520–820 MHz UHF Band IV and Band V	Digital switchover	Tasks to assist the government's switch-off of analog television. Digital dividend of 126 MHz which includes the 700 MHz band (694–820 MHz) is to be achieved as soon as practicable following the switch-off of analog television.	SHORT High *Ongoing work plan*

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
			790–862 MHz—WRC-12 Agenda item 1.17—consider sharing studies between mobile and other services in this spectrum.	
UHF	694–820 MHz	Reallocation of 700 MHz band	The decision to allocate the 700 MHz (or 'digital dividend') band comes after the Australian Government directed the ACMA in July 2010 to clear 126 MHz of digital dividend spectrum and reallocate this spectrum for new uses.	SHORT High *Ongoing work plan*
UHF	698–820 MHz	Potential expansion of the 800 MHz band	The ACMA is undertaking work to determine the future use of the 803–820 MHz band which is not included as part of the 700 MHz allocation.	SHORT High *Review commenced 2011*
UHF	825–845 MHz 870–890 MHz	800 MHz band	Embargo 26—no apparatus licences may be issued in Australia due to spectrum licensing provisions. Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences.	SHORT High *Ongoing work plan*
UHF	820–960 MHz	Band review to improve arrangements 803–960 MHz—Channels 68 and 69 may be considered as part of the 800/900 MHz band review	This band is undergoing review to consider spectrum planning options for the digital CMTS segments and a possible extension of the 800 MHz band. Embargo 34—no new assignments in specified portions of the respective CT3 and CT2 cordless telephone bands to support possible replanning or spectrum licensing.	SHORT High *Review commenced 2011*
L-band	1164–1610 MHz	Growth of GNSS—introduction of Galileo, QZSS and Compass, along	The ACMA plans to continue to accommodate GNSS in this spectrum and believes that GNSS should not be constrained by other	MEDIUM Medium *Ongoing*

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
		with other regional positioning systems and augmentation system. Interference concerns between Defence's JTIDS and Galileo	services in this band. The ACMA will continue to monitor international policy and technological developments. The ACMA is working to facilitate communications between Defence and the EC to resolve potential interference issues. Work dependent on deployment of Galileo.	
	1427.9–1510.9 MHz	Review band to assess potential use for mobile broadband services	The ACMA may revise the *1.5 GHz Band Plan* to determine whether the existing technical and licensing arrangements reflect the most efficient use of spectrum. The ACMA will consider whether the current allocation for terrestrial DAB+ services should remain. The ACMA will consider the potential use of the band for mobile broadband services. Planning in the band will also consider potential future use by satellite digital radio and other services.	MEDIUM Medium Work subject to government decisions on digital radio and the *1.5 GHz Band Plan*. *Commenced in 2011*
	1518–1544 MHz/ 1626.5–1675 MHz (L-band extension bands[94])	Possible introduction of MSS systems, in particular for the satellite component of IMT (identified at WRC-07)	Introduction of MSS would require revision of the *1.5 GHz Band Plan* to permit MSS systems and clearing of incumbent users in the 1525–1535 MHz band. The ACMA plans to continue to protect DRCS/HCRC in the 1518–1525 MHz band, and the protection of 1660–1670 MHz RAS and 1668–1668.4 MHz SRS will be considered. The ACMA will monitor demand in these	MEDIUM Medium *Ongoing work*

[94] [1518–1525 MHz/1668–1675 MHz] and MSS down/uplink [1525–1544 MHz/1626.5–1660.5 MHz]

