Reconfiguring the   
890–915/935–960 MHz band

Consultation paper

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[Executive summary 1](#_Toc468705304)

[Glossary 5](#_Toc468705305)

[Introduction 8](#_Toc468705306)

[Background 9](#_Toc468705307)

[Relationship to the Review of the 803–960 MHz band 9](#_Toc468705308)

[Practical implications for the 890–915/935–960 MHz band 9](#_Toc468705309)

[Legislative and policy environment 10](#_Toc468705310)

[The ACMA’s role 10](#_Toc468705311)

[Existing licensing regimes 11](#_Toc468705312)

[Future changes to spectrum management legislation 12](#_Toc468705313)

[The ACMA’s mobile broadband strategy 12](#_Toc468705314)

[Best practice regulation processes 13](#_Toc468705315)

[Problems 14](#_Toc468705316)

[Current arrangements 14](#_Toc468705317)

[Market demand for spectrum 15](#_Toc468705318)

[Why is government action required? 16](#_Toc468705319)

[What are the drivers for reform? 16](#_Toc468705320)

[Economic impact 16](#_Toc468705321)

[What are the alternatives to reform? 17](#_Toc468705322)

[Licensing considerations 20](#_Toc468705323)

[Pricing considerations 21](#_Toc468705324)

[Objectives 22](#_Toc468705325)

[Total welfare standard 22](#_Toc468705326)

[Objectives for the broader review of the 803–960 MHz band 22](#_Toc468705327)

[Criteria for optimising the use of the 890–915/935–960 MHz band 23](#_Toc468705328)

[Options that may achieve the objectives 26](#_Toc468705329)

[Consideration of options 27](#_Toc468705330)

[Description of options 27](#_Toc468705331)

[Option 1: Status quo 27](#_Toc468705332)

[Option 2: Reliance on secondary market 27](#_Toc468705333)

[Option 3: Band clearance and price-based allocation (PBA) 28](#_Toc468705334)

[Option 4: Reliance on secondary markets with contingencies   
for reallocation 29](#_Toc468705335)

[Option 5: Hybrid of options 2 and 3 31](#_Toc468705336)

[Assessment of options 31](#_Toc468705337)

[Preferred options 35](#_Toc468705338)

[Conclusion 37](#_Toc468705339)

[Invitation to comment 38](#_Toc468705340)

[Making a submission 38](#_Toc468705341)

[Appendix 1: Impact analysis of allocation options 41](#_Toc468705342)

[Analysis of Option 1: Status quo 41](#_Toc468705343)

[Analysis of Option 2: Reliance on secondary market 43](#_Toc468705344)

[Impacts of Option 2 43](#_Toc468705345)

[Analysis of Option 3: Band clearance and price-based allocation (PBA) 44](#_Toc468705346)

[Impacts of Option 3 45](#_Toc468705347)

[Analysis of Option 4: Reliance on secondary markets with   
contingencies for reallocation 46](#_Toc468705348)

[Impacts of Option 4 46](#_Toc468705349)

[Analysis of Option 5: Hybrid of options 2 and 3 47](#_Toc468705350)

[Appendix 2: Spectrum valuation 50](#_Toc468705351)

[Spectrum valuation uncertainty 50](#_Toc468705352)

[Spectrum value data points 50](#_Toc468705353)

[800 MHz expiring spectrum licences 50](#_Toc468705354)

[700 MHz Digital Dividend auction 51](#_Toc468705355)

Executive summary

The Australian Communications and Media Authority (the ACMA) commenced a review of arrangements in the 803–960 MHz frequency band in May 2011 (the Review). Following two rounds of consultation, a [decision paper](http://www.acma.gov.au/~/media/Spectrum%20Licensing%20Policy/Information/Word%20Document/The%20ACMAs%20long-term%20strategy%20for%20the%20803960%20MHz%20band_decision%20paper%20docx.docx) was released in November 2015, detailing a range of reforms for the band and an implementation plan for effecting those reforms.

While the review dealt with a number of other issues, its main focus was on the refarming of spectrum not currently allocated for mobile broadband, resulting in new spectrum for mobile broadband, improved provisions for low interference potential devices and new arrangements for land mobile and fixed services. However, the review also touched on how existing mobile broadband allocations could be replanned to enable them to be put to their most economically and technically efficient use. In particular, the ACMA had for some time been exploring options for a potential reconfiguration of the existing 890–915/935–960 MHz bands (otherwise known as the 900 MHz ‘GSM’ band[[1]](#footnote-1)), with the goal of improving its configuration to support the latest iteration of mobile broadband. In its executive summary, the decision paper noted that:

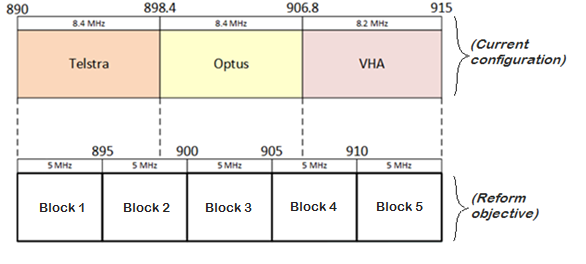
The ACMA has previously foreshadowed that frequency arrangements for cellular services in the … 890–915/935–960 MHz [band] … would be reconfigured as part of the review. However, identifying the best option or options for achieving this reconfiguration is a complex issue and will require further consideration before any long-term decisions are made.

Since that decision, the ACMA has continued to explore 890–915/935–960 MHz reform options in parallel to the implementation of the outcomes described in the decision paper relating to other parts of the broader 803–960 MHz band. Those reform options are the subject of this paper.

4th Generation Long Term Evolution (4G LTE) technologies[[2]](#footnote-2) currently represent the optimal use of the band, however, for reasons described in this paper, would require a reorganisation of licensing arrangements into 5 x 5 MHz frequency division duplex (FDD) pairs. The band is currently licensed to Telstra, Optus and Vodafone in 8.4 MHz, 8.4 MHz and 8.2 MHz FDD pairs (respectively), which is not conducive to the deployment of LTE throughout the band. Figure 1 depicts the misalignment between current arrangements and a more desirable 5 MHz block-based plan optimised for LTE.

In examining options for reform, the ACMA has considered whether there are arguments for retaining the current configuration, and in particular, whether there are alternative uses of the spectrum that might mean the existing configuration could potentially be used just as efficiently as if it were reconfigured. One such alternative use could be the deployment of narrowband Internet of Things (NB-IoT) technologies in the ‘leftover’ segments of the current allocations that cannot be used for 4G (that is, the remainder 3.4 and 3.2 MHz paired segments). NB-IoT is a recent variation of the 4G standard designed to support machine-to-machine (M2M) services, a key physical layer component of the emerging IoT concept.

1. Current and proposed arrangements for the base-receive component of the 890–915/935–960 MHz band (the band is planned as an FDD pair and the corresponding base-transmit frequencies are 45 MHz higher, i.e., 935–960 MHz)



NB-IoT, as its name suggests, is narrowband in nature—each carrier occupies the same bandwidth as an LTE physical resource block (180 kHz). Spectrum access can be achieved via a number of methods, including nesting within an existing (broadband) LTE carrier, or as one or more standalone carriers in either dedicated NB-IoT spectrum or the small guard bands between LTE and/or 3G carriers (factored into the licensed frequencies). While the ACMA does not speculate on the viability or otherwise of NB-IoT and its variants in future radiocommunications markets, it finds that the proposed 5 MHz-based licences could efficiently support both broadband and narrowband carriers with little or no broadband capacity penalty. As a result, this potential alternative use does not mean there is a case for the current configuration to be retained.

This paper looks at a range of potential allocation options to reconfigure the band into 5 MHz blocks. It sets out the ACMA’s preferred approach to the evaluation of these options, and signals some preliminary views that have been formed as a result of this evaluation process. The options identified include various combinations of interventionist, non-interventionist, market and non-market-based solutions.

There are two ‘pure’ methods of achieving the reforms that the ACMA could recommend to the government:

* reliance on secondary trading, involving conversion to spectrum licences with administratively-set prices and encouraging incumbents to trade spectrum holdings in order to obtain optimal band configuration

band clearance and reallocation by price-based allocation (PBA),

as well as two other options that combine elements of the two pure methods:

* reliance on secondary markets with contingencies for reallocation[[3]](#footnote-3), comprising an initial trading period, which would potentially (subject to the success or otherwise of the initial trading period) be followed by a band clearance and price-based allocation

allocation via conversion to spectrum licences of a single 2 x 5 MHz block to each incumbent carrier and subsequent allocation of the remaining two blocks by a price-based allocation.

The options described in this paper, along with a default ‘status quo’ option, have been analysed against a range of public interest criteria drawn from a previous process involving the reissue of existing spectrum licences. While the reissue of spectrum licences raises somewhat different issues from the present process, most (though not all) of the public interest criteria identified in that process are helpful in evaluating allocation methods to meet the reform objectives. Therefore, the ACMA has adopted the following criteria for the purposes of achieving the optimal use of the 890–915/935–960 MHz band:

1. promoting the most efficient use of spectrum
2. investment and innovation
3. competition
4. consumer convenience.

This analysis shows that while trading between incumbents in the secondary market could achieve the reform objectives with the least amount of regulatory intervention in the market, the risks of the objectives not being achieved may be too high, given the importance of these reforms. It follows that a band clearance followed by a price-based allocation (PBA) (for example, auction) of the reconfigured blocks (5 x 2 x 5 MHz) is likely to be most conducive to achieving the reconfiguration in a timely manner.

There are, however, other potential paths to reconfiguration. Notably, the bands in question present an opportunity to test the ability for the secondary market to act, which is relevant in the current climate of broader reform of spectrum management and markets. An option considered in this paper would afford spectrum incumbents a finite period to negotiate towards the desired band configuration. The government’s role in this process would be limited to ensuring conditions and settings are in place that would facilitate trading, including (but not limited to) conversion of existing apparatus licences to spectrum licences.

If a suitable agreement could not be reached during the abovementioned trading period, *then* a clearance and price-based allocation process could be brought into effect. While this approach would need to be carefully designed, it could serve the dual purposes of testing the secondary market—which itself could prove instructive in the context of broader reforms—with safeguards in place that ensure the optimal band configuration was ultimately reached.

Of the options canvassed (including retention of the status quo), the Authority currently sees the above two (clearance and reallocation as spectrum licences, or a finite period for renegotiation between incumbents prior to a decision on whether to reallocate the bands) as the most likely to achieve the desired band reconfiguration. The ACMA welcomes submissions on these options and any other aspect of this paper.

A final ACMA decision on a preferred reform method is expected in the coming months and will take into account responses to this paper. Depending on the outcome, implementation of any preferred option will be subject to existing law. In the case of options involving clearance of apparatus licences and reallocation of the spectrum as spectrum licences, the ACMA would be required to follow the steps outlined in the *Radiocommunications Act 1992* for reallocation of encumbered spectrum (Part 3.6 refers). This law prescribes roles for both the ACMA and the minister. In the case of options involving the conversion of apparatus licences to spectrum licences, the ACMA would be required to make recommendations to the minister about designation of the relevant parts of the spectrum for spectrum licences (Part 2.2. refers). Nothing in the present discussion paper should be taken to fetter the ACMA (or the minister) in the exercise of these discretionary powers under the Radiocommunications Act.

# Glossary

| **Term** | **Definition** |
| --- | --- |
| 2G | 2nd generation or 2G is the generation of standards that includes GSM technologies. |
| 3G | 3nd generation or 3G is the generation of standards that includes UMTS and technologies that provide both voice and mobile broadband access services. |
| 3GPP | 3rd Generation Partnership Project is an international body responsible for the standardisation of (cellular) mobile (including broadband) telecommunications, including the 2G, 3G, 4G and (soon) 5G technology standards. |
| 4G | 4th generation or 4G is the generation of standards that includes LTE technologies that provide broadband data access services. |
| 850 MHz band | The frequency segments 825–845/870–890 MHz currently licensed to Telstra and Vodafone for the provision of 3G and 4G services (3GPP band 5)—noting there is currently a 1 MHz frequency misalignment with technical standards. |
| 850 MHz expansion band | The FDD-paired frequencies lower-adjacent to the 850 MHz band that are standardised by 3GPP for 4G technologies (3GPP bands 26 and 27). |
| 900 MHz ‘GSM’ band | Informal name for the 890–915/935–960 MHz band historically used for the delivery of 2G GSM services. |
| (Spectrum or Service) Allocation | For the purposes of radiofrequency spectrum planning, an allocation is a specific range of frequencies allocated to use by one or more radiocommunications services within a band plan or spectrum plan. |
| Apparatus licence | An apparatus licence authorises, under the *Radiocommunications Act 1992*, the use of a radiocommunications device under a particular service type, in a particular frequency range and at a particular geographic location for a period of up to five years. |
| Band plan | Either an administrative or legislative instrument that sets out the allocations of frequencies to services within a specific radiofrequency band. |
| Cat-M1, NB1 | *See* NB-IoT |
| Cellular network | A cellular network is a network of radiocommunications services distributed over land areas called cells. Each cell is serviced by a base station, each of which is inter-connected via a core network. User devices connected to cellular networks can be seamlessly passed between cells.  2G, 3G and 4G mobile networks are examples of cellular networks. |
| Duplex | The means of separating the two sides of a radio ‘conversation’ between two stations (e.g. defining separate channels between the audio sent from a mobile phone to a base station and the audio coming from the other end).  Can be achieved by using separate frequencies (frequency division duplex) or dividing receive/transmit into discrete time blocks (time division duplex). |
| Embargo | A spectrum embargo is a policy notice of intent by the ACMA to restrict the allocation of new licences in a particular frequency range to support replanning of that frequency range. Spectrum may still be able to be accessed on an exceptions basis through an application for an exemption to the embargo. |
| FDD | Frequency Division Duplex—using two discrete frequency blocks for duplexing. The frequency separation between these blocks is known as the FDD ‘split’ (e.g. the FDD split between mobile services operating in the 803–960 MHz band is 45 MHz). |
| GSM | Global System for Mobile telecommunications, a 2G cellular standard. |
| Guard band | A frequency band that is either deliberately vacant or has specific operating conditions to minimise intra-band interference between the two bands on either side (analogous to a ‘buffer’). |
| IoT | Internet of Things—a high-level concept involving the wide-area interconnection of an unlimited number of M2M devices via any type of communications link. |
| International spectrum harmonisation | The generally desirable outcome where radiocommunications services operate throughout the world in similar spectrum bands. Among other benefits, harmonisation facilitates lower-cost equipment through economies of scale. |
| International Telecommunication Union (ITU) | A specialised agency of the United Nations that is responsible for issues that concern information and communication technologies. The ITU coordinates the shared global use of radio spectrum and assists in the development of spectrum harmonisation arrangements. |
| LPWA network | Low power wide area (LPWA) networks typically consist of cheap, low power/duty-cycle devices (such as data loggers or sensors) ubiquitously deployed over a large area. |
| LTE | Long Term Evolution—a 4th Generation 3GPP technology standard for [wireless](http://en.wikipedia.org/wiki/Wireless) communications including high-speed data for mobile devices. |
| Machine-to-machine (M2M) | A concept that allows communications between devices of the same type for the purposes of monitoring or providing sensor capabilities. |
| MNO | Mobile network operator |
| Mobile broadband | The variety of ways an internet service is delivered via a mobile network, typically comprising mobile wireless internet services provided via a dongle, USB modem or data card service, or mobile phone handset internet services. |
| Mobile service | When used in this paper, a mobile service means the operation of a radiocommunications service to allow communications between two locations that move, i.e. those points are mobile and are not limited to a particular points on or near the surface of the Earth. |
| NB-IoT | Narrowband IoT—a component of the 3GPP standard for LTE specifically designed to serve low-power M2M devices. Variants include Cat-M1, which involves using dedicated 1.4 MHz LTE channels for low power M2M, and Cat-NB1, under which individual (narrowband) LTE physical resource blocks, either within an existing conventional LTE channel or stand-alone, are dedicated to serving low power M2M. |
| RALI | A Radiocommunications Assignment and Licensing Instruction (RALI) is a technical document made by the ACMA that outlines frequency assignment and information pertaining to coordination and interference management. |
| Radiocommunications service | A grouping of radiocommunications types involving the transmission, emission and/or reception of radio waves for specific telecommunication purposes. Examples include fixed, mobileand satellite services. |
| UMTS | Universal Mobile Telecommunications Service—a 3rd Generation 3GPP technology standard for [wireless](http://en.wikipedia.org/wiki/Wireless) communications. |
| Spectrum licence | A spectrum licence issued under the *Radiocommunications Act 1992* authorises the use of a particular frequency band within a particular geographic area for a period of up to 15 years. The geographic area can vary in size, up to and including the entire country. |
| Willingness to pay | The maximum amount an individual is willing to sacrifice to procure a good or avoid an undesirable outcome. |

# Introduction

Between 2011 and 2015, the ACMA undertook an extensive review of the 803–960 MHz band to ensure that the band is used efficiently, can accommodate current and future demands, and continues to maximise the public benefit derived from its use.

