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Spectrum Options: 403–520 MHz

Initial consultation on future arrangements for the 400 MHz band

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Executive Summary

The purpose of this paper is to stimulate discussion and gather information from stakeholders to assist ACMA to develop future arrangements for the radiofrequency spectrum in the range 403–520 MHz (the 400 MHz band). The 400 MHz band is predominantly used by the land mobile service, but also accommodates other services, including the fixed (point-to-point and point-to-multipoint), radiolocation and amateur services.

There has been increasing pressure from industry and users of the band to establish arrangements that will better accommodate future communication needs through current and emerging technologies. Much of the band has become congested in the major capital cities, and overall there is a growing need to support more spectrally efficient technologies. These technologies include trunking and more extensive use of narrower bandwidth channels for land mobile and fixed services.

A further motivation for reviewing the band is to identify harmonised spectrum to facilitate radiocommunications interoperability of certain government agencies (such as law enforcement and other emergency services). Consultation about possible future arrangements for the 400 MHz band provides an ideal opportunity for stakeholders to consider their needs and to put forward implementation strategies for improved radiocommunications interoperability.

This paper seeks information and comment on the following broad areas:

- Options for improving technical efficiency in the use of the 400 MHz band, such as reducing channel bandwidths, reviewing preferred transmit/receive frequency separations (also commonly referred to as ‘splits’), increased use of digital technologies and trunking systems and exploring opportunities for channel loading and sharing.
- Consideration of the allocation and licensing mechanisms used in the 400 MHz band with the goal of improving allocative efficiency. This includes the possibility of increased use of market mechanisms to facilitate greater efficiencies in the 400 MHz band, and of class licensing or spectrum licensing arrangements in various parts of the band.
- Consideration of new technologies and complementary uses of the band such as public cellular mobile telephone services particularly suited for deployment in regional and rural areas.

- Opportunities for the harmonisation of spectrum use by certain government agencies.

This paper represents the initial public step in the review process. All responses to this discussion paper will be taken into account by ACMA in formulating more detailed options and strategies. Any detailed proposals for implementing changes to the arrangements in the 400 MHz band will be subject to further consultation with stakeholders and potentially affected incumbent licensees.

Consultation process

ACMA invites comments and feedback on the issues discussed in this paper. Section 7.1 provides a list of issues for comment. At the same time as releasing *Spectrum Options: 403–520 MHz* for comment, ACMA is also releasing: [1]

- A consultation document on the Spectrum Management Principles, which outlines the principles ACMA is proposing to use to guide its approach to a range of significant spectrum management initiatives it will be addressing in the next three to five years, including its approach to the 400 MHz band.
- The *Five-Year Spectrum Outlook 2009–2014* paper, which outlines issues affecting spectrum requirements of key radiocommunications services over the next five years and ACMA's proposed actions to address these issues.
- The *Independent Review of Government Spectrum Holdings* (IRGSH) and ACMA's response to that document.

The Spectrum Management Principles, once finalised, will articulate the framework that will guide ACMA's response to the demand pressures identified in the Five-Year Spectrum Outlook. Those two documents are intended to outline the framework ACMA will apply and to place in context ACMA's approach to significant spectrum management issues over the next three to five years. These issues include, among others, any spectrum released following the cessation of analog television services;[2] government spectrum holdings; expiring spectrum licenses; the availability of spectrum for wireless access services; and options for the 400 MHz band.

The release of these papers is timed to precede ACMA's radiocommunications conference, RadComms08, which will be held on 30 April to 2 May in Melbourne. This is to allow interested parties to familiarise themselves with the papers and facilitate discussion at the conference. In addition to the opportunities available during the conference, and the invitation to provide written submissions, ACMA is interested in hearing from parties who would like to discuss the issues raised in these papers. ACMA will consider the value of focussed meetings, workshops and seminars based on the level of interest and availability of resources. There will also be an opportunity for representatives of the various radiocommunications sectors to engage with ACMA

[1] The three consultation papers referred to are available on the ACMA website at www.acma.gov.au.
[2] ACMA recognises that decisions about the future requirements of broadcasting are for the Minister under s.31 of the Radiocommunications Act, however these observations apply to any ACMA decision-making, for example in relation to spectrum that has been removed from the broadcasting services bands following analog television cessation.

on the issues covered in these papers during the next meeting of ACMA's new advisory group, the Radiocommunications Consultative Committee.

The consultation strategy outlined here is in line with ACMA's new approach to consultation on spectrum matters which was announced earlier this year.[3]

Written submissions

Written submissions on the issues raised in this discussion paper may be made to the Australian Communications and Media Authority (ACMA) as follows:

By email: freqplan@acma.gov.au

By mail:
Mr Christopher Hose
Manager
Government Planning Section
Australian Communications and Media Authority
PO Box 78
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The closing date for submissions is Friday 18 July 2008.

Electronic submissions in Microsoft Word or rich text format are preferred. Please direct any questions about this discussion paper to Andrew Stewart on 02 6219 5238.

Publication of submissions

In general, ACMA publishes all submissions it receives. However, ACMA will not publish submissions that it considers contain defamatory or irrelevant material.

ACMA prefers to receive submissions which are not claimed to be confidential. However, 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.

ACMA will not automatically accept all claims of confidentiality. ACMA will consider each claim for confidentiality on a case-by-case basis. If ACMA accepts a confidentiality claim, it will not publish the confidential information unless required to do so by law.

When can ACMA be required by law to release information?

ACMA may be required to release submissions by law under the *Freedom of Information Act 1982* (Cth) or for other reasons including for the purpose of parliamentary processes or court subpoena. ACMA will seek to consult submitters of

[3] More information about the consultation process is available on ACMA's website at www.acma.gov.au/WEB/STANDARD/pc=PC_310939.

confidential information before that information is provided to another body or agency, but ACMA cannot guarantee that confidential information will not be released through these or other legal means.

Sharing of information

Under the *Australian Communications and Media Authority Act 2005*, ACMA is able to disclose submissions to the Minister, Department including authorised officials, Royal Commissions and certain Commonwealth authorities such as the Australian Competition and Consumer Commission and Australian Securities and Investment Commission.

If information is accepted by ACMA as confidential, ACMA will seek to consult with the submitter of the information where ACMA intends to share that information.

1 Introduction

1.1 Background

The management of the radiofrequency spectrum is undergoing major changes with the increasing sophistication and proliferation of radio technologies simultaneously:

- placing increasing demand on the spectrum; and
- increasing the opportunity for more productive use of the spectrum.

The framework and tools used to manage the spectrum need to accommodate these factors if ACMA is to continue to maximise the public benefit derived from the use of the spectrum.

The 400 MHz band is predominantly used by the land mobile service, but also accommodates other services including the fixed (point-to-point and point-to-multipoint), radiolocation and amateur services.

ACMA is coming under increasing pressure from industry and users of the 400 MHz band to review the planning, licensing and pricing arrangements for the band to improve spectrum availability for future communication needs and to better accommodate current and emerging technologies. Much of the band is now congested in the major capital cities and there is a growing need to provide for technologies that make more efficient use of the spectrum.

In addition to improving the overall spectrum utilisation of the 400 MHz band, there is another major imperative for reviewing arrangements in the band. Harmonised spectrum to facilitate radiocommunications interoperability of certain government agencies (such as law enforcement and other emergency services) has become an issue of great interest to many government agencies.

To this end, the National Coordinating Committee for Government Radiocommunications (NCCGR) was established in late 2003 as the result of a national will to address core issues relating to spectrum and inter-jurisdictional operations, and to ensure that the relevant issues are considered and discussed within

a national framework. ACMA participates in this forum and is committed to working with member organisations to assist in these interoperability objectives.[4]

Also of relevance is the expiry of the spectrum licences in the upper part of the band in 2012. ACMA is considering the future arrangements for the spectrum licensed portion of the band and seeks to have these arrangements in place well before the licences expire. The future of the spectrum licences will be the subject of further consultation by ACMA.

1.2 Purpose

The purpose of this paper is to stimulate discussion and gather information from stakeholders to assist with the development of future arrangements for the 400 MHz band.

This paper represents the initial public step in the review process. The review is intended to:

- identify what scope there is to increase the public benefit from the use of the radiofrequency spectrum by:
  - creating incentives for users to reduce the amount of spectrum used to provide the services supplied using the 400 MHz band; and
  - facilitating spectrum in the 400 MHz band being made available for higher value uses now and in the future.
- obtain information on the factors that should be taken in account when reconsidering pricing, planning and licensing in the band.

Stakeholder views and responses to this discussion paper will be used by ACMA to assist this process to develop short, medium and long-term strategies for use of the 400 MHz band.

All responses to this discussion paper will be taken into account by ACMA in formulating more detailed options and strategies. Any detailed proposals for the introduction of changes to the arrangements in the 400 MHz band will be subject to further consultation with stakeholders and potentially affected incumbent licensees.

In managing the spectrum, ACMA considers the demands of existing and potential new spectrum users. Accurate and representative input from stakeholders on the issues raised in this paper is essential.

1.3 Scope

This paper discusses options for future arrangements for the 400 MHz band. The paper focuses on arrangements for services that currently operate in the band, including:

[4] See www.nccgr.org.au/ for more information about the work of the NCCGR.

- land mobile (including identification of harmonised spectrum to support interoperability of certain government radiocommunications);
- fixed point-to-point;
- fixed point-to-multipoint;
- the Citizen Band Radio Service (CBRS); and
- the amateur service (in 440–450 MHz).

1.3.1 OUT OF SCOPE: 380–400MHz, 406–406.1MHz, 430–440MHz

Changes to arrangements in the ranges 406–406.1 MHz and 430–440 MHz are outside of the scope of this exercise. The potential for changes to 380–400 MHz is being discussed in a separate process between ACMA, Defence, and law enforcement and security agencies.

1.3.2 OUT OF SCOPE: UHF CHANNEL 27 (519–526 MHz)

In Australia UHF television channel 27 spans 519–526 MHz. To date the channel has not been used for television broadcasting, mainly because the land mobile service, in line with the 400 MHz Plan, supports use for land mobile and fixed applications up to 520 MHz. As a result the remaining 6 MHz (520–526 MHz) is not able to be used for a 7 MHz bandwidth television signal.

On 6 October 2006 ACMA placed a spectrum embargo (Embargo 45) on 518–520 MHz.[5] The embargo requires that no new assignments may be made in the embargoed frequency range, including assignments for existing licensees seeking to expand or modify their communications systems in the embargoed band. The embargo applies Australia-wide.

The purpose of the embargo on the upper 1 MHz (519–520 MHz) is to facilitate the possible expansion of UHF television channel 27. This channel is currently 6 MHz wide. A 7 MHz wide channel is required to accommodate a television transmission that complies with Australian broadcasting standards. The purpose of the embargo on the lower 1 MHz (518–519 MHz) is to preserve planning options for adjacent channel sharing. These parameters will be established once the future of channel 27 is decided. At this time ACMA has not made a decision on the future use of this spectrum, and this spectrum is not being considered as part of this consultation process.

1.4 Structure of the paper

Chapter 2 outlines the legislative context within which ACMA manages the spectrum; the draft Spectrum Management Principles which, when finalised, will guide ACMA's approach to fulfilling its statutory spectrum management obligations; and the spectrum planning and licensing instruments currently available to ACMA.

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[5] Spectrum Embargo 45 is available from www.acma.gov.au/webwr/radcomm/frequency_planning/spectrum_embargoes/embargo45.pdf.

Chapter 3 describes the current arrangements in the 400 MHz band in Australia and internationally. It outlines the expected changes in the usage of the band in regions of most relevance to Australia for this band, and the expected implications for equipment availability.

The remaining three chapters of the paper outline and seek comment on possible amendments to the arrangements for planning, licensing, and pricing of the 400 MHz band.

2 Context

2.1 Legislative basis for Australian spectrum management

The *Radiocommunications Act 1992* (the Act) provides the legislative basis for managing Australia's spectrum. The object of the Act provides a high level overview and guidance for ACMA's spectrum management activities.

2.1.1 SPECTRUM MANAGEMENT OBJECTIVES

The object of the Act (Section 3) provides broad guidance to ACMA in the execution of its spectrum management responsibilities. While not providing detailed guidance, an understanding of the Act's object is an essential starting point in any consideration of the Australian spectrum management environment. Section 3 of the Act is reproduced below.

3 The object of this Act

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

(a) maximise, by ensuring the efficient allocation and use of the spectrum, the overall public benefit derived from using the radiofrequency spectrum;

(b) make adequate provision of the spectrum:

  (i) for use by agencies involved in the defence or national security of Australia, law enforcement or the provision of emergency services; and

  (ii) for use by other public or community services;

(c) provide a responsive and flexible approach to meeting the needs of users of the spectrum;

(d) encourage the use of efficient radiocommunication technologies so that a wide range of services of an adequate quality can be provided;

(e) 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;

(f) support the communications policy objectives of the Commonwealth Government;

(g) provide a regulatory environment that maximises opportunities for the Australian communications industry in domestic and international markets;

(h) promote Australia's interests concerning international agreements, treaties and conventions relating to radiocommunications or the radiofrequency spectrum.

2.2 Spectrum management principles

ACMA has been developing principles intended to guide the management of spectrum within its existing legislative responsibilities and government policy settings. The spectrum management principles are intended to:

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

A key theme of the principles is to optimise the use of market mechanisms with regulatory intervention to maximise public benefit.

The spectrum management principles are currently in draft form and are being released for public comment in a separate document. The draft principles are included in this document to explain the factors that, subject to the outcomes of that consultation process, ACMA proposes to take into account in making spectrum management decisions.

The spectrum management principles consultation document also notes that ACMA will take account of the principles of good regulatory process outlined in the *Report of the Taskforce on Reducing the Regulatory Burden on Business*. One of the principles of good regulatory process is that an appropriate framework should be used to assess the range of feasible policy options. Subject to the statutory framework, ACMA will adopt a total welfare standard as its overarching framework for assessing the optimal approach to individual spectrum management issues. Consistent with this, in evaluating regulatory options ACMA will take into account effects on consumers, producers and other stakeholders, including the impact on the government sector.

The spectrum management principles are consistent with the principles of good regulatory process and the total welfare standard. They provide directions that will generally result in welfare being maximised and articulate ACMA's proposed standard approach to spectrum regulation.

PRINCIPLES

Principle 1—Allocate spectrum to the highest value use or uses

An important part of maximising the overall public benefit from use of the spectrum is seeking to allocate spectrum to its highest value use in any primary allocation.[6] At times it may be efficient to share spectrum in which case multiple users may achieve the highest value use. The highest value use will sometimes be a commercial use and sometimes be a use by a government or community organisation. An assessment of highest value use needs to take account of the value to potential licensees, consumers and the wider Australian society.

[6] We use the term 'primary allocation' to refer to spectrum allocations by the regulator (ACMA).

When constructing arrangements for spectrum bands, ACMA will consider what is likely to be the highest value utilisation for the band and design arrangements accordingly (for example, the service types for the band, the licence system, entry barriers, restrictions on usage and the sharing arrangements). In doing so, ACMA will aim to construct arrangements that provide incentives and the flexibility for users to achieve the highest value use. If frequency coordination and interference protection requirements are low, ACMA will consider allowing multiple users to occupy the same spectrum space collectively, with minimal entry barriers.

The allocation method that ACMA employs in any circumstance will be the one that is judged most likely to result in allocation of the spectrum to the highest value use. Where scarcity does not exist, simple over-the-counter allocation is likely to be appropriate. For spectrum for which demand is likely to exceed supply, ACMA considers that in general the market is likely to be more effective than the regulator in achieving an efficient use. If a bidder's willingness to pay does not reflect the total value generated by their use of the spectrum, a simple price-based allocation may not work efficiently to allocate spectrum to its highest value use. In such cases, it may be appropriate to design the allocation mechanism to address risks of market failure.[7]

Principle 2— Enable and encourage users to move spectrum to its highest value use or uses

The highest value use of spectrum will change over time as technology develops, and consumer and social preferences evolve, and as the competitive positions of licensed spectrum users change. Maximising the overall public benefit derived from the spectrum means that spectrum must be allowed to move to the highest value use following its initial allocation as quickly and easily as possible.

A change in use may be facilitated through trading or third-party authorisation, or may be a result of the same licensee employing their spectrum for a different use. Licence conditions and technical frameworks need to be as flexible as possible so as to allow quick and efficient changes in use. Allowing spectrum to move to the highest value use quickly and easily will ensure that the costs of transfer incurred by the regulator and licensee are minimal, and that the benefits of allocation to the highest value use are realised quickly without the delay and costs of regulatory intervention.