Band	Frequency range	Spectrum management issue	ACMA approach	**TIME FRAME** **Priority** ***Status***
			bands for MSS.	
	1610–1626.5 MHz/ 2483.5–2500 MHz	Increased interest in mobile television and MSS systems (possibly including ATC)	The ACMA will continue to monitor national and international demand for MSS systems and satellite delivery of mobile television. In the case that an MSS system is introduced, the effects of such a system on co- and adjacent-band services will need to be considered.	MEDIUM Low *International MSS satellites planned to cover Australia.* *Introduction of Australian MSS systems.* *Compatibility with existing and potential future services.*
	1710–1755 MHz 1805–1850 MHz (paired)	1800 MHz band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences. Embargo 26—no apparatus licences may be issued (in state capital cities except Hobart, but also in certain regional and urban areas of eastern Australia, Tasmania, SW WA and Darwin in 1710–1725/1805–1820 MHz) due to spectrum licensing provisions. 1785–1805 MHz—New plan to include band in the LIPD for wireless audio device use. Potential to remove Embargo 38.	SHORT High *Ongoing work plan*
	1900–1920 MHz 1920–1980 MHz 2110–2170 MHz (paired)	2 GHz band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences.	SHORT High *Ongoing work plan*
	1980–2110 MHz/ 2170–2300 MHz	Introduction of TOB services	Introduction of arrangements supporting TOB services in the bands 2010–2110 MHz and 21270–2300 MHz. Development of coordination arrangements between TOB services and	SHORT High *Ongoing work plan*

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
			service operating in and adjacent to the bands 2010–2110 MHz and 21270–2300 MHz in consultation with stakeholders.	
	2302–2400 MHz (2.3 GHz)	Service planning	The ACMA will review options to expand the band from 98 MHz to 100 MHz bandwidth. Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences. Embargo 26—no apparatus licences may be issued in Australia due to spectrum licensing provisions. Embargo 49—no new assignments for terrestrial radiocommunication services to support the development of space communications facilities in the general area of the Mingenew site.	SHORT Medium *Monitoring*
	2570–2620 MHz	Conversion of 2.5 GHz	Conversion existing 2.5 GHz Television Outside Broadcast Network (TOBN) apparatus licences to spectrum licences in the mid-band gap. Embargo 43—no new assignments to support planning for terrestrial fixed and mobile services.	SHORT High *Ongoing work plan*
	2500–2570 GHz and 2620–2690 GHz	Reallocation of 2.5 GHz band	On the 1 November 2011, the minister made a Spectrum Reallocation Declaration, declaring that parts of 700 MHz and 2.5 GHz band are to be reallocated as spectrum licences. Embargo 43—no new assignments to support planning for terrestrial fixed and mobile services.	SHORT High *Ongoing work plan*

Band	Frequency range	Spectrum management issue	ACMA approach	**TIME FRAME** **Priority** ***Status***
S-band	2700–3400 MHz	Assignment coordination difficulties between radar operators	The ACMA will work with Defence, Airservices Australia and the BoM to consider improved sharing arrangements between radiolocation and radionavigation services in these bands. A possible outcome could lead to increased spectrum availability in these bands to enable the introduction of IMT and Broadband services in the future. This outcome would be consistent with Agenda item 1.1 to be considered at WRC-15.	MEDIUM Medium *Ongoing work plan*
C-Band	3442.5–3475/ 3542.5–3575 MHz (3.4 GHz)	Extension of arrangements under RALI FX14 to support WAS in regional and remote areas not subject to spectrum licensing	The ACMA will review the band to ascertain if it is suitable for WAS applications. Explore options for the use of 3492.5–3542.5 MHz. Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences. 3400–3575 MHz—Embargo 52—no new assignments for WAS (point-to-multipoint services) where any part of the necessary bandwidth is inside the designated areas of the WPA. 3492.5–3542.5 MHz—Embargo 61—no new frequency assignments to support future planning for terrestrial fixed and mobile services.	SHORT Medium *Ongoing work plan*
	3492.5–3542.5 MHz (3.5 GHz)	Potential use for WAS applications Australia-wide	The ACMA will review the band to ascertain if it is suitable for WAS applications. Potential industry consultation.	MEDIUM Medium *Monitoring*

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
			Embargo 26—no apparatus licences may be issued in certain regional and urban areas due to spectrum licensing provisions. 3575–3710 MHz—Embargo 42—no assignments may be made in order to support roll out of WAS—the ACMA has allowed WAS (point-to-multipoint services) to be licensed in regional and remote areas of Australia via administrative allocation process. 3400–4200 MHz—Embargo 49—no new assignments for terrestrial radiocommunication services to support the development of space communications facilities in the general area of the Mingenew site.	
	3600–4200 MHz		3400–4200 MHz—The ACMA does not support ubiquitous, uncoordinated deployment of Earth stations in bands shared with terrestrial services. 3575–3710 MHz—Embargo 42—no assignments may be made in order to support roll out of WAS— The ACMA has allowed WAS (point-to-multipoint services) to be licensed in regional and remote Australia via administrative allocation process. 3400–4200 MHz—Embargo 49—no new assignments for terrestrial radiocommunication services to support the development of space communications facilities in the general area of the Mingenew site.	MEDIUM Medium *Monitoring*

