Spectrum available for IoT

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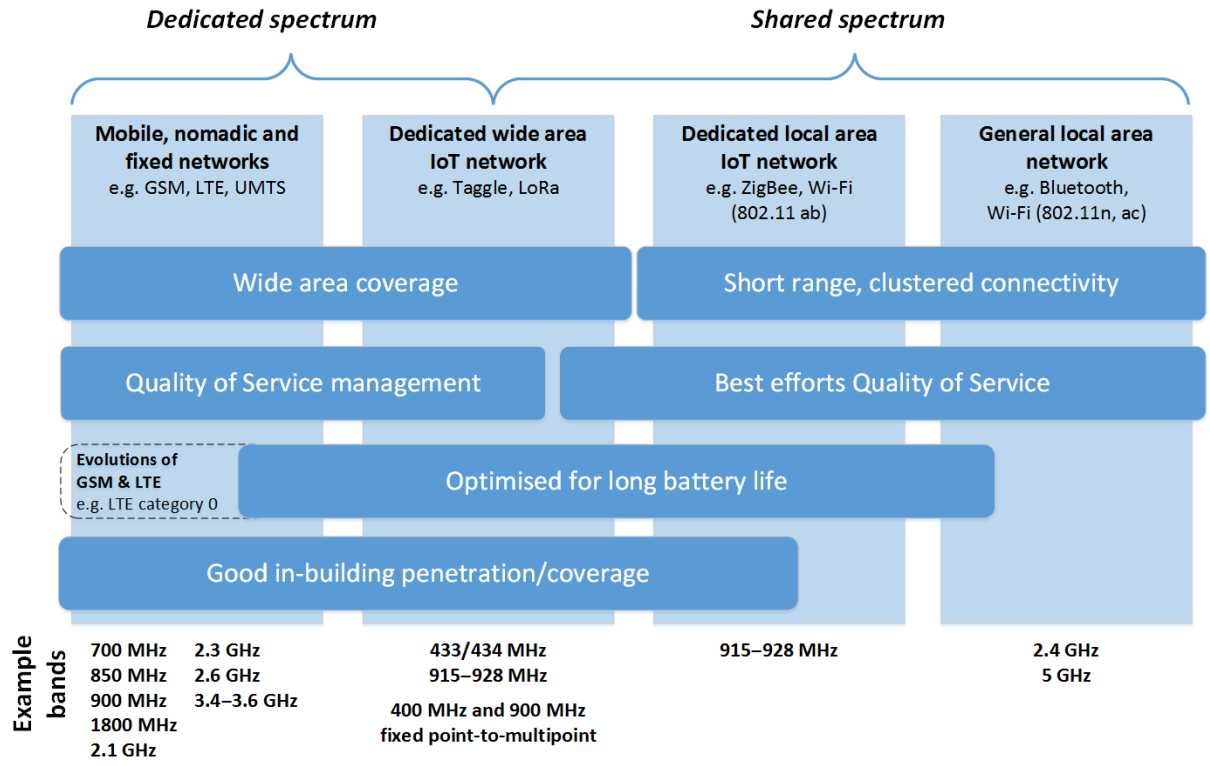
In November 2015, the ACMA released the Occasional paper *The Internet of Things and the ACMA's areas of focus* which explored Australia's state of readiness for IoT and areas where the ACMA can further facilitate IoT developments. In this paper, spectrum was identified as an infrastructure and device enabler for IoT. It was noted that the immediate focus in spectrum planning is concerned with accommodating M2M and IoT applications within the existing licensing framework and the identification of candidate spectrum bands to address expected future demand. This spectrum planning approach is outlined in the ACMA's Five-year spectrum outlook.

When it comes to spectrum to support M2M and IoT applications, a mix of licensing arrangements and variety of frequency bands may be required to support different IoT use cases (see Figure 1).

Figure 1: Spectrum available for IoT applications



Source: ACMA, based on Ofcom model 2015, updated for Australian spectrum band plans.

Licensing arrangements

Class Licensing

The ACMA has licensing arrangements in place that encourage innovation in M2M and IoT via the class-licensing regime. To some extent, M2M and IoT applications may utilise existing class licensed spectrum (that is, spectrum 'commons). Class licences authorise users of designated segments of spectrum to operate on a shared basis. A class licence is not issued to an individual user and does not incur licence fees. Unlike other forms of radiocommications licensing (namely, apparatus and spectrum licences) that are issued and used on an individual basis, use of this type of 'licence-exempt' spectrum does, however, come with the potential of higher chance of interference.

Currently, spectrum that is globally available at a low cost (or free as class licensed spectrum) is in the Industrial Scientific Medical (ISM) bands, which include the 900 MHz band, the 2.4 GHz band and the 5.8 GHz band.

ISM bands are to a large degree globally harmonised although the regulatory arrangements can vary. In Australia, access to these bands is governed by the Radiocommunications (Low Interference

Potential Device Class licence) 2015, known as the LIPD Class licence. The LIPD Class licence has over 50 items that would permit M2M or IoT type operations, including for high latency, low power, low data rate devices requiring high reliability.