ACMA will apply administrative incentive prices to licences allocated over-the-counter to try to ensure that spectrum is used efficiently. Where there is excess demand ACMA will aim to set administrative incentive prices that reflect the opportunity cost as much possible in order to encourage spectrum to be used by the licensees who most value the spectrum.

[7] There may be a significant risk of market failure in some allocation processes if, for example, some services generate substantial broader social value that is not be reflected in the revenue earned by the services provider (externalities), or the governance or administrative arrangements of some potential bidders mean the costs of coordinating to bid effectively in a market allocation process are prohibitively high.

Principle 3—Use the least cost and least restrictive approach to achieving policy objectives

Planning, licensing, allocation and compliance measures should aim to minimise the total cost of achieving spectrum management policy objectives, including the cost to government, cost to licensees and cost to the community. Good regulatory practice requires that all benefits and costs of regulations, including compliance costs, be rigorously assessed. The least cost and least restrictive approaches will reduce regulatory burdens and allow greatest freedom for spectrum users to optimise spectrum utilisation.

Principle 4—Balance certainty and flexibility

ACMA considers it is important to regulate the use of spectrum in a way that provides sufficient certainty for spectrum users. It is also important to provide the flexibility for users to adapt to changing technology and market conditions, and allow ACMA to change the rules and use of the spectrum where necessary to ensure the efficient allocation and use of spectrum.

To maximise the public benefit from use of the spectrum it is likely to be necessary to ensure:

1. licensees have sufficient certainty regarding their rights to use the spectrum to support investment in long-lived assets, and the flexibility to change the use of the spectrum if appropriate;
2. adjacent licensees have sufficient certainty regarding the type and extent of interference they may expect; and
3. ACMA can, when it is expected to provide net benefit, change the technical or regulatory conditions governing the use of parts of the spectrum to facilitate a change in use.

At times these concerns will be in conflict. ACMA will seek to balance the need for certainty and flexibility in regulating use of the spectrum.

Principle 5—Balance the cost of interference and the benefits of greater spectrum utilisation

The value of the spectrum to society is likely to be maximised if the spectrum is used to its fullest but the level of interference is acceptable to all users. Minimising interference imposes direct costs on licensees complying with regulations. It may also impose costs on the Australian economy if spectrum is used less intensively than it would be when some level of interference is allowed. However, an interference environment that is too noisy for affected users may reduce the utility of the spectrum. There is a balance where public benefit is maximised. The optimal approach to interference management may change over time and may be different for different uses of the spectrum.

2.3 Spectrum planning hierarchy

Successful spectrum planning promotes technically efficient use by managing interference and minimising the amount of spectrum denied to other uses. To manage the risk of interference and still permit simultaneous use, radio receivers generally need to be adequately separated in frequency or in geographic distance from

undesired transmissions. The frequency/distance separation relationship depends on the characteristics of the services concerned and on the propagation characteristics of the frequency band. It is necessary for ACMA to establish and codify these relationships to enable efficient use of the band to be made and the risk of interference to be addressed in the optimal way.

The technical framework required to manage interference and enable efficient use of the spectrum includes specifying criteria in licensing documents, equipment standards and frequency coordination procedures. As part of its spectrum planning activities, ACMA develops frequency coordination procedures and licensing documents and participates in standards development. The primary spectrum planning documents released by ACMA are outlined below.

2.3.1 SPECTRUM PLAN

The Australian Radiofrequency Spectrum Plan (the Plan) is the highest level domestic technical document showing the allocation of bands to various types of services. It may be compared to a town plan subdividing land into zones where certain activities are permitted. As well as providing the first layer of spectrum resource allocation, there is a degree of interference avoidance built into the service allocation relationships and associated regulations.[8]

The Plan is drawn from and largely aligned with the Radio Regulations of the International Telecommunication Union (ITU). The Radio Regulations are revised every few years at World Radiocommunication Conferences. The last conference was held in Geneva in 2007. Outcomes from this conference will be implemented in a new version of the Radio Regulations, expected to be published on 1 January 2009. ACMA will take conference outcomes into account when releasing a new Plan at the same time.

2.3.2 BAND PLANS

A band plan specifies the purposes for which a band or bands may be used, and may provide for the reservation of parts of the spectrum for public or community services. Frequency band plans are legal instruments and are prepared for parts of the spectrum where there is a clear need arising from government policy initiatives or community demand. Administrative band plans, or channel plans, serve a similar purpose to frequency band plans, but are not legally binding instruments. They provide a policy basis for band usage. Both types of plan may prescribe usage and specify channelling arrangements for specified frequency bands.

The current *400 MHz Plan* is an administrative plan that sets out arrangements for 403–420 MHz and 450–520 MHz bands.

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[8] The Plan is available free online at www.acma.gov.au/ACMAINTER.131180:STANDARD::pc=PC_2713. Printed copies of the Plan can be purchased from ACMA.

2.3.3 RADIOCOMMUNICATIONS ASSIGNMENT AND LICENSING INSTRUCTIONS

Radiocommunications Assignment and Licensing Instructions (RALIs) are a further important tool in Australian spectrum management and provide detailed guidance on specific spectrum access arrangements. Details such as permitted frequency channelisation, antenna performance characteristics and coordination arrangements are often prescribed in RALIs.

2.3.4 TECHNICAL STANDARDS

In some circumstances ACMA may mandate technical standards for equipment operated in certain bands. These standards are usually developed by Standards Australia.[9]

2.4 Radiocommunications licensing framework

Consistent with the Act, ACMA has three licence regimes available to authorise the operation of radiocommunications:

- apparatus licensing;
- spectrum licensing; and
- class licensing.

The key characteristics of the three licensing regimes are outlined below.

2.4.1 APPARATUS LICENCES

Apparatus licences specify technical conditions for the operation of a device such as frequency, transmit power, emission type and, importantly, geographic location. The apparatus licensing regime involves coordinating the proposed use of a particular radiocommunications device with previously coordinated and licensed devices. If coordination is successful, an apparatus licence is issued to authorise operation of that device. The scope to change any of the parameters after a device is licensed is limited, and primarily depends on whether it can be re-coordinated with other licensed devices in the band.

Apparatus licences are typically issued on an 'over-the-counter' basis, although they are auctioned in some circumstances when there is expected to be excess demand for a licence.[10] Apparatus licences are often issued for one year, but may be issued for up to five years and may be renewed by the licensee upon expiry. Licensees are required to pay an annual fee. Licensees may trade or lease their licences.

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[9] For more information, visit the Standards Australia website at www.standards.org.au.

[10] For example, Low Power Open Narrowcasting (LPON) apparatus licences are auctioned when there is expected to be competing demand for a licence. LPONs allow for the provision of niche radio broadcasting services, such as tourist and racing information, or ethnic and religious programming. They are offered on a rolling quarterly program and while most are allocated with no contest, there are typically three or four auctions each year.

Devices authorised by apparatus licences are typically fully coordinated with other licensed devices, either by ACMA or by an accredited person.[11] Detailed information about the service is recorded and maintained by ACMA in its Register of Radiocommunications Licences to facilitate coordination. The coordination typically provides an assured grade of service with closely-managed interference levels.

Apparatus licensing is usually associated with a 'command and control' approach to spectrum management. This approach may be optimal in some cases, but it may also be administratively cumbersome for large numbers of stations and can be time-consuming and inflexible for operators who wish to deploy services quickly or alter an existing service. It can also be resource intensive for ACMA as it involves individual licensing and detailed frequency coordination.

2.4.2 SPECTRUM LICENCES

Spectrum licences have been implemented with an area-based approach (in contrast to the site-based approach often used for apparatus licences). This approach provides exclusive spectrum access to a potentially large area (Australia-wide, state or regional area). Licensees are responsible for network deployment and management within the bounds of a generic technical framework. The technical framework manages interference at the frequency and geographic boundaries and provides for a degree of technology flexibility. However the framework is designed with the likely use of the band in mind so it can be constraining if the use varies significantly from the originally envisaged range of services. The development and allocation of spectrum licences can be a resource intensive exercise for ACMA.

Larger operators generally favour the spectrum licence approach as it facilitates the deployment of large-scale networks over large geographic areas. Spectrum licensees may sell or lease rights to access all or part of the spectrum covered by their spectrum licence.

Spectrum licences provide for licence periods of up to 15 years. This provides longer tenure than apparatus licences but, in contrast with apparatus licences, there is no presumption of a right of renewal in the case of spectrum licences (section 5.1.2 provides more detail).

2.4.3 CLASS LICENSING

Class licensing, sometimes referred to as the 'public park' or 'spectrum commons' approach, allows users to operate devices in designated segments of spectrum on an uncoordinated and shared basis. Users must operate devices in accordance with specified parameters that typically include frequency bands, radiated power limits and out-of-band emission levels. Technical and operational conditions may also be specified. Australia's class licensing regime has some similarities to the unlicensed or licence-exempt spectrum concepts used in other countries.

[11] More information about accredited persons is available on ACMA's website at www.acma.gov.au/web/STANDARD//pc%3DPC_500.

Users do not have to apply to ACMA to operate in class licensed bands and no fees are payable.[12] However, devices do not receive interference protection and are not coordinated in terms of location and numbers of devices in operation. Anyone can operate any number of devices, anywhere, as long as they abide by the conditions of the class licence. Interference management in class licensed bands relies largely on the 'level playing field' approach where all users are subject to the same limitations on radiated power and frequency range. Generally class licensing is used where there is a low potential for interference, for example, for devices which use low power.

Public park spectrum may provide greater flexibility for users and can increase efficiency and innovation by lowering barriers to entry for small operators and new applications. On the other hand it may also give rise to 'the tragedy of the commons', whereby high levels of use can reduce the quality of service and make the bands inappropriate for some services.

The *Radiocommunications (Citizen Band Radio Stations) Class Licence 2002* (the Class Licence) authorises the operation of Citizen Band (CB) radios in the 400 MHz band on a 'public park' or 'spectrum commons' basis. Many users satisfy their radiocommunications requirements with CB radios operated in accordance with the conditions in the Class Licence. However, for many others, the risk of interference is too great, especially in high spectrum use areas, to make this option viable.

[12] Some class licences authorise the operation of user terminals that communicate with apparatus licensed devices operated by service providers. In these cases, the service provider pays a licence fee for the apparatus licensed device but there is no direct charge by ACMA for access by users to the spectrum.

3 Overview of existing arrangements

This chapter outlines the current arrangements in Australia for use of the 400 MHz band, trends in usage in the band, and the extent to which alternative bands could be regarded as good substitutes. It also considers the use of the band in the USA and Europe and the expected implications for the availability of equipment.

3.1 Australian arrangements

In Australia the 400 MHz band is home to around 59,000 systems. Figure 1 shows the percentage of the various services making up these assignments. Each frequency assignment represents a licensed system. For example, a land mobile base station, point-to-multipoint base or one end of a point-to-point link.

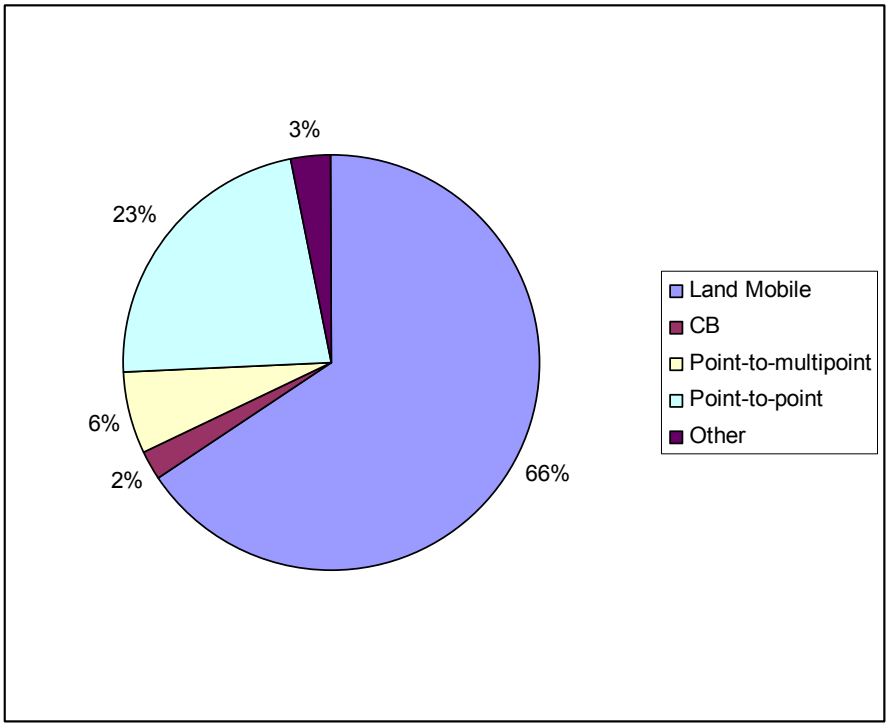

Figure 1: Service types in the 403–420 and 450–520 MHz bands

3.1.1 CURRENT USAGE: 403–420 AND 450–520 MHz—THE 400 MHz PLAN

Spectrum in the range 403–420 and 450–520 MHz is administered in accordance with the band plan for the 400 MHz band (the 400 MHz Plan). It provides an administrative basis for the operation of:

- narrowband land mobile services (single/two frequency with 12.5/25 kHz channelling and two frequency trunked with 12.5 kHz channelling);
- fixed services[13] (single frequency with 12.5/25 kHz channelling, two frequency point-to-point with 25 kHz channelling and two frequency point-to-multipoint with 12.5/25 kHz channelling); and
- other uses of the band such as the wideband fixed point-to-point service in rural parts of Australia.[14]

The 400 MHz Plan and subordinate instruments including relevant RALIs are available on the ACMA website,[15] and a diagram depicting narrowband arrangements for the 400 MHz Plan is provided in Attachment 1. The 400 MHz Plan also provides for the operation of the wideband fixed point-to-point service in some areas of rural Australia.

Standards AS/NZS 4295:2004, AS/NZS 4768.1:2003 and AS/NZS 4768.2:2003[16] are relevant to the use of land mobile equipment used in the 400 MHz band.

3.1.2 CURRENT USAGE: 420–450 MHz BAND

Allocation arrangements for the 420–450 MHz band are defined by the Plan, as outlined in Attachment 2:

- The 420–430 MHz range is used for defence and broader government purposes.
- The amateur service has access to 420–450 MHz on a secondary basis. Most amateur activity takes place in the 430–440 MHz range.
- The frequency range 430–450 MHz is allocated to the radiolocation service on a primary basis, and is intended to be used principally for the purposes of defence.

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[13] Narrowband fixed service (point-to-point and point-to-multipoint) uses include linking land mobile sites and telemetry and telecommand applications.

[14] Wideband fixed service uses in rural areas include the delivery of universal service obligation (USO) telecommunication services.

[15] The 400 MHz Plan is available from www.acma.gov.au/WEB/STANDARD/pc=PC_2571. Frequency coordination procedures relevant to the 403-520 MHz band are contained in RALI LM8 *Frequency Assignment Requirements for the Land Mobile Service* (RALI LM8 is available from www.acma.gov.au/web/STANDARD//pc%3DPC_2609), RALI FX17 *Frequency Assignment Requirements for Narrowband Single Channel Two Frequency Point-to-Point Services in the 400 MHz and 900 MHz Band* (RALI FX17 is available from www.acma.gov.au/WEB/STANDARD/pc=PC_2604) and RALI FX16 *Point-to-Multipoint Fixed Services in the 400 MHz and 900 MHz Bands* (RALI FX16 is available from www.acma.gov.au/WEB/STANDARD/pc=PC_2603).

[16] Standards are available from the Standards Australia website at www.standards.org.au/.

- The 440–450 MHz frequency range has relatively limited use by any service, and the major use is by the amateur service for repeater links and television transmissions.[17]

3.1.3 CONGESTION

One of the drivers behind ACMA's review of the band is the difficulty that some existing or potential users have in gaining access to the band in certain geographic areas. This difficulty manifests through an inability of spectrum users to acquire licences (licence congestion) which in turn is influenced by the technical assignment rules that form the basis for the coordination (and ultimately licensing) of stations in the band.

For some time, ACMA has been aware of anecdotal evidence suggesting that the significant licence congestion in some geographical areas is not accompanied by congestion of the spectrum itself (i.e. large amounts of spectrum are physically unused for significant periods of time).