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
			3600–3700 MHz—Embargo 52—no new assignments for WAS (P-MP services) where any part of the necessary bandwidth is inside the designated areas of the WPA.	
	4940–4990 MHz (4.9 GHz band)	Potential use by public protection and disaster relief (PPDR) organisations for broadband data applications	The ACMA will consult to assist the development of the appropriate spectrum management processes, in order to support use of the band by public safety applications. Consultation with Defence and other stakeholders. Band channelling arrangement options for PPDR.	SHORT High *Ongoing work plan*
	5091–5150 MHz	Allocated to the AM(R)S on a primary basis at WRC-07 for surface applications at airports, aeronautical telemetry and security-related transmissions	The ACMA will consider the effect of the introduction of AM(R)S on existing services, including the impact on Globalstar feeder links. Sharing between possible future AM(R)S systems and the FSS should be possible by adhering to the provisions of ITU-R Resolutions 418, 419 and 748. International sharing studies. International deployment of technology. Coordination with Globalstar Earth stations.	MEDIUM Low *Monitoring*
	5600–5650 MHz	The BoM is concerned about the introduction of class-licensed RLANs and the potential interference to its weather radars	The ACMA believes that sharing between RLANs and weather radars based on international arrangements is possible. However, it will proceed carefully with the implementation of RLANs sharing this band to minimise the likelihood of interference and will monitor the outcomes of sharing studies overseas.	MEDIUM Medium *Monitoring*

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
	5850–5925 MHz (5.9 GHz band)	Development of spectrum access and licensing arrangements to facilitate the introduction of intelligent transportation systems (ITS)	Embargo 48 currently protects options for the future use of this band. The ACMA released a public consultation paper in November 2009 outlining possible arrangements for ITS in the band. Following analysis of submissions and further engagement with industry, arrangements for ITS will be finalised.	SHORT Medium *Monitoring*
X-Band	9300–9500 MHz	Increased use of maritime radar and possible replacement of racon technology	The ACMA will monitor the deployment of maritime radars and the developments of non-magnetron radars, and will consult with AMSA on the continuation of racons after 2013.	LONG Low *Monitoring*
	10.6–10.68 GHz	Sharing between EESS and the fixed service	Consultation between the ACMA and stakeholders led to agreement that there would be no further use of fixed P-MP or mobile systems in the band, and that power and elevation angle limits (in line with Resolution 751) would be implemented for new fixed P-P links. The ACMA will document and formalise final arrangements in the near future, following additional formal consultation.	MEDIUM Low *Monitoring*
	13.75–14.0 GHz	Some interest in simplified licensing arrangements in the band, which still satisfies current international sharing arrangements	Any consideration of revision to licensing arrangements would first require consultation with interested and affected stakeholders in the band.	LONG Low *Monitoring*
	14.40–14.83 GHz/ 15.15–15.35 GHz	Introduction of Defence common data link (CDL)	The ACMA will work with Defence and other government users to identify	MEDIUM Medium

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
		systems—spectrum is currently used extensively by fixed links and FSS	appropriate whole-of-government approaches to support use of the band by CDL systems, while maintaining access for existing and future fixed- and satellite-services. The ACMA will also work with Defence to explore options for customised CDL systems that maintain interoperability with overseas systems but are better suited to Australian spectrum arrangements.	*Monitoring*
	15.7–16.6 GHz	Use of this band for the operation of ASDE overseas; possible interest for future use in Australia	The ACMA will continue to monitor ASDE developments and its possible future introduction in Australia. Any future introduction of ASDE would require prior consultation with Defence.	LONG Low *Monitoring*
	23.6–24 GHz (24 GHz band)	Sharing issues between automotive UWB short-range radar (SRR), and the EESS and RAS	Sharing with RAS facilitated by separation distances, antenna elevations and terrain shielding. Exclusion zones have been established around licensed RAS facilities. The ACMA considers the density of SRRs required to cause harmful interference to the EESS will not occur in the short- to medium-term. In addition, a migration to 79 GHz SRRs is expected within the next 10 years.	LONG Low *Monitoring*
	26.5–27.5 GHz	27 GHz band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences.	SHORT High *Ongoing work plan*
	27.5–28.35 GHz	28 GHz band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences.	SHORT High *Ongoing work plan*