The scope of that review included consideration of options to reconfigure the 890–915/935–960 MHz band (historically known as the ‘GSM 900 band’). This stemmed from a general acceptance that the current configuration of that band, which was put in place to enable the deployment of 2nd Generation GSM technologies in the early 1990’s, was not optimised (at the time) for 3rd and (now) 4th generation technologies (see *Problems* for further discussion).

However, [decisions arising from the review](http://www.acma.gov.au/~/media/Spectrum%20Licensing%20Policy/Information/Word%20Document/The%20ACMAs%20long-term%20strategy%20for%20the%20803960%20MHz%20band_decision%20paper%20docx.docx) did not include a way forward on proposed reforms to the 890–915/935–960 MHz band. Those aspects were deferred to be dealt with as part of a separate process that would run parallel to the implementation of decisions affecting the rest of the 803–960 MHz band. The intent of this paper is to progress those outstanding aspects.

Arrangements in the 890–960 MHz frequency band are administered by the 900 MHz band plan (see [RALI MS 41](http://acma.gov.au/~/media/Spectrum%20Engineering/Information/Word%20Document/RALI%20MS%2041%20-%20900%20MHz%20band%20plan%20docx.docx)). In the band plan, 890–915/935–960 MHz is allocated to ‘Digital CMTS’ (Digital Cellular Mobile Telephone Service), an outdated term that will change in any future revisions of the plan. Terminology changes aside, 890–915/935–960 MHz will remain allocated for the provision of cellular mobile communications for the foreseeable future. The focus of this paper is reforming how frequency blocks are configured, allocated and licensed *within* that frequency range.

No changes to legislation or regulations are proposed. Rather, this paper is an examination of which existing tools (see *Options that may achieve the objectives*) may best be used to bring about the desired reforms. A range of reform options have been identified and analysed against various criteria to determine a ‘preferred’ method.

# Background

## Relationship to the Review of the 803–960 MHz band

The 2015 [decision paper](http://www.acma.gov.au/~/media/Spectrum%20Licensing%20Policy/Information/Word%20Document/The%20ACMAs%20long-term%20strategy%20for%20the%20803960%20MHz%20band_decision%20paper%20docx.docx) on the Review of the 803–960 MHz band set out a long-term refarming agenda for spectrum not currently used for mobile broadband, while deferring decisions on reconfiguring the 890–915/935–960 MHz band to optimise its utility for 4th Generation (4G) services.

4G is optimally deployed in spectrum blocks that are multiples of 5 MHz. As the 890–915/935–960 MHz band is currently licensed to MNOs in 8.4, 8.4 and 8.2 MHz frequency division duplex (FDD) paired blocks, optimisation of the band for mobile broadband will require migration to a 5 MHz paired-block structure. The ACMA’s reasoning in pursuing this reform separately to the implementation of the broader 803–906 MHz review outcomes is that the 890–915/935–960 MHz band is already allocated for delivery of commercial mobile services. This allowed the issue to be ‘decoupled’ and treated in isolation from the broader review. This in turn would give more time to develop and canvass options for achieving the reconfiguration with stakeholders.

Meanwhile, the progressive implementation of outcomes of the broader review has been able to proceed. Broadly, implementation will involve clearance and reorganisation of incumbent narrowband fixed and mobile services to enable the release of the 850 MHz expansion band for new mobile broadband services, as well as permitting LPWA machine-to-machine networks in the broader 803–960 MHz band.

While the broader review of 803–960 MHz has been completed, reconfiguration of the 890–915/935–960 MHz band remains a key objective of the ACMA’s mobile broadband strategy (discussed further below). Maximising the efficient exploitation of existing mobile broadband allocations is a feature of this strategy, which provides among other things:

In considering re-farming of spectrum for mobile broadband, the ACMA will take into account the uptake of spectrally efficient technologies, as well as network infrastructure and topology deployments in efforts to deliver greater mobile broadband capacity using currently available spectrum.

In this context, maintenance of the historic 2G-centric arrangements is no longer conducive to the most technically-efficient use of the band.

### Practical implications for the 890–915/935–960 MHz band

Of specific relevance to the 890–915/935–960 MHz band, implementation of the review outcomes will include clearance of the 2 x 1 MHz block immediately lower-adjacent to the current 850 MHz spectrum licensed band. This is to enable the ‘downshifting’ of the 850 MHz band by 1 MHz (see the decision paper for information on time frames for clearance of this block).

The relevance of this reform is that the ability to deploy LTE in the lower 5 MHz block (890–895/935–940 MHz, shown as ‘block 1’ in the *What are the drivers for reform?* section of this paper) in a post-reform environment will be constrained until the downshift can occur, and by extension the value of block 1 will be diminished until that time. While the downshift will be an important step in the overall optimisation of arrangements in the 890–915/935–960 MHz band, it can be considered separately in the context of the reconfiguration options discussed in this paper and need not result in any delay to the reconfiguration occurring.

In addition to the adjacent-band interference issues associated with block 1, the overlap of blocks 3, 4 and 5 (base receive) and the US ISM band (902–928 MHz) can also result in interference. While operation of ISM devices below 915 MHz is illegal in Australia, instances of non-compliant devices causing interference into mobile base stations are not infrequent.

By affecting the utility—and by extension the value—of individual 5 MHz blocks in the 890–915/935–960 MHz band, the above issues make it likely that the value to carriers of the proposed 5 x 5 MHz paired blocks will not be homogeneous. This potential heterogeneity of block values has implications for the options for achieving a reconfiguration (see Chapter 4 of the [decision paper](http://www.acma.gov.au/~/media/Spectrum%20Licensing%20Policy/Information/Word%20Document/The%20ACMAs%20long-term%20strategy%20for%20the%20803960%20MHz%20band_decision%20paper%20docx.docx) for a more detailed treatment of this issue).

## Legislative and policy environment

### The ACMA’s role

Section 9 of the *Australian Communications and Media Authority Act 2005* (the ACMA Act) sets out the spectrum management functions of the ACMA, including to:

* manage the radiofrequency spectrum in accordance with the *Radiocommunications Act 1992*

advise and assist the radiocommunications community.

Consistent with the spectrum management functions set out in the ACMA Act, the object of the Act is to provide for management of the radiofrequency spectrum in order to (among other goals)[[4]](#footnote-4):

* maximise, by ensuring the efficient allocation and use of the spectrum, the overall public benefit derived from using the radiofrequency spectrum
* provide a responsive and flexible approach to meeting the needs of users of the spectrum

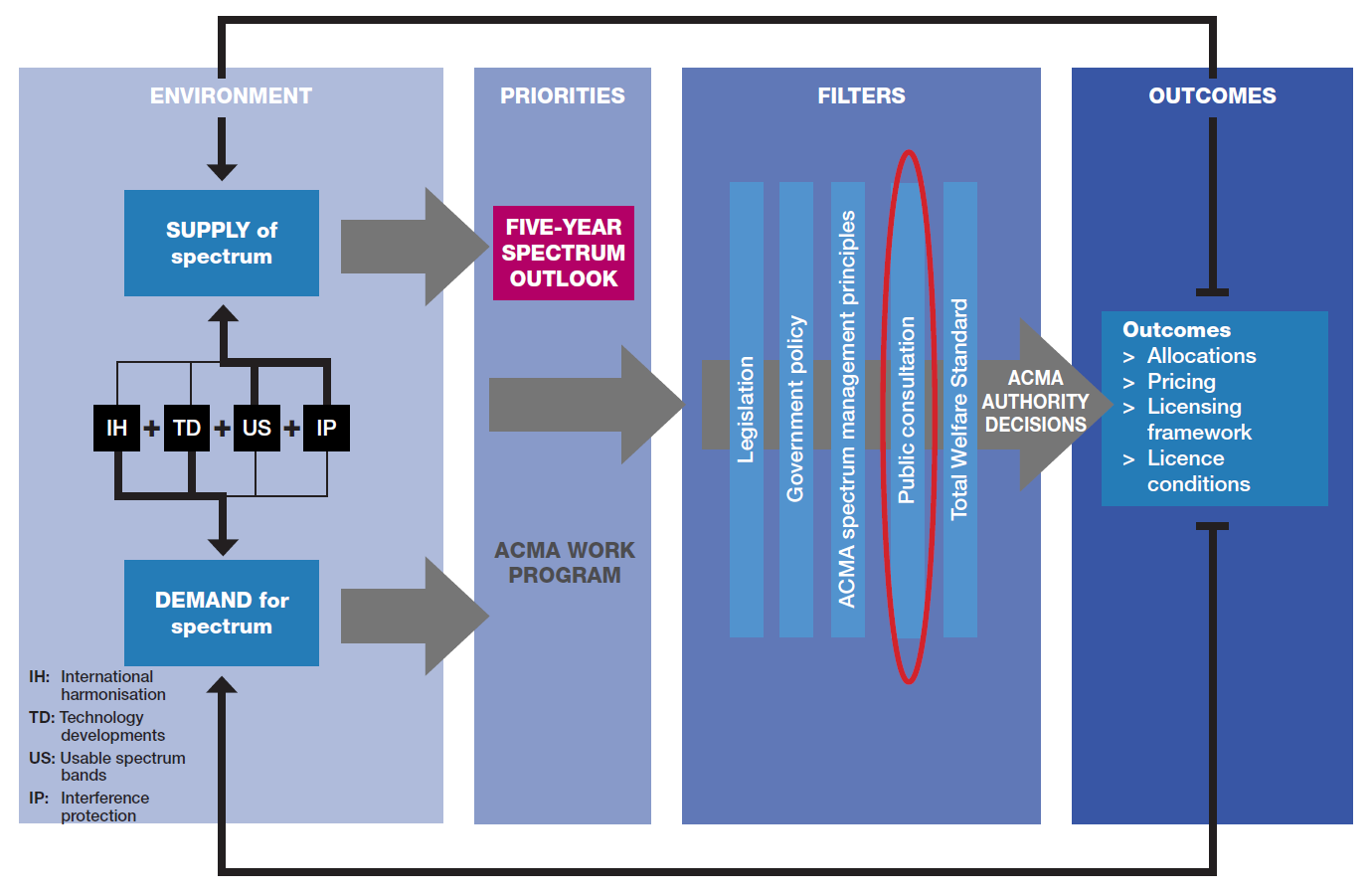
encourage the use of efficient radiocommunication technologies so that a wide range of services of an adequate quality can be provided.

The ACMA is also guided by the [Principles for Spectrum Management](http://www.acma.gov.au/theACMA/About/The-ACMA-story/Facilitating/decisionmaking-process-fyso-25-1)[[5]](#footnote-5) (the Principles), which are:

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

The ACMA adheres to the object of the Act and the Principles through a balanced application of market and regulatory mechanisms. Figure 2 describes the ACMA’s general approach to spectrum management decision-making. The review of the 803–960 MHz band was first flagged in the ACMA’s Five-year spectrum outlook (FYSO) 2011–2015, and was discussed in later versions of the FYSO. In terms of the general approach, the release of this paper falls under the ACMA’s public consultation ‘filter’. The ACMA will continue to apply the elements of its spectrum management decision framework, including the spectrum management principles, as it considers the responses to this paper.

1. Spectrum management decision framework



### Existing licensing regimes

There are currently three licence types available to authorise access to spectrum—spectrum, apparatus and class licences.

An apparatus licence authorises the use of a device (or group of devices) operating under a particular radiocommunications service type, in a particular frequency range, and at a particular geographic location[[6]](#footnote-6) for a period of up to five years. Access to the 890–915/935–960 MHz band is currently authorised via the public mobile telecommunications service (PMTS) class B apparatus licence type.

A spectrum licence authorises the use of a particular frequency band within a particular geographic area for a period of up to 15 years. The geographic area can vary in size and can comprise the entire country. Spectrum licences have historically been utilised for the majority of bands used to deploy commercial mobile networks.

An inherent feature of spectrum licensing is technological flexibility—that is, the licensing rules, while usually optimised for an expected technology, specify only generic technical detail and limitations[[7]](#footnote-7) while not expressly mandating a particular type of technology or service. This allows a licensee to deploy any technology as long as it complies with the terms and conditions of the licence, without intervention from the regulator. It is up to the licensee to manage interference between devices, although the adoption of international standards mitigates the potential for interference between devices. Spectrum licences are more conducive to spectrum trading than apparatus licences, due to design features such as their longer and more certain tenure and their ability to be aggregated or sub-divided.

Noting the above benefits of spectrum licences, it is the preference of the ACMA and existing licensees that access to the 890–915/935–960 MHz band should ultimately be authorised via spectrum licences (or an equivalent new licensing arrangement—see the *Licensing considerations* chapter for a detailed discussion), instead of apparatus licences.

### Future changes to spectrum management legislation

In May 2014, the government commenced a review of Australia’s spectrum policy and management framework—the [Spectrum Review](https://www.communications.gov.au/what-we-do/spectrum/spectrum-review). This review concluded in May 2015, with the release of the [Spectrum Review Report](https://www.communications.gov.au/node/1190http:/www.communications.gov.au/spectrumreview), which outlined recommended changes to existing legislation to improve Australia’s spectrum management framework. The government has agreed to implement the recommendations of the Spectrum Review, which includes the replacement of ‘ … current legislative arrangements with new legislation that removed prescriptive process and streamlines licensing, for a simpler and more flexible framework’*.*

In March 2016, the government [released](https://www.communications.gov.au/have-your-say/spectrum-reform-legislative-proposals-consultation) a [Legislative Proposals consultation paper](https://www.communications.gov.au/file/15631/download?token=0L4TaEso) on its proposed approach to the Radiocommunications Bill 2016. The consultation period on the new bill closed in April 2016 and the government is currently considering submissions.

The Spectrum Review indicated that transitional arrangements would need to be worked through carefully with stakeholders and that the full transition to a new framework would take place over a number of years. As described in the Legislative Proposals consultation paper, in transitioning to the new framework, the rights of existing licence holders will not be diminished. It is proposed that:

* the legislation will commence approximately one year after passage of the new legislation through parliament
* licensing processes currently underway will continue under the current framework
* where practicable, class licences will be deemed as spectrum authorisations on commencement of the new legislation
* apparatus licences will transition to the new framework over a period of time in a staged approach

spectrum licences will continue until expiry unless the parties agree to transition earlier.

Given the expected changes to current legislation, including licensing arrangements, the exact licence type to be used for a reconfigured 890–915/935–960 MHz band will depend on whether reconfiguration of the band occurs before or after the perspective legislative changes occur (should they occur). However, given that there is consensus that spectrum licensing should be used to authorise access to the band, it is anticipated that equivalent licensing arrangements would be employed should reconfiguration occur after any new legislation is in force.

## The ACMA’s mobile broadband strategy

Mobile broadband services deliver substantial economic and societal benefits to the Australian economy and community. The growth in demand for mobile broadband capacity is ongoing and is likely to lead to continuing pressures for additional spectrum, although the extent and timing of these needs cannot be predicted with any certainty.

The ACMA has developed a [set of strategies](http://www.acma.gov.au/~/media/Spectrum%20Transformation%20and%20Government/Issue%20for%20comment/IFC%2022%202015/MBB%20strategyThe%20ACMAs%20spectrum%20management%20strategy%20to%20address%20the%20growth%20in%20mobile%20broadband%20capacity%20docx.docx) to address the growth in demand for mobile broadband capacity. A key part of these strategies is the articulation of a spectrum management process for the release of additional spectrum for mobile broadband in bands where there is evidence of a change in highest value use. Another increasingly important strategy—highly relevant in the context of this paper—is ensuring that existing mobile allocations are used efficiently, by optimising licensing arrangements to promote the deployment of the latest/future generations of mobile broadband technologies.