An understanding and acknowledgement of the separate issues of licence and spectrum congestion is fundamental to a proper consideration of reviewing the band with the goal of improving spectrum use. Different solutions are required to address these different forms of congestion.

There is strong anecdotal evidence that many of the existing challenges in the band are primarily due to licence congestion rather than spectrum congestion. However, ACMA considers it prudent to review both aspects of congestion and acknowledges that a range of complementary allocative (such as licensing and market approaches) and technical solutions are likely to be required in order to maximise the benefit derived from use of the band.

3.1.4 EXPECTED TRENDS IN USAGE IN AUSTRALIA

Analysis of frequency assignments in the 403–430 MHz and 450–520 MHz ranges shows these bands to be licence congested in the larger urban areas. For example, Figure 2 below shows the number of 25 kHz channels in use (out of a total of 39 available) in part of the 400 MHz band (segment I), with dark shading indicating where use is at or near capacity. In highly populated areas the segment is heavily congested. This degree of usage is typical for the 400 MHz band.[18]

A survey of frequency assigners corroborates this analysis: in the 400 MHz band assigners state they are having difficulty finding frequencies in the larger urban areas. Trends in assigning show that additional assignments are generally only made by splitting existing channels (i.e. 25 kHz to 2 × 12.5 kHz) or by using low power systems.

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[17] See Wireless Institute of Australia Band Plan at www.wia.org.au/bandplans/Australian%20Amateur%20Band%20Plans%202005-10.pdf.

[18] ACMA Spectrum Planning Report SP 4/05 Quantifying Spectrum Use in the 400 MHz Land Mobile Band.

The spectrum from 430–450 MHz is relatively lightly used, mainly for the amateur service. Amateur repeaters and links are authorised for use by apparatus licences and general amateur use is not recorded.

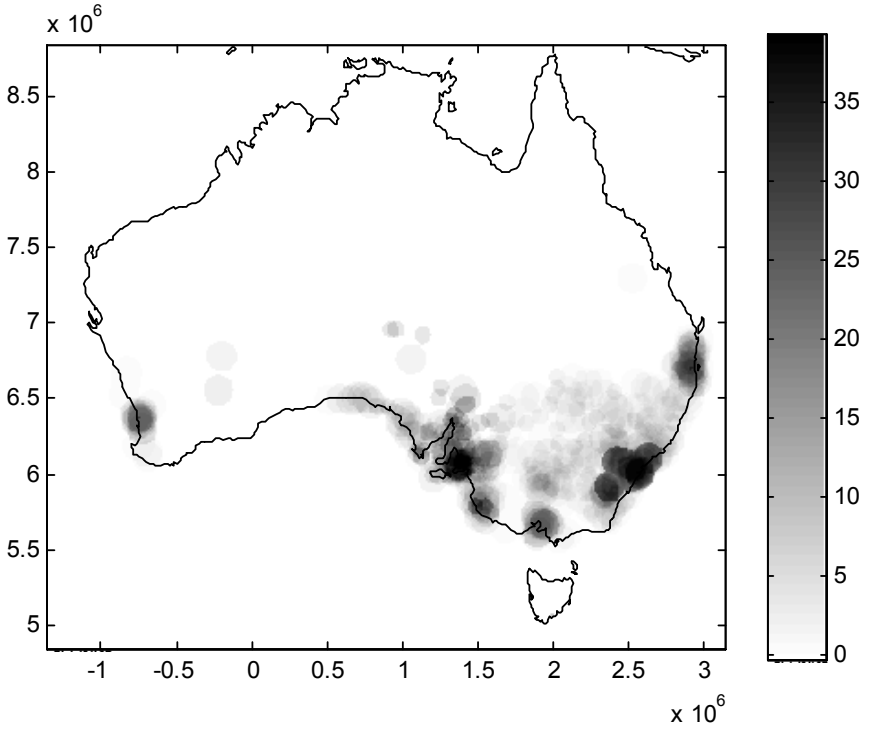

Figure 2: Channel use for land mobile services in the 400 MHz band Segment I. Dark shading indicates where use is at or near capacity.

3.1.5 SUBSTITUTES

If sufficient spectrum with the appropriate characteristics is available as a substitute for access to the 400 MHz band, then the potential disruption and cost of reviewing and implementing changes to the band may not be warranted.

Spectrum substitutability implies that spectrum may be available in alternative frequency bands that provides for the same or sufficiently similar functionality. In some cases, the availability of substitutable spectrum may remove or perhaps delay the need to carry out potentially complex replanning of service deployments in bands with high levels of congestion. Similarly, if sufficient substitutable spectrum is available the opportunity cost may be lower than might be suggested if the 400 MHz band is considered in isolation.[19]

ACMA notes that spectrum around the 400 MHz band is generally considered desirable for a wide range of radiocommunications applications for a number of

[19] Opportunity cost is the value of the spectrum if it is used for the best alternative that has been forgone.

reasons such as propagation, equipment availability and hardware preferences. As with other radio technologies, the equipment availability is strongly dependent upon economies of scale and the market influence of international and regional standards. Similarly, for other technical or operational reasons it may be unlikely that substitute spectrum in other bands is available to support all of the applications and activities currently accommodated in the 400 MHz band.

As the land mobile service is the predominant use of the 400 MHz band, it serves as the best example to illustrate the possibilities of spectrum substitutability. Existing arrangements that ACMA considers might provide some degree of alternative to the 400 MHz band for land mobile use include:

- VHF Bands:
  - VHF Mid Band (VHF Mid Band Frequency Band Plan (70–87.5 MHz))
  - VHF High Band (VHF High Band Frequency Band Plan (148–174 MHz))
- 900 MHz Band (900 MHz Band Plan (820–960 MHz));[20] and
- Cellular mobile services, evolutions of which are a part of broader wireless access services (WAS).[21]

Each of the examples above may in some cases provide a degree of spectrum substitutability, particularly for analog voice applications. However, it might be more appropriate to regard the alternative bands as more of a complement rather than a complete alternative to the types of existing and emerging land mobile services accommodated in the 400 MHz band. Digitisation and deployment of standards based products tend to be targeted at particular applications using specific frequency bands. The practical impact is that, while the VHF bands identified above are planned to support land mobile activities, for certain applications, a number of equipment availability and technical issues effectively preclude the use of these bands as a direct substitute for the 400 MHz band.

Similarly, whilst the arrangements in the relevant parts of the 900 MHz band are designed to support land mobile services, it provides a different technical environment to the 400 MHz band and in practice faces similar congestion problems.

The use of cellular mobile systems (i.e. mobile phones) provides a functional alternative to some applications traditionally supported through use of 400 MHz land mobile systems. Some users are utilising commercial mobile phone networks in place of, or as a complement to, dedicated land mobile networks operated in the 400 MHz (or 900 MHz) band. However, not all (400 MHz or otherwise) land mobile uses can be supported by cellular type systems, leaving a continued need for spectrum supporting traditional land mobile networks in bands such as 400 MHz.

Overall, ACMA's preliminary view is that while substitutable spectrum for at least some types of land mobile systems in the 400 MHz band potentially exists, the

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[20] Further information on the VHF Mid and High Band Plans and the 900 MHz Band Plan is available on ACMA's website at www.acma.gov.au/WEB/STANDARD/pc=PC_2704.

[21] Further information on WAS is available on ACMA's website at www.acma.gov.au/WEB/STANDARD/pc=PC_100424.

alternative bands have practical limitations that substantively diminish their utility for particular applications and/or types of deployment. Accordingly, the availability of spectrum alternatives for some type of uses does not substantively diminish the need to review the arrangements in the 400 MHz band and the pursuit of improved spectrum access arrangements. Broadly similar arguments can be made for other uses of the 400 MHz band such as the fixed and radiolocation services.

1. **ACMA seeks comments on the extent to which other spectrum can be regarded as a close substitute for spectrum in the 400 MHz band.**
2. **ACMA seeks comments on the extent to which other services provide a functional alternative to services provided using the 400 MHz band.**

3.2 Equipment issues

For the frequency range 403–520 MHz, Australia is almost exclusively an importer of radiocommunications equipment. Therefore Australian arrangements should ideally be compatible with overseas equipment capabilities to the maximum extent possible.

Equipment manufactured for the US and European market reflects the frequency ranges described below, and is not necessarily able to comply with equipment standards applicable to Australia. As a result, equipment availability and compliance with Australian Standards varies somewhat over the frequency range.

In general, where there is overlap between European and US arrangements equipment availability is excellent and equipment costs are lower than in other parts of the surrounding spectrum. This means that the cost of establishing and maintaining radiocommunications networks in the 410–420 MHz and 450–470 MHz ranges can be significantly less than the cost of establishing similar networks elsewhere in the 400 MHz band.

3.3 Arrangements in the United States and Europe

To provide context for reviewing the band in Australia this section provides a brief overview of relevant arrangements in the US and Europe. Arrangements in the US and Europe are included because, as described above, these areas have traditionally had the greatest influence on equipment availability and cost, and therefore the greatest impact on Australian spectrum planning arrangements in the band.

Although Asia is an increasingly important and developing source of radiocommunications equipment, the Asia-Pacific region has traditionally not had a major influence on 400 MHz band arrangements in Australia. Planning arrangements in this band throughout Asia are fragmented and lack the cohesion that is apparent for radio products targeted at North America and Europe. Typically, products marketed in Australia comply with the standards developed for these major markets.

Accordingly, there is less ability to draw conclusions on specific Asian arrangements that are relevant to Australia. While ACMA is aware of relevant issues in the band throughout Asia, these have not been included in this section.

3.3.1 UNITED STATES

Current arrangements

In the US, the frequency range 406.1–420 MHz is used by the mobile service for general-purpose federal government applications. Technology in this band includes analog conventional and trunked systems, Ericsson EDACS,[22] Motorola SmartZone[23] and APCO25.[24] A 9 MHz transmit/receive separation is typically used for duplex operation.

The 420–430 MHz frequency range is allocated for the fixed and mobile services on a primary basis and the radiolocation service on a secondary basis. The 430–440 MHz band is allocated for the radiolocation service on a primary basis and the amateur service on a secondary basis.

The frequency range 450–470 MHz is used mainly by the land mobile service, and the 470–512 MHz range is shared between the mobile and broadcasting services. The 512–526 MHz range is used for broadcasting.

The Federal Communications Commission (FCC) is responsible for management of the spectrum other than spectrum used by the federal government. The National Telecommunications and Information Administration (NTIA) manages spectrum used by the federal government.

Trends in usage

Land mobile spectrum scarcity is not a problem unique to Australia. Many administrations face similar issues and some have already taken action to remedy the problem. The FCC has taken a number of steps to alleviate it.

From February 1997, the FCC directed that all 25 kHz land mobile equipment operating below 512 MHz must be able to support a voice channel in a 12.5 kHz bandwidth. It also directed that equipment suppliers must provide equipment capable of operating in 6.25 kHz channels from January 2001. The Canadian Government has taken similar steps.

In the 1990s the NTIA recognised a need to develop long-range spectrum plans, and initiated a program of strategic spectrum planning. The NTIA Requirements Study, released in April 1995, found that the 23 MHz of spectrum allocated to the non-federal public safety services was insufficient, and that additional spectrum would be needed for basic voice dispatch and other current public safety spectrum needs. Frequency assignment records show that federal land mobile assignments were increasing at around 12 per cent per annum.

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[22] Enhanced Digital Access Communication System (EDACS) is a fault tolerant, trunked system commonly used by public safety and public transit agencies. More information is available online at www.macom-wireless.com/products/pve/edacs.asp.

[23] SmartZone is Motorola trunking system using a proprietary standard (SmartNet II signalling).

[24] APCO25 refers to a suite of standards for use by federal, state and local government public safety agencies to enable them to communicate in emergency situations. More information is available online at www.apcointl.org/frequency/project25/.

The general land mobile community using the remaining 400 MHz spectrum expressed the view that the demand for land mobile services exceeded the amount of spectrum currently allocated in many geographic areas. Licence data indicated that the number of private land mobile transmitters was increasing at a rate of nearly 8 per cent per annum.

Studies of spectrum use showed that the 400 MHz band was heavily used throughout the continental US. Trends include a migration of the fixed service to other bands and an increase in the use of trunking systems.

3.3.2 EUROPE (AND ITU REGION 1)

Current usage

The European Radiocommunications Office (ERO) is the permanent office supporting the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT). The ECC brings together the radiocommunications and telecommunications regulatory authorities of the 47 CEPT member countries.

A table of ERO common frequency allocations covering the range 403–520 MHz is provided at Attachment 3. In summary, the band is allocated for the following purposes:

- 399.9–406.1 MHz: various satellite and meteorological purposes
- 406.1–410 MHz: land mobile and radio astronomy
- 410–430 MHz: land mobile
- 430–440 MHz: amateur and radiolocation
- 440–470 MHz: mobile
- 470–608 MHz: broadcasting

In most of Europe, arrangements for the 406.1–430 and 450–470 MHz bands comply with the CEPT report ERC 25, with local administrations devising individual channelling plans. Under the CEPT arrangements, simplex operation is supported, and a 10 MHz frequency split is prescribed for duplex operation.

Trends in usage

In Europe, CEPT ECC Report 25, *Strategies for the European use of frequency spectrum for PMR/PAMR applications*, found that trends for the future of land mobile include:

- An increasing number of users – the number of land mobile base stations is increasing;
- Increasing requirements for the carriage of data;
- Increased requirement for national roaming/interoperability;
- An increasing migration from analog to digital systems;
- A migration to wideband (≥200 kHz) systems for large networks; and
- Organisations tending to consolidate onto larger networks.

The report concluded that a common approach should be taken to refarming spectrum used by the land mobile service to meet future needs and that spectrum should be made available for both narrowband and wideband applications. Spectrum should also be preserved for small networks.

In the UK, land mobile systems in the 400 MHz range comply with UK Interface Requirement 2044. This specifies 12.5 kHz channelling for analog FM equipment with a small number of channels available for 25 kHz equipment.

4 Government spectrum harmonisation

Federal, state and territory governments are significant users of spectrum, particularly for land mobile radiocommunications supporting emergency services such as police, fire and ambulance. Favourable propagation characteristics and readily available equipment has lead to the 400 MHz band being heavily used by government in support of these services.

Radiocommunications interoperability between government services (principally emergency services) and between different state, territory and federal government jurisdictions has been repeatedly identified as a crucial requirement. The identification of harmonised spectrum for government users had been acknowledged as being a critical element in achieving this aim, with spectrum in the 400 MHz band generally acknowledged as the most appropriate to achieve this harmonisation.

As identified earlier in this paper, the provision of adequate spectrum for emergency services is an element of the object of the Act. ACMA considers the identification of harmonised spectrum for government radiocommunications interoperability as critical to achieving this element of the Act while also seeking to promote an efficient allocation of spectrum (consistent with other elements of the object of the Act). The review of the 400 MHz band presents an important opportunity to progress this issue. Progress will require continued or increased commitment from Australian governments to address radiocommunications interoperability and the associated spectrum harmonisation requirements.

The creation of consolidated government networks that replace existing disparate networks is likely to lead to spectrum efficiency dividends. Such savings would free up spectrum for the entire user community and will therefore also support the object of maximising the overall public benefit derived from using the radiofrequency spectrum.

While committed to play its part in achieving government radiocommunications interoperability goals, ACMA's role is limited to supporting the identification of appropriate spectrum to achieve interoperability objectives. Broader support, guidance and commitment from Australian governments and individual government agencies are essential for real interoperability objectives to be realised. For instance, governments must fund and support agencies to migrate their radiocommunications

networks to appropriately identified harmonised spectrum, and agencies themselves must develop and agree on compatible technology standards and operational arrangements to achieve genuine interoperability.

A new national committee for the purpose of harmonising government spectrum use was established in 2003 with the support of the Minister for Defence, the Attorney General and the Minister for Justice and Customs, the State Premiers and the Territory Chief Ministers. Known as the National Coordinating Committee for Government Radiocommunications (NCCGR), the committee has a core objective of developing and maintaining a national strategic plan for government radiocommunications through a coordinated approach by jurisdictions.[25]

Further NCCGR objectives include meeting interoperability needs, and the promotion of the effective and efficient use of the radiofrequency spectrum by government. All Australian government jurisdictions are members, and there are a number of observers and advisers, such as Emergency Management Australia, the Department of Defence, ACMA and the police services representative body.

ACMA has been and will continue to work closely with the NCCGR and other relevant bodies towards achieving spectrum harmonisation to support interoperability.

4.1 Existing arrangements supporting government spectrum harmonisation

ACMA and its predecessors have made various attempts over the years to harmonise spectrum used across Australia for government emergency service purposes.