Further information is provided in Table 1 below with details in the LIPD Class Licence.

Table 1: Spectrum available for IoT (Class licensed)

Frequency band (MHz)	Description
472.0125–472.1125	Telecommand or telemetry transmitters (max power 100 mW EIRP)
0.07–0.119	Telecommand or telemetry transmitters (max power 10 mW EIRP)
0.135–0.160	Telecommand or telemetry transmitters (max power 10 mW EIRP)
0.119–0.135	Telecommand or telemetry transmitters (max power 1.5 W EIRP)
0.160–0.190	Telecommand or telemetry transmitters (see details for limitations)
2400–2450	Telecommand or telemetry transmitters (max power 1 W EIRP)
5725–5795	Telecommand or telemetry transmitters (max power 1 W EIRP)
5815–5875	Telecommand or telemetry transmitters (max power 1 W EIRP)
5795–5815	Telecommand or telemetry transmitters (max power 2 W EIRP)
915-928	Frequency hopping transmitters (max power 1 W EIRP)
2400-2483.5	Frequency hopping transmitters (max power 500 mW EIRP)
2400-2483.5	Frequency hopping transmitters (max power 4 W EIRP)
5725-5850	Frequency hopping transmitters (max power 4 W EIRP)
915-928	Digital modulation transmitters (max power 1 W EIRP)
2400-2483.5	Digital modulation transmitters (max power 4 W EIRP)
5725-5850	Digital modulation transmitters (max power 4 W EIRP)
5150-5250	Radio local area network transmitters (max power 200 mW EIRP)
5250-5350	Radio local area network transmitters (max power 200 mW EIRP)
5470-5600	Radio local area network transmitters (max power 1 W EIRP)
5650-5725	Radio local area network transmitters (max power 1 W EIRP)
59000-63000	Data communication transmitters outdoors (max power 150 W EIRP)
57000-66000	Data communication transmitters indoors (max power 20 W EIRP)

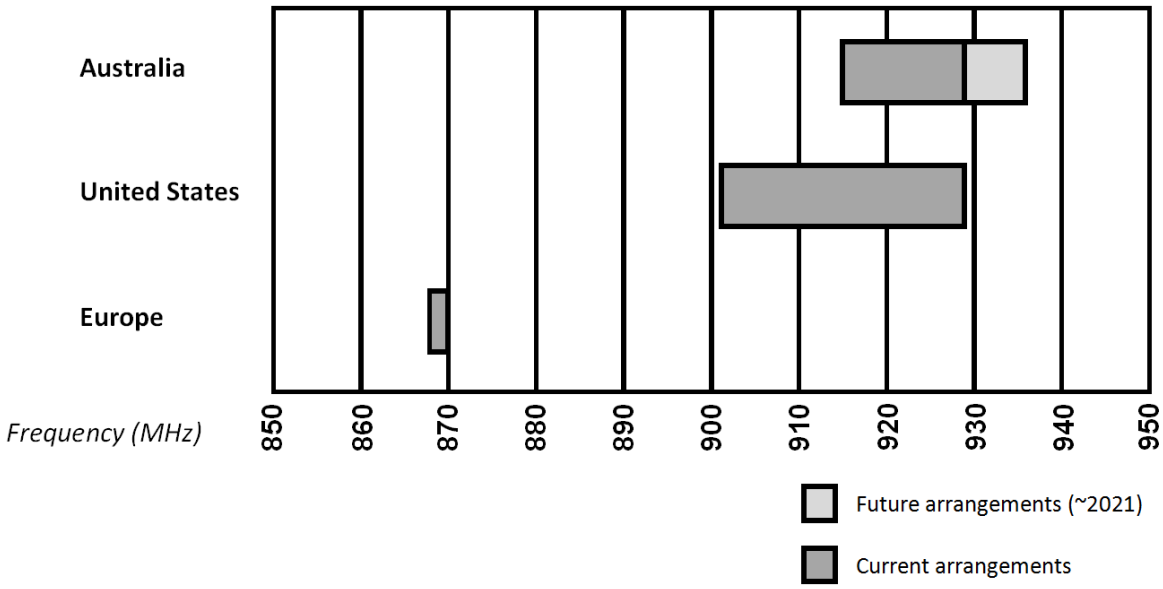
International comparison

Existing class licensing arrangements are largely internationally harmonised. For any particular spectrum band there are often a number of different uses internationally. While spectrum arrangements are rarely unique to Australia, not all overseas equipment will be able to be used under Australian spectrum arrangements if an arrangement from a different market has been adopted in Australia (for example, in the 900 MHz band discussed below). In a recent consultation regarding changes to the LIPD Class Licence, the ACMA proposed to update existing arrangements supporting the use of devices providing wireless connections to the internet in line with changes overseas. The proposed changes aim to provide greater opportunities for low data rate machine-to-machine and internet-of-things links using 915-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz band.