In February 2016, the ACMA released its [mobile broadband work program](http://www.acma.gov.au/~/media/Spectrum%20Transformation%20and%20Government/Issue%20for%20comment/IFC%2022%202015/Mobile%20broadband%20work%20programFebruary%202016%20update%20docx.docx), which is the first ongoing update detailing the progress of mobile broadband spectrum planning projects.[[8]](#footnote-8) The 890–915/935–960 MHz band is included in the current work program and is identified as being under replanning at the re-farming stage.[[9]](#footnote-9) This recognises the desirability of repurposing arrangements in the band to support the efficient transition from 2G (voice, text and narrowband data) to 4G (broadband) technologies.

## Best practice regulation processes

To further assist with developing efficient and effective regulation, the ACMA adheres to the Australian Government’s best practice regulation processes. This includes considering the various policy options and making an assessment of the costs and benefits associated with each option. The aim is to ensure that the chosen policy option conforms to these guiding elements, as well as addressing the problems identified in this paper. This is performed in a transparent and accountable manner to help reduce the regulatory burden upon business, communities and individuals.

# Problems

## Current arrangements

High-level spectrum arrangements for the 890–915/935–960 MHz band are enshrined in the 900 MHz band plan (see [RALI MS 41](http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwi2r5mf_ZfOAhUMmJQKHc99BkYQFggdMAA&url=http%3A%2F%2Fwww.acma.gov.au%2F~%2Fmedia%2FSpectrum%2520Engineering%2FInformation%2FWord%2520Document%2FRALI%2520MS%252041%2520-%2520900%2520MHz%2520band%2520plan%2520docx.docx&usg=AFQjCNGhZNARLZYDPoQF1d9_e5SGv2qUhA)). The band is licensed to Telstra, Optus and Vodafone in 8.4, 8.4 and 8.2 MHz frequency division duplex (FDD) paired blocks respectively (which adds up to the 2 x 25 MHz allocated to ‘Digital CMTS’—an outdated term—in RALI MS 41). Access to the band is currently authorised through the PMTS class B apparatus licence type, which yields approximately $75 million annually in licence fees.

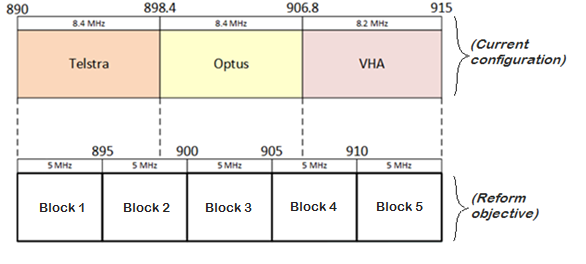
In terms of the technology used in the 890–915/935–960 MHz band, it has long been a cornerstone in the delivery of cellular communications services in Australia, first through the deployment of the 2G Global System for Mobile (GSM, hence the band being colloquially referred to as the ‘900 MHz GSM band’), and more recently, 3G Universal Mobile Telecommunications System (UMTS) services. The band has also been included in the relevant 3GPP standards for 4G LTE, which is more efficient (can provide greater data rates using a given spectrum bandwidth) than 3G.

Due to the evolution of mobile technologies, mobile network operators (MNOs) internationally have begun switching off 2G networks and re-farming spectrum holdings for other more advanced technologies. In Australia, Telstra, Optus and Vodafone have publicly announced their 2G networks will be switched off, in December 2016, April 2017 and September 2017 respectively. All three incumbent MNOs have also, to varying degrees, deployed other mobile technologies in the band. Both Optus and Vodafone have re-farmed some of their holdings and have made extensive 3G deployments. Telstra has also repurposed some of its holding to undertake trials of 4G services.

LTE technology can operate using a range of different channel sizes: 1.4, 3, 5, 10, 15, and 20 MHz, however LTE is more spectrally efficient in channels of 5 MHz, or multiples thereof. Increases in channel size (in 5 MHz increments) up to a 20 MHz channel increases throughput, but results in only incremental gains to spectral efficiency. While LTE can operate using channels smaller than 5 MHz, this is generally avoided, as efficiency suffers and the level of throughput adds little to the overall capacity of a network. Therefore, bands for 3G and 4G technologies are predominately planned based on a minimum block size of 5 MHz.

This means the current division into two 8.4 MHz, plus a single 8.2 MHz frequency-division duplex (FDD) blocks, is not conducive to the optimal deployment of 4G (or 3G) services across the entire band. To achieve the optimal use, it would be necessary to change the licence parameters to align with a band configuration based on 5 MHz FDD blocks. Figure 3 shows the lower (base-receive) part of this band, with the current licensing arrangements shown at the top of the diagram and the desirable 5 MHz block-based configuration shown at the bottom.

1. Current and proposed arrangements for the base-receive component of the 890–915/935–960 MHz band (the band is planned as an FDD pair and the corresponding base transmit frequencies are 45 MHz higher, i.e., 935-960 MHz)



## Market demand for spectrum

The demand for additional mobile broadband harmonised spectrum is strong in Australia, as evidenced by the recently concluded 1800 MHz regional spectrum auction and the recent ministerial request for the ACMA to return the three 700 MHz unsold lots resulting from the 2013 digital dividend auction to the market.[[10]](#footnote-10)

Optus, Telstra, TPG and Vodafone all secured spectrum in the 1800 MHz auction, resulting in total revenues (including withdrawal penalties) of approximately $543.5 million, equivalent to an average price of $0.71 per MHz per head of population within the licence area ($0.71/MHz/pop).

It is worth noting that the regional licences on offer in the 1800 MHz regional spectrum auction were for 11-year licences beginning 30 May 2017, rather than the 15-year spectrum licences traditionally on offer. Given the shorter duration of these licences, implied valuation of a 15-year licence would be even higher. These prices for the 1800 MHz auction were achieved in the presence of competition limits, with Optus and Telstra bidding up to their limits in most regions. The participation of fixed-line telecommunications service provider TPG, which is not at present an MNO, further boosted demand for the spectrum.

As per the above discussion on *The ACMA’s mobile broadband strategy*, it is important that existing mobile spectrum allocations are being used as efficiently as possible. Arguably, optimisation of existing mobile allocations should precede efforts to identify new spectrum to meet rising demand for mobile broadband capacity, especially where this would require the clearance of other important users from their current spectrum allocations. Optimisation of current mobile allocations so as to deliver the most technically efficient (in terms of bits/sec/Hz) services possible is supported in principle by all incumbent MNOs, as evidenced by submissions to date to the ACMA.

## Why is government action required?

The current configuration of the 900 MHz band is the product of current apparatus licensing arrangements in the band. Reconfiguration to optimise use of the spectrum is only possible through government regulatory action to change existing licensing arrangements. The only scenario under which no government action would be required is maintaining the status quo and leaving the band configuration ‘as is’. For reasons explored in this paper, this option would not best serve the interests of the Australian community.

All options for reform (see *Options that may achieve the objectives*) would require a degree of intervention. Although the level of intervention would differ, even the ‘lightest touch’ option—that of allowing the current licence holders to negotiate the configuration free from further government influence—would necessitate a change in licensing configuration and type to facilitate trading, which under the current legislative framework would require action by both the ACMA and the Minister for Communications and the Arts.

The 890–915/935–960 MHz band provides an excellent example of the benefits of optimising an existing spectrum allocation for mobile broadband, and it requires government intervention because the existing licensing arrangements result in less-than-optimal conditions for third-party actors to meet the reform objectives by themselves.

## What are the drivers for reform?

LTE is currently the most efficient technology available to commercial operators in this band, which means it provides the highest level of cellular mobile broadband service to the community. Being a band below 1 GHz, which is internationally harmonised and standardised for the delivery of LTE services, means that it is of a very high value to commercial operators.

To maximise the overall public benefit derived from the spectrum, MNOs require the flexibility to be able to readily deploy the latest releases of standardised mobile broadband technologies available[[11]](#footnote-11) in this band, being 4G Long Term Evolution (LTE)-based technologies at present.

At its broadest, a shift to LTE technologies would promote the object of the Radiocommunications Act*:*

The object of this Act is to provide for management of the radiofrequency spectrum in order to … maximise, by ensuring the efficient allocation and use of the spectrum, the overall public benefit derived from using the radiofrequency spectrum.

### Economic impact

The current band configuration, which is impeding the optimal use of the band, has a negative economic impact. While the ACMA cannot precisely quantify the potential loss in economic value associated with retention of the inefficient band plan, its significant size can be inferred using estimates of the current value of spectrum if optimally configured. As shown in [Appendix 2](#_Appendix_2:_Spectrum), the market value of 890–915/935–960 MHz spectrum, optimally configured, can be estimated as being between $1.00/MHz/pop and $1.36/MHz/pop (for a 15-year licence).

There are three elements of the loss of welfare derived from the current inefficient band configuration:

1. The licensees are unable to deploy broadband networks with channel bandwidths wider than 2 x 5 MHz, which is unlikely to provide optimal network capacity that would generate values outlined in Appendix 2
2. 2 x 10 MHz (the sum of the residual lots when 2 x 5 MHz is subtracted from each of the current lots) is unable to be used for its optimal use
3. As previously discussed, access to the 890–915/935–960 MHz band is currently authorised via apparatus licences. Under current legislation, apparatus licences can only be issued for a maximum term of five years, which reduces industry investment certainty relative to long-duration licences (that is, spectrum licences, which have a maximum term of 15 years).[[12]](#footnote-12)

Loss of value from licensees being able to deploy only 2 x 5 MHz bandwidth channels

It is not possible to estimate with any precision the loss in value licensees place on being able to only deploy single 2 x 5 MHz bandwidth mobile broadband channels versus more optimal channel widths, however it is likely to be significant. For example, in its submission to the *Draft ministerial direction on unsold 700 MHz spectrum*, Telstra noted that:

It is generally not economic for commercial LTE operators to invest in a single 2 x 5 MHz block of spectrum as the reduced network capacity and speed associated with the smaller bandwidth does not normally justify the investment.

Loss of usability of 2 x 10 MHz

Using $1.18/MHz/pop as a mid-point estimate of the value, and assuming the population is 24.5 million, this places the value of 2 x 10 MHz of 890–915/935–960 MHz band at approximately $578 million (for a 15-year licence). If the reconfiguring of the band (maintaining the current sub-optimal use of the 2 x 10 MHz) is delayed for a year, the loss of economic welfare is approximately $27 million, assuming there is no alternative use. If the delay is two years, the loss is $52 million, and so on.

This is a simplified estimate as MNOs may enjoy some economic benefit from holding on to this spectrum, including for example potential deployment of standalone NB-IoT carriers. However, this benefit is likely to be a small fraction of the economic welfare that would result from the residual spectrum being able to be used for mobile broadband (more so if aggregated with adjacent blocks to enable deployment of larger bandwidth profiles).

## What are the alternatives to reform?

As above, the alternative to reform is to maintain the status quo. For this option to be consistent with the broad objectives set out in the following chapter, there would need to be a legitimate alternative to LTE that can use the existing 8.4 and 8.2 MHz FDD paired configurations just as (or more) efficiently to delivery equally as high (or higher) value services.

The existing configuration was introduced in 1992 to support 2G GSM deployments, which require multiples of 200 kHz channels (8.4 and 8.2 MHz being divisible by 200 kHz). This technology has long been superseded by 3 and 4G technologies, with all incumbent operators indicating that 2G networks will be switched off by late 2017.

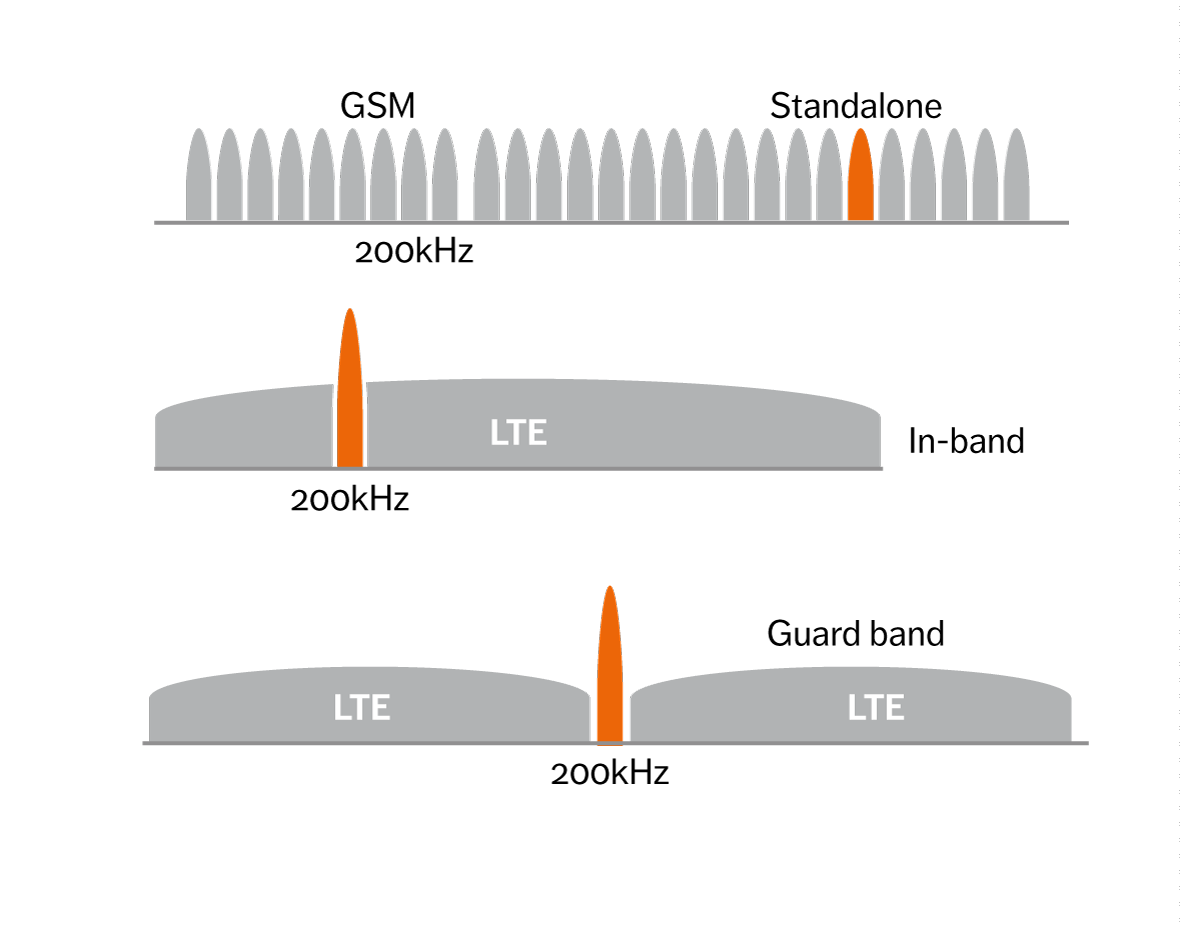
While it is true that operators can each deploy one 3G or 5 MHz 4G carrier within their current licensing arrangements, a case would need to be made that residual 3.4/3.2 MHz blocks could be used for a sufficiently valuable purpose to retain the existing arrangements. It is feasible for 2G services to continue to operate in these residual blocks—a moot point given that operators are in the process of switching off their 2G networks—however, evolving technology has resulted in 2G no longer representing the optimal use of this band.

The recent incorporation of NB-IoT modes into 4G standards presents another alternative use of the residual spectrum. This is a new class of pared-back, low-complexity devices specified to operate on, or separate to, conventional LTE networks. Narrowband modes are advantageous from an IoT perspective, as they enable bespoke devices with extremely low duty cycles[[13]](#footnote-13) to be optimised for single narrowband frequencies, resulting in extremely low power usage and enabling operation in situ for very long periods on a single battery.

3GPP Release 13 specifies devices operating solely on 1.4 MHz LTE carriers, termed Cat-M1. A further evolution under Release 13, termed Cat-NB1 (previously known as Cat-M2 in earlier Release 13 development), is the specification of devices to operate within a single 180 kHz LTE physical resource block (PRB). Separately under Release 13, extended coverage GSM-IoT (EC-GSM-IoT) has been specified to make use of legacy, stand-alone 200 kHz GSM physical channels for IoT devices. EC-GSM-IoT and Cat-NB1 technologies present a potential means of at least partially putting the residual 3.4/3.2 MHz blocks to some useful purpose.