The first attempt to provide a level of spectrum harmonisation came about in response to the deficiencies revealed by Cyclone Tracy in December 1974. By the late 1970s a pair of contiguous blocks of 64 channels (each 25 kHz wide) had been identified in spectrum between 450 and 470 MHz in an attempt to redress the lack of interoperability among services attending on that occasion. This spectrum is now referred to as the Law Enforcement and Public Safety (LEPS) spectrum and is discussed further below. Today this spectrum is used almost exclusively by the various police services though genuine interoperability is limited.

As states began moving to whole-of-government mobile radio networks, the early 1990s presented a second opportunity to accommodate the objective of harmonised spectrum for government uses.

After consultation with Defence (which previously had largely exclusive access to the band), much of the 420–430 MHz band was made available for mobile service use for government purposes, providing common and virtually unoccupied spectrum for government. To date only the Victorian Government has availed itself of this opportunity to use spectrum for a whole-of-government network.[26]

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[25] More information on the NCCGR is available on the Committee website at www.nccgr.org.au/.
[26] NSW operates separate networks for fire and ambulance in the 420–430 MHz band.

While a positive move, the 420–430 MHz band is not considered adequate in either the amount of spectrum available or the technical characteristics (such as frequency splits available) to completely address spectrum harmonisation issues.

In a process related to the overall review of 400 MHz band, ACMA is currently in the early stages of discussion with Defence and the law enforcement/security community as to the possibility of increased non-Defence access to the 380–400 MHz band for police/security use. The outcomes of these discussions will feed into the broader 400 MHz band review discussed in this paper and may influence the preferred location of spectrum identified for broader government spectrum use.

4.2 The Independent Review of Government Spectrum Holdings

To assist ACMA in undertaking its spectrum management responsibilities, an Independent Review of Government Spectrum Holdings (IRGSH) was commissioned in 2006. The intention of the review was to assist ACMA to better achieve an appropriate balance between government use of the radiofrequency spectrum and its use by the broader community. The Terms of Reference for the review are included as Attachment 4. The IRGSH Final Report and ACMA's preliminary response will be released in April 2008 at the same time as this consultation paper.[27]

A key finding of the IRGSH (identified in two recommendations) concerned spectrum requirements for government radiocommunications supporting emergency services.

The findings of the IRGSH and the responses to this discussion paper will assist ACMA in making future decisions on spectrum for government in the 403–520 MHz and, potentially, the 380–400 MHz band.

4.3 Potential for government-only use of 403–420 MHz

Overall, assignments for the land mobile service in the 400 MHz band are split roughly evenly between government and commercial/private use. In the 403–420 MHz band, government is the predominant user, accounting for around 80 per cent of the frequency assignments.

ACMA, by way of the Australian Radiofrequency Spectrum Plan, has preserved the mobile service allocation in the 420–430 MHz band for use for Australian, state and territory government purposes.[28]

Given the existing dominance of assignments to government in 403–420 MHz and its adjacency to the already government identified 420–430 MHz band, some or all of the

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[27] The discussion paper is available on ACMA's website at www.acma.gov.au.

[28] By way of an Australian Footnote AUS91 in the Australian Radiofrequency Spectrum Plan: *Use of the mobile service is limited to Australian, State and Territory Government purposes. The Department of Defence is normally consulted in considering non-defence use of this service.*

band would be a good candidate for being made available for government purposes exclusively.

This would allow the 420–430 MHz block to be combined with spectrum in the adjacent 403–420 MHz band to produce a series of paired segments and possibly some single frequency segments appropriate to meet the consolidated requirements of certain government agencies. Importantly, the identification of a significant contiguous block of spectrum available to government only would facilitate the deployment of large multi-agency networks, which require large contiguous bands to operate.

The amount of spectrum made available specifically for government users would need to be critically considered based on a range of factors. A balance needs to be reached between spectrum that is identified for government use only and spectrum where government users would participate in the market on the same basis as others.

If a proposal was adopted to make spectrum available in 403–420 MHz (or other spectrum) for government use only, government users would be treated in the same way as other users if they were to require additional spectrum in other frequency ranges. The ability of government users to enter the general market to acquire additional spectrum technically compatible with 'government only' spectrum would be a considered in developing overall arrangements in any band identified exclusively for government use.

3. **Comment is sought on the possibility of making spectrum available in the 403–420 MHz band for government use only.**

4. **When combined with the existing 420–430 MHz government band, government land mobile use could be consolidated in the band 403–430 MHz. Are there alternative parts of the 400 MHz band that offer advantages for consolidated government land mobile operations?**

This approach, if adopted, would not necessarily mean that other services (e.g., amateur, fixed, radiolocation) would see their access to parts of this band reduced or eliminated. Sharing arrangements could allow continued access, either on the same basis as currently exists or revised in some manner.

Licensing arrangements for a block of 'government spectrum' may more appropriately take the form of area-based spectrum rights provided by spectrum licences, rather than the traditional apparatus licence regime. Under such an arrangement government jurisdictions would manage their own spectrum resource. Allowance would need to be made in some way for federal government requirements which are typically Australia-wide.

5. **Comment is sought on the rights a spectrum management regime should retain to authorise spectrum use in bands identified for government use.**

4.4 The LEPS spectrum (formerly the '64 Channel Block') and 'CT' frequencies

The Law Enforcement and Public Safety (LEPS) spectrum consists of two paired 1.6 MHz blocks (458.3375–459.9375 MHz and 467.8375–469.4375 MHz). This spectrum originally supported 25 kHz channels, but in a number of cases users have increased the utility of the spectrum by implementing 12.5 kHz channelisation. The segments are preserved, by way of a spectrum embargo (Embargo 36), for use by government agencies involved in the national security of Australia, law enforcement or the provision of emergency services, including interoperability objectives.[29] There are also frequencies around 480 MHz identified nationally for counter-terrorism (CT) purposes.

The LEPS frequencies lie in an area of spectrum that can be used by most land mobile equipment. That is, equipment with a switching range of 403–470 MHz or 450–520 MHz. Equipment capable of using the CT frequencies is generally capable of the higher band switching range only. This can lead to interoperability problems with organisations that have a requirement to use the lower part of the 400 MHz band as their equipment is generally only capable of the lower band switching range.

If the mobile service in the 403–420 MHz range (or alternative spectrum) becomes available exclusively for government use, availability of the LEPS spectrum and CT channels would be phased out with the expectation that the newly identified harmonised government spectrum would be used for these roles. This would be consistent with the object of providing adequate spectrum for government use and maximising the overall public benefit from use of the spectrum.

6. ACMA seeks comments on issues with phasing out the current LEPS and CT spectrum, and accommodating this requirement within spectrum specifically identified for government users.

[29] Spectrum Embargo 36 is available online at www.acma.gov.au/acmainterwr/radcomm/frequency_planning/spectrum_embargoes/emb36.pdf.

5 Licensing, pricing and trading

5.1 Licensing

5.1.1 CURRENT APPROACH

Almost all current use of the 400 MHz band is authorised by apparatus licences. Apparatus licences in the 400 MHz band are mainly issued over the counter following frequency coordination by either ACMA or an accredited person. In 2007 accredited persons assigned the majority of land mobile and point-to-multipoint licences in the 400 MHz band, and a limited number of point-to-point licences.

In 1997, 2 × 4 MHz of spectrum in the upper part of the 400 MHz band (approximately 501–505 and 511–515 MHz) was allocated by auctioning spectrum licences. The bandwidths on offer ranged from 12.5 kHz to 1 MHz. The auction gained just over $1 million in auction receipts. In addition, a few unsold lots have subsequently sold at the reserve price under a price-based allocation of residual lots, which is held at three-monthly intervals, the latest sale being in August 2007.[30] Device registrations of spectrum licences are about 5 per cent of assignments of land mobile licences, although in terms of bandwidth the spectrum licensed band comprises just over 10 per cent of the 400 MHz band allocated to mobile services.

Most Citizen Band Radio Service (CBRS) use is supported by a class licence (the use of CBRS repeaters is authorised by apparatus licences).

5.1.2 LICENSING OPTIONS

Apparatus licensing arrangements in the band have served stakeholder requirements well for many years. However, those arrangements are based on a one-size-fits-all service model, where ACMA's frequency coordination principles intend to achieve a set grade of service in all circumstances. In areas of diverse terrain, such a model will often result in conservative use of spectrum. For example, in an area where terrain shielding exists, the prescribed minimum frequency re-use distance would be able to

[30] Information about the auction results for these spectrum licences is available on ACMA's website at www.acma.gov.au/WEB/STANDARD/pc=PC_364.

be reduced, but current assignment rules (as per RALI LM8 for the land mobile service) make this difficult.[31]

In addition, the best model for one type of application may not be optimal for another application. For example, systems consisting of one or two base stations require detailed coordination with surrounding systems (as per the current arrangements). Large networks consisting of many base stations operating in contiguous blocks of spectrum must also follow the current arrangements. However, it may well be the case that the licensee could effectively deploy a large network without strict adherence to the frequency coordination requirements of RALI LM8 and still successfully coordinate the network.

While the relative mix between spectrum, apparatus and class licensing may change, it seems likely that all three licensing regimes will continue to be relevant to the 400 MHz band. As set out above, apparatus licences are currently heavily used in the 400 MHz band. Future arrangements could include increased use of class and spectrum licensing.

In particular, in some cases it may be desirable to use the spectrum licensing option to facilitate optimum use of the spectrum. Spectrum licensing can remove many of the technical coordination constraints existing under the 'command and control' approach, and maximise the spectrum user's flexibility in how he or she makes use of the spectrum. In particular, this could manifest through the creation of private band managers that acquire spectrum licences and then provide access to that spectrum under varying arrangements to individual users.

Some possible alternative licensing arrangements are identified in this paper. Others may be developed pending the responses to this discussion paper. Further consultation will be carried out after analysis of the responses to this paper and the development of options for future arrangements.

7. Comment is sought on approaches to licensing spectrum use that would result in more efficient use of the 400 MHz band.

Expiring spectrum licences

In 2012, the spectrum licences in this band will expire.[32] ACMA is considering the future arrangements for the spectrum licensed portion of the band and seeks to have these arrangements in place well before the licences expire. Under the Act, ACMA has three options for the expiring spectrum licences:

1. ACMA may re-allocate new spectrum licences in the bands under section 60 of the Act by an auction, tender, or pre-determined or negotiated price.

[31] RALI LM8 is available on ACMA's webite at www.acma.gov.au/WEB/STANDARD/pc=PC_2609.

[32] Spectrum licences in the 500 MHz band were initially issued for a period of 10 years from 1997 to 2007. In response to an amendment to the Act, which extended the maximum spectrum licence period to 15 years, 500 MHz spectrum licensees were offered the chance to increase their licence term to 15 years (that is 1997–2012). Most licensees chose to accept that offer.

2. ACMA may renew licences to the same licensees without undertaking a price-based allocation in certain circumstances:
   - ACMA can renew a licence that is part of a class of services for which the Minister determines renewing licences to the same licensees would be in the public interest.
   - ACMA can renew the licence if it is satisfied that special circumstances exist in which it is in the public interest for the existing licensee to continue to hold the licence.

   In either case, incumbent licensees will be charged a spectrum access charge which ACMA determines under section 294 of the Act.
3. ACMA may use a different licensing system in the band such as apparatus licences.

Under any of these options ACMA could possibly vary previously established licence conditions.

To date, the Minister has not determined a class of services for which renewal would be in the public interest.

The future of the spectrum licences will be the subject of further consultation by ACMA.

8. ACMA seeks views on the arrangements for the spectrum licences in the upper 400 MHz band including comments on the possibility of alternative arrangements such as altering the bandwidth, the technical framework or the licence type.

5.1.3 APPARATUS LICENCE PERIODS IN THE 400 MHz BAND

As provided for under paragraph 103(3) of the Act, an apparatus licence may be issued for any period not exceeding five years. Around 95 per cent of apparatus licences for assignments in the 400 MHz band are renewed annually, but some have a period greater than one year. The development of future arrangements for the 400 MHz band could be impeded if apparatus licences were issued with licence periods greater than 1 year.

In light of ACMA's intent to review arrangements for the band, a policy was recently introduced to limit licence periods in the 450–520 MHz range to one year. This is consistent with a previously adopted policy of limiting licence periods to one year in the 403–420 MHz band. This should help facilitate the introduction of new arrangements within a reasonable time frame, should any changes result from the consultation process commenced with this discussion paper.

It is expected this policy of one year licence renewals in the 400 MHz band will remain in place until ACMA finalises its review of the arrangements for the band.

5.2 Pricing

5.2.1 CURRENT APPROACH

Apparatus licences in the 400 MHz band are subject to the apparatus licence tax on issue or renewal of the licence. This tax is calculated on a formula based on the band, the bandwidth, the location, the power and the type of the licence. The annual rate of tax on licences in the 400 MHz band is shown in the table below.

Table 1 Annual apparatus licence taxes on licences (as at 1 April 2008)

Licence type	Location	Bandwidth	
		12.5 kHz	25 kHz
Land Mobile	Sydney, Melbourne, Brisbane	$1,127	$2,253
	Adelaide, Perth, Newcastle	$515	$1,031
	Regional	$88	$176
	Remote	$44	$88
Fixed point-to-point	Sydney, Melbourne, Brisbane	$231	$461
	Adelaide, Perth, Newcastle	$106	$211
	Regional	$32	$36
	Remote	$32	$32
Fixed point-to-multipoint	Sydney, Melbourne, Brisbane	$911	$1,822
	Adelaide, Perth, Newcastle	$417	$833
	Regional	$71	$142
	Remote	$35	$71

Prior to 2005, the annual apparatus licence tax on fixed services was low compared with the tax on land mobile licences. As they share the same spectrum bands, the Australian Communications Authority (ACA)[33] moved to increase the tax on fixed services to equivalence with land mobile services over five years. When the program is completed in 2009, the tax on point-to-multipoint services will be the same as the tax on land mobile. The tax on point-to-point assignments will be one quarter of that of land mobile, which reflects the approximate relative spectrum denial.

5.2.2 PRICING OPTIONS

As outlined in section 2.2, one of the principles ACMA proposes to use to guide its approach to spectrum management is to provide incentives for spectrum to be used efficiently, and consistent with this, to facilitate spectrum moving to its highest value use over time. The annual apparatus licence tax is intended to signal the value of

[33] The ACA was a predecessor organisation to ACMA.

spectrum.[34] It is one of the principal instruments available to ACMA to create incentives for the efficient use and efficient allocation of spectrum between users.

In other countries, such as the UK, the regulator has sought to estimate the opportunity cost of administratively priced spectrum and use this as the basis for setting prices. To date, ACMA has not sought to estimate the opportunity cost of spectrum in the 400 MHz band.

The opportunity cost, or value of the spectrum in the best alternative forgone, can mean either the value of the spectrum to another person using it to provide similar services, or its value in some alternative use. Where there is no excess demand, the opportunity cost is zero.

One measure of the value or opportunity cost of the marginal unit of spectrum is the cost of providing the same level or quality of service without that unit of spectrum by using an alternate method. If, for example, an incumbent user of spectrum for fixed links was denied a marginal unit of spectrum, they could choose to use a more spectrally efficient method of transmission, use a different frequency band, or use non-wireless methods.

Setting prices at a level that reflects the value of spectrum may encourage spectrum to move to higher value users with less additional intrusive regulatory interventions. As part of its review of the 400 MHz band, ACMA may consider the level of the apparatus licence fees in the band by reference to the estimated opportunity cost of the spectrum.

9. ACMA seeks comment on the expected cost to users of the 400 MHz band of providing the same service with less spectrum (e.g., 12.5 kHz rather than 25 kHz channels).

Pricing and spectrum sharing

A number of options for increasing sharing in the 400 MHz band are outlined in the next chapter. If spectrum sharing is implemented or increased it may be appropriate to reflect this in the level of the apparatus licence tax.

ACMA will consult with affected stakeholders in more detail as part of its consideration of any changes to the level or structure of apparatus licence tax.

5.3 Secondary trading

Secondary trading refers to licensees selling or leasing all or part of the right to access spectrum granted by the licence they hold. Secondary trading is allowed under sections 131AA to 131AC of the Act for apparatus licences and section 85 of the Act for spectrum licences.

[34] ACMA apparatus licence fee schedule 2007, p 4.