Some class licensed/commons IoT solutions that are possible in other regions are not applicable in Australia, particularly in the 900 MHz band. Australia has adopted a mix of Public Mobile Telecommunication Service (PMTS) systems from both Europe and the US. From Europe Australia has adopted the "GSM" band (890-915 MHz paired with 935-960 MHz) and from the US Australia has adopted the spectrum licensed 850 MHz band (825-845 MHz paired with 870-890 MHz), as well as part of the adjacent land mobile allocation in the US.

This mix of different PMTS solutions has restricted the size of Australia's ISM band to 915-928 MHz while in the US the ISM band is able to extend from 902-928 MHz. This means some solutions that are available in the US need to be modified to work in the Australian context. There are also solutions used in Europe, namely devices that can operate at or around 868 MHz, that cannot be utilised in Australia as this frequency overlaps with Australia's allocation to the land mobile service. In addition, while Europe has recently made available 915-921 MHz for low duty cycle applications, these arrangements would be ineffectual in Australia given the arrangements already in place and range of devices already supported.

International 'LIPD' arrangements in the 900 MHz band



Spectrum licensing

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

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

Spectrum licences provide for licence periods of up to 15 years. This provides longer tenure than apparatus licences but, in contrast with apparatus licences, there is no presumption of a right of renewal in the case of spectrum licences. Further information regarding bands that are currently subject to spectrum licensing is available on the ACMA website.

Appendix A to the ACMA discussion paper *Beyond 2020–A spectrum management strategy to address the growth in mobile broadband capacity* details the currently available spectrum for mobile broadband purposes. Note that some of these bands are apparatus licensed as noted in the appendix.

It is expected that M2M or IoT services will make use of commercial mobile networks enabled in the main by spectrum licensing.

Apparatus Licensing

Apparatus licences are typically issued on an 'over-the-counter' basis. Apparatus licences are often issued for one year, but may be issued for up to five years and may be renewed by the licensee upon expiry. Licensees are required to pay an annual fee and to co-ordinate with existing services to a set of technical conditions. Licensees may trade or lease their licences.

Services authorised by apparatus licences are typically fully coordinated with other licensed services, either by ACMA or by an accredited person.[1] Detailed information about the service is recorded and maintained by ACMA in its Register of Radiocommunications Licences to facilitate coordination. The coordination typically provides an assured grade of service with closely-managed interference levels.

Types of services that are authorised by apparatus licensing include:

> Fixed services- point-to-point and point-to-multipoint

> Land mobile services

> Public telecommunications services

> Scientific

Fixed services

The fixed service has allocations across the entire radiofrequency spectrum, from very low frequency (VLF) to extremely high frequency (EHF).[2]

The fixed service in the UHF bands is predominantly used by narrowband applications including those that link land mobile base stations, referred to as point to point links (P-P), and those that perform telecommand and telemetry functions referred to as point to multipoint services (P-MP).

At 400 MHz and 800/900 MHz, P-MP systems are typically those in which a single central master station communicates with a number of outlying remote fixed stations. The predominant use of these systems is for data transmission with typical applications including telemetry, supervisory control and data acquisition (SCADA) systems, computer networking and alarm systems.

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

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

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

The 3.4 GHz band (outside spectrum-licensed areas) is also used for P-MP services to provide rural communities with fixed telephony and data communications services.

Land mobile

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

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

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

Public telecommunications service (PTS)

A PTS licence is a type of apparatus licence that is issued for a service that consists of 1 or more stations that are operated for the provision of a public mobile telecommunications service (PMTS).

PTS licences also authorise stations that are operated to provide a carriage service to mobile devices where the service may not meet all the requirements of a public mobile telecommunications service. An example of such a station is a femtocell (low power station) deployed on the customer side of a telecommunications network boundary and provisioned via a fixed broadband service.

The PTS licence type and its various licence sub-types are defined in the Radiocommunications (Interpretation) Determination 2015.

Under the PTS licence type, the following licensing options are available:

- PMTS class B - authorising land stations that operate in the following paired frequency ranges:
  - 825-845 / 870-890 MHz
  - 890-915 / 935-960 MHz
  - 1710-1785 / 1805-1880 MHz
  - 1920-1980 / 2110-2170 MHz
  - 3400-3600 MHz; and
- PMTS class C - authorising stations that are located on an aircraft (except in specified circumstances being on-ground operation for testing and maintenance).

Radiocommunications devices (including mobile telephone handsets) associated with PMTS class B and PMTS class C stations are authorised by the Radiocommunications (Cellular Mobile Telecommunications Devices) Class Licence 2014.

Scientific

A Scientific licence is issued to authorise a station which operates primarily to perform any of the following activities:

- research into radiocommunications;
- investigation of radiocommunications;

- instruction in radiocommunications;
- demonstration of equipment;
- testing of equipment;
- trials of new radiocommunications technology;
- radio propagation path testing.

Examples of the above could include periods of performance testing required to develop, prove and apply new technology, to evaluate products, to allow a new product time to mature or to establish a market for a new product.