Cat-NB1 can be operated ‘in band’, that is, share the same frequencies as a conventional LTE carrier, or as a standalone carrier in the guard frequencies between the assigned LTE channel bandwidth and its actual emission profile (and of course in ‘clean’ spectrum where conventional LTE is not deployed). Figure 4 depicts the physical variations between different spectrum occupancy modes. EC-GSM-IoT, being a non-LTE technology, can only operate as stand-alone carriers.

1. Description of standalone (including guard band) and in-band operation of narrowband carriers with respect to conventional LTE carriers (note that Cat-NB1 can operate in all three configurations, while EC-GSM-IoT can only operate standalone). [Ref: [NB-IoT: A sustainable technology for connecting billions of devices](http://www.ericsson.com/thecompany/our_publications/ericsson_technology_review/archive/narrowband-iot-connecting-billions-devices) by Ericsson]



3GPP and industry have undertaken a significant amount of work towards determining the amount of data that would need to be serviced by narrowband carriers within a 900 MHz cell. This has been calculated using a combination of predicted factors including transferred data, duty cycle and geographic device density. For a London-based scenario, the expected number of devices to be served by a single narrowband carrier in a cell is 52,000.[[14]](#footnote-14) Based on expected individual device duty cycles and data rates (up to 500 kbit/s on the downlink and 40 kbit/s on the uplink[[15]](#footnote-15)), it is expected that each Cat-NB1 carrier will be able to handle some 200,000 devices—almost four times the required amount for the geotype described above.

To efficiently use 3.2 or 3.4 MHz entirely for stand-alone narrowband carriers (either EC-GSM-IoT or standalone 4G Cat-NB1), an operator would need to deploy about 17 carriers. Based on the above discussion, this would meet the anticipated traffic demand for narrowband many times over and would therefore unlikely be an efficient use of that spectrum.

While the ACMA would not make technology-specific planning decisions that might constrain future capacity if NB-IoT demand expectations were significantly exceeded, it seems unlikely at this stage that there would be a need for more than one narrowband carrier on an operator’s network to service a potential IoT market. There is sufficient guard space between 3G or 4G carriers for multiple standalone narrowband carriers and operators will have the choice to incorporate in-band Cat-NB1 carriers in future 900 MHz LTE deployments.

The conclusion is that a 5 MHz block-based configuration is no barrier to deploying NB-IoT technologies if operators wish to do so, and therefore has little bearing on the threshold question of whether or not reform is necessary. In simple terms, the status quo is conducive to some 3G or 4G deployments plus a number of standalone NB-IoT carriers, with some spectrum likely to be leftover. This would be inefficient and not conducive to achieving the optimal use of the band.

By contrast, the proposed 5 MHz-based configuration would be conducive to both band-wide 4G (or 3G) *and* NB-IoT (concurrently if an operator so wishes), thus optimising technical efficiency, the value of the use of the band and ultimately the public benefit derived from its use, consistent with the object of the Act*.*

## Licensing considerations

As described above, the 890–915/935–960 MHz band is currently apparatus-licensed to Telstra, Optus and Vodafone. This is an exception to the general rule that MNOs are usually issued with spectrum licences to authorise the operation of commercial mobile broadband services. It came about because arrangements in the band, one of the very first to accommodate cellular mobile services in Australia, pre-dated the current licensing system.

In more recent times, frequency bands used for cellular services have almost always been spectrum-licensed.[[16]](#footnote-16) This is done for a number of reasons, but in essence because spectrum licences have inherent attributes that provide operators with the flexibility and long-term certainty and security to plan and manage their networks in a way that best meets their business needs, as well as a technology-neutral path to upgrading networks in response to evolving standards.

These attributes include licence duration of up to 15 years—apparatus licences can only be issued for a maximum period of five years—and greater flexibility to trade licences between operators, as spectrum licences may be sub-divided or aggregated. These attributes facilitate market-driven optimisation of frequency bands. For these and other reasons, operators themselves prefer spectrum licensing regimes and have informally indicated that they would support migrating to spectrum licensing in the 890–915/935–960 MHz band.

While apparatus licences can also be traded, this trading is hampered by an inability to trade sub-divided lots within apparatus-licences. There are potential work-arounds for this—for example, if licensees were able to agree on terms to trade parts of their apparatus licences, the ACMA could consider whether it was in the public interest to facilitate the transaction by swapping out the present licences for multiple apparatus licences configured so as to allow the trade to be put into effect. Unlike the situation with spectrum licences, however, this model obviously depends on intervention by the ACMA.

All of the *Options that may achieve the objectives* set out in this paper would result in a change from apparatus to spectrum licensing, with the exception of the ‘status quo’ option.

## Pricing considerations

Licensees are currently paying a price of approximately $26 million each per year (equivalent to $0.47/MHz/pop for a 15-year licence).[[17]](#footnote-17) This price is not market-determined or market-equivalent (that is, determined by estimates of opportunity cost). Where administrative pricing of a band is considered appropriate, the price should in general be related to market value in order to promote efficient spectrum use. This principle underpins historical ACMA interventions to review the administrative pricing of bands, most recently in the ACMA’s work on 400 MHz and Ka-band licence fees. It is also consistent with the recently completed Spectrum Review. The Spectrum Review recommended new legislation providing for greater market-based activity, which may include more market-determined, or market-equivalent, pricing. The Spectrum Review’s *Potential Reform Directions* paper stated:

Prices for spectrum should in general be market‐based to incentivise efficient use and encourage spectrum to move to its highest value use.

Consideration of this principle suggests that current administrative pricing of spectrum in the 890–915/935–960 MHz band may be problematic because incumbents are currently paying an equivalent price of $0.47/MHz/pop, substantially less than the estimated market value (assuming an appropriately-configured 15-year licence) of between $1.00 and $1.36/MHz/pop.

The likely significant heterogeneity of utility and value of the five notional 5 MHz lots within the band, previously discussed in the [*Practical implications for the 890–915/935–960 MHz band*](#_Practical_implications_for) section, would need to be addressed in any reform option that required administrative determination of market-equivalent pricing of the band.

# Objectives

Many current uses of spectrum enjoy continuing growth and new services are continually being developed. Both the growth in demand for existing services and the changing uses of spectrum need to be supported within what is a finite resource, which is largely already assigned to existing users. The challenge for spectrum managers is to facilitate changes in spectrum use in an environment where the rate of technology change is intensifying. Meeting these challenges requires careful planning and the need to make balanced decisions about spectrum use.

The ACMA plans and regulates spectrum use in Australia. This includes monitoring compliance with licensing requirements and investigating complaints of interference to services. The ACMA runs a continual program of critical evaluation of demand and spectrum access requirements across all sectors to better understand the complex and dynamic interaction of social, economic and technical factors that drive spectrum requirements.

The ACMA’s spectrum management framework includes the object of the Act and the *Principles for spectrum management* (the Principles).[[18]](#footnote-18) The key theme of both the object and the Principles is to maximise the overall public benefit derived from use of the radiofrequency spectrum. These are described in the *Legislative and policy environment* section of this paper.

The Principles aim to be consistent with good regulatory practice as they provide guidance and directions that assist the ACMA in its decision-making. For the reasons set out in the *Problems* chapter, the current licensing arrangements in the 890–915/935–960 MHz band are not consistent with the abovementioned parts of the object of the Act or the Principles. To ensure that it is promoting the objects of the Act and the Principles outlined above, the ACMA is reviewing these arrangements, as well as how access to the band is authorised.

The policy objective of this review, expressed at its broadest and simplest, would be to ensure that the band is able to be allocated to its highest value use in Australia and the public benefit derived from the band is being maximised (object (a); principles 1 and 2).

## Total welfare standard

The ACMA uses a total welfare standard as its overarching framework when assessing the optimal approach to individual spectrum management issues. As such, in considering the highest value use for a given spectrum band, the ACMA considers the impact that a change in use would have on all parties in the economy. Importantly, this will include not only an assessment of those costs and benefits that can be readily calculated, but also those costs/benefits that are more intangible and may be harder to quantify.

## Objectives for the broader review of the 803–960 MHz band

To guide the broader review of the 803–960 MHz band, the ACMA developed, in conjunction with stakeholder feedback, key high-level objectives which are consistent with the aforementioned guiding elements. These objectives were as follows:

* improve the allocative, technical and dynamic efficiency of arrangements in the band by reviewing the relevant planning and licensing mechanisms
* align planning and licensing arrangements with current and anticipated demands, and support international harmonisation and the latest technologies
* incorporate spectrum in the upper part of the digital dividend (803–820 MHz), which is not being included in the initial 700 MHz band allocation, to expand services in the 800 and 900 MHz bands

improve the utility and flexibility of the band.

The reorganisation of the 890–915/935–960 MHz was removed from the scope of the broader review, but remains a vital component in meeting the above objectives.

## Criteria for optimising the use of the 890–915/935–960 MHz band

In order to inform the relative net benefits of the options under consideration for reorganising the 890–915/935–960 MHz band, it is necessary to identify a set of criteria to analyse each of the options against. The ACMA proposes to have regard to a set of public interest criteria previously used to guide the exercise of the minister’s power, under subsection 82(3) of the Act, to determine a specified class of services for which re-issuing [expiring] spectrum licences (or ESLs) (in the 800 MHz, 1800 MHz, 2 GHz, 2.3 GHz, 3.4 GHz and 27 GHz bands) to the same licensees would be in the public interest. The explanatory statement to the Radiocommunications (Class of Services) Determination 2012 provides that in making that determination, the minister had regard to the following public interest criteria:

1. promoting the highest value use (HVU) for spectrum
2. investment and innovation
3. competition
4. consumer convenience
5. determining an appropriate rate of return to the community.

It is considered appropriate to have regard to this criteria for present purposes because:

* licensees are familiar with the public interest test criteria used in the ESL context

the criteria are more targeted than the relatively broadly articulated objects of the Act (as set out in section 3).

Notwithstanding that the process for reconfiguring the 890–915/935–960 MHz bands is a different matter to the exercise of the minister’s power to issue a determination under subsection 82(3) of the Act, both matters raise common public policy questions, including whether it is preferable to re-issue (administratively-priced) long-term licences for mass-market mobile broadband services to the present holders of the spectrum, or to allow the existing licences to expire and auction new long-term licences to the highest bidder.

The context that led to the making of the Radiocommunications (Class of Services) Determination 2012 was that the relevant ESLs had a fixed-licence term and expiry date, meaning that the decision over re-issue or re-auction had to be made before a certain date, and the minister’s options were restricted to whether it was in the public interest for new spectrum licences to be issued to the current holders. In contrast, the 890–915/936–960 MHz band licences are apparatus licences of one year’s tenure and as such may be renewed indefinitely at the ACMA’s discretion.

Other options for effecting change in the licensing arrangements in the 890–915/936–960 MHz bands include conversion of some or all of the apparatus-licensed spectrum to spectrum licences (in accordance with Part 2.2 of Chapter 2 of the Act) or the clearance of existing apparatus licences and (price-based) re-allocation of the spectrum to the highest bidder as spectrum licences, pursuant to the processes set out in Part 3.6 of Chapter 3 of the Act.

It is considered that public interest criteria that the minister had regard to in making the Radiocommunications (Class of Services) Determination 2012 are similarly useful for evaluating the impact of each of the options to achieve a reconfiguration of the 890–915/936–960 MHz band—with two important qualifications.

The first is a simple semantic issue. The term ‘highest value use’ is used to describe a hierarchy of broad usage types and may inform decisions to effect a change of use (that is, refarming) between types. In this case, however, the 890–915/935–960 MHz band exclusively accommodates a single usage type, being mobile, which isn’t going to change as a result of these reforms. What will change is the ability to optimise capacity delivery through a change of *technology*; that is, the objective is to improve the efficiency of the existing use of the band. To that end, criterion 1 has been re-expressed as *promoting the most efficient use of spectrum.*

The second, more substantial qualification concerns the fifth criterion in the ESL process, *determining an appropriate rate of return to the community.* In the present context, the ACMA considers that this criterion is subordinate to, or implicit in, criterion 1 (most efficient use). As previously discussed, the ACMA takes as a planning principle that where administrative pricing of a band is considered appropriate, the price should in general be related to market value in order to promote efficient spectrum use. In the absence of further guidance from the Object of the Act, the ACMA considers that the market price obtained for the band or, if administratively allocated, the best estimate of the market price, represents an appropriate rate of return for the community.

As market pricing of spectrum is a way of encouraging spectrum to move to its highest value use, the issue of rate of return to the community has been subsumed into consideration of options against the first criterion (promoting efficient use of spectrum). Once criterion 5 is subsumed in this way, the resultant set of criteria for evaluating options for achieving the optimal use of the 890–915/935–960 MHz band are:

1. promoting the most efficient use of spectrum
2. investment and innovation
3. competition
4. consumer convenience.

In the 890–915/935–960 MHz context, the importance of each criterion to the overall objectives vary. While setting quantitative weighting values for each criterion would be, to some degree, arbitrary, and therefore not an appropriate means of assessing the options set out in this paper, it can be considered that the criteria are listed in descending order of importance, that is, *promoting the most efficient use of spectrum* can be considered the most significant of the above criteria to achieving the optimal use of the band.

The *Assessment of options* in this paper has been carried out against each of the above criteria individually and does not prioritise one over the other, however this loose hierarchy of criteria has been taken into account when selecting the *Preferred options*.

Criterion 1 can be seen as the one that is the closest aligned with object of the Act and is most central to the broad ‘optimal use’ objective of these reforms. *Promoting the most efficient use of spectrum* would result from moving to a 5 MHz block-based plan with as large contiguous allocations as possible (and with no spectrum unallocated/unused). There are several ways this might be achieved through changes to regulatory arrangements in the 890–915/935–960 MHz band, including appropriately designed price-based allocations, and/or ensuring the spectrum prices (licence fees) are reflective of the market value for spectrum. (In the case of price-based allocation options, it is noted that combining this with price-based allocations for other substitutable or complementary spectrum assets is liable to further promote the object of the Act.)

*Investment and innovation* remains an important criterion, as long-term certainty of access to this band should encourage significant investment in 4G network infrastructure. Maximising the scope for investment and innovation would result from moving to a 5 MHz block-based plan in as timely manner as possible, and with spectrum licences (or equivalent) accompanied by well-defined tenure and conditions.

*Competition* is always an important criterion when considering spectrum allocations for commercial services, however, it is not as critical in the context of achieving the optimal configuration of a long-standing band in which the predominant technology is being phased out by incumbents. In addition, competition is not a specific objective outlined in the objects of the Act. To some extent, the downstream competition impacts are captured under the first object of the Act—a spectrum allocation that results in a substantial lessening of competition in the downstream market is unlikely to be an allocation that maximizes the overall public benefit derived from using the radiofrequency spectrum (that is, the efficient allocation and use of the spectrum).

Fostering of competition might better facilitate engagement in the market for 890–915/935–960 MHz spectrum by non-incumbents and might work to better equalize (comparable) spectrum holdings between MNOs. Engagement by non-incumbents would be best promoted through the selection of allocation options that involve loosening incumbents’ property rights on holdings in the band, such as clearing the band and allocating it via a competitive process.

*Consumer convenience* can be optimally achieved through selection of allocation options that either pre-allocate spectrum to incumbents (including a status quo option) or encourage secondary market action. In the ESL context, consumer convenience largely described service continuity and the relative impacts of each option on access to networks by subscribers. In the 890–915/935–960 MHz band context, this is expected to be less relevant, as:

* the switch-off of 2G networks will result in a degree of service discontinuity (degree varies between MNOs) that is common to all reconfiguration options

the significant multi-band holdings of all MNOs currently providing a service in the 890–915/935–960 MHz band significantly mitigate the risk of discontinuity of service if access to 890–915/935–960 MHz is lost. (Note that this does not apply to 2G-only subscribers, however as per the above point, these users will be equally affected regardless of reconfiguration option).

# Options that may achieve the objectives

There are a range of options for reform that could potentially involve varying degrees of government intervention and/or dependence on market mechanisms to solve the problems described in this paper. Each of these options have their own complexities and implications, with some aspects requiring ministerial involvement.