5.3.1 CURRENT LEVELS OF TRADING

It could be expected that bands which are congested would be subject to a larger volume of trading. Compared to similar bands for land mobile or fixed services, the 400 MHz Band has a slightly higher level of trading. However, the data is variable, and therefore sensitive to single multi-licence trades. Further, trading parties are required to notify ACMA, although it is not always clear which licence transfers are a trade to a third party and which are a result of internal reorganisation or change of name.

Figure 3 shows the turnover rate of land mobile and fixed licences in a number of bands. The fraction is measured as the average annual number of trades (taken over the four years from 2004 to 2007) divided by the number of licences in the category.

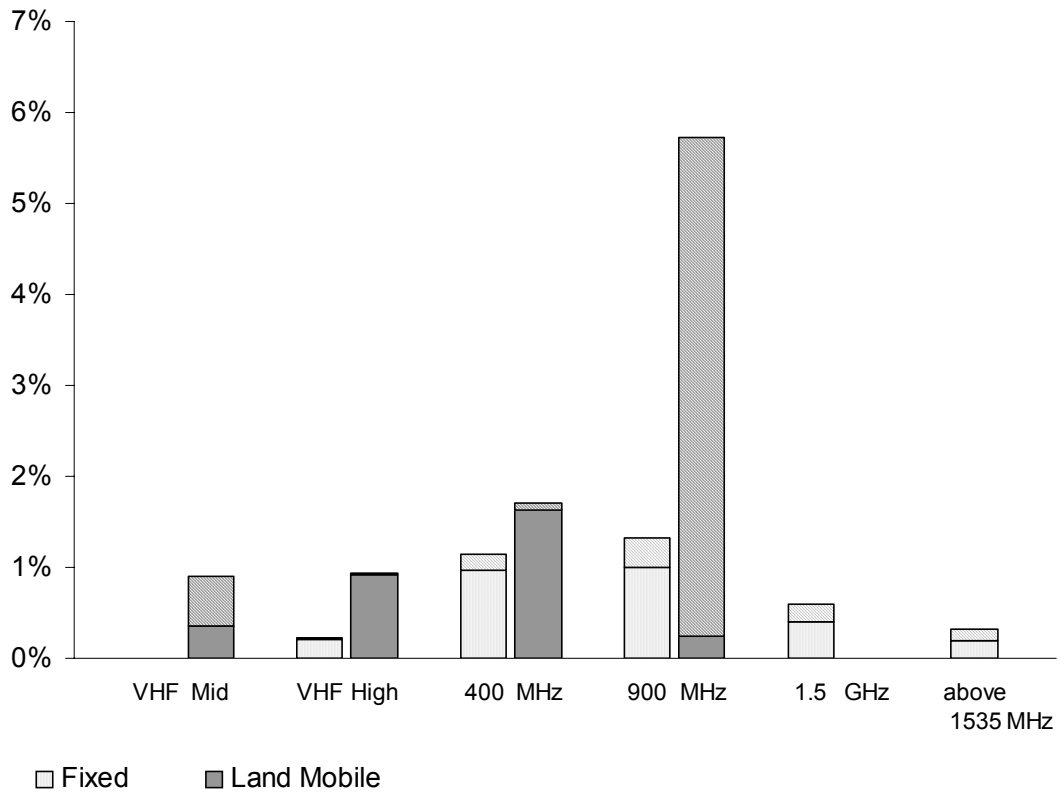

Figure 3: Turnover of fixed and land mobile licences

The very high fraction for land mobile trades in the 900 MHz Band in 2007 is driven by the transfer of over 300 licences from Ericsson to Tasmania Police in July 2007.[35] Also, in July 2006, 474 licences, predominantly fixed above 1.5 GHz, and land mobile in the VHF Mid Band and the 400 MHz Band, were transferred from Western

[35] It is understood that the EDACS network which had been supplied by Ericsson was transferred to the Tasmanian State government following congestion and supply issues. For more information see www.grn.tas.gov.au/ministers_media_release.

Power when it was disaggregated.[36] If these two significant trades are removed (as shown by hatching), the 400 MHz Band emerges as the most heavily traded band.

5.3.2 FUTHER INITIATIVES TO SUPPORT SECONDARY MARKETS

A well functioning secondary market in spectrum will facilitate spectrum moving to higher value uses over time, in response to changes in technology, consumer preferences, and the competitive position of parties in the market. It may provide an alternative to administrative approaches for reallocating and replanning spectrum.

ACMA provides a public register of licensees. Interested parties can access the Register of Radiocommunications Licences on ACMA's website at www.acma.gov.au to determine what trading has occurred.

ACMA may also consider if additional measures should be taken to support the operation of secondary markets.

10. ACMA seeks comments on factors that affect the operation of the secondary market in the 400 MHz band.

5.4 Opportunities for regional variations in spectrum management arrangements

There are different spectrum management challenges in different geographic areas of Australia. These differences are typically characterised by the high spectrum demand experienced in urban areas such as capital cities (particularly Sydney, Melbourne and increasingly Brisbane) and the lower demand but more challenging coverage environment in rural and remote areas. Consequently, consistent with the draft spectrum management principle of balancing the risk of interference and the cost of regulation, different approaches to spectrum management may be appropriate on a regional basis.

There are a number of existing Australian spectrum management arrangements that reflect geographic differences in the spectrum environment. One significant example is the location dependence of apparatus licences fees, with licences becoming increasingly less expensive away from high spectrum demand areas.[37]

On occasion, spectrum planning arrangements have been developed that reflect the different requirements and opportunities in areas with lower spectrum demand. A good example of such arrangements is the apparatus licensing arrangements for regional/rural broadband wireless access in the 5.8 GHz band.[38]

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[36] In 2006, Western Power was disaggregated into four bodies: the Electricity Networks Corporation, the Electricity Generation Corporation, the Electricity Retail Corporation and the Regional Power Corporation. Licences held by Western Power were transferred to three of the four new bodies.

[37] The Apparatus Licence Fee Schedule is available on ACMA's website at www.acma.gov.au/WEB/STANDARD/pc=PC_1614.

[38] More information about these arrangements is available on ACMA's website at www.acma.gov.au/WEB/STANDARD/pc=PC_2626.

These arrangements acknowledged the opportunity to permit higher powered low cost point-to-point arrangements in rural and regional areas without significantly impacting on the various short-range communications systems authorised in the band under class licence arrangements. Such arrangements were considered feasible due to the generally lower spectrum use of the class licensed bands in regional and rural areas when compared to urbanised areas. This general concept may have some relevance in developing options for future arrangements in the 400 MHz band.

There may also be opportunities for changes to spectrum management arrangements to be phased in over different timeframes depending on geographic location. For instance, many of the most pressing issues in the 400 MHz band are currently limited to high population areas such as Sydney and Melbourne. It might be prudent for some replanning or licensing options (particularly those more difficult or expensive) to be introduced in these areas before the lower population areas. This may ease the burden on some stakeholders of adjusting to new arrangements (such as purchasing new equipment) while not significantly reducing the efficiency of spectrum allocation and use.

11. ACMA seeks comments on opportunities for regional variations to spectrum management arrangements in the 403–520 MHz band (including planning, licensing and allocation methods).

6 Technical issues

There are a number of options relating to the technical framework for licensing use of the 400 MHz band that are being explored. In broad terms these can be grouped into options related to:

- reduced channel bandwidth and re-packing;
- increased spectrum sharing; and
- facilitating change of use of the spectrum.

Each is discussed below. The options are not mutually exclusive. It may be optimal to pursue some of the options to increase spectrum sharing and options to reduce channel bandwidth and re-pack the spectrum.

6.1 Reduced channel bandwidth and re-packing

Use of analog FM radio equipment requiring 25 kHz channels is well established in the 400 MHz band and has been for many years. Overall, around 70 per cent of the frequency assignments in the 400 MHz band are to systems using 25 kHz or greater bandwidth.

Use of the 400 MHz band is dominated by the land mobile and fixed (point-to-point) services. Table 2 shows the percentage of assignments above and below or equal to 12.5 kHz bandwidth for these service types.

Table 2: Bandwidth percentage – Land Mobile and Fixed (Point-to-Point) Assignments

Bandwidth	Land Mobile (%)	Point-to-Point (%)	Both (%)
≤12.5 kHz	36.9	2.3	28.0
>12.5 kHz	63.1	97.7	72.0

For the land mobile service, 63.1 per cent of frequency assignments are to 25 kHz channels, implying that around this percentage of equipment in use requires a bandwidth of 25 kHz. There appears to be scope to significantly decrease the amount of spectrum used for the land mobile service by moving towards increased use of 12.5 kHz equipment. Land mobile equipment using 12.5 kHz channels is readily available and offers virtually identical performance to 25 kHz equipment.

For the fixed (point-to-point) service, 25 kHz equipment dominates, accounting for 97.7 per cent of assignments. A justification for a 25 kHz (or greater) bandwidth requirement for point-to-point links is to support higher data rates for digital signals.

Table 3 shows the type of emission carried by these links: analog telephony or a digital signal. It shows that 72 per cent carry analog voice and 28 per cent of them carry digital information. The digital systems are potentially unable to move to narrower bandwidths due to data rate requirements. The analog systems, however, have the potential to reduce bandwidth to 12.5 kHz.

Table 3: Breakdown of emission types for land mobile and fixed (point-topoint) assignments

Emission Type	Land Mobile (%)	Point-to-Point (%)
Analog	92.2	71.3
Digital	7.8	28.7

Overall growth in the number of radio systems in congested areas can be achieved by freeing up more spectrum. There appears to be scope for a migration of all land mobile and most fixed (point-to-point) systems from 25 kHz to 12.5 kHz.

A process of 'channel splitting', whereby an occupied 25 kHz channel is converted to two 12.5 kHz channels, may be used to make new channels available.[39] This practice is evident in Sydney and Brisbane where growth in the overall number of land mobile systems operating in accordance with the 400 MHz Plan has occurred despite congestion of the band.[40]

Figure 4 shows spectrum use for land mobile services in south eastern Australia in Segment K of the 400 MHz Plan.[41]

The figure on the left represents the current deployment, where both 12.5 kHz and 25 kHz services are in operation. The figure on the right demonstrates the reduction in licence congestion in the event that all existing 25 kHz services were converted to 12.5 kHz bandwidth.

[39] Although the splitting of 25 kHz channels is not consistent with the 400 MHz plan, accredited persons are able to assign 12.5 kHz services in segments of the band designated for 25 kHz channelling. This is possible because the 400 MHz plan is an administrative band plan, and therefore lacks the statutory obligations associated with Frequency Band Plans.

[40] In Melbourne, growth in the number of assignments in congested parts of the band seems to have been provided by the increased use of low power services.

[41] See Attachment 2 for information on the part of the band referred to as segment K.

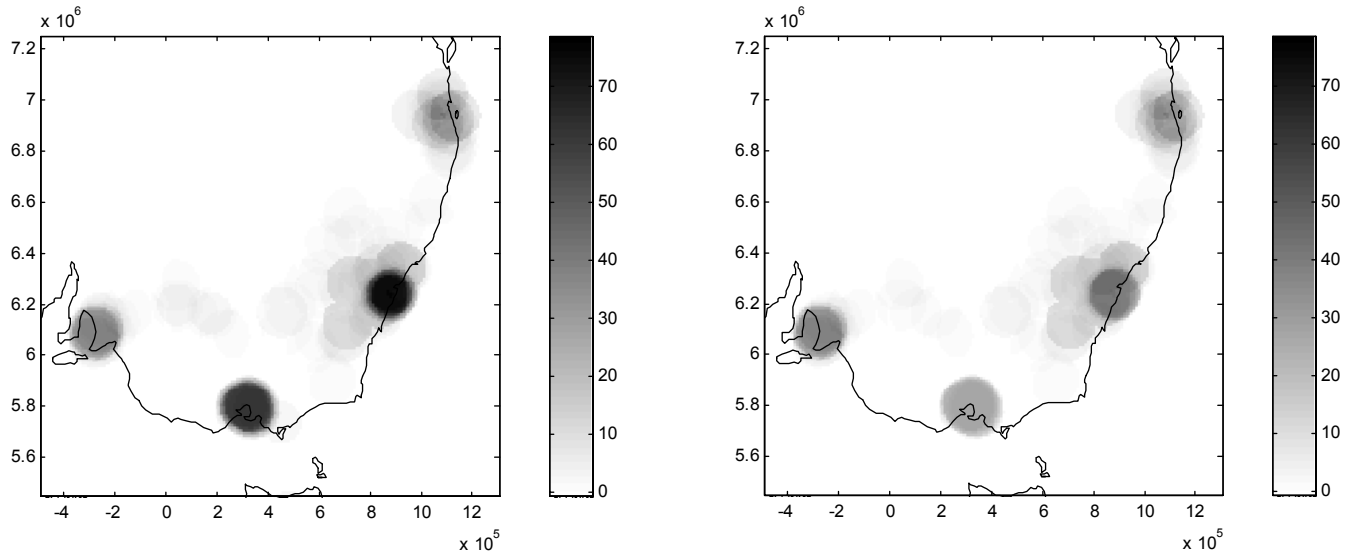

Figure 4: Spectrum use for land mobile services in south eastern Australia in Segment K of the 400 MHz Plan. The vertical shaded scale denotes the number of channels allocated (from zero to all).

12. Information is sought on the issues that a migration to 12.5 kHz systems will raise. What are the costs? How much time would be needed for such a migration?

6.1.1 MIGRATING FROM 25 kHz TO 12.5 kHz

In the replanning processes for the VHF bands that occurred in the 1990s, a strategy of on-channel bandwidth reduction was used to optimise the availability of spectrum while minimising disruption to users (see Figure 5). Licensees using 25 kHz equipment on a particular channel migrate to a 12.5 kHz system on that channel. Base equipment needs to be updated at the time of migration, but mobiles can be incrementally replaced or upgraded. Over time, the spaces between channels open up and other 12.5 kHz assignments can be made. For the VHF land mobile bands this process took around ten years.

ACMA is considering imposing restrictions on the assignment of new frequencies to 25 kHz analog FM systems within the frequency ranges 403–420 MHz and 450–520 MHz. Existing 25 kHz systems would still be able to operate and expand for a limited time, but new analog systems requiring 25 kHz channels would not generally be permitted.

In time, measures would be imposed to create incentives to reduce and possibly to remove 25 kHz analog FM assignments in this spectrum. Such measures could include pricing incentives to encourage users to move from 25 kHz to 12.5 kHz assignments. Alternatively administrative action by ACMA to not renew 25 kHz assignments after a certain date is an option.

A transition from 25 kHz to 12.5 kHz channelling would appear to be a good candidate for a geographically based phased approach where measures to enforce bandwidth reductions are delayed in areas with lower congestion.

13. ACMA seeks comments on the factors that should be taken into account in seeking to reduce and ultimately remove 25 kHz analog FM land mobile equipment from the band.

14. ACMA seeks comments regarding the proposal to migrate to 12.5 kHz assignments.

15. What type of approaches should be considered by ACMA to facilitate migration away from the use of 25 kHz analog FM systems in the 400 MHz band?

Potential options for migration

A number of options are available to support a migration from 25 kHz to 12.5 kHz channels:

- The 'Interleave' method (see Figure 5) which interleaves 12.5 kHz channels with the existing 25 kHz raster. A new 12.5 kHz channel is assigned to the same centre frequency as the current 25 kHz channel. When an adjacent channel is converted to 12.5 kHz, an extra 12.5 kHz channel can be inserted between the two on the 12.5 kHz raster.

  This option would offer a relatively soft migration path for users as the mobile fleet can be upgraded over time. A disadvantage is that additional channels are not available immediately because new channels are only released when two or more adjacent channels become clear.

- The 'Offset' method (Figure 6) which divides a current 25 kHz channel in two so that two 12.5 kHz channels can immediately be inserted with centre frequencies offset by 6.25 kHz to the 25 kHz raster.

  This method would provide simple splitting, but causes more complexity in the channel raster definition as centre frequencies are not reused. Base equipment and mobiles would usually need to be replaced and/or retuned all at once, to avoid interference issues from the adjacent channel. Some accredited persons have advised that they are already using this option occasionally for clients when adjacent channels are not available.

- Another option is for a group of 25 kHz channels to migrate into a block of 12.5 kHz channels (Figure 7), thus freeing up contiguous blocks of spectrum for other purposes.

  This option would require extensive retuning and replacement of equipment as well as a complete re-coordination of systems. The advantage of this approach is that it would create blocks of unencumbered spectrum that could be easily and efficiently re-farmed.