Band	Frequency range	Spectrum management issue	ACMA approach	TIME FRAME Priority *Status*
	31.0–31.36 GHz	31 GHz band	Technical and regulatory processes supporting the reissue and/or reallocation processes of expiring spectrum licences.	SHORT High *Ongoing work plan*
	77–81 GHz (79 GHz band)	Possible introduction of automotive 79 GHz UWB SRR in Australia	The ACMA will monitor developments in 79 GHz UWB SRR through consultation with peak groups and will liaise with potentially affected users as appropriate.	LONG Low *Monitoring*

6.2.2 Service planning

Project	ACMA approach	TIME FRAME Priority *Status*
Earth station siting	Consultation has commenced on the development of a long-term strategy for the sustainable siting of Earth stations.	MEDIUM–LONG Medium *Ongoing work program*
Global navigation satellite system (GNSS)	Monitoring work has been underway since 2008 to support the introduction and growth of GNSS. Galileo is expected to be launched in 2014.	LONG Low *Monitoring*
Microwave-fixed services bands	Review of planning arrangements for microwave-fixed services bands. Consultation on bands in the range 1.5–3.8 GHz concluded December 2010 Bands above 5 GHz to be considered in 2012.	MEDIUM Medium *Ongoing work program*
Mobile broadband	Development of a spectrum management strategy that focuses on emerging technologies and mobile broadband services.	MEDIUM Medium *Ongoing work program*
Smart infrastructure	Building on the government's smart infrastructure initiative. Identification of suitable spectrum is underway.	LONG Low *Monitoring*
Ultra wide-band (UWB) devices	The ACMA intends reviewing existing arrangements to allow UWB technologies to be deployed in various bands while providing adequate protection to existing services. This work will be done through consultation with industry.	LONG Low *Ongoing work*

6.2.3 Regulatory frameworks

Project	ACMA approach	Time frame
Earth receive station licensing	The ACMA has commenced consultation on its regulatory response to address non-compliance. This work program will continue in 2012.	Medium
LIPD class licence	The existing LIPD class licence was made in July 2000 and was last amended in July 2011. The ACMA considers that it is timely to review the licence and conditions for operation, frequency bands and radiated power limits.	Long
WRC-12 implementation	Implementing regulatory changes from outcomes of WRC-12 meeting in Geneva.	Medium
WRC-15 planning	Work to support development of an Australian position on WRC-15 Agenda items.	Medium
Develop methodology for implementing opportunity cost pricing in appropriate bands	In January 2010, the ACMA decided to consider the use of opportunity cost pricing for annual fees for administratively allocated spectrum. Work has begun to develop a methodology for introducing opportunity cost pricing into various bands.	Medium
Remote blasting and firing devices	The ACMA is planning to consult with industry on the possible development and making of a regulation in accordance with s.314(2)(c) of the Act. The regulation would enable the ACMA to issue radiocommunications licences authorising the operation of remote firing devices for commercial and public safety purposes.	Medium
Principles for spectrum management	The principles were released in 2009 and will be reviewed to ensure that they reflect key concepts in spectrum management.	Long
Infrastructure park	The ACMA is undertaking research and analysis into the development of a type of 'private park' to be made available for smart infrastructure.	Short
Longer term planning for the 1800 MHz band	The ACMA is considering options to allow mobile services to access the 1800 MHz band in regional and remote areas that are not currently spectrum-licensed. This project will require consideration of the impact on existing fixed services operating in the band.	Short
Review of arrangements for LPON services	The ACMA is considering options for the future operation of LPON services resulting from the expiry of the dropthrough specified in the section 34 determination at the end of 2013. This project will involve consultation with industry and affected stakeholders.	Short