Examples of individuals who, and organisations which, would meet the above criteria could include:

- teaching institutions;
- research bodies;
- manufacturers of radiocommunications equipment;
- business organisations or persons engaged in the design and/or repair of radiocommunications equipment; and
- business organisations or persons engaged in the sale of radiocommunications equipment.

The ACMA has a policy of facilitating technical trials of new technologies, including broadcasting technologies, where radiofrequency spectrum can be allocated for the trial, so that interference is not caused to any existing radiocommunications service. Note that permission to conduct a trial in no way pre-empts or constrains future policy. In particular:

- Allocation of spectrum for a trial confers no rights to use of that spectrum other than for the purpose and duration of the trial.
- Allocation of a part of the spectrum for a trial does not preclude trials of other systems using that spectrum or imply that the application being trialled will be the preferred user of that spectrum in the future.
- Permission to trial a particular technological system does not imply the system will be introduced into Australia permanently or, if it is, that it will use the same part of the spectrum as the trial service.
- The fact of participation in a trial does not imply the trial participant will be permitted to operate the system being trialled if the Australian Government decides on its permanent introduction.
- In any application involving the participation of the public, potential triallists should address the issue of access to equipment in the market place for the proposed tests, how equipment will be made available in the market and how consumers will be made aware of the temporary nature of the trial.
- People who acquire equipment in connection with trials, including retailers or members of the public who purchase receivers to participate in trials, or receive trial services, do so at their own risk that the trial may be discontinued.

The ACMA is conscious of the possibility that demand from bona fide applicants to conduct trials in nominated markets and/or on particular frequencies may exceed the availability of spectrum. Additionally, the ACMA is aware of the possibility that more than one applicant may wish to undertake trials at the same time.

If these situations arise, the ACMA's preference is for aspirant triallists to resolve competing demands though a process of negotiation. However, if negotiation does not produce a workable solution, the principles used to guide the ACMA in reaching a decision will include:

- the purpose of the trial;
- the preparedness of the applicant to commence a service on the nominated date;
- the nominated date of the trial;
- whether the trial could practicably proceed using a different location or frequencies; and
- such other matters the ACMA considers relevant.

For more information about trials of new technologies, please consult the ACMA's *Guidelines for dealing with applications for apparatus licences for the trial of new radiocommunications technologies*.

While an apparatus licence may be issued for any period up to five years, in the case of scientific licences, the licence period should be for the minimum time necessary for a client to achieve their purpose. This will be subject to the ACMA's normal administrative process of issuing licences for a period of one year, which may be renewed if required.

Scientific licences will be reviewed at the end of the licence period, to determine if stations continue to accord with the intended purpose of scientific stations. The intention of licensees taking out scientific licences should always be to convert to an appropriate apparatus type as soon as possible.

Satellite systems licensing

Space systems licensing is a combination of the three licence types above (apparatus, spectrum and class). Communications to and from the satellite may be licensed in the following ways:

1. Licensing the ground segment
   Individual earth stations are apparatus licensed for transmitting, receiving, or both. This is often used for a small number of stations at known locations, and/or where coordination with terrestrial services is required.
2. Licensing the space segment of the network
   Apparatus licences are granted for space stations transmitting, receiving, or both; in conjunction with this the earth stations are authorised through a class licence. This is often used for large numbers of stations that are not coordinated with terrestrial services
3. Spectrum licensing
   Spectrum licensing is not often used for satellite services.

The most suitable option depends on the configuration of the satellite, the nature of its spectrum use and the commercial preferences of the satellite operator or the service provider.

Provided that the operation of the satellite is authorised under a space licence, and a relevant entry exists in the one of the space objects determinations, the operation of earth stations that communicate with the satellite may be authorised by the Radiocommunications (Communications with Space Objects) Class Licence 2015. These arrangements efficiently support the operation of satellite systems that communicate with a large number of user terminals.

Where the satellite is not authorised under a space licence, or the operating frequency range is not covered in the Communications with Space Objects Class Licence, the system may be able to be licensed via the ground segment of the network. That is, an apparatus licence is would be required to authorise communications between earth stations and the satellite. Licences may be issued to authorise transmissions (Earth transmit) or reception of transmissions (Earth receive). Note that apparatus licences are only available in bands allocated for that purpose in the Australian Radiofrequency Spectrum Plan.

Spectrum review

In May 2014, the Minister for Communications, the Hon Malcolm Turnbull MP, announced a review of Australia's spectrum policy and management framework.[3] The Spectrum Review looked at the changes needed to cope with the increase in demand for spectrum and changes in technology, markets and consumer preferences. The review reported to the minister in March 2015. The *Spectrum Review Report*[4] outlines recommended changes to improve Australia's spectrum policy and

[3] The Hon Malcolm Turnbull MP, Minister for Communications, Spectrum reform to drive future innovation and productivity, media release, 23 May 2014.