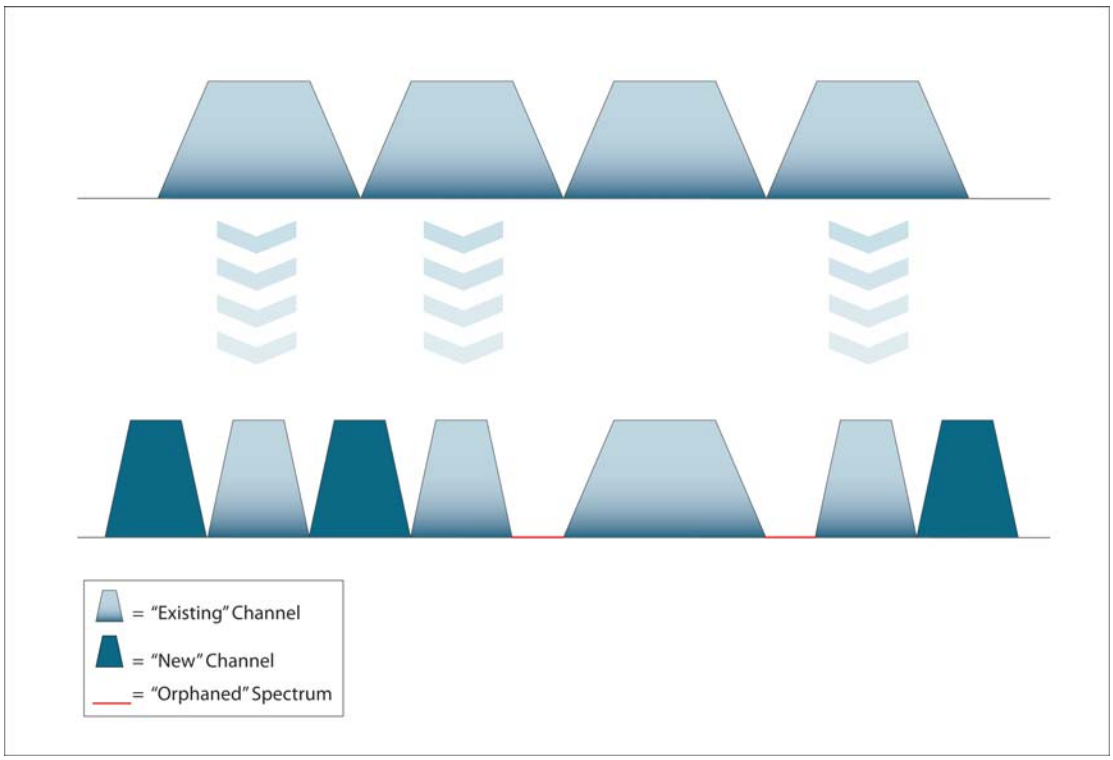

Figure 5: Interleave bandwidth reduction.

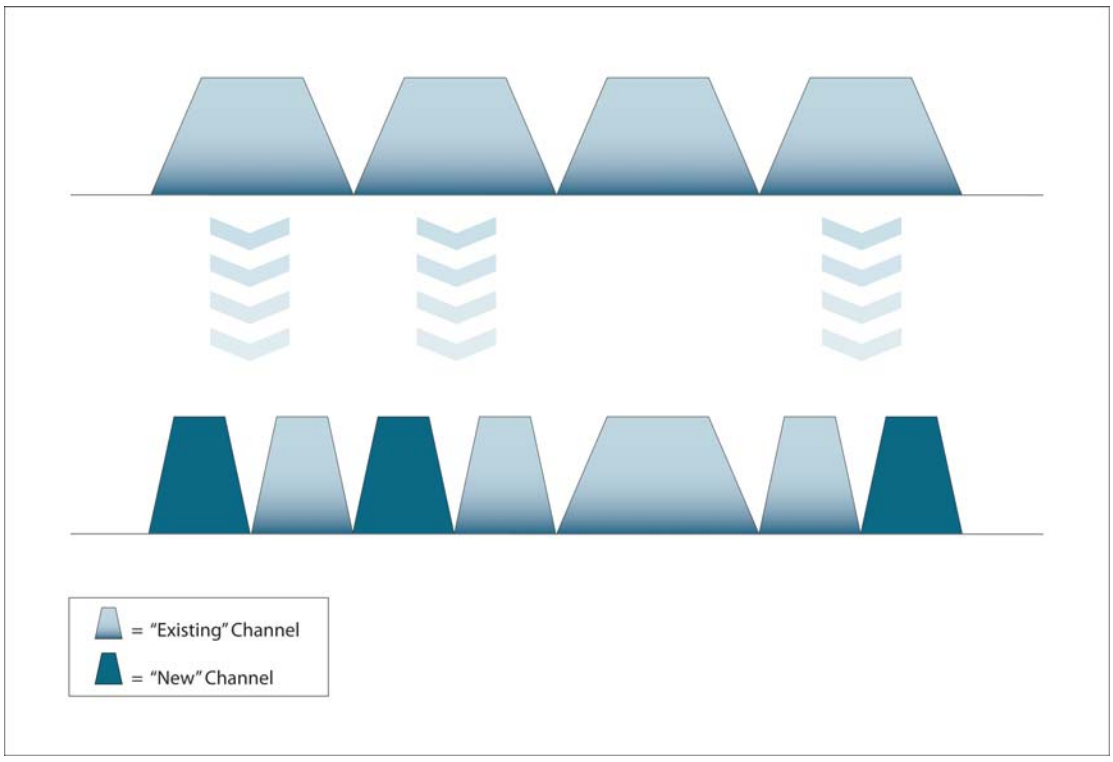

Figure 6: Offset channel bandwidth reduction migration path.

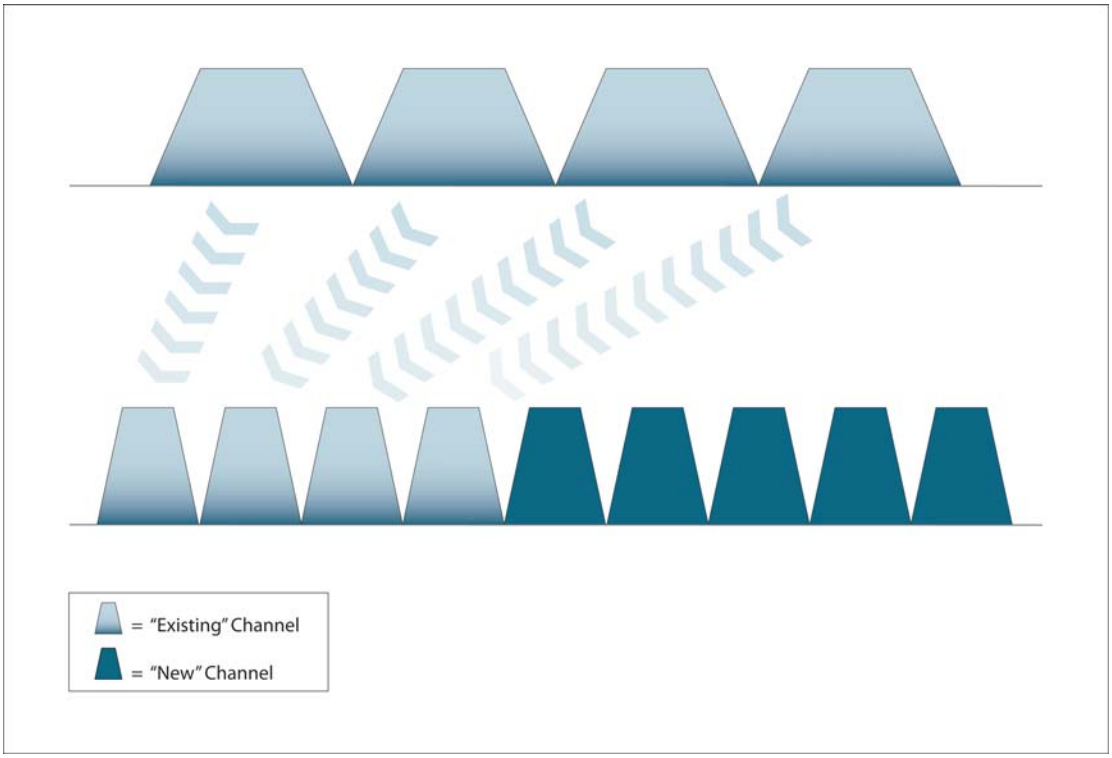

Figure 7: Block channel bandwidth reduction migration path.

16. **If ACMA concludes that a migration to 12.5 kHz operation of 25 kHz analog FM systems within the frequency ranges 403–420 MHz and 450–520 MHz is important to the replanning of this spectrum, what are the implications for stakeholders of the different approaches discussed above?**

17. **What would be the preferred bandwidth reduction migration path if ACMA decided to mandate a migration to 12.5 kHz channelling?**

6.1.2 UHF CITIZEN BAND—INCREASE IN AVAILABLE CHANNELS

The UHF Citizen Band (CB) comprises forty 25 kHz channels. Use of UHF CB is supported by a class licence. Anyone may operate UHF CB equipment provided that operation and the equipment used is in keeping with the conditions of the licence. Users do not have to apply for a licence and no fees are payable by CB radio users.

UHF CB equipment is cheap compared to typical land mobile equipment. Eight repeater channels are available, increasing the potential range of use to tens of kilometres. Australians are enthusiastic users of UHF CB for business and personal purposes. The main disadvantage to users is that no protection from interference is offered and therefore channels may be subject to congestion.

In light of the overall considerations in the band outlined in this paper, including the possibility of a reduction in channel bandwidth elsewhere in the band, it may be desirable to extend this potential bandwidth reduction to UHF CB. The existing 25 kHz channel bandwidth would be reduced to 12.5 kHz via an appropriate migration scheme.

For an environment such as UHF CB, where there is a very large quantity of existing equipment in use, a scheme where the old and new equipment have a degree of compatibility is desirable. This may suggest that the interleave method of yielding more channels could be the most appropriate.[42]

If an 80 channel UHF CB band is to be implemented, ACMA anticipates that there would be a period of time during which existing equipment using 25 kHz bandwidth would be permitted to continue operation, and new 80 channel 12.5 kHz equipment would also be permitted to operate. After the phase-out date only the use of 12.5 kHz channel equipment would be authorised. Use of 25 kHz bandwidth UHF CB equipment would not be supported.

It is acknowledged that arrangements would need to be addressed to preserve the utility of the emergency channels throughout any transitional period.

18. ACMA seeks views on increasing the number of UHF CB channels from 40 to 80 by the implementation of 12.5 kHz channelisation, with a corresponding phase-out of 25 kHz channel equipment.

6.1.3 ACCOMMODATING MORE DIGITAL LAND MOBILE

Overseas trends and research indicate that there will be a significant increase in the use of digital modulation schemes for land mobile equipment in the future. Generally digital land mobile equipment uses the spectrum at least as, and in many cases more, efficiently than analog systems.

There are a number of digital technologies in use by land mobile equipment around the world. TETRA equipment requires an RF channel bandwidth of 25 kHz, but uses Time Division Multiple Access (TDMA) techniques so that up to four communications channels are supported within this bandwidth. TETRA usually employs a frequency split of 10 MHz (with 5, 7 and 8 MHz also part of the TETRA standard for 400 MHz).

APCO equipment is able to support a wide range of frequency splits,[43] with 9 MHz being commonly used in the United States.

Current Australian arrangements effectively prevent the operation of TETRA in the 403–420 MHz and 450–500 MHz ranges as the available frequency splits for duplex operation are not compatible.

19. ACMA seeks comments on the future requirement for digital land mobile operation and ways that ACMA can facilitate greater use of this more spectrally efficient technology.

[42] See discussion above in section 6.1.1 Migrating from 25 kHz channels to 12.5 kHz channels.
[43] For example the Metropolitan Mobile Radio (MMR) network in Victoria is an APCO network employing frequency splits of 4, 5.5, 6 and 9.5 MHz.

6.2 Spectrum sharing

It is becoming increasingly necessary to share spectrum among services and users throughout almost all bands. The emphasis in spectrum management in recent years has turned towards finding ways to share spectrum among competing needs.

There are many examples of successful sharing within the bands of interest. The frequency range 420–430 MHz is shared among the radiolocation, mobile, amateur and fixed services. All these services exist harmoniously within the band. In other parts of the 400 MHz band a single service dominates. Usually it is the land mobile service that sees the greatest use. In the bands where the land mobile service dominates the spectrum, users generally have exclusive access to channels in an area.

6.2.1 TIME-SHARING

One way of sharing spectrum may be to time-share channels between users in a common area. It is often the case that a particular user of a channel does not always need the channel to be available for use except at particular times of the day. For example, a dispatch service does not usually require use of a channel out of business hours, while a security service may require 24 hour availability, and the operator of an entertainment venue may only require channel availability at night. There may be opportunities to take this information into account when assigning frequencies in certain circumstances in an apparatus licence regime.

In addition, users with a light channel usage requirement may comfortably share a channel with a user with a similar requirement, as the times when each user requires a channel rarely coincide. However additional equipment may be required for sharing in two frequency networks.

Spectrum sharing studies would need to be carried out by ACMA to determine the best ways to implement sharing schemes and what economic and other user incentives may be useful in developing such arrangements. Such studies would take into account technical criteria as well as information from spectrum users on the practicalities of sharing the use of a channel.

If time sharing of channels was considered viable, it would be logical to consider pricing incentives to encourage such sharing.

20. Comment is sought on the viability of time-sharing channels and the circumstances under which doing so would improve the productivity (efficient use) of the 400 MHz band.

6.2.2 CHANNEL LOADING

Channel loading for the land mobile service is a measure of how much traffic a channel experiences. It is related to the number of mobiles operating on that channel and the type of traffic. Another way to characterise the loading of a channel is a measure of what percentage of the time the channel is occupied. Optimum use of the spectrum would see any assigned channel experiencing a high degree of loading, as appropriate for the type of use.

In terms of efficient spectrum use, a communication channel would ideally be carrying useful traffic for a high percentage of time, if not continuously. This is not always an appropriate measure of usage efficiency though, as for some uses (for example defence, emergency services) a channel may generally see light use, but when the channel is required it must be available. A workable definition for efficient channel 'use' must have regard to the type of use.

In the UK the number of channels assigned for a particular licence in the land mobile service is determined by the assumed, and sometimes measured, traffic load. It is assumed that a channel is fully loaded within an area when the number of mobiles exceeds 150 for voice and 350 for data.[44]

The Canadian spectrum regulator, Industry Canada, employs a similar system for channel assignment, based on channel loading and a measure of message delay.[45]

In Australia there are no traffic level requirements for channels allocated for the land mobile service, except for trunking systems.[46] There is, however, an expectation by ACMA that an assigned channel will be used effectively.

21. ACMA seeks views on whether it may be desirable to prescribe minimum channel loading requirements in some or all parts of the 403–520 MHz band, to foster appropriate usage rates of spectrum. What channel loading levels would be considered appropriate? Because some uses (or users) require high channel availability and do not necessarily consistently use a channel to high capacity, what criteria could be used to quantify and assess efficient channel use?

6.2.3 ASSIGNMENT AND COORDINATION RULES

ACMA generally develops assignment and coordination rules (outlined in RALIs) to support the administrative allocation of apparatus licences. As mentioned earlier in this paper, while having served Australia well in the past, this method is based on a one-size-fits-all approach which arguably may not encourage the most efficient use of the spectrum.

For example, the current frequency assignment requirements for the land mobile service given in RALI LM8 are based on only two service models—one for large coverage applications and the other for small coverage applications. The large coverage model provides for a 40 km notional service radius, with a reuse distance of 100 km for two-frequency systems and a 140 km reuse distance for single-frequency systems. The small coverage model provides for a 2 km notional service radius and a 10 km reuse distance.

There may be opportunities for changes to the existing assignment and coordination rules currently in place to increase the efficiency of spectrum use in the band.

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[44] Ofcom, *Of 164: Business Radio Technical Frequency Assignment Criteria*.
[45] Industry Canada. *GL-04 - Channel Loading Guidelines*, available online at http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/sf08015e.html.
[46] RALI LM3: Trunked Land Mobile Services.

ACMA seeks general comment from stakeholders on its assignment and coordination rules used in 403–520 MHz and how these rules might be changed to facilitate better use of spectrum under an apparatus licensing regime.

22. Comment is sought on ways that ACMA's apparatus licence assignment and coordination rules could be changed to facilitate better use of 403–520 MHz.