By default, the ‘no change’ option must be considered in this analysis—that is, the existing spectrum holdings would remain apparatus licensed and administratively priced.

Three conventional options have been identified:

* **Option 1: Status quo**—No change to existing licensing arrangements.
* **Option 2: Trading**—Convert to spectrum licences with administratively-set prices and rely on trading in the spectrum market to obtain optimal band configuration.

**Option 3: Price-based allocation (PBA)**—Band clearance and reallocation by price-based allocation.

Options 2 and 3 are essentially bookend options, that is, the most pure and historically well-understood methods of achieving this type of reform, however, they both have their advantages and disadvantages. So, in addition to the above options, an effort has been made to identify compromises between these options. While there is no perfect way to implement these reforms, it may be possible to identify a ‘best fit’ solution that optimally combines the advantages of the abovementioned reform options. As a result, two further options have been identified, being a slightly adjusted combination of options 2 and 3, and a hybrid of the two:

* **Option 4: Reliance on secondary markets with contingencies for reallocation**—This would comprise a two-stage process involving an initial trading period potentially followed by a band clearance and price-based allocation if specific pre-determined reform criteria could not be met during the trading period.

**Option 5: Hybrid**—This would entail allocating a 2 x 5 MHz block to each existing licence-holder and allocating the remaining blocks by a price-based allocation.

# Consideration of options

The information provided in the preceding chapters demonstrates there is evidence that the optimal use of the 890–915/935–960 MHz band has changed as technology has evolved. The ACMA has identified and considered options to ensure that the 890–915/935–960 MHz band is put to its optimal use.

This chapter expands on each of the options outlined in the previous chapter, and provides an assessment of their suitability for meeting the reform objectives. These assessments have been made against the criteria set out in the *Objectives* chapter. A synopsis of these assessments is provided in this chapter—a more detailed examination of each option against each specific criteria is contained in *Appendix 1: Impact analysis of allocation options*.

## Description of options

### Option 1: Status quo

The status quo is retaining the current licensing and pricing framework for the band. The key characteristics of the status quo are:

* Bandwidth configuration—The current 890–915/935–960 MHz allocations are not of optimal size for the deployment of 4G technologies across the entire band.
* Licensing issues—The band is currently apparatus licensed, and under embargo with the condition that licences are renewed for no longer than one year. All incumbent operators agreed that certainty is critical and that the 890–915/935–960 MHz band should be spectrum licensed.

Pricing—Licensees are currently paying a price of approximately $26 million each per year (approximately $78 million per annum in total). This price is not market‐determined or market‐equivalent (that is, determined by estimates of opportunity cost). Nevertheless, the size of the fees are significant, comprising over half of the Commonwealth’s total revenue arising from the issuance of apparatus licences under the Act.

### Option 2: Reliance on secondary market

This option relies on trading in the spectrum market to obtain optimal band configuration. This would entail making a recommendation to the government to convert the existing 8.4 and 8.2 MHz apparatus licences to spectrum licences, and then enabling the incumbent licence holders to, over time, trade spectrum holdings (or compensation as applicable) to achieve spectrum blocks that are conducive to industry’s preferred deployment model (presumably 4G).

The Spectrum Review report recommended to replace the current legislative framework with legislation that ‘… facilitates … trading of spectrum’.[[19]](#footnote-19) However, this option also includes some government intervention in the form of administrative pricing. This is considered below.

Market considerations

Any option that provides for an outcome that is consistent with the 4G bandwidth configuration is likely to provide for significant net benefits for MNOs and society in general. However, this option depends upon the functioning of the secondary market for spectrum to achieve this optimal configuration. It is therefore necessary to consider the nature of the market for 890–915/935–960 MHz spectrum, and the likelihood that the outcome can be achieved.

The key risk associated with Option 2 is that MNOs will not be able come to a mutually-acceptable negotiated outcome, with the potential outcome being the retention of the current arrangements and not meeting the reform objectives. It is not possible to definitively estimate the likelihood of these risks being realised, however, the following paragraphs attempt to tease out some of the key issues at play.

A secondary risk is that, as a result of non-incumbents not being directly engaged in the refarming process, a potential new high value user may be precluded from accessing the spectrum.

Market elements that may enable trading

There are clear incentives that exist for licensees to trade in order to achieve the assumed optimal bandwidth configuration. Moving to a more functional bandwidth configuration is likely to generate increases in productive efficiency in the band, which in turn increases the quality of services that can be deployed through the use of the band, and therefore the revenue earning potential of licensees. It follows that licensees would have some level of willingness to pay or accept that would be necessary to undertake trading.[[20]](#footnote-20)

Market elements that may preclude trading

The key elements that may mean licensees would be unlikely to successfully trade might include:

* a single 2 x 5 MHz block is of some, albeit limited utility for deploying an LTE network
* diverging views between licensees on what represents a mutually-agreeable outcome, possibly owing to strategic positioning by one or more licensees

A need to set prices prior to the negotiation taking place, exacerbated by a high degree of uncertainty on the value of the blocks (in both absolute terms and relative to one another).

The latter point owes to the variance in interference potential of different blocks with other bands or services—in particular, the band-edge coexistence issues between the block 1 uplink and the 850 MHz band downlink, and the overlap of blocks 3–5 with the US ISM band (see Chapter 4 of the [decision paper](http://www.acma.gov.au/~/media/Spectrum%20Licensing%20Policy/Information/Word%20Document/The%20ACMAs%20long-term%20strategy%20for%20the%20803960%20MHz%20band_decision%20paper%20docx.docx) for a detailed description).

Past experience has shown that administrative allocations requiring stakeholder consensus can result in delays to allocation. For example, the ACMA played a role in negotiating an allocation of spectrum for MNOs in the 1800 MHz band in regional areas. Despite several years of negotiation, the MNOs were unable to come to a mutually beneficial outcome, and instead the spectrum was auctioned.

### Option 3: Band clearance and price-based allocation (PBA)

Under this option, the entire 890–915/935–960 MHz band would be reallocated via a price-based allocation. This would involve placing a cessation date on existing apparatus licences and making a recommendation to the government to allocate spectrum licences in 5 MHz blocks through a price-based allocation. As with all price-based allocation processes, mechanisms to safeguard competition, such as the imposition of spectrum limits in the auction rules[[21]](#footnote-21), could be applied.

Negative views have typically been based on concerns that revoking licences will:

* result in a lack of certainty of access, which may reduce licensees’ ability to confidently invest in the use of spectrum

increase the risk of disruption to consumer services.

There is no Australian precedent for revoking the rights of telecommunications carriers in bands used for the provision of mobile services, with the spectrum then put back up for allocation for use by the same sector. The previous government considered these issues as part of the ESL, but this resulted in policy decisions to re-issue existing spectrum licences where licensees were able to show use of the spectrum, rather than putting the new licences to auction.

However, in those cases the bands were both already spectrum-licensed and appropriately configured, so their relevance to the 890–915/935–960 MHz context is limited. In any case, the underlying rationale for the abovementioned policy decisions had much to do with protection of consumers from disruption in bands in which mass-market technologies had been deployed. While this latter point has some relevance here, it is significantly mitigated by the current 2G switch-off timetable.

In any case, a key benefit of this option would be achieving the optimal band configuration in a timely manner, while at the same time enabling access to the band by operators who value it the highest (and would thereby put it to its highest value use).

### Option 4: Reliance on secondary markets with contingencies for reallocation

This would essentially be a two-stage process to achieve the desired band configuration. Stage 1 would be an implementation of a trading period with a finite time limit (indicatively one or two years, but this remains an open proposition). Trading would be enabled through an immediate[[22]](#footnote-22) reconfiguration of the existing apparatus licences by the ACMA, into licence blocks that could readily be traded into the desired configuration (nominally 5 and 3.4 MHz paired block licences to Telstra, 1.6, 5 and 1.8 MHz paired block licences to Optus, and 3.2 and 5 MHz paired block licences to Vodafone).

If, by completion of the trading period, an agreement on a satisfactory reconfiguration had been reached, the ACMA could consider whether it was in the public interest to recommend to the minister that the reconfigured apparatus licence holdings should be converted to spectrum licences. In the absence of agreement, the option of clearance and reallocation of the spectrum via price-based allocation would remain.

A potential variation on this option could involve converting the existing apparatus licences to short-term (that is, for the duration of the trading period) spectrum licences to facilitate trading. Under current law, this would be much more complex to set up (and again, subject to agreement by the minister to adopt ACMA recommendations to convert). The option of reconfiguration of apparatus licences is seen as the simplest way of enabling trading during the initial trading period. Under either approach, a threshold question would be whether, how and with what level of legal certainty a ‘trigger’ for moving to a clearance and price-based allocation (if necessary) could be constructed and signalled to spectrum incumbents in advance.

This would be the first time such an approach had been used in Australian spectrum management, and would require careful consideration against both current and future legislative environments. Any process of conversion of apparatus to spectrum licences would also require consideration of an appropriate spectrum access charge for the licences.

In general, Option 4 would have the benefit of freeing incumbents to trade their way to improved configuration while mitigating some of the risks associated with Option 2.

Market considerations

As with Option 2, the timely success of this option would partially depend on incumbents being able to come to a mutually beneficial outcome, and the nature of the market might impact the ability of a trading solution to be achieved.

Market elements that may enable trading

As with Option 2, there would be obvious incentives for licensees to trade in order to achieve an optimal band configuration. Moving to a more functional configuration would improve technical and allocative efficiency in the band, which would improve the quality of service delivered to the community, and by extension, the revenue earning potential of MNOs. It follows that licensees would need to reach an agreement based on a market-determined willingness to pay or surrender some/all of their holdings to reach a mutually-agreeable trade.

Under this option, trading may be more likely to achieve the desired reconfiguration outcome than Option 2 if there is a finite time limit placed on the trading period. Willingness to trade in this period would be guided by an assessment of the potential risks and benefits associated with trading against those of Option 3.

The retention of annually-renewed apparatus licensing during the trading period might also provide scope for the ACMA to apply some incentivisation measures to further encourage trading. This might include an increase, or stepped increases, in licence fees towards a price reflecting the market value of the lots if optimally reconfigured.

Market elements that may preclude trading

As described under Option 2, there are a range of reasons why licensees might not ultimately agree on a mutually beneficial outcome. An additional risk with Option 4 is that one or more licensees may conclude that a band clearance and price-based allocation would be a better outcome than could be obtained through trading. This will necessitate that Option 4 is carefully designed in a way that government discretion isn’t fettered when it comes to determining if/when a price-based allocation might ensue if agreement could not be reached.

There would also be some design challenges associated with ensuring that there is no uncertainty around the ultimate price structure during the trading period. A core premise of this option is that the issuing of spectrum licences would essentially be delayed. It is likely that the ultimate price would be reflective of ‘market value’ for 3GPP-standardised sub-1 GHz spectrum, of which there are numerous comparable data points described in this paper and elsewhere. However, unless there were clear signals of what the ultimate conversion price might be, at least in approximate terms (and relative to the price that might be paid if the band was put to a price-based allocation), the secondary market would not be able to engage with any confidence. This would likely be highly detrimental to trading, so heading this off would be critical to the success of the option.

### Option 5: Hybrid of options 2 and 3

The intent of this option is to afford incumbents with a measure of certainty by administratively allocating (via spectrum licence, subject to ministerial adoption of ACMA recommendations to do so) a 2 x 5 MHz block to each carrier; and recommending that the government allocate the remaining blocks by price-based allocation (totalling 2 x 10 MHz). The initial allocation could be effected in a number of ways—two of which are described below:

* **Option 5a**—Administrative allocation (via conversion to spectrum licensing) of a 2 x 5 MHz block to each of the three incumbent licensees, the lower (block 1), middle (block 3 as a starting point—see below) and upper (block 5) to Telstra, Optus and Vodafone respectively, and putting the intermediate (blocks 2 and 4) blocks to market (see Figure 3 in the *Current arrangements* section of this paper for a description of block numbering).

**Option 5b**—Same as Option 5a, but instead of an administrative allocation of three blocks, the order in which they are allocated would be determined by a market allocation process—that is, each carrier would be guaranteed 2 x 5 MHz, but would need to compete for which block they obtain.

A possible implementation option for both of the above variations might involve deferring finalisation of specific frequency block allocations until after the auction, so as to ensure holdings remain contiguous. Under this scenario, the frequencies allocated to the holder of the ‘middle’ position in the band (Optus under Option 5a or any of the three operators under Option 5b) might not be finalised until after the remaining 2 x 10 MHz had been sold.

This could be one possible means of ensuring contiguity in the case where one of the operators in either block 1 or 5 acquired a large amount (or all) of the remaining spectrum. For example, if, say, the holder of block 1 successfully acquired all of the remaining spectrum, they would be allocated the lower 2 x 15 MHz (rather than being allocated the lower 2 x 10 MHz and 2 x 5 MHz in block 4) and the other two operators would be allocated block 4 and block 5.

## Assessment of options

[*Appendix 1*](#_Appendix_1:_Impact) contains detailed assessments of each of the above options against the criteria set out in the *Objectives* chapter. These assessments are summarised in Table 1.