[4] Available on the Department of Communications website.

management framework. On 25 August 2015, the government released its response, agreeing to implement the recommendations of the Spectrum Review.[5]

The Government has agreed to implement the recommendations of the Spectrum Review including establishing a single licensing system based around a limited number of parameters of the licence (for example frequency band, geographic area, licence duration and renewal rights of the licence). The intention is to establish a single licensing system to replace the current tripartite licensing system. The Government has released an implementation timeline and transitional arrangements for stakeholders indicating that a progressive implementation of the new licensing system will commence in mid-2017 following consultation on a draft policy statement in early 2016 and draft licensing instruments in mid to late 2016.

Current ACMA projects

800/900 Review implementation

IoT technologies will also be able to take advantage of new arrangements resulting from the review of the 803-960 MHz band. These provisions will extend to both bespoke solutions and commercial solutions subject to meeting licence conditions (will be authorised under amendments to the LIPD class licence). The changes to the LIPD class licence as part of this review are scheduled to be implemented in 2021. Currently the earliest any new commercial spectrum suitable for mobile broadband and mobile telephony in the band would be available for use would be 2024.

New arrangements for class licensed low interference potential devices (LIPDs) will be as follows:

- Additional spectrum will be made available for systems operating in the range 928–935 MHz (limited to 928–933 MHz in high and medium density areas):
  - limited to low EIRP (25 mW) and low duty cycle (1%) technologies, suitable for supporting a range of applications, including some fixed links, M2M applications such as automation, switching, metering and control.
- The abovementioned provisions will be limited to devices intended for long-term operation in a fixed installation and conditions will be conducive to long battery life devices.

If necessary early access to the band (i.e. prior to 2021) could be considered on a coordinated basis using (for example) apparatus licences. This could be considered either on a case-by-case apparatus licensed basis or through development of interim arrangements in the LIPD class licence

The 803-960 review also expands the 850 MHz spectrum licensed segments which will allow further opportunities for IoT devices that operate on a commercial cellular network.

ITS at 5.9 GHz

Intelligent Transport Systems can be considered a subset of IoT technologies, since 2008 the ACMA has embargoed the 5.9 GHz band (5.85-5.925 GHz) for the future planning of Intelligent Transport Systems. The ACMA is looking to finalise these regulatory arrangements within the coming year. The 5.9 GHz band has been identified for use by ITS in both the United States and Europe with slightly different standards being adopted in each region. Australia is looking to align its regulatory arrangements with the standards being developed in Europe.

VHF broadcasting service bands review

Spectrum in these bands (45–52 MHz, 56–70 MHz, 85–108 MHz and 137–144 MHz) has been vacated following the switch-off of analog television. The VHF broadcasting services bands (BSB) review will examine potential future uses for these bands. Subsequently, projects will be needed to implement arrangements for any new uses of the bands.

[5] The Hon Malcolm Turnbull MP, Minister for Communications, Next stage of spectrum reform to commence, media release, 25 August 2015.

The ACMA will commence this review of VHF BSB now that the two government reviews into digital radio have been completed. The DRM+ digital radio technology can operate in some of these bands, however the report of the digital radio reviews makes no finding on this potential.

IoT could form part of the considerations given that Ofcom have recently undertaken a consultation to determine the potential to make some spectrum available around this frequency range.

Preparations for WRC-19

WRC-19 agenda item 1.13 is to consider identification of frequency bands for the future development of International Mobile Telecommunications (IMT), including possible additional allocations to the mobile service on a primary basis. This agenda item is widely acknowledged to be focussing on spectrum harmonisation requirements for 5G mobile broadband technologies.

The frequency bands to be considered under this agenda item are 24.25–27.5 GHz, 37–40.5 GHz, 42.5–43.5 GHz, 45.5–47 GHz, 47.2–50.2 GHz, 50.4–52.6 GHz, 66–76 GHz and 81–86 GHz, which have allocations to the mobile service on a primary basis; and 31.8–33.4 GHz, 40.5–42.5 GHz and 47–47.2 GHz, which may require additional allocations to the mobile service on a primary basis.

WRC-19 agenda item 1.16 is to consider issues related to wireless access systems, including radio local area networks (WAS/RLAN), in the frequency bands 5150–5350 MHz (to enable outdoor usage), 5350–5470 MHz, 5725–5850 MHz and 5850–5925 MHz, while ensuring the protection of incumbent services including their current and planned use.

Studies on the technical and operational aspects of radio networks and systems, as well as spectrum needed, including possible harmonized use of spectrum to support the implementation of narrowband and broadband machine-type communication infrastructures will also be undertaken in preparation for WRC-19. The Director of the Radiocommunication Bureau will report on this study as part of his overall report WRC-19. WRC-19 will then decide on the next appropriate action.

The ACMA intends to monitor and, where appropriate, engage with stakeholders via the usual international preparatory process to develop Australian positions on these matters.

Compliance and labelling arrangements

In addition to licensing and spectrum management requirements, radiocommunications equipment may be subject to regulatory requirements imposed at the point of supply of the equipment to the Australian market.