6.2.4 THE TWO FREQUENCY FIXED POINT-TO-MULTIPOINT SERVICE

The two frequency point-to-multipoint service is typically a digital or analog radiocommunication system in which a single central master station communicates with a number of outlying remote fixed stations. The predominant use of this service is for data transmission. Typical applications include telemetry, supervisory control and data acquisition (SCADA) systems, computer networking and alarm systems. These systems typically exhibit high channel occupancy.

For interference management purposes the notional service area is defined by a circle of 30 km radius around the master station. A minimum separation distance of 100 km is required before a master station can reuse the channel.

The master station may also be wired as a repeater, with outlying remote control stations operating in the remote frequency configuration and communicating with remote stations via the master station.

In response to demand for more spectrum for two frequency 400 MHz point-to-multipoint systems, the 400 MHz Plan was modified in 2002 to provide greater opportunities for point-to-multipoint applications in segments allocated for land mobile use.

Trends in frequencies assigned to this service indicate strong growth and a high demand for this service type.

Simplified licensing arrangements for 12.5 and 25 kHz point-to-multipoint service use

Currently 400 MHz Plan paired segments B/J, Q/U and R/V are used exclusively for two frequency 12.5 and 25 kHz point-to-point and point-to-multipoint services.[47] Other segments used for the land mobile service are also available for the two frequency point-to-multipoint service.

Under current apparatus licensing arrangements these systems have exclusive access to a channel in an area. However, point-to-multipoint applications should generally be able to adequately operate with non-exclusive access to spectrum, as they can tolerate widely varying access delays, are resilient to interference and can share spectrum with minimal penalty.

[47] Attachment 2 contains the 400 MHz band arrangements and shows the concept of two frequency paired spectrum.

This spectrum could be made available without protection from interference, or on a user-coordinated basis:

- The no-protection option is attractive to the user in that it provides the greatest degree of flexibility and ease of operation. Users would simply find a channel with sufficient availability and operate on it. Use of coding schemes to avoid data collisions would be desirable, and a duty cycle limit may need to be prescribed to allow other users reasonable access to a channel.
- The user-coordination option would require a publicly accessible register to be kept of users of this spectrum: system managers would need to apply a simple coordination procedure to find a frequency and would be responsible for entering details of their devices in the register to receive protection from interference.

In this context, the following question takes into account:

- the demand for spectrum in the 400 MHz band for two frequency point-to-multipoint systems;
- the fact that these systems currently have exclusive access to a channel in an area; and
- that these systems can usually share spectrum with minimal penalty.

23. ACMA seeks comments on the possibility of identifying parts of the 400 MHz band for point-to-multipoint applications authorised under a class licensed, 'public park' scheme. If such spectrum was made available would the 'uncoordinated, no-protection' or 'user coordinated' options be preferred?

6.2.5 FREQUENCY SPLITS (DUPLEX OPERATION) AND SITE SENSE

The transmit to receive frequency separation or 'split' and site sense specified in a band plan is set to maximise the utility of a band through minimising site interference issues and intermodulation interference.

Currently the 400 MHz band identifies transmit/receive frequency splits of 5.2 MHz, 9.45 MHz, 9.5 MHz and 10 MHz for two frequency operation. Most, but not all, equipment supports these frequency splits. Some digital technologies specify or have a preference for other frequency splits.

Changes in overall frequency usage may also lead to consideration of additional transmit/receive frequency splits to accommodate new technologies and facilitate more efficient use of spectrum.

Site sense refers to whether the base transmit frequency is above or below the base receive frequency. Prudent band planning sees base transmit frequency segments being separated from base receive frequency segments, thereby requiring the use of both transmit high and transmit low sense. Analog FM equipment almost universally supports either sense: some digital equipment may have a preference for a particular site sense.

24. Noting the relationships between transmit/receive frequency split, site sense and efficient use of spectrum, comment is sought on preferred frequency splits and site sense for various equipment types and technologies.

6.2.6 SINGLE FREQUENCY OPERATION

There are several single frequency segments in the 400 MHz Plan, containing around 12,700 land mobile assignments. These assignments are for either high (83 W EIRP) or low power (8.3 W EIRP) mobile services, with 40 km and 2 km service area radii respectively. Almost all single frequency assignments (97 per cent) are to low power services, reflecting the large use of portable handsets and low power bases for short range (maximum of 1–2 km) communications in these segments. The remaining 3 per cent are for high power wide area single frequency communications.

Single frequency land mobile systems are typically used for communications within small to medium sized sites, such as shopping centres, resorts and building sites. Figure 8 shows the service model for low power systems as provided by RALI LM8.

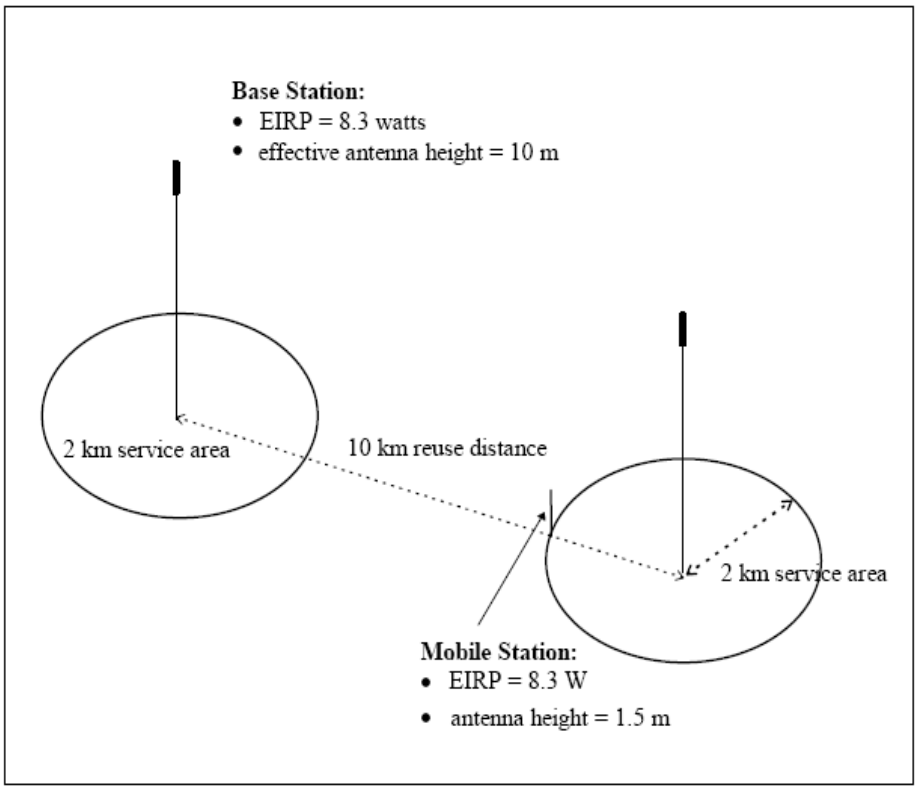


Figure 8: Low-power land mobile radio system service model as given in RALI LM8.

It is ACMA policy to discourage the use of high power single frequency systems as their presence at a communications site typically denies the use of 30 adjacent channels at that site. Given the nature of the typical use of single frequency systems ACMA is considering whether it is unreasonable to adjust this policy to permit the use of low power single frequency systems only or restrict single-frequency high powered

systems to remote areas or very uncongested sites. Normally, two frequency working is more suited to operations where a large coverage area is required.

25. ACMA seeks comments on the issues associated with restricting high power single frequency systems and any issues arising from ACMA permitting the use of only low power for these systems in the 400 MHz band.

It may also be desirable to provide 'public park' spectrum for low power single frequency systems where individual licensing of systems would not be required. This spectrum could be made available without protection from interference, or on a user-coordinated basis as described for point-to-multipoint services earlier in this paper.

26. ACMA seeks comments on the option of identifying parts of the 400 MHz band for low power single frequency applications under a class licence.

6.3 Facilitating change of use

6.3.1 GREATER USE OF 440–450 MHz BY THE LAND MOBILE SERVICE

Currently the 440–450 MHz band is allocated to the radiolocation service on a primary basis, and the amateur, fixed and mobile services on a secondary basis. The radiolocation, fixed and mobile allocations are accompanied by an AUS11 footnote identifying that the service is intended to be used principally for the purposes of defence. Most frequency assignments in the band are to the amateur service.

The current level of defence use of the band, particularly of the primary radiolocation service is not well understood by ACMA. Further information on existing and potential defence use of the band needs to be collected prior to detailed consideration of expanded land mobile use of the band.

Despite the need for further detailed information and consideration of existing and potential defence use of the band, the extended use of the band by the land mobile service and its impact on the amateur service has been considered to some extent in the past, and can be commented on in this paper.

Spectrum in the 440–450 MHz range has been used for the mobile service on a temporary basis for events such as the Melbourne Commonwealth Games and Formula 1 Grand Prix. Sharing of this spectrum with the amateur service has been achieved by removing authorisation for amateur use of this spectrum in the relevant location for a particular time period. This arrangement has worked well in the past.

It is difficult to gauge usage of spectrum by amateur radio operators because their licence supports more or less unfettered usage of amateur allocations on an uncoordinated basis. Many amateur stations are mobile. Nonetheless devices such as amateur repeaters and links are authorised for use at fixed locations by an apparatus licence, and records of these are kept by ACMA. Currently there are around 578 spectrum accesses in the 430–440 MHz band and 222 in the 440–450 MHz band. In

comparison, there are around 15,700 frequency assignments in the segment 450–460 MHz (the adjacent 10 MHz), mainly for the land mobile service.

Examination of the amateur licences for repeaters and links shows that while demand continues to grow among amateur users in the broader 420–450 MHz band, there is significantly less growth in these licence numbers in the 440–450 MHz segment. Examination of the amateur band plan developed by the Wireless Institute of Australia[48] shows that 440–450 MHz is used for repeater links and amateur television, and not for general repeater use.

ACMA acknowledges the value of the amateur service in promoting self training, intercommunication and technical investigations and its role in providing backup emergency communications at times. Nevertheless the demand for spectrum for the land mobile service is significant and may be a more efficient use of this spectrum. For this reason, increased use of the 440–450 MHz range by non-defence land mobile systems is under consideration.

Greater use of this segment for the land mobile service would mean the exclusion of amateur use in areas where land mobile systems are operated, in a similar way to the 420–430 MHz band, where government land mobile use is dominant.

27. ACMA seeks information on the existing and potential defence uses of the 440–450 MHz band.

28. ACMA seeks comments on the possibility of opening up some or all of the 440–450 MHz band for greater use by the land mobile service for purposes other than defence.

6.3.2 INCREASED AVAILABILITY OF SPECTRUM FOR TRUNKED RADIO NETWORKS

Trunking techniques were first used by switched telephone networks to make better use of the limited capacity of lines between telephone exchanges. The same principle of sharing a communications channel between multiple users can also be applied to radiocommunications.

The first trunked mobile radio communication systems were deployed in the 1970s in North America with proprietary signalling protocols and shortly afterwards in Europe using analog MPT1327 technology. Various trunking systems are in use today.

From ACMA's perspective, the main benefit of trunking is spectrum efficiency, or more radio users per spectrum channel compared with a conventional channel. Trunking offers users a range of benefits over conventional land mobile, as is outlined in below.

Table 4: Conventional and trunked land mobile use comparison[49]

Conventional Land Mobile	Trunked Land Mobile

[48] The Wireless Institute of Australia is a peak body representing all amateur radio operators in Australia.

[49] Information sourced from the TETRA MOU website at www.tetramou.com/tetramou.aspx?id=2552.

Contention	All call requests are handled on the control channel for immediate call processing or in order of queue priority if the system is busy.
Manual Switching of Channels	Automatic cell handover takes away the need for manual channel selection, supporting geographical mobility and frequency re-use.
Inefficient Channel Utilisation	The automatic and dynamic assignment of a small number of communication channels shared amongst a relatively large number of users ensures an equal grade of service for all radio users on the system.
	Efficient use of shared communications facilities
Lack of Privacy	The dynamic and random allocation of channels makes it more difficult for a casual eavesdropper to monitor conversations.
Radio User Abuse	Abuse is minimised as the identity of all radio users and the time and duration of messages are known and can therefore be easily traced to the abuser.

ACMA supports the deployment of trunking systems as their use leads to efficient use of the spectrum.

Currently the 400 MHz Plan specifies one paired segment (E-M) for trunked radio networks and in terms of the density of frequency assignments it is heavily used. While other segments used by conventional systems are also available for trunking, the presence of conventional land mobile systems makes it difficult to deploy trunking systems in these segments as trunking systems operate best using particular configurations of channels. Trunking is also supported in the 420–430 MHz band.

29. ACMA seeks views on levels of congestion experienced in land mobile systems.

30. If more spectrum was dedicated for use by trunked radio networks, would users consider moving to a trunked system?

6.3.3 CELLULAR MOBILE SYSTEMS IN THE 400 MHz BAND

WRC-07 identified the 450–470 MHz band for use by administrations wishing to implement International Mobile Telecommunications (IMT). The IMT standards family includes IMT-2000 (current generation digital cellular mobile telephone systems) and IMT-Advanced (emerging‘ 4G’ and future systems).[50] The global IMT identification can be expected to stimulate the development of harmonised wireless access products for the 450–470 MHz band, particularly suited to rural and remote areas.

In Australia, there has been sporadic interest in use of segments of the 400 MHz band for cellular mobile systems, mainly to service regional and rural markets. Limited trials, authorised by Scientific Apparatus licences, of systems for monitoring and control applications (but not public telecommunications services) are currently underway.

One current IMT technology capable of operation in the 400 MHz band is CDMA450. CDMA450 has the same spectral efficiency and data capabilities as the CDMA2000 system, with the advantages provided by the propagation characteristics of the

[50] Domestically IMT is generally considered as part of broader wireless access services.

400 MHz band including greater range (larger cell sizes) and better in-building coverage. Such a system has advantages particularly in remote areas.

In Europe around 28 countries have deployed CDMA450 networks in the 452.5–457.475 and 462.5–467.475 MHz frequency range. In the Asia-Pacific region around ten countries have operational CDMA450 networks.

31. ACMA seeks comment on the possibility of making spectrum available in the 450–470 MHz band for wireless access services.

7 Summary

This paper prompts discussion on a number of issues relating to use of the spectrum between 403 and 520 MHz. Comment is sought on the issues raised in this paper, which are outlined below, and any others considered relevant. Responses to this paper will be used to develop detailed strategies for future use of this spectrum with public discussion paper(s) being released at a later date seeking comment on the strategies and options.

7.1 Issues for comment

1. **ACMA seeks comments on the extent to which other spectrum can be regarded as a close substitute for spectrum in the 400 MHz bands.**
2. **ACMA seeks comments on the extent to which other services provide a functional alternative to services provided using the 400 MHz band.**
3. **Comment is sought on the possibility of making spectrum available in the 403–420 MHz band for government use only.**
4. **When combined with the existing 420–430 MHz government band, government land mobile use could be consolidated in the band 403-430 MHz. Are there alternative parts of the 400 MHz band that offer advantages for consolidated government land mobile operations?**
5. **Comment is sought on the rights a spectrum management regime should retain to authorise spectrum use in bands identified for government use.**
6. **ACMA seeks comments on issues with phasing out the current LEPS and CT spectrum, and accommodating this requirement within spectrum specifically identified for government users.**
7. **Comment is sought on approaches to licensing spectrum use that would result in more efficient use of the 400 MHz band.**
8. **ACMA seeks views on the arrangements for the spectrum licences in the upper 400 MHz band including comments on the possibility of alternative arrangements such as altering the bandwidth, the technical framework or the licence type.**

9. **ACMA seeks comment on the expected cost to users of the 400 MHz band of providing the same service with less spectrum (e.g., 12.5 kHz rather than 25 kHz channels).**

10. **ACMA seeks comments on factors that affect the operation of the secondary market in the 400 MHz band.**

11. **ACMA seeks comments on opportunities for regional variations to spectrum management arrangements in the 403–520 MHz band (including planning, licensing and allocation methods).**

12. **Information is sought on the issues that a migration to 12.5 kHz systems will raise. What are the costs? How much time would be needed for such a migration?**

13. **ACMA seeks comments on the factors that should be taken into account in seeking to reduce and ultimately remove 25 kHz analog FM land mobile equipment from the band.**

14. **ACMA seeks comments regarding the proposal to migrate to 12.5 kHz assignments.**

15. **What type of approaches should be considered by ACMA to facilitate migration away from the use of 25 kHz analog FM systems in the 400 MHz band?**

16. **If ACMA concludes that a migration to 12.5 kHz operation of 25 kHz analog FM systems within the frequency ranges 403–420 MHz and 450–520 MHz is important to the replanning of this spectrum, what are the implications for stakeholders of the different approaches discussed above?**

17. **What would be the preferred bandwidth reduction migration path if ACMA decided to mandate a migration to 12.5 kHz channelling?**

18. **ACMA seeks views on increasing the number of UHF CB channels from 40 to 80 by the implementation of 12.5 kHz channelisation, with a corresponding phase-out of 25 kHz channel equipment.**

19. **ACMA seeks comments on the future requirement for digital land mobile operation and ways that ACMA can facilitate greater use of this more spectrally efficient technology.**

20. **Comment is sought on the viability of time-sharing channels and the circumstances under which doing so would improve the productivity (efficient use) of the 400 MHz band.**

21. **ACMA seeks views on whether it may be desirable to prescribe minimum channel loading requirements in some or all parts of the 403–520 MHz band, to foster appropriate usage rates of spectrum. What channel**

loading levels would be considered appropriate? Because some uses (or users) require high channel availability and do not necessarily consistently use a channel to high capacity, what criteria could be used to quantify and assess efficient channel use?