1. Summary of the consistency of options with the reform objectives

| **Option** | Promoting the most efficient use of spectrum | Promotes investment and innovation | Promotes competition | Promotes consumer convenience |
| --- | --- | --- | --- | --- |
| **1. Status quo (non-reform option)** | * This option would retain the current apparatus licensing regime—doesn’t encourage trading to the same extent as spectrum licensing. * MNOs would continue to be unable to deploy LTE channels wider than 2 x 5 MHz each. * A total of 2 x 10 MHz in the band would have little utility post 2G-switchoff. * This option would preclude a new market entrant. * The current licence fees are likely to be less than market value (in comparison to prices paid for substitutable spectrum), therefore there is a reduced incentive for spectrum to be used efficiently. | * Retention of the current band configuration would continue to stifle investment. * Retention of apparatus licensing may not offer the required certainty of tenure, therefore investment confidence may not be optimal. | * Each of the three incumbents would be likely to retain their current holdings within the band. As such, there would be no change to downstream competition. * Under the status quo, non-incumbents are not encouraged to enter the market. | * A degree of service discontinuity is inevitable, regardless of reconfiguration outcomes, given 2G services will be switched off within the next 12 months. In this particular band, the degree of discontinuity will vary between incumbents, depending on whether they operate a combination of 2 and 3G services or just 2G in the band. * No change to spectrum arrangements would mean that MNOs do not incur additional costs associated with altering networks to ensure consumers have service continuity. |
| **2. Trading (reform option)** | * Under this option, conversion to spectrum licensing would confer improved certainty of tenure and improve investment confidence. * This option would enhance licensees’ ability to trade towards the optimal bandwidth configuration. * This option carries a risk that a mutually acceptable outcome might not be reached, with the potential outcome being the retention of the current inefficient arrangements. * This option would not encourage new market entrants but nor does it preclude them. * Administrative pricing would likely achieve a lower price than a market determined price, therefore reducing the incentive for spectrum to be used efficiently and/or traded. | * As with all reform options the licensees would be provided with spectrum licences, which would confer improved property rights and investment certainty (relative to Option 1). * If trading towards the optimal configuration were unsuccessful, the incentive to invest in the band would continue to be stifled. | * This option would not reduce competition in downstream market. * However, this option would not directly encourage engagement by non-incumbents, which would have the effect of inhibiting the promotion of competition in the downstream market. | * With the exception of services that are reliant on 2G (which becomes a moot point post-2G switch off), the risk of service discontinuity is low as MNOs are unlikely to trade spectrum if it resulted in disruption to their customers. |
| **3. Clearance and price-based allocation (reform option)** | * Under this option, conversion to spectrum licensing would confer improved certainty of tenure and improve investment confidence. * This option would ensure that the spectrum was put to its optimal use in a timely manner. * This option would better encourage new market entrants than any of the other options. * This option would be most conducive to reaching a spectrum price which reflects the market value—assuming all of the spectrum was sold (necessitating realistic reserve pricing)—which will encourage the efficient use of spectrum. | * As with all reform options the licensees would be provided with spectrum licences, which would confer improved property rights and investment certainty (relative to Option 1). * The timely reconfiguration resulting from this option would increase incumbents’ preparedness to invest in infrastructure in the band (relative to Option 2). | * This option would better encourage (relative to Option 2) participation in the market by non-incumbents. * An incumbent could lose its spectrum holdings in the 890–915/935–960 MHz band, which may impact its competitive position in the downstream market. * There are potential sensitivities associated with removing or varying the long-standing rights of licensees in the band, although these are in-part offset by the fact the band is in the process of undergoing a ‘natural’ change of use (2G->3/4G). | * The risk of disruption to customers due to failure of retaining spectrum in the band is likely to vary depending on the reliance a MNO has on this band. If a MNO relies on the band for coverage for a particular service (i.e. has no other sub-1 GHz access for that service) then there is a risk of service degradation. Conversely, if other bands are more heavily relied on for coverage and capacity the risk is low, at worst capacity might be slightly degraded and/or coverage in remote areas may be temporarily affected. |
| **4. Trading then clearance/price-based allocation (reform option)** | * Under this option, the potential to ultimately convert to spectrum licensing could confer improved certainty of tenure and improve investment confidence. * This option might result in increased incentives to trade towards the optimal configuration (relative to Option 2). * Implementation of this option might be subject to gaming if strict conditions and success indicators are not in place. * This option would provide a chance to test the secondary market with safeguards in place to ensure the optimal band configuration is ultimately achieved. * If a price-based allocation were to become necessary, the delay attributed to the failed trading period would result in attendant losses in economic welfare. * If the initial trading period were to be successful, the impact that spectrum price has on spectrum efficiency would be consistent with Option 2. * If trading were to fail and an auction process invoked, the impact that spectrum price has on spectrum efficiency would be consistent with Option 3, albeit realised at a later date (owing to the delay attributed to the initial trading period). | * As with all reform options the licensees would be provided with spectrum licences, which would confer improved property rights and investment certainty (relative to Option 1). * The guaranteed reconfiguration resulting from this option, would increase (relative to Option 2) incumbents’ preparedness to invest in the infrastructure in the band. * The potential two-stage nature of this option means that certainty would be delayed by the duration of the initial trading period. | * If the trading period were to be successful, the impact on competition would be consistent with that outlined in Option 2. If an auction were to be required, the impact on competition would be consistent with to that outlined under Option 3, albeit with a delay of a number of years. | * If the trading period were to be successful, the impact on customer convenience would be consistent with that outlined in Option 2. If an auction were to be required, the impact on customer convenience would be consistent with that outlined under Option 3. |
| **5. Hybrid (reform option)** | * Conversion to spectrum licensing would confer improved certainty of tenure and improve investment confidence. * This option would result in fragmentation, which is not the most efficient (and by extension the highest value) use of the band. * The coexistence between administratively and market-set prices would put new market entrants at a significant disadvantage, possibly to the extent that they would not participate in the price-based allocation process for the two lots not administratively allocated. Disenabling a new entrant may inhibit spectrum being used in its highest value use. * Administrative pricing of three blocks would likely achieve a lower price than market value, therefore reducing the incentive to use these blocks efficiently. | * As with all reform options the licensees would be provided with spectrum licences, which would confer improved property rights and investment certainty (relative to Option 1). * This option would provide incumbents with certainty of ongoing tenure within at least part of the band. * However, the likely fragmented band configuration that would result from this option would be likely to undermine investment confidence. | * All incumbent licensees would retain access to at least one lot, so this option is unlikely to reduce competition in downstream market. * While it would be feasible for a non-incumbent to bid for the 2 x 10 MHz subject to price-based allocation, they would be at a significant (potentially prohibitive) disadvantage with respect to incumbents. This owes to inequities resulting from mixing administratively-priced (pre-allocated to incumbents) and market-priced (through price-based allocation) blocks in the band. | * All incumbent licensees would retain access to at least one block, so this option is unlikely to impact customer convenience. |

## Preferred options

Based on the assessments of options provided in [*Appendix 1*](#_Appendix_1:_Impact) and summarised above in Table 1, the two options that are preferred by the ACMA at this stage are options 3 and 4.

**Option 3** would involve clearing the 890–915/935–960 MHz band and recommending to the government that spectrum licences be issued via a price-based allocation. This would maximise the likelihood of the spectrum moving to its optimal use and user, and enable prices to be determined by market forces—important given the inherent uncertainty associated with the value of spectrum generally and the significant heterogeneity of lot values within the particular band. It would also be the most likely option to encourage market participation by non-incumbents.

This option would carry a higher risk (relative to other options) of an incumbent potentially losing access to 890–915/935–960 MHz spectrum, which could adversely affect its competitive position in the downstream market. While the implications of this risk for operators is unknown (input is sought on this later in the paper), it is understood that they will vary between incumbents depending on the multi-band spectrum holdings that each incumbent MNO possesses. Any risk to service continuity could be partially mitigated by the diverse spectrum portfolios held by incumbents. This mitigation is common to all reform options (including Option 4 described below).

There may also be sensitivities involved with revoking the rights of telecommunications carriers in bands used for the provision of mobile services, with an end-date placed on the existing licences and the spectrum meanwhile put back up for allocation for long-term use by the same sector and for the same purposes (albeit using more evolved technologies). There have been previous instances where the government has considered either reallocating or reissuing licences in an MNO-encumbered band. In each of those (few) cases, a policy decision was taken by the government to reissue the licences.

However, in those cases, the bands were both already spectrum-licensed and appropriately configured, so their relevance to the 890–915/935–960 MHz context is limited. In any case, the underlying rationale for the above-mentioned policy decisions had much to do with protection of consumers from disruption in bands in which mass-market technologies had been deployed. While this latter point has some relevance here, it is significantly mitigated by the current 2G switch-off timetable.

With that in mind, while any option involving a clearance and market-based allocation is likely to have a higher impact on industry and consumers than those that involve some retention of incumbents’ rights, the current transition between technology evolutions means that this impact is likely to be low at present. Put simply, the 2G switch-off may present an opportunity to effect a band clearance and reallocation, with fewer of the negative impacts on consumer convenience that might otherwise occur in a band where the dominant technology’s service life still has a long way to run.

Generally speaking, when deciding how to re-allocate expiring spectrum licences, decisions about whether to re-auction or re-issue licences are typically informed by a balanced assessment of risk of investment uncertainty (which in this band is moot given that there is an embargo on licence renewals in place) and customer service discontinuity.

However, auctions can be useful where there is uncertainty over the optimal use of the spectrum, for example, when there is interest from a non-incumbent. In the context of the 890–915/935–960 MHz band, this may suggest that Option 3 might be a preferred allocation method.

The other current ACMA-preferred option is **Option 4**, which would provide for a two-stage process to achieve the desired band configuration. Stage 1 would allow for licensees to trade appropriately reconfigured apparatus licences, but within a finite time limit. If licensees were unable to agree to a mutually beneficial outcome, then stage 2 could be invoked. Stage 2 would be consistent with Option 3—involving clearance of the band and a recommendation that the government issue spectrum licences via a price-based allocation.

This conditional strategy has to date not yet been applied in the Australian spectrum environment, but is topical in the context of the current review into spectrum management in Australia, as it would provide the government with an opportunity to test (and industry with an opportunity to demonstrate) the ability of the secondary market to work under controlled conditions.

There would be obvious incentives for licensees to trade in order to achieve the assumed optimal band configuration—moving to a more functional configuration would increase the technical efficiency, and by extension, the revenue-earning potential of spectrum holdings. Under this option, the potential for a clearance and price-based allocation process may provide additional encouragement to engage in the trading process.

If trading during stage 1 were to be successful, the impact would be consistent with that described under Option 2. Notably however, this option would not necessarily represent an impediment to the MNOs assembling large holdings within particular bands, as there would be scope for licensees to do multiband trades (as with Option 2).

It is likely that the success of the trading period would depend upon all incumbents negotiating in good faith to come to an agreed outcome. This represents a key risk of this option, and appropriate safeguards would need to be engineered to ensure that the system could not be gamed to force a clearance/price-based allocation. To that end, the criteria for invoking a clearance/PBA (stage 2) would need to be well-designed and encourage engagement between incumbents in the negotiation process.

The advantage of this option is that it would provide MNOs with the ability and encouragement to trade their apparatus licences towards the preferred configuration, while maintaining the potential to clear and reallocate the band as a means of safeguarding against failure. A secondary advantage might also be that, having elements of options 2 and 3, consumer disruption could be minimised as a result both of trading outcomes being reflective of MNOs’ sunk costs and the abovementioned argument that the 2G switch-off and its effect on the (relative) service continuity between options.

On the other hand, the deferral of a government decision on reallocation would likely introduce a degree of residual uncertainty about what might ultimately transpire at the completion of the trading period. A corollary is that an incumbent who might prefer to bid for spectrum at an auction might choose to play a waiting game and not engage in the trading (this in itself would be risky given it would be presumptive of a ministerial decision that may or may not eventuate). Furthermore, under this option, a new market entrant would not be directly encouraged to participate unless the band was cleared and subject to a price-based allocation. Lastly, as suggested in the *description of Option 4*, it might be necessary to pre-determine prices for converted licences (assuming successful trading outcomes) to enable participation in trading by incumbents during stage 1.

# Conclusion

Reconfiguring the 890–915/935–960 MHz band is a high priority for the ACMA, as the current arrangements are inefficient and not conducive to deriving the optimal public benefit from its use. 4G mobile broadband services are a key productivity enabler, and international standardisation in the band means that 4G deployments represent its optimal use.

The misalignment between the number of incumbent licensees and the number of blocks in a 4G-optimised band means that achieving the reconfiguration is a complex process. The ACMA, in consultation with government and affected stakeholders, has been examining a range of allocation options to bring about these changes against a range of criteria to ensure that a) they are brought about in the least disruptive manner as possible, and b) they result in a reconfiguration that optimises the public benefit derived from the use of the band into the future.

This paper was put together to show both the thinking behind this process and the ACMA’s leanings on which options might be preferable in a transparent manner. These preferences in no way represent a decision—they are simply provided to give stakeholders some visibility on the ACMA’s current disposition in considering this matter. A final decision is expected to be made in early 2017.

# Invitation to comment

The ACMA invites comments on the issues set out in this discussion paper or any other relevant issues. In particular, interested stakeholders are encouraged to provide answers to a range of questions:

* Are the reform options presented in this paper appropriate, and are there any implementation issues or suggestions that haven’t been identified?
* What are the consumer implications of the options presented? In particular, how would options that would involve a clearance of incumbent operators affect industry and consumers?
* Are there any other options that may have been overlooked?
* Are the criteria against which the options have been examined appropriate?
* Are there any other additional criteria that should be included in this analysis?
* Are the preferred options (options 3 and 4) identified in this paper appropriate to meet the reform objectives?
* If not, which of the alternative options would be more appropriate?
* If so, is there a clear preference between option 3 and 4?

## Making a submission

* [**Online submissions**](http://www.acma.gov.au/theACMA/Consultations/Consultations)—submissions can be made via the comment function or by uploading a document. The online consultation page provides details.
* **Submissions by post**—can be sent to:

The Manager, Spectrum Planning Section

Spectrum Planning and Engineering Branch

Communications Infrastructure Division

PO Box 78, Belconnen, ACT 2616

**The closing date for submissions is COB, 24 February 2017**.

Electronic submissions in Microsoft Word or Rich Text Format are preferred.

Enquiries

* Consultation enquiries can be emailed to [900MHzreview@acma.gov.au](mailto:900MHzreview@acma.gov.au).

Media enquiries can be directed to Emma Rossi on 02 9334 7719 or by email to [media@acma.gov.au](mailto:media@acma.gov.au).

Effective consultation

The ACMA is working to enhance the effectiveness of its stakeholder consultation processes, which are an important source of evidence for its regulatory development activities. To assist stakeholders in formulating submissions to its formal, written consultation processes, it has developed [*Effective consultation—a guide to making a submission*](http://www.acma.gov.au/theACMA/About/Corporate/Responsibilities/acma-evidenceinformed-regulation-and-effective-consultation). This guide provides information about the ACMA’s formal written public consultation processes and practical guidance on how to make a submission.

Publication of submissions

In general, the ACMA publishes all submissions it receives. The ACMA prefers to receive submissions that are not claimed to be confidential. However, the ACMA accepts that a submitter may sometimes wish to provide information in confidence. In these circumstances, submitters are asked to identify the material over which confidentiality is claimed and provide a written explanation for the claim.

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The purposes for which personal information is being collected (such as the names and contact details of submitters) are to:

* contribute to the transparency of the consultation process by clarifying, where appropriate, whose views are represented by a submission

enable the ACMA to contact submitters where follow-up is required or to notify them of related matters (except where submitters indicate they do not wish to be notified of such matters).

The ACMA will not use the personal information collected for any other purpose, unless the submitter has provided their consent or the ACMA is otherwise permitted to do so under the Privacy Act.

Submissions in response to this paper are voluntary. As mentioned above, the ACMA generally publishes all submissions it receives, including any personal information in the submissions. If a submitter has made a confidentiality claim over personal information that the ACMA has accepted, the submission will be published without that information. The ACMA will not release the personal information unless authorised or required by law to do so.

If a submitter wishes to make a submission anonymously or use a pseudonym, they are asked to contact the ACMA to see whether it is practicable to do so in light of the subject matter of the consultation. If it is practicable, the ACMA will notify the submitter of any procedures that need to be followed and whether there are any other consequences of making a submission in that way.

Further information on the Privacy Act and the ACMA’s privacy policy is available at [www.acma.gov.au/privacypolicy](http://www.acma.gov.au/privacypolicy). The privacy policy contains details about how an individual may access personal information about them that is held by the ACMA, and seek the correction of such information. It also explains how an individual may complain about a breach of the Privacy Act and how the ACMA will deal with such a complaint.

# Appendix 1: Impact analysis of allocation options

This appendix contains an analysis of each of the potential reform *Options that may achieve the objectives* against the reform criteria set out in the *Objectives* chapter. This analysis is summarised in Table 1 of the *Assessment of options* section of this paper. A detailed description of each of these options is contained in the *Consideration of options* chapter of this paper.

## Analysis of Option 1: Status quo

Criteria 1—Promoting the most efficient use of spectrum

As described in the *Problems* chapter, there is a strong evidence base to suggest the deployment of 4G technologies represents the optimal use of the band, meaning a 5 MHz-based bandwidth configuration is key to achieving the optimal use.

In addition, the status quo precludes MNOs from deploying LTE networks utilising more than 2 x 5 MHz (that is, in 2 x 10 MHz, 2 x 15 MHz or 2 x 20 MHz blocks). While it is possible to deploy LTE networks using this increment of spectrum, it is unlikely to be the most cost effective deployment. Network deployment costs do not increase in equal proportion with the amount of bandwidth used. Indeed, many fixed costs associated with network deployments—for example, site survey, build, power supply and site rental—are the same for a 2 x 5 MHz carrier as for a 2 x 20 MHz carrier. In addition, there are potentially significant increases in spectral efficiency associated with wider bandwidth LTE channels. These are key reasons why MNOs prefer wider bandwidth deployments.

In its submission to the *Draft ministerial direction on unsold 700 MHz spectrum[[23]](#footnote-23)*, Telstra noted the likely lack of demand for single 2 x 5 MHz blocks:

Larger contiguous blocks of spectrum allow LTE systems to use the spectrum resource most efficiently and deliver the best speeds and customer experience. Current LTE technology is deployed in increments of 2x5 MHz (for frequency division duplex spectrum) up to a maximum of 2x20 MHz in a single transceiver. It is generally not economic for commercial LTE operators to invest in a single 2x5 MHz block of spectrum as the reduced network capacity and speed associated with the smaller bandwidth does not normally justify the investment.

The LTE carrier aggregation feature can be used to combine smaller blocks of spectrum, either within the same band or across bands, but there is a loss of efficiency due to overheads in the aggregation process. Further, only certain combinations of blocks of spectrum can be aggregated and the number of combinations is limited – because of technology and cost constraints in the user device hardware.

For these reasons, it is highly desirable that allocations of spectrum suitable for commercial LTE use are designed to give operators the opportunity to acquire larger contiguous blocks of spectrum such as 2x10 MHz, 2x15 MHz or 2x20 MHz.

However, the current licensing and pricing arrangements in the band are likely to inhibit trading, which in-turn restricts the band being reconfigured to optimise its use. Current arrangements also hinder the ability for non-incumbents to purchase 890–915/935–960 MHz spectrum in order to enter the market.