The ACMA's supply regulatory requirements cover:

- Technical requirements (standards)
- Labelling
- Record keeping

Equipment is only subject to the ACMA's supply regulatory arrangements if it is within the scope of an applicable technical standard.

Technical standards may be imposed in relation to the following areas:

- Telecommunications— Performance requirements for customer equipment (that may connect to a telecommunications network) or customer cabling (for example, cables, plugs, sockets and connectors) used in a customer premises (such as, a house or commercial building). Telecommunications performance requirements are limited to the following areas: health and

safety, access to emergency call services, network integrity and interoperability with the standard telephone service.

- Radiocommunications—Technical performance limits for transmitters and receivers (part of the ACMA's spectrum management responsibilities). The arrangements also apply to transmitters that are embedded in other devices (for example, 802.xx devices in televisions).
- Electromagnetic compatibility (EMC)—Performance requirements to limit the unintended interference from emissions of radio frequency (RF) energy) for electrical and electronic devices. The arrangements cover most common household products (for example, whitegoods, kitchen appliances and IT equipment). EMC technical requirements will only apply to radiocommunications equipment if the equipment is capable of operating in 'non-transmitter' mode (e.g. smart phone in airplane mode).
- EME—Performance requirements for RF electromagnetic energy (EME) intended to limit the risks to human health as a result of public exposure to radio transmitter communications.

More information on applicable technical standards is available on the ACMA website. IoT equipment may be subject to EME requirements. Radiocommunications transmitter technical standards will only apply to certain equipment. Typically, this is equipment that operates under a class licence (e.g. 2.4 GHz, 5.8 GHz). Compliance with technical standards may also be a condition of a licence allocated under the *Radiocommunications Act 1992*.

The supply regulatory arrangements also impose labelling and record-keeping obligations on a supplier of specified radiocommunications products before a product is supplied to the Australian market. The obligations are detailed in the Radiocommunications (Compliance Labelling – Devices) Notice 2014 (the RLN) made under section 182 of the *Radiocommunications Act 1992*. Further information is available on the ACMA website.

Attachment A: 915-935 MHz

For any particular spectrum band there are often a number of different regulatory arrangements and uses internationally. While spectrum arrangements are rarely unique to Australia, not all overseas equipment will be able to be used under Australian spectrum arrangements if an arrangement from a different market has been adopted in Australia. This is the case for example in the 900 MHz band.

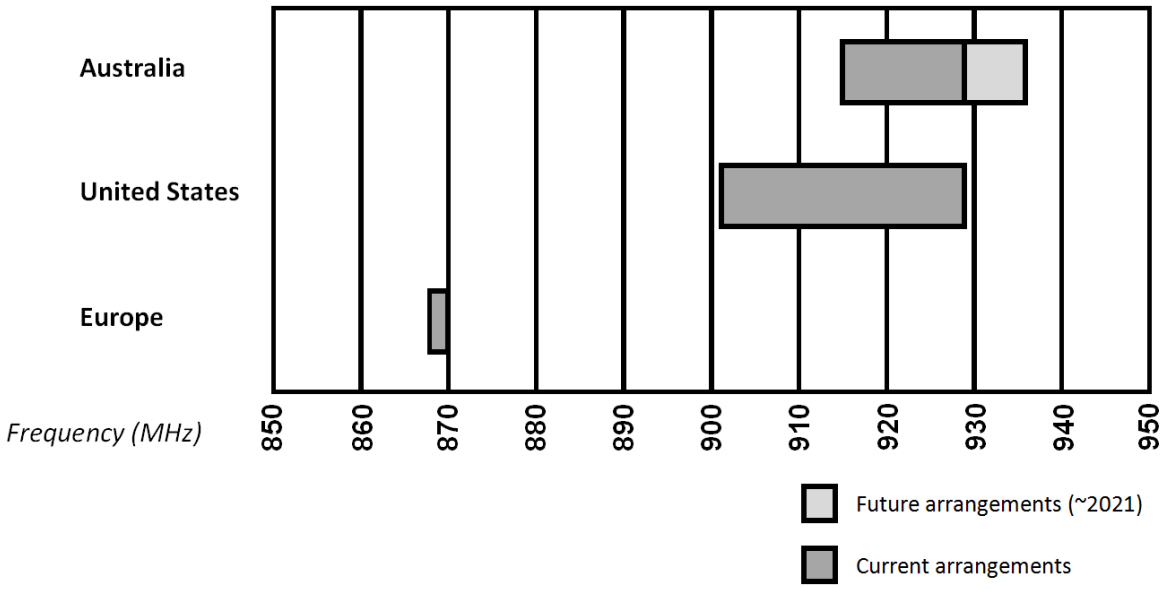
International Comparison

In the 900 MHz band, Australia has adopted a mix of Public Mobile Telecommunication Service (PMTS) systems from both Europe and the USA. From Europe, Australia has adopted the "GSM" band (890-915 MHz paired with 935-960 MHz) and from the USA Australia has adopted PMTS arrangements in the spectrum licensed 850 MHz band (825-845 MHz paired with 870-890 MHz), as well as part of the adjacent land mobile allocation in the USA. This mix of different PMTS solutions has restricted the size of Australia's 900 MHz ISM band to 915-928 MHz while in the US the ISM band extends from 902-928 MHz.