22. **Comment is sought on ways that ACMA's apparatus licence assignment and coordination rules could be changed to facilitate better use of 403–520 MHz.**

23. **ACMA seeks comments on the possibility of identifying parts of the 400 MHz band for point-to-multipoint applications authorised under a class licensed, 'public park' scheme. If such spectrum was made available would the 'uncoordinated, no-protection' or 'user coordinated' options be preferred?**

24. **Noting the relationships between transmit/receive frequency split, site sense and efficient use of spectrum, comment is sought on preferred frequency splits and site sense for various equipment types and technologies.**

25. **ACMA seeks comments on the issues associated with restricting high power single frequency systems and any issues arising from ACMA permitting the use of only low power for these systems in the 400 MHz Band.**

26. **ACMA seeks comments on the option of identifying parts of the 400 MHz band for low power single frequency applications under a class licence.**

27. **ACMA seeks information on the existing and potential defence uses of the 440–450 MHz band.**

28. **ACMA seeks comments on the possibility of opening up some or all of the 440–450 MHz band for greater use by the land mobile service for purposes other than defence.**

29. **ACMA seeks views on levels of congestion experienced in land mobile systems.**

30. **If more spectrum was dedicated for use by trunked radio networks, would users consider moving to a trunked system?**

31. **ACMA seeks comment on the possibility of making spectrum available in the 450–470 MHz band for wireless access services.**

Submissions on the issues raised in this discussion paper may be made to the Australian Communications and Media Authority (ACMA) as follows:

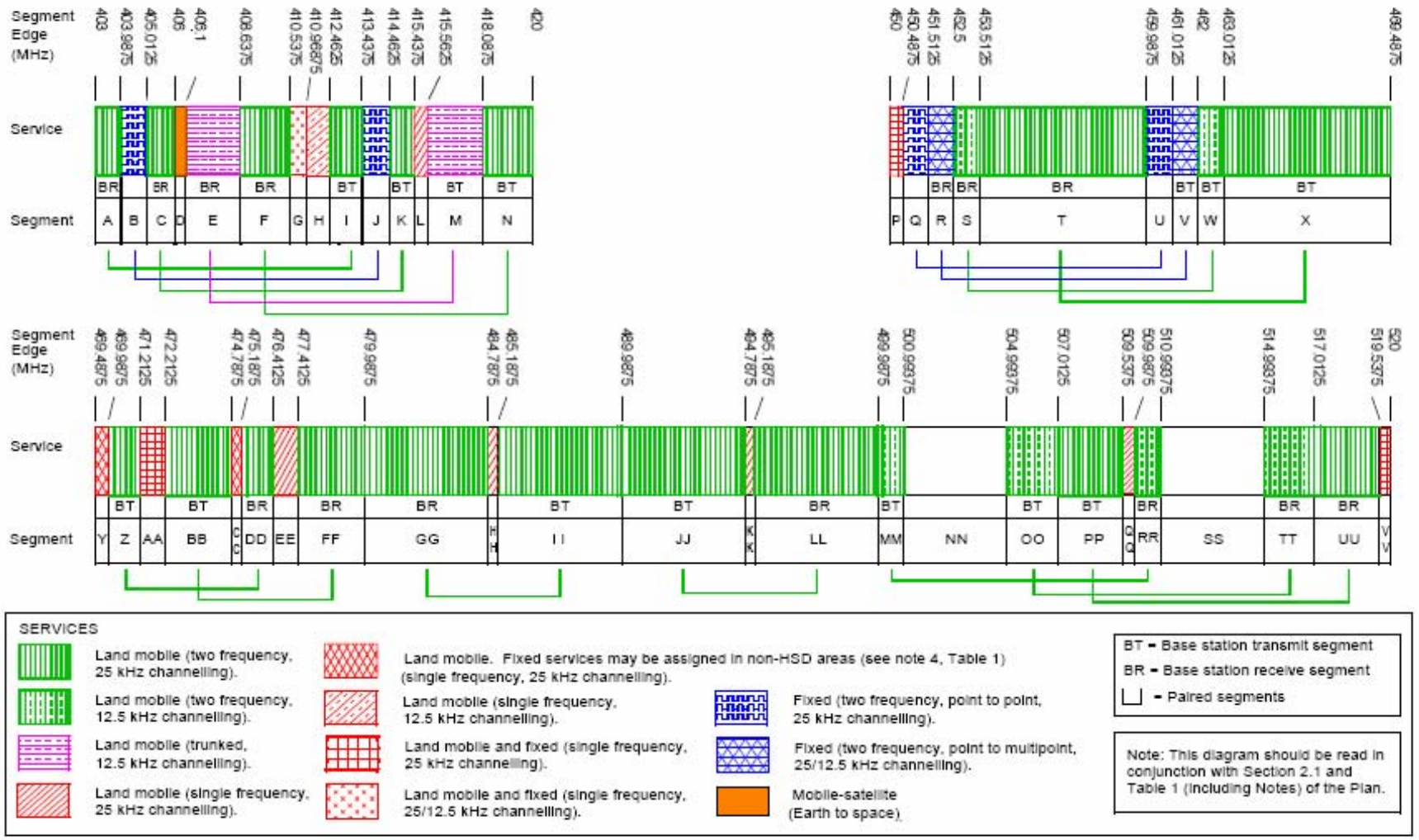
By email: freqplan@acma.gov.au

By mail: Mr Christopher Hose
Manager
Government Planning Section
Australian Communications and Media Authority
PO Box 78
Belconnen ACT 2616

Electronic submissions in Microsoft Word or rich text format are preferred.

If you have any questions or would like to discuss any matter covered in this discussion paper, contact Andrew Stewart on 02 6219 5238 or email andrew.stewart@acma.gov.au.

Attachment 1—400 MHz Plan Narrowband Services Diagram



Attachment 2—Australian Radiofrequency Spectrum Plan 420–450 MHz

Column 1: ITU Radio Regulations Table of Allocations			**Column 2:**
Region 1	Region 2	Region 3	Australian Table of Allocations
420 – 430 FIXED MOBILE except aeronautical mobile Radiolocation 269 270 271			**420 – 430** RADIOLOCATION AUS11 MOBILE AUS91 Amateur Fixed AUS94
430 – 432 AMATEUR RADIOLOCATION 271 272 273 274 275 276 277	**430 – 432** RADIOLOCATION Amateur 271 276 277 278 279		**430 – 432** RADIOLOCATION AUS11 Amateur AUS95
432 – 438 AMATEUR RADIOLOCATION Earth exploration-satellite (active) 279A 138 271 272 276 277 280 281 282	**432 – 438** RADIOLOCATION Amateur Earth exploration-satellite (active) 279A 271 276 277 278 279 281 282		**432 – 438** RADIOLOCATION AUS11 Amateur Earth exploration-satellite (active) 279A 282 AUS95
438 – 440 AMATEUR RADIOLOCATION 271 273 274 275 276 277 283	**438 – 440** RADIOLOCATION Amateur 271 276 277 278 279		**438 – 440** RADIOLOCATION AUS11 Amateur AUS95
440 – 450 FIXED MOBILE except aeronautical mobile Radiolocation 269 270 271 284 285 286			**440 – 450** RADIOLOCATION AUS11 AUS90 Amateur Fixed AUS11 Mobile AUS11 286

AUS11 This service is intended to be used principally for the purposes of defence. The Department of Defence is normally consulted in considering non-defence use of this service.
AUS90 In consideration of Resolution **217 (WRC-97)**, the use by wind profiler radars is confined to the sub-bands 448 - 450 MHz and 1 270 - 1 295 MHz.
AUS91 Use of the mobile service is limited to Australian, State and Territory Government purposes. The Department of Defence is normally consulted in considering non-defence use of this service.
AUS94 The following bands are intended to be used principally for the purposes of defence:
420.75 - 421.25 MHz, 424.75 - 425.25 MHz and 427.75 - 428.25 MHz.
The Department of Defence is normally consulted in considering non-defence use of these bands.
AUS95 This band may be used by stations of the fixed and mobile services for the purposes of defence on condition that harmful interference is not caused to stations of other services allocated in this band.

Attachment 3—European spectrum arrangements

FREQUENCY BAND	ALLOCATIONS	APPLICATIONS
380.0 - 385.0 MHz	MOBILE	Defence systems (335.4 - 399.9 MHz) DMO (380.0 - 380.15 MHz) Emergency services AGA communications (civil) (384.8 - 385.0 MHz)
385.0 - 387.0 MHz	MOBILE	Defence systems (335.4 - 399.9 MHz) PMR/PAMR (385.0 - 390.0 MHz)
387.0 - 390.0 MHz	MOBILE	Defence systems (335.4 - 399.9 MHz) PMR/PAMR (385.0 - 390.0 MHz)
390.0 - 395.0 MHz	MOBILE	Defence systems (335.4 - 399.9 MHz) DMO (390.0 - 390.15 MHz) Emergency services AGA communications (civil) (394.8 - 395.0 MHz)
395.0 - 399.9 MHz	MOBILE	Defence systems (335.4 - 399.9 MHz) PMR/PAMR
399.9 - 400.05 MHz	MOBILE-SATELLITE (Earth-to-space) RADIONAVIGATION-SATELLITE	
400.05 - 400.15 MHz	STANDARD FREQUENCY AND TIME SIGNAL-SATELLITE	
400.15 - 401.0 MHz	METEOROLOGICAL-SATELLITE (Earth-to-space) METEOROLOGICAL AIDS MOBILE-SATELLITE (space-to-Earth) SPACE OPERATION (space-to-Earth) SPACE RESEARCH (space-to-Earth)	MSS Earth stations Sondes
401.0 - 402.0 MHz	EARTH EXPLORATION-SATELLITE (Earth-to-space) METEOROLOGICAL-SATELLITE (Earth-to-space) METEOROLOGICAL AIDS	Sondes Weather satellites
402.0 - 403.0 MHz	EARTH EXPLORATION-SATELLITE (Earth-to-space) METEOROLOGICAL-SATELLITE (Earth-to-space) METEOROLOGICAL AIDS	Sondes Weather satellites Medical implants (402.0 - 405.0 MHz)
403.0 - 406.0 MHz	METEOROLOGICAL AIDS	Medical implants (402.0 - 405.0 MHz) Sondes
406.0 - 406.1 MHz	MOBILE-SATELLITE (Earth-to-space)	EPIRBs
406.1 - 410.0 MHz	LAND MOBILE RADIO ASTRONOMY	Radio astronomy PMR/PAMR (406.1 - 430.0 MHz)
410.0 - 420.0 MHz	MOBILE except aeronautical mobile	PMR/PAMR (406.1 - 430.0 MHz)
420.0 - 430.0 MHz	MOBILE except aeronautical mobile Radiolocation	PMR/PAMR (406.1 - 430.0 MHz)
430.0 - 433.05 MHz	AMATEUR	Amateur (430.0 - 440.0 MHz)

	RADIOLOCATION	
433.05 - 434.79 MHz	AMATEUR RADIOLOCATION Land Mobile	Amateur (430.0 - 440.0 MHz) ISM Non-specific SRDs
434.79 - 438.0 MHz	AMATEUR AMATEUR-SATELLITE RADIOLOCATION	Amateur (430.0 - 440.0 MHz) Amateur-satellite (435.0 - 438.0 MHz)
438.0 - 440.0 MHz	AMATEUR RADIOLOCATION	Amateur (430.0 - 440.0 MHz)
440.0 - 450.0 MHz	MOBILE except aeronautical mobile Radiolocation	On-site paging (440.0 - 470.0 MHz) PMR/PAMR (440.0 - 470.0 MHz) DMO (445.2 - 445.3 MHz) PMR 446 (446.0 - 446.1 MHz) PMR 446 (446.1 - 446.2 MHz)
450.0 - 455.0 MHz	MOBILE	On-site paging (440.0 - 470.0 MHz) PMR/PAMR (440.0 - 470.0 MHz) Analog cellular (450.0 - 460.0 MHz)
455.0 - 456.0 MHz	MOBILE	On-site paging (440.0 - 470.0 MHz) PMR/PAMR (440.0 - 470.0 MHz) Analog cellular (450.0 - 460.0 MHz)
456.0 - 459.0 MHz	MOBILE	On-site paging (440.0 - 470.0 MHz) PMR/PAMR (440.0 - 470.0 MHz) Analog cellular (450.0 - 460.0 MHz) On-board communications (457.525 - 457.575 MHz)
459.0 - 460.0 MHz	MOBILE	On-site paging (440.0 - 470.0 MHz) PMR/PAMR (440.0 - 470.0 MHz) Analog cellular (450.0 - 460.0 MHz)
460.0 - 470.0 MHz	MOBILE	On-site paging (440.0 - 470.0 MHz) PMR/PAMR (440.0 - 470.0 MHz) Analog cellular On-board communications (467.525 - 467.575 MHz)
470.0 - 608.0 MHz	BROADCASTING Mobile	SAP/SAB and ENG/OB Broadcasting (terrestrial) (470.0 - 862.0 MHz) Radio Microphones (470.0 - 862.0 MHz)

Attachment 4—Terms of reference for the Independent Review of Government Spectrum Holdings

1. Identify the major government spectrum holdings below 31 GHz.

For the purposes of the Review:

- Government means the Australian Government and the governments of the states and mainland territories, including the business enterprises of those governments. Spectrum holdings of local governments, governments of offshore territories, Telstra or National Broadcasters are not within the scope of the Review

- Holdings include all mechanisms by which spectrum is formally reserved, allocated, licensed or otherwise identified or made available for Government use. Holdings may be set out in statutory instruments such as spectrum plans and frequency band plans, in administrative instruments such as Radiocommunications Assignment and Licensing Instructions (RALIs) or by radiocommunications licences;

2. Describe both actual and potential uses of major Government spectrum holdings through:

- An audit of current use by Government of major spectrum holdings;
- A survey of expected use by Government of major spectrum holdings; and
- An examination of both existing and potential demand for non-government use of major spectrum holdings.

3. Identify major spectrum holdings for which existing or potential demand indicates that the overall public benefit could be maximised by:

- Making all or part of the holding available for non-government use, including:
  - proposals for the clearance or reallocation of spectrum; or
  - Identifying increased sharing opportunities and arrangements in current government spectrum holdings; or
  - Devolving management of major government spectrum holdings to other government agencies, including the processes and approaches that could be used to achieve devolved management arrangements.

4. Develop a strategic approach to the re-allocation of government spectrum holdings to non-government uses that takes the following factors into account:

- Current and expected operational requirements;

- Budget and other financial constraints;

- The likely effect in Australia of development in technology and international regulatory arrangements; and

- The legislative requirements of the Act.

5. Review the medium and long term effectiveness of existing regulatory arrangements to maximise the efficient use of the spectrum in relation to major government spectrum holdings.

6. Identify regulatory mechanisms and approaches that will assist ACMA to maximise the overall public benefit from major government spectrum holdings, including mechanisms and approaches that will assist ACMA consideration of proposals by government for new spectrum holdings.

7. Examine the opportunity cost of major government spectrum holdings in order to identify opportunities for improved charging arrangements and other incentive mechanisms. For the purpose of the Review, opportunity cost evaluations should take into account alternative uses for a spectrum holding. For example, the band 230–240 MHz is held by the Department of Defence but could also be used for Digital Audio Broadcasting (DAB). This indicates that the opportunity cost of this holding may be significant. In contrast, the 20.2–21.2 GHz and 30–31 GHz bands are generally only used for defence purposes. This indicates that the opportunity cost of this holding may be low.