As outlined above, apparatus licences are likely to be considered less tradeable than spectrum licences. There is less clarity around the property rights of apparatus licences relative to spectrum licences. For example, it is not clear whether the licensees would be trading one-year licences only, or one-year licences with an option to purchase the subsequent years licences. If it is the latter, there is the obvious difficulty around valuing this future option. This lack of clarity may inhibit trading. Indeed, the spectrum licensing framework—with its increased clarity around property rights—was initially introduced in part to enhance the tradability of spectrum.

Another key problem with this option is that prices are not set by market forces. Licensees are currently paying a price of approximately $26 million each per year. This price is not market‐determined or market‐equivalent (that is, determined by estimates of opportunity cost). Given the relatively low current prices (in comparison to spectrum values in other equivalent bands—see *Appendix 2: Spectrum valuation)*, incumbents do not have a strong incentive to sell.

While the ACMA has a stated policy of using opportunity cost as the basis for setting prices for spectrum, it is not possible to set prices in a way that perfectly reflects market demand and supply—Appendix 2 provides more discussion about difficulties in valuing spectrum accurately. This is especially difficult where spectrum blocks are heterogeneous, as is the case in the 890–915/935–960 MHz band (discussed in the *Problems* chapter). At present, MNOs pay similar prices for spectrum in the 890–915/935–960 MHz band, even though the blocks are heterogeneous. In the absence of incentives driven by varying, market-driven prices, licensees do not face the appropriate incentives to use spectrum efficiently.

However, as 2G networks are switched off, licensees will be paying ongoing licence fees for spectrum that is not used. This may provide an additional incentive to trade spectrum in order to reconfigure the band into more useable blocks—licence fees which more closely align with the market value of the spectrum are likely to strengthen this incentive.[[24]](#footnote-24)

Furthermore, hindering the potential entry into the market by potential non-incumbents, with potentially innovative business strategies or operating models, from participating in a spectrum re-allocation risks not identifying the highest value long-term use of the band.

Criteria 2—Promotes investment and innovation

It is likely that the current bandwidth configuration—largely incompatible with 4G LTE technologies—is stifling investment in infrastructure in the band.

In addition, continuation of apparatus licensing would be less likely than spectrum licensing to provide MNOs with certainty of tenure that would enable them the confidence to undertake investment.

Criteria 3—Promotes competition

Each of the three MNOs has a (roughly) equal share of the band, which would be unlikely to change under the status quo option.[[25]](#footnote-25) In this way, the maintenance of the status quo would not change competition in the downstream market. This is not a comment on the level of competitiveness in the downstream market; rather that the status quo would not directly lead to a change in competition in the downstream market.

On the other hand, the current regulatory and licensing framework is not conducive to potential new (non-incumbent) market entrants from purchasing spectrum in the band, which would by extension assist in entry into the downstream market for mobile communications.

Criteria 4—Promotes consumer convenience

This criteria was included in the ESL process to ensure decision-makers had regard to the potential for customer service disruption. Concerns over the potential for service disruption are key to decisions over whether to administratively renew or re-auction expiring spectrum licences.

The status quo ensures MNOs do not have to incur additional costs associated with altering networks to ensure consumers have service continuity. In this case, the status quo will allow existing networks to continue operating in the band and will provide service continuity. It should be noted that the forthcoming switch-off of 2G technologies means that some existing services will be disrupted, regardless of band reform, and the status quo would partially preclude the deployment of new services post switch-off in the spectrum currently used for 2G. So in that context, the status quo would be more likely to inhibit service continuity than reconfiguring the band.

## Analysis of Option 2: Reliance on secondary market

This option relies on trading in the spectrum market to obtain optimal band configuration. This would entail conversion of existing 8.4 and 8.2 MHz apparatus licences to spectrum licences, and enabling the incumbent licence holders, over time, to trade spectrum holdings (or compensation as applicable) to achieve spectrum blocks that are conducive to industry’s preferred deployment model (presumably 4G).

The Spectrum Review report recommended replacing the current legislative framework with legislation that ‘ … facilitates … trading of spectrum’.[[26]](#footnote-26) However, this option also includes some government intervention in the form of administrative pricing. Relevant market considerations are described in *Option 2: Reliance on secondary market* section of this paper.

### Impacts of Option 2

This section will consider the impacts of Option 2 relative to Option 1, by reference to ‘criteria for optimising the use of the 890–915/935–960 MHz band’ (as described in the *Objectives* chapter of this paper).

Criteria 1—Promoting the most efficient use of spectrum

The key advantage of this option over the status quo, is that the conversion of existing 8.4 and 8.2 MHz apparatus licences to spectrum licences provides incumbents with improved ‘property rights’, conferring a degree of certainty of tenure for MNOs that would enable them the confidence to undertake investment. This would increase the likelihood that spectrum would be put to its optimal use.

The enhanced ability to trade resulting from conversion to spectrum licensing would also increase the likelihood that spectrum could be put to its optimal use, that is, by trading towards a more technically-efficient band configuration.

However, as outlined above, there is a risk that licensees might not be able to reach a mutually acceptable negotiated outcome, potentially resulting in the retention of the current inefficient band plan (either in part or in its entirety). If this were to be the case, there would be little improvement over the status quo in terms of spectrum being put to its optimal use.

Under this option prices would not be set by market forces. In order for the trading period to potentially function, the government would need to set a price for the converted spectrum licences, which could then be re-calculated for the 2 x 5 MHz licences (that is, on a per MHz basis). This may result in a lower licensing price (compared to a competitive auction process), which subsequently reduces the incentive for licensee to trade unused spectrum.

Furthermore, if the negotiations between licensees were to be drawn out, there may be a delay in reaching optimal bandwidth configuration, resulting in a reduction in public benefit derived from the use of the band. A discussion on quantifying this loss is included in the *Problems* chapter.

While trading would not be limited to the incumbent licensees, this option would not directly encourage a non-incumbent to purchase spectrum.

Criteria 2—Promotes investment and innovation

As outlined above, the enhanced property rights and ability to trade could increase incumbents’ ability to invest in the infrastructure in the band.

However, the abovementioned risk that MNOs will not be able to come to an agreement, dictates that the ability of licensees to efficiently use the band might ultimately not materially improve, which could have the effect of supressing licensee incentive to invest in the band.

Criteria 3—Promotes competition

Given that trades would only occur if both/all parties were satisfied, this option would not result in a lessening of competition in the downstream market. However, given that this option would not directly encourage non-incumbents to enter the market for spectrum in the band, it is unlikely that it would achieve the objective of promoting competition in the downstream market for communications.

Criteria 4—Promotes consumer convenience

This option provides the same impact on consumer convenience as the status quo option. Under ordinary circumstances where trades will only occur when mutually agreeable, it might be the case that incumbents would be reticent to willingly undertake a spectrum trade that results in consumer service discontinuity. However, given that the 2G switch-off is a foregone conclusion, MNOs might be motivated to trade vacated spectrum to gain investment certainty in either 4G technologies in the 890–915/935–960 MHz band, or alternatives in other bands.

## Analysis of Option 3: Band clearance and price-based allocation (PBA)

Under this option, the entire 890–915/935–960 MHz band would be reallocated via a price-based allocation process. This involves not renewing apparatus licences and allocating spectrum licences in 5 MHz lots through a price-based allocation. As with all price-based allocations, mechanisms to safeguard competition, such as the imposition of spectrum limits in the auction rules[[27]](#footnote-27), could be applied. A key benefit of this option would be achieving the optimal band configuration in a timely manner. Potential sensitivities are described in the *Option 3: Band clearance and price-based allocation (PBA)* section of this paper.

### Impacts of Option 3

This section will consider the impacts of Option 3 relative to Option 1, by reference to the ‘criteria for optimising the use of the 890–915/935–960 MHz band’ (as described in the *Objectives* chapter of this paper).

Criteria 1—Promoting the most efficient use of spectrum

This option would assure that the band is put to its optimal use in a timely manner. Importantly, this includes opening the band to non-incumbents.

Furthermore, it is likely that this approach will obtain a spectrum price that reflects market value—if the reserve prices are set such that all spectrum is sold—which will help ensure spectrum is used efficiently.

Criteria 2—Promotes investment and innovation

The guaranteed move to an optimal lot configuration would result in increased certainty of both tenure and configuration for licensees, which would increase investment certainty.

Criteria 3—Promotes competition

The impact that a market-based allocation of the 890–915/935–960 MHz band would have on competition in the downstream market is a key factor in considering the appropriate approach for reconfiguring the band. There are two somewhat orthogonal dimensions to these impacts that need to be carefully considered and balanced appropriately:

* a market allocation would increase the likelihood (compared to options 1 and 2) of entry into the market by a non-incumbent(s), and increase competition in the downstream market accordingly

a market allocation would increase the likelihood that an incumbent may lose spectrum in the 890–915/935–960 MHz band, which may impact its competitive position.

Criteria 4—Promotes consumer convenience

This option would increase the risk that an incumbent may lose access to 890–915/935–960 MHz spectrum, which could adversely affect their subscribers’ service continuity. The significance of these potential impacts would vary between incumbents, depending on the multi-band spectrum holdings that an incumbent MNO possess. For example, MNOs that rely on this band for coverage (that is, it is their prime sub-1 GHz band for a particular service/technology) are likely to experience increased consumer inconvenience—due to loss of coverage layer access—should they lose access to the band. On the other hand, MNOs with deployments in multiple sub-1 GHz bands are only likely to suffer an impact limited to a temporary capacity decrease, rather than a loss of coverage.[[28]](#footnote-28)

## Analysis of Option 4: Reliance on secondary markets with contingencies for reallocation

This would essentially be a two-stage process to achieve the desired band configuration. Stage 1 would involve a reliance on incumbent MNOs to trade (appropriately reconfigured) apparatus licences to reach the desired configuration, but with a finite time limit for trading (nominally two years, but this remains an open proposition).

If, after completion of the trading period, an agreement on a satisfactory reconfiguration could be reached, the ACMA would then issue spectrum licences that reflect the new arrangements. However, the ACMA would reserve the right to implement Option 3—that is, if a satisfactory reconfiguration could not be achieved during the trading period, then the ACMA could clear the band and undertake to allocate the band via a price-based allocation.

This option would necessitate the government determining whether the trading period has been successful, and outlining a ‘trigger’ for moving to a clearance and price-based allocation (if necessary). This would be the first time such an approach had been used in Australian spectrum management, but might provide a useful opportunity to test the secondary market with a risk-mitigation safeguard in place. Relevant market considerations are described in the *Option 4: Reliance on secondary markets with contingencies for reallocation* section of this paper.

### Impacts of Option 4

This section will consider the impacts of Option 4 relative to Option 1, by reference to the ‘criteria for optimising the use of the 890–915/935–960 MHz band’ (as described in the *Objectives* chapter of this paper).

Criteria 1—Promoting the most efficient use of spectrum

As with Option 2, existing 8.4 and 8.2 MHz apparatus licences would ultimately be converted to spectrum licences, conferring all of the previously-described benefits of long-term investment certainty, which would ultimately be more conducive to achieving the optimal use of the band than the status quo.

By comparison to Option 2, this option may increase the impetus for trading towards the optimal band configuration. However, if licensees choose not to engage in trading—possibly for the purposes of forcing a clearance and price-based allocation (noting that potential clearance triggers would need to be carefully codified to prevent such tactics)—it might delay the reconfiguration being achieved. Therefore, there is a risk that this option might not provide for the timely reconfiguring of the band, potentially inhibiting it being put to its optimal use.

A key benefit of this option is that it enables both a secondary market to engage, while retaining the option to eventually clear and subject the band to a price-based allocation process if necessary, thereby ensuring that the spectrum will ultimately be put to its optimal use. However, invoking the clearance/PBA option would in itself represent a delay in achieving the optimal band configuration, with a consequent loss in economic welfare.

Criteria 2—Promotes investment and innovation

As with Option 2, this option would provide for enhanced property rights and increases incumbents’ ability to invest in infrastructure in the band. Furthermore, the increased incentives to trade under this option—and resultant increase in likelihood of reaching the optimal band configuration (relative to Option 2)—would only serve to increase incumbents’ preparedness to invest in infrastructure in the band.

However, until the optimal configuration has been reached—either through agreement or reconfiguration—there may be a degree of uncertainty that suppresses preparedness to invest. While uncertainty *during* the process is common to all options (excluding Option 1, where there is no reform process), the potential two-staged nature of this option means that the period of uncertainty may be longer than for other options. Conversely, it is possible that a secondary market resolution of the issue could occur quicker than a regulatory intervention followed by a price-based allocation process.

Criteria 3—Promotes competition

The impact that this option has on competition in the downstream market would depend on whether trading is successful. If the trading period were successful, the impact would be consistent with that outlined in Option 2.

If the option to move to a clearance and price-based allocation process were eventually invoked, the impact would be consistent with that of Option 3, with the variation that the delay in moving to a PBA would have delayed the potential for a new market entrant to purchase spectrum (noting that there would be no barrier to a non-incumbent engaging in the secondary market during the trading period).

Criteria 4—Promotes consumer convenience

The likelihood of service discontinuity for consumers would depend on whether or not a clearance and price-based allocation process were to eventuate. If this did not eventuate (that is, if trading was successful, or if it were unsuccessful, but shown that the level of engagement was not sufficient to meet the clearance triggers), the likelihood (and degree) of service discontinuity would be consistent with that of Option 2. Otherwise, it would be consistent with that of Option 3, albeit with a likely delay in the timing of that discontinuity.

## Analysis of Option 5: Hybrid of options 2 and 3

The intention of this option is to afford incumbents with a measure of certainty by administratively allocating (via spectrum licence) a 2 x 5MHz block to each carrier; and allocating the remaining blocks by a price-based allocation (totalling 2 x 10 MHz). The initial allocation could be effected in a number of ways—two of which are described below:

* **Option 5a**—Administrative allocation (via conversion to spectrum licensing) of a 2 x 5 MHz block to each to the three incumbent licensees, the lower (block 1), middle (block 3 as a starting point—see below\*) and upper (block 5) to Telstra, Optus and Vodafone respectively, and putting the intermediate (blocks 2 and 4) blocks to market (see Figure 3 in the *Current arrangements* section of this paper for a description of block numbering).

**Option 5b**—Same as Option 5a, but instead of an administrative allocation of three blocks, the order in which they are allocated would be determined by a market allocation process, that is, each carrier would be guaranteed 2 x 5 MHz, but would need to compete for which block they obtain.

A possible implementation option for both of the above variations on this option might involve deferring finalisation of specific frequency block allocations until after the auction, so as to ensure holdings remain contiguous. Under this scenario, the frequencies allocated to the holder of the ‘middle’ position in the band (Optus under Option 5a or any of the three operators under Option 5b) might not be finalised until after the remaining 2 x 10 MHz had been sold.

This could be one possible means of ensuring contiguity in the case where one of the operators in either block 1 or 5 acquired a large amount (or all) of the remaining spectrum. For example, if, say, the holder of block 1 successfully acquired all of the remaining spectrum, they would be allocated the lower 2 x 15 MHz (rather than being allocated the lower 2 x 10 MHz and 2 x 5 MHz in block 4), and the other two operators would be allocated block 4 and block 5.

Criteria 1—Promoting the most efficient use of spectrum

As with Option 3, this option would assure a timely move to the optimal band configuration. While this would be more conducive to 4G deployments than Option 1, limitations in contiguous allocations (described below) might dictate that the optimal use is less likely to be achieved than for other options. This option would result in at least one incumbent being left with a single 2 x 5 MHz block. As described under *Option 1: Status quo*, industry does not place a high value in such small allocations and would prefer larger contiguous allocations.[[29]](#footnote-29)

This is one of the key disadvantages of this option—notwithstanding industry preferences, larger blocks are more allocatively and technically efficient and therefore more conducive to the *most* optimal use (optimal LTE deployments are in 20 MHz blocks). A disadvantage of a hybrid implementation would be continuance of the ‘fragmented’ nature of spectrum holdings in the 890–915/935–960 MHz band. Contiguous allocations would be restricted to a maximum of 2 x 15 MHz for one operator only. If one operator was able to achieve this maximum allocation, it would mean two operators would be left with only 2 x 5 MHz holdings in the band. Otherwise, the resultant configuration would be 2 x 10 MHz for two operators and 2 x 5 MHz for the other.