This means some solutions that are available in the US need to be either modified or restricted to work in the Australian context. There are also solutions used in Europe, namely devices that can operate at or around 868 MHz, that cannot be utilised in Australia as this frequency overlaps with Australia's allocation to the land mobile service. In addition, while Europe has recently made available 915-921 MHz for low duty cycle applications, these arrangements would be ineffectual in Australia given the arrangements already in place and range of devices already supported.

Tables A-1 to A-3 provide details of the LIPD arrangements implemented in different countries.

International 'LIPD' arrangements in the 900 MHz band



Australian Environment

865-876 MHz

Europe has developed arrangements for LIPDs (also called short range devices) in the 863-876 MHz band - refer to Table A-3. Parts of this band is also available in some countries in the Asia-Pacific region under various arrangements (see Table A4). This spectrum is currently used for Mobile broadband (870-876 MHz), CTS cordless telephones (863-865 MHz) and land mobile services (865-870 MHz) in Australia. Furthermore, as part of the 803-960 MHz review, services in the 863-870 MHz band are being relocated to make the spectrum available for mobile broadband services. As such this band is not available for use by LIPD in Australia.

915-928 MHz

The Australian arrangements (refer to Table A-1) for this band typically support the use of LIPD devices that conform to the USA arrangements (Table A-2) in the 915-928 MHz frequencies only. Parts of this band is also available in some countries in the Asia-Pacific region under various arrangements (see Table A4).

In a recent consultation regarding changes to the LIPD Class Licence, the ACMA proposed to update existing arrangements supporting the use of devices providing wireless connections to the internet in line with changes overseas. The proposed changes aim to provide greater opportunities for low data rate machine-to-machine and internet-of-things links using a number of bands including 915-928 MHz. Further information is available on the ACMA website.

The ACMA currently has no plans to implement additional restrictions on devices operating in the 915-928 MHz band.

928-935 MHz

IoT technologies will also be able to take advantage of new arrangements resulting from the review of the 803-960 MHz band. These provisions will extend to both bespoke solutions and commercial solutions subject to meeting licence conditions (will be authorised under amendments to the LIPD class licence). The changes to the LIPD class licence as part of this review are scheduled to be implemented in 2021.

New arrangements for class licensed low interference potential devices (LIPDs) will be as follows:

- Additional spectrum will be made available for systems operating in the range 928–935 MHz (limited to 928–933 MHz in high and medium density areas):
- limited to low EIRP (≤ 25 mW) and low duty cycle (≤1%) technologies, suitable for supporting a range of applications, including some fixed links, M2M applications such as automation, switching, metering and control.
- The abovementioned provisions will be limited to devices intended for long-term operation in a fixed installation and conditions will be conducive to long battery life devices.

If necessary early access to the band (i.e. prior to 2021) could be considered on a coordinated basis using (for example) apparatus licences. This could be considered either on a case-by-case apparatus licensed basis or through development of interim arrangements in the LIPD class licence.

To obtain an apparatus licence an application will need to be made to the ACMA and usually requires some technical analysis to be undertaken. This technical analysis (usually called coordination) will determine if the proposed system can be used without causing interference to an existing radiocommunications system.

The steps that need to be taken for a coordinated apparatus licence to be issued are:

- Undertake coordination[6] in against existing services in accordance with current planning rules (typically contained in documents called RALIs).
    - If coordination is successful a request for a radiocommunications licence can be made to the manager of the Spectrum Planning Section as approval for out of policy consideration will need to be made. (In situations such as for early access, there are unlikely to be planning arrangements in place so the specific details will need to be considered),A request for out of policy consideration for a licence can be sent to freqplan@acma.gov.au
- When/if approval is given, a submission for an appropriate licence type, with the approval from the manager of the Spectrum Planning Section attached, can be made to the ACMA. If an accredited person is involved this will usually involve the submission of the Frequency Assignment Certificate (FAC),
    - More information on the FAC submission process can be found at http://acma.gov.au/Industry/Spectrum/Radiocomms-licensing/Apparatus-licences/apparatus-licensing-system-acquire-a-licence-acma#aal
- A licence will be issued on payment of appropriate fees

More information on licence fees can be found at http://acma.gov.au/theACMA/About/Making-payments/Apparatus-licence-fees/apparatus-licence-fees-acma

[6] Coordination is the process in which it is determined if two or more radiocommunication systems can operate harmoniously. This is done by the ACMA, or an Accredited Person, using a certain set of rules which will depend on the radiocommunication systems being considered. These rules are contained in documents called Radiocommunication Assignment and Licensing Instructions (RALIs). A list of Accredited Persons can be found at http://acma.gov.au/Industry/Spectrum/Spectrum-planning/Current-APs-info-and-resources/accredited-persons-list-spectrum-planning-acma.