Appendix A—Table of frequency bands

Frequency band		**Frequency range**	
VLF		3–30 kHz	
LF		30–300 kHz	
MF		300–3000 kHz	
HF		3–30 MHz	
VHF		30–300 MHz	
UHF		300–3000 MHz	
	L-band		1000–2000 MHz
	S-band		2000–4000 MHz
SHF	C-band	3–30 GHz	4–8 GHz
	X-band		8–12 GHz
	Ku-band		12–18 GHz
	K-band		18–26 GHz
	Ka-band		26–40 GHz
EHF		30–300 GHz	

Note: there are variations in the frequency ranges corresponding to the band names for the microwave frequency bands (L-band, S-band, etc.). In particular, several exceptions to the above frequency bands exist for allocations to the satellite services and, when referring to the satellite service, Table 5.2 should be used instead (see section 5.7.1). Similarly, for the definition of frequency bands in relation to space science services, Table 5.3 should be used (see section 5.8.1).

Appendix B—Acronyms and abbreviations

Acronym	Definition
2G	second generation mobile telephone services
3G	third generation mobile telephone services
4G	fourth generation mobile telephone services
3GPP	Third Generation Partnership Project
A-SMGCS	advanced surface movement and guidance control system
AAD	Australian Antarctic Division
ABC	Australian Broadcasting Corporation
ACARS	aircraft communications addressing and reporting system
ACMA	Australian Communications and Media Authority
the ACMA Act	*Australian Communications and Media Authority Act 2005*
ACMI	air combat manoeuvring instrumentation
the Act	*Radiocommunications Act 1992*
ADS-B	automatic dependent surveillance-broadcast
AEW&C	airborne early warning and control
AFTN	aeronautical fixed telecommunications network
AIS	automatic identification system
AM	amplitude modulation
AMHS	aeronautical message handling system
AM(R)S	aeronautical mobile (route) service
AMS(R)S	aeronautical mobile satellite (route) service
AMSA	Australian Maritime Safety Authority
AMSR	advanced microwave scanning radiometer
AMSU	advanced microwave sounding unit
AMT	aeronautical mobile telemetry
APT	Asia-Pacific Telecommunity
ARNS	aeronautical radionavigation service
ARSG	Australian Radiocommunications Study Group
ASDE	airport surface detection equipment
ASTRA	Australian Strategic Air Traffic Management Group
ATC	air traffic control
ATM	air traffic management
ATN	aeronautical telecommunications network
ATPC	automatic transmitter power control
AusSAR	Australian Search and Rescue
AWACS	airborne warning and control system
BGAN	broadband global area network
BoM	Bureau of Meteorology
the BSA	*Broadcasting Services Act 1992*
BSB	broadcasting services bands
BSS	broadcasting-satellite service
BWA	broadband wireless access
CASA	Civil Aviation Safety Authority
CB	Citizen Band

Acronym	Definition
CBRS	citizen band radio service
CDL	common data link
CDMA	code division multiple access
CDSCC	Canberra Deep Space Communication Complex
CEPT	European Conference of Postal and Telecommunications Administration
CPDLC	controller pilot data link communications
CRS	cognitive radio system
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTS	cordless telecommunications service
DAB	digital audio broadcasting
DAB+	digital audio broadcasting plus
DBCDE	Department of Broadband, Communications and the Digital Economy
DCITA	Department of Communications, Information Technology and the Arts
DECT	digital enhanced cordless telecommunications
Defence	Department of Defence
DMB	digital multimedia broadcast
DORIS	doppler orbitography and radiopositioning integrated by satellite
DRCS	digital radio concentrator system
DRM	digital radio mondiale
DSC	digital selective calling
DSL	digital subscriber line
DSRC	dedicated short-range communications
DSRR	digital short-range radio
DTH	direct-to-home
DTTB	digital terrestrial television broadcasting
DVB RCS	digital video broadcasting-return channel via satellite
DVB-S	digital video broadcasting-satellite
DVB-S2	digital video broadcasting-satellite-second generation
EC	European Commission
ECC	Electronic Communications Committee (Europe)
EDGE	enhanced data rates for GSM evolution
EESS	Earth exploration-satellite service
EHF	extremely high frequency (30–300 GHz)
EIRP	equivalent isotropically radiated power
ENG	electronic news gathering
EPIRB	emergency position-indicating radio beacon
ESA	European Space Agency
ESTRACK	ESA station tracking network
ETSI	European Telecommunications Standards Institute
FANS	future air navigation system
FCC	Federal Communications Commission
FDD	frequency division duplex
FLO	forward link only
FM	frequency modulation
FSK	frequency shift keying