As with all of the reform options, spectrum licensing would allow trading in the secondary market to achieve a more efficient configuration post-reform, which would entail one or more operators vacating the band. However, this would defeat the purpose of an interventionist reform, as it would be more efficient to rely on the secondary market in the first instance.

As with Option 2, the price of the administratively allocation blocks may be less than if this price were market determined, which would lessen the incentive for these blocks to be used efficiently.

As with Option 3, this option might directly encourage non-incumbents to enter the market for spectrum in the 890–915/935–960 MHz band (albeit on face value only—see discussion below under *Promotes competition*), however, this would further exacerbate the fragmentation problem: a new market entrant would be only be able to secure licences for a maximum of 2 x 10 MHz (that is, the spectrum available for price-based allocation). Were they to be successful in doing so, each incumbent licensee would be left with only 2 x 5 MHz.

Criteria 2—Promotes investment and innovation

The hybrid option would provide incumbents with some certainty of ongoing tenure within the band. In particular, under Option 5a, the current block 1 and block 5 licensees would be assured that they would retain this spectrum. However, as outlined above, it would not be clear whether the ‘middle’ licensee would have been pre-allocated block 2, 3 or 4 until after the two-block price-based allocation, as this would depend on the outcome of that process.

As with all reform options, licensees would ultimately be issued spectrum licences, which would result in improved property rights and investment certainty.

Criteria 3 – Promotes competition

Each of the two hybrid options would in effect provide incumbents with a block ‘set aside’ at an administratively-set price, which may be lower than a market-determined price. This would not only lessen competition in a downstream market, but the resultant mixture of administratively and market-priced blocks might also result in incumbents gaining a strong advantage over non-incumbents who wish to enter the market.

By way of a (stylised) demonstration of the potential materiality of this advantage, suppose the three incumbents were each provided with one block at an administrative price of (say) $150 million each, but the value they placed on all blocks (ignoring heterogeneity between blocks) was $200 million. When competing for one of the remaining blocks during a price-based allocation process, they would be able to bid up to $250 million, to match their total valuation of $400 million for two blocks. If the new market entrant placed a similar value on the spectrum, they would be easily outbid. This advantage would not be consistent with an efficient allocation.

Criteria 4 – Promotes consumer convenience

Under this option, all incumbent licensees would be provided with ongoing access to one block. In the case of Option 5a, Telstra and Vodafone would retain their spectral location, meaning service discontinuity would be less likely to be an issue, however Optus would be at risk of only being left with a partial overlap of its current holdings. The risk of frequency relocation in the band for all incumbents would increase under Option 5b.

Another advantage of Option 5a over 5b would be that current interference management measures that have been put in place by licensees would continue to help preserve the utility of those holdings, noting that the interference issues differ between blocks.

# Appendix 2: Spectrum valuation

The Appendix provides some discussion about the difficulties in accurately valuing spectrum and includes data points that can be used to help inform an estimate value of the 890–915/935–960 MHz band.

## Spectrum valuation uncertainty

There are various methods that can be used to value spectrum. Market-based approaches, such as a price-based allocation, are generally viewed as the most accurate way to determine a spectrum price. Administratively-set prices, such as those based on ‘opportunity cost’, may be more problematic in achieving as accurate price.

In order to set prices according to opportunity cost, the government must undertake a significant work program to estimate the likely value MNOs place on spectrum. The values generated through such analysis are subject to significant uncertainty, which often necessitates a conservative approach. It is possible, however, to use relevant data points generated from market activity if they are available.

The recently completed 1800 MHz regional auction result showed the unpredictable nature of spectrum valuations—Box 1 provides further details. This unpredictability has implications for administrative price setting, in that it emphasises how difficult it is to set prices that mimic market outcomes.

Furthermore, in the case of the 890–915/935–960 MHz band, administrative price setting with the objective of mimicking market valuation is particularly difficult, given the high level of heterogeneity amongst the spectrum blocks on offer.

**Box 1: Example of spectrum valuation uncertainty**

Fifteen-year 1800 MHz spectrum licences in metropolitan areas were renewed in 2013 for an administratively set $0.23 per MHz per head of population ($0.23/MHz/pop), substantially below the average equivalent price of $0.71/MHz/pop for 1800 MHz regional spectrum yielded at the recent auction. It can be estimated that the average price of $0.71/MHz/pop for an ~11-year licence (~12 years for the three residual lots) is equivalent to $0.86/MHz/pop for a 15-year licence.

The $0.23/MHz/pop reissue price was based on an [estimate](https://www.communications.gov.au/documents/valuation-public-mobile-spectrum-1710-1785-mhz-and-1805-1880-mhz) (by Plum Consulting, commissioned by DoCA) of the extent to which access to the 1800 MHz band reduces the costs of network deployment (that is, cost reduction value), plus an arbitrary uplift for ‘auction avoidance benefits’ and option value. In this way, the re-issue price attempted to mimic market-based valuation, but as the regional auction results suggest, it is likely to have been below market valuation.

## Spectrum value data points

There are multiple data points informing the likely value of sub-1 GHz spectrum that is harmonised for 4th generation (LTE) technologies in Australia.

### 800 MHz expiring spectrum licences

A relevant data point that may inform estimates of the value of sub-1 GHz spectrum is the price paid for the expiring spectrum licences at 825–845 MHz and 870–890 MHz upon reissue in 2013. Telstra and Vodafone paid $1.23/MHz/pop for the reissue of 15-year licences in this band. At the time, Plum Consulting undertook modelling in support of this 800 MHz[[30]](#footnote-30) expiring spectrum licences process.[[31]](#footnote-31) The modelling suggested a mid-point cost reduction value of $0.97/MHz/pop, with an uplift of between 25 per cent and 50 per cent may be applied to the cost reduction valuation to take account of auction avoidance, option values et cetera, to give a range of potential prices between $1.21/MHz/pop and $1.46/MHz/pop—noting the wide range identified in the modelling commensurate with the significant uncertainty associated with the drivers of this value.

The fact that Telstra and Vodafone paid $1.23/MHz/pop for these 800 MHz expiring licences is only partially relevant, considering the value of 890–915/935–960 MHz band licences. Significant sunk costs had already invested by Telstra and Vodafone in building their networks based on 800 MHz spectrum, including investment in building a customer base using handsets and equipment configured for 800 MHz spectrum. This made the renewal of these licences critical to the business continuity of Telstra and Vodafone.

In contrast, current investment in the 890–915/935–960 MHz band is less likely to be relevant to future service provision, given the forthcoming switch-off of 2G services. While this will vary between MNOs (noting that there are also 3G services in the band that will continue for the foreseeable future), the business criticality of ongoing access to the band by incumbent MNOs is not likely to be as high as it was for the abovementioned expiring spectrum licences.

### 700 MHz Digital Dividend auction

In 2013, 2 x 30 MHz from the 700 MHz band (703–748/758–803 MHz) was sold at auction for $1.36/MHz/pop; 2 x 20 MHz to Telstra and 2 x 10 MHz to Optus. However, one-third of the spectrum on offer at the auction went unsold, suggesting that the market clearing value of the spectrum was less than that value. On the other hand, the amount of spectrum each bidder could purchase at auction was limited to 2 x 25 MHz.

It is worth noting that on May 6 2016, the Department of Communications and the Arts [released](https://www.communications.gov.au/have-your-say/draft-ministerial-direction-unsold-700-mhz-spectrum) an exposure draft of Radiocommunications (Spectrum Licence Allocation—Residual 700 MHz Band One) Direction 2016, in response to a proposal from Vodafone for acquisition of 2 x 10 MHz of the unsold 700 MHz spectrum. Vodafone proposed to acquire this spectrum for a licence term of 11 years and 9 months, for $594.3 million, payable in three instalment payments over three years. This price is broadly equivalent to $1.36/MHz/pop when expanded to a full 15-year tenure.

Optus submission to the Productivity Commission’s Public Safety Mobile Broadband inquiry

The Productivity Commission was asked to [undertake](http://www.pc.gov.au/inquiries/completed/public-safety-mobile-broadband) a 'first principles' analysis of the most efficient, effective and economical way of delivering mobile broadband capability to public safety agencies by 2020. One key input into the analysis were estimates of the opportunity cost of spectrum that may have been assigned for public safety use. Optus [submitted](http://www.pc.gov.au/__data/assets/pdf_file/0010/190387/sub018-public-safety-mobile-broadband.pdf) that the opportunity cost of spectrum in the 900 MHz, 800 MHz and 750 MHz ranges would likely be between $1.00–$1.36/MHz/pop.

1800 MHz regional auction

The above relates specifically to sub-1 GHz spectrum. However, the recently completed 1800 MHz regional spectrum auction provides additional evidence of the demand for spectrum and, as such, provides important circumstantial evidence supporting the above value estimates. Optus, Telstra, TPG and Vodafone all secured spectrum in that auction, resulting in total revenues (including withdrawal penalties) of approximately $543.5 million, equivalent to $0.71/MHz/pop. It is worth noting that the regional licences on offer in the 1800 MHz regional spectrum auction were for 11-year licences beginning 30 May 2017, rather than the 15-year spectrum licences traditionally on offer.

Comparison of data points

Based on the above data points, it can be estimated that the market value of the 890–915/935–960 MHz band is between $1.00/MHz/pop and $1.36/MHz/pop (for a 15-year licence). Table 2 provides a comparison of above data points with the current administratively-set licence fee applicable to the 890–915/935–960 MHz band. This comparison shows that the current licence fees for the band is likely to be less than the market value, and subsequently, may not be encouraging efficient use of the band.

For example, the NPV of the current stream of payments is approximately $584 million over the course of the next 15 years, when discounted on a commercial basis, that is, after-tax cash flows (recognising the tax deductibility of apparatus licence taxes) at an after-tax discount rate. By contrast, if 2 x 25 MHz of spectrum was sold at $1.18/MHz/pop (that is, the midpoint of the estimated market value range), the gross revenue would be approximately $1.45 billion.

1. Comparison of data points (note that 890–915/935–960 MHz spectrum value is comparable to that of the 700 and 800 MHz bands; 1800 MHz values are generally lower)

| Allocation | Value/price (per MHz/pop) |
| --- | --- |
| 800 MHz expiring spectrum licences | $1.23 |
| 700 MHz digital dividend auction | $1.36 |
| 1800 MHz regional auction | $0.71 for 11 year licence  (equivalent to $0.86 for 15-year licence) |
| 890–915/935–960 MHz (based on current apparatus licence fee) | $0.47  (NPV assumes 8.4%pa discount rate and 2.5%pa inflation) |

1. This terminology is a colloquialism used to reflect the band’s historic use and differentiate it from the broader ‘900 MHz band’ (890–960 MHz), for which frequency arrangements are set out in an administrative band plan (RALI MS41). [↑](#footnote-ref-1)
2. It is recognised that 3G will also continue to be used in the band, however since this is also licensed in 5 MHz blocks, it will fit within the proposed 5 MHz-based plan. [↑](#footnote-ref-2)
3. Noting that it may be preferable to issue appropriately reconfigured apparatus licences (that is, licences in spectrum blocks more conducive to trading) during the trading period, as opposed to direct conversion to spectrum licences as in the first ‘pure’ method. Further discussion on using apparatus licences in this context is provided in the [Consideration of options](#_Option_4:_Sequential) chapter. [↑](#footnote-ref-3)
4. The object of the *Radiocommunications Act 1992* is to provide for management of the radiofrequency spectrum, to achieve the goals set out in paragraphs 3(a) to 3(h). [↑](#footnote-ref-4)
5. Available on the [ACMA website](http://www.acma.gov.au/Industry/Spectrum/Spectrum-planning/About-spectrum-planning/principles-for-spectrum-management). [↑](#footnote-ref-5)
6. Area-wide apparatus licences can also be issued. [↑](#footnote-ref-6)
7. Technical details and limitations include maximum power, frequency range, out-of-band emissions limits, and geographical licence area. [↑](#footnote-ref-7)
8. This work program will be regularly reviewed and included in the annual update to the [FYSO](http://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/5-Year-Spectrum-Outlook/five-year-spectrum-outlook-2015-19). [↑](#footnote-ref-8)
9. Frequency bands in the *re-farming* stage have either already been re-farmed, or the decision has been made to re-farm the band, and final technical frameworks and re-allocation instruments have been or are being prepared. [↑](#footnote-ref-9)
10. See: <http://www.minister.communications.gov.au/mitch_fifield/news/700_mhz_spectrum_to_be_sold_by_competitive_auction#.WCz9h01f270>. [↑](#footnote-ref-10)
11. The international standardisation body responsible for cellular mobile broadband services is the 3rd Generation Partnership Project (3GPP). The 890–915/935–960 MHz band is one of the frequency bands for which 2, 3 and 4G technologies are standardised. [↑](#footnote-ref-11)
12. The maximum duration of 890–915/935–960 MHz band licences are further reduced as the band is currently under embargo with the condition that licences are renewed for no longer than one year. [↑](#footnote-ref-12)
13. Devices that periodically transmit or receive small amounts of data but then sit idle for a vast majority of time. [↑](#footnote-ref-13)
14. <http://www.ericsson.com/thecompany/our_publications/ericsson_technology_review/archive/narrowband-iot-connecting-billions-devices> [↑](#footnote-ref-14)
15. <http://www.lightreading.com/mobile/4g-lte/atandt-plans-4g-iot-in-san-fran-talks-priorities/d/d-id/724712> [↑](#footnote-ref-15)
16. Minor exceptions include areas where mobile broadband is only one of several uses and the demand for spectrum does not exceed supply, as is the case for example in the 1800 MHz band in remote areas. [↑](#footnote-ref-16)
17. Appendix 2: Spectrum valuation provides further details on spectrum valuations. [↑](#footnote-ref-17)
18. Available [here](http://www.acma.gov.au/Industry/Spectrum/Spectrum-planning/About-spectrum-planning/australian-spectrum-management-principles-spectrum-planning-acma). [↑](#footnote-ref-18)
19. Spectrum Review report, p 5. [↑](#footnote-ref-19)
20. Willingness to pay is the maximum amount an individual is willing to sacrifice to procure a good or avoid something undesirable. [↑](#footnote-ref-20)
21. Scope of competition rules could also be expanded to include total sub-1 GHz holdings per operator in a way that ensures that the market remains competitive. [↑](#footnote-ref-21)
22. At next renewal, which occurs annually under the current spectrum embargo. [↑](#footnote-ref-22)
23. <https://www.communications.gov.au/have-your-say/draft-ministerial-direction-unsold-700-mhz-spectrum> [↑](#footnote-ref-23)
24. Appendix 2 provides some data points which inform on the likely value of sub-1 GHz spectrum. [↑](#footnote-ref-24)
25. Noting that the lower 5 MHz is impacted by compatibility issues across the 890 MHz boundary and frequencies above 902 MHz may experience interference from unlicensed US ISM band devices. [↑](#footnote-ref-25)
26. Spectrum Review report, p. 5. [↑](#footnote-ref-26)
27. Scope of competition rules could also be expanded to include total sub-1 GHz holdings per operator in a way that ensures that the market remains competitive. [↑](#footnote-ref-27)
28. Noting that the 2G switch-off will separately impact coverage regardless of reform outcomes. [↑](#footnote-ref-28)
29. Telstra submission to the *Draft ministerial direction on unsold 700 MHz spectrum* <https://www.communications.gov.au/have-your-say/draft-ministerial-direction-unsold-700-mhz-spectrum>. [↑](#footnote-ref-29)
30. For all general purposes, the term ‘800 MHz band’ refers to 803–890 MHz, however for the purposes of discussing spectrum licences authorising access to the 850 MHz band (825–845/870–890 MHz), the spectrum licences retain the name ‘800 MHz spectrum licences’. This inconsistency of terminology owes to the first-in-time nature of the existence of that sub-band—the scarcity of other mobile sub-bands within the *broader* 800 MHz band at the time of issue of the original spectrum licences meant that there was no need for strict naming conventions to differentiate between various bands and sub-bands. This leaves a confusing legacy that will, in time, dissipate as the new naming conventions permeate (see last year’s decision paper for clarification of band nomenclature). [↑](#footnote-ref-30)
31. See [Valuation of public mobile spectrum at 825-845 MHz and 870-890 MHz](https://www.communications.gov.au/documents/valuation-public-mobile-spectrum-825-845-mhz-and-870-890-mhz), Plum Consulting. [↑](#footnote-ref-31)