Table A-1: Australian arrangements in the 900 MHz band

Item	Class	Frequency (MHz)	Max EIRP	Additional Notes	Reference
20	All (any) transmitters	915-928	3 mW	No conditions	Radiocommunications (Low Interference Potential Devices) Class Licence 2015
43	RFID	918-926	1 W	No conditions	
45	RFID	920-926	4 W	1. Must comply with ISO/IEC standard; 2. Limit on emission below 917.75 MHz; 3. Limit on emissions above 926 MHz; 4. Must only be used where 1 W is not sufficient.	
54	Frequency hopping	915-928	1 W	Minimum number of hopping channels	
58	Digital Modulation	915-928	1 W	Power Spectral density limit	
-	Under development	928-935	25 mW / PSD not to exceed -14.5 dBm/kHz	Low EIRP and low duty cycle technologies (≤ 25 mW, ≤1%), suitable for supporting a range of applications, including some fixed links, M2M applications such as automation, switching, metering and control.	Review of the 803-960 MHz band

ISM Equipment emission limits:

- CISPR 11 – 900 MHz: Class A Industrial (46.5 dBuV/m @ 10m)
- EN 55011: Class B Domestic (37 dBuV/m @ 10m)
- FCC Part 18 902-928 (25uV/m @ 300m)

Table A-2: USA arrangements in the 900 MHz band

Item	Application	Frequency (MHz)	Max ERP	Bandwidth	Reference (may also provide additional requirements)
15.243	Material characteristic measurement	890-940	500uV/m @ 30 m	Self-contained, antenna permanently attached	AN1200.04 – FCC Regulations for ISM Band Devices: 902-928 MHz
15.245	Field disturbance sensors	902-928	500mV/m @ 3 m	-	

15.247	Frequency hopping and Digital modulation	902-928	1 W	Antenna Gain / transmitter power trade-offs, minimum number of hopping channels for different channel bandwidths	

Table A-3: European arrangements in the 863-876 MHz and 900 MHz bands

Application	Frequency (MHz)	Max ERP	Duty Cycle	Bandwidth	Reference (may also provide additional requirements)
Non-Specific (Narrow/wideband modulation)	863-870	25 mW	≤ 0.1% duty cycle or listen before talk (LBT), duty cycle may be increased to 1% in 865-868 MHz	≤ 100kHz	ETSI EN 300 220-1
Non-Specific (FHSS)	863-870	25 mW	≤ 0.1% duty cycle or listen before talk (LBT), duty cycle may be increased to 1% in 865-868 MHz	≤ 100kHz	ETSI EN 300 220-1
Non-Specific (DSSS and other wideband modulations)	863-870	25 mW (Power density is limited to -4,5 dBm/100 kHz)	≤ 0.1% duty cycle or LBT with adaptive frequency agility (AFA), duty cycle may be increased to 1% for wideband modulation other than DSSS (bandwidths 200 kHz to 3 MHz) in 865-868 MHz provided erp is ≤10 mW	No requirement	ETSI EN 300 220-1
RFID	865-868	2 W	-	≤ 200kHz	ETSI EN 302 208-1
Non-Specific	868-870 (various segments)	868-868.6 MHz - 25 mW 868.7-869.2 MHz - 25 mW 869.4-869.65 MHz - 500 mW 869.7-870 MHz - 25 mW	868-868.6 MHz, 869.7-870 MHz ≤ 1% duty cycle or LBT with AFA 868.7-869.2 MHz ≤ 0.1% duty cycle or LBT with AFA 869.4-869.65 MHz ≤ 10% duty cycle or LBT with AFA 869.7-870 MHz operating below 5 mW, no requirement	869.4-869.65MHz ≤ 25kHz No requirement for other bands	ETSI EN 300 220-1
Non-Specific	870-875.8	25 mW	≤ 0.1% duty cycle, for ER-GSM protection (918-921 MHz, where applicable) it is limited to 0.01% duty cycle and max transmit-on time of 5ms/1s.	≤ 600 kHz	ERC Recommendation 70-03
Non-Specific	870-876	25 mW	≤ 0.1% duty cycle, for ER-GSM protection (918-921 MHz, where applicable) it is limited to 0.01% duty cycle and max transmit-on time of 5ms/1s.	≤ 200 kHz	ERC Recommendation 70-03

Application	Frequency (MHz)	Max ERP	Duty Cycle	Bandwidth	Reference (may also provide additional requirements)
Non-Specific	915-921	25 mW	≤ 0.1% duty cycle, for ER-GSM protection (918-921 MHz, where applicable) it is limited to 0.01% duty cycle and max transmit-on time of 5ms/1s.	≤ 200kHz	ETSI EN 300 220-1
Non-Specific	915.2-920.8	25 mW except for the 4 radio microphone channels where 100 mW erp applies	-	≤ 600kHz or ≤ 400kHz on the radio microphone channels	ETSI EN 300 220-1
Radio Microphones	