Acronym	Definition
FSS	fixed-satellite service
FWA	fixed wireless access
GA	Geoscience Australia
GBAS	ground-based augmentation system
GBSI	global broadband satellite infrastructure
GHz	gigahertz
GMDSS	global maritime distress and safety system
GNSS	global navigation satellite system
GOES	geostationary operational environmental satellite
GPRS	general packet radio service
GPS	global positioning system
GRAS	ground-based regional augmentation system
GSM	global system for mobile communications
GSM-900	GSM services operating in the 900 MHz band
GSM-1800	GSM services operating in the 1800 MHz band
HAPS	high altitude platform stations
HCRC	high capacity radio concentrator
HD	high definition
HDTV	high definition television
HF	high frequency (3–30 MHz)
HIPERMAN	high performance radio metropolitan area network
HPON	high power open narrowcasting
HSDA	high spectrum density area
HSDPA	high-speed downlink packet access
HSPA	high-speed packet access
HSUPA	high-speed uplink packet access
ICAO	International Civil Aviation Organisation
IEEE	Institute of Electrical and Electronics Engineers
ILS	instrument landing system
IMO	International Maritime Organisation
IMT	international mobile telecommunications
IP	internet protocol
IRGSH	Independent Review of Government Spectrum Holdings
IRNSS	Indian Regional Navigation Satellite System
ISM	industrial, scientific and medical
ISP	internet service provider
ITS	Intelligent Transportation Systems
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union Radiocommunication Sector
JTIDS	joint tactical information distribution system
kHz	kilohertz
LEOP	launch and early orbit phase
LF	low frequency (30–300 kHz)
the LIPD class licence	Radiocommunications (Low Interference Potential Devices) Class Licence 2000
LMDS	local multipoint distribution system
LOS	line-of-sight
LPON	low power open narrowcasting

Acronym	Definition
LRIT	long range identification and tracking
LTE	long-term evolution
Mbps	megabits per second
MBWA	mobile broadband wireless access
MCA	mobile communications systems on aircraft
MDS	multipoint distribution system
MetAids	meteorological aids service
MetSat	meteorological-satellite service
MF	medium frequency (300–3000 kHz)
MHz	megahertz
MIMO	multiple-input and multiple-output
the minister	Minister for Broadband, Communications and the Digital Economy
MLS	microwave landing system
MPEG	Moving Picture Experts Group
MSDA	medium spectrum density area
MSI	maritime safety information
MSS	mobile-satellite service
MSS/ATC	mobile-satellite service ancillary terrestrial component
MTSAT	multi-functional transport satellite
NAS	narrowband area service
NASA	National Aeronautics and Space Administration
NBDP	narrow-band direct printing
NDB	non-directional beacon
NMSC	National Marine Safety Committee
NOAA	National Oceanic and Atmospheric Administration
NPOESS	national polar-orbiting operational environmental satellite system
NTIA	National Telecommunications and Information Administration
OFDMA	orthogonal frequency-division multiple access
OR	off-route
P-MP	point-to-multipoint
P-P	point-to-point
PDC	pre-departure clearance
pfd	power flux density
POES	polar operational environmental satellite
PPDR	public protection and disaster relief
PSR	primary surveillance radar
PTS	public telecommunications service
QZSS	quasi-zenith satellite system
R	route
racon	radar beacon
RALI	radiocommunications assignment and licensing instruction
RAS	radio astronomy service
RCC	Radiocommunications Consultative Committee
RFID	radiofrequency identification
RLAN	radio local area network
RNSS	radionavigation-satellite service

Acronym	Definition
RQZ	radio quiet zone
SAR	search and rescue
SAR	synthetic aperture radar
SART	search-and-rescue radar transponder
SBS	Special Broadcasting Service
SCADA	supervisory control and data acquisition
SD	standard definition
SDR	software-defined radio
SFN	single frequency network
SHF	super high frequency (3–30 GHz)
SKA	Square Kilometre Array
SMS	short message service
SNG	satellite news gathering
SOLAS	(International Convention of) Safety of Life at Sea
SOS	space operations service
the Spectrum Plan	Australian Radiofrequency Spectrum Plan 2009
SRD	short-range device
SRR	short-range radar
SRS	space research service
SSM/I	special sensor microwave imager
SSR	secondary surveillance radar
STL	studio-to-transmitter link
TACAN	tactical air navigation
TCDL	tactical common data link
TCR	telemetry, command and ranging
TDD	time division duplex
TDMA	time division multiple access
TETRA	terrestrial trunked radio
TMI	tropical rainfall measuring mission microwave imager
TOB	television outside broadcast
TRMM	tropical rainfall measuring mission
TT&C	tracking, telemetry and control
UAV	unmanned aerial vehicle
UHF	ultra high frequency (300–3000 MHz)
UK	United Kingdom
UMB	ultra-mobile broadband
UMTS	universal mobile telecommunications system
US	United States (of America)
USB	universal service bus
USO	universal service obligation
UWB	ultra wideband
VHF	very high frequency (30–300 MHz)
VLF	very low frequency (3–30 kHz)
VoIP	voice over internet protocol
VOR	VHF omnidirectional range
VSAT	very small aperture terminal
WAAS	wide area augmentation system
WAS	wireless access services
WCDMA	wideband code division multiple access

Acronym	Definition
Wifi	wireless fidelity
WiMAX	worldwide interoperability for microwave access
WLL	wireless local loop
WRC-2000	World Radiocommunication Conference 2000
WRC-03	World Radiocommunication Conference 2003
WRC-07	World Radiocommunication Conference 2007
WRC-12	World Radiocommunication Conference 2012

Submissions

The ACMA released the *Five-year spectrum outlook 2011–2015* on 30 March 2011 and received 11 submissions that supported the ACMA's current views on spectrum demand.

The ACMA invites the radiocommunications community to consider and make comment on the 2012–2016 edition of the Outlook, with a particular focus on what spectrum priorities should be for 2013–2017.

Submissions close on **31 August 2012**.

Written comments or queries about this edition of the Outlook may be forwarded to:

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Publication of submissions

In general, the ACMA publishes all submissions it receives. However, the ACMA will not publish submissions that it considers contain defamatory or irrelevant material. The ACMA prefers to receive submissions that are not claimed to be confidential. However, the ACMA accepts that a submitter may sometimes wish to provide information in confidence. In these circumstances, submitters are asked to identify the material over which confidentiality is claimed and provide a written explanation for confidentiality claims. The ACMA will not automatically accept all claims of confidentiality. The ACMA will consider each claim for confidentiality on a case-by-case basis. If the ACMA accepts a confidentiality claim, it will not publish the confidential information unless required to do so by law.

Release of information in submissions

Submissions provided to the ACMA may be required to be released under the *Freedom of Information Act 1982*. The ACMA may also be required to release submissions for other reasons including for the purpose of parliamentary processes or where otherwise required by law, for example, a court subpoena. While the ACMA seeks to consult, and where required by law will consult, with submitters of confidential information before that information is provided to another body or agency, the ACMA cannot guarantee that confidential information will not be released through these or other legal means.

Information-sharing

Under the *Australian Communications and Media Authority Act 2005*, the ACMA may disclose certain information to the minister, the Department of Broadband, Communications and the Digital Economy, including authorised officials, Royal Commissions, the Telecommunications Industry Ombudsman, certain Commonwealth authorities such as the Australian Competition and Consumer Commission and Australian Securities and Investments Commission and the authority of a foreign country responsible for regulating matters relating to communications or media.

Effective consultation
The ACMA is working to enhance the effectiveness of its stakeholder consultation processes, which are an important source of evidence for its regulatory development activities. To assist stakeholders in formulating submissions to its formal, written consultation processes, it has developed the following guide: *Effective consultation: A guide to making a submission*. This guide provides information about the ACMA's formal, written, public consultation processes and practical guidance on how to make a submission.

Disclaimer
The information in the Outlook should not be taken to indicate the ACMA's commitment to a particular policy or course of action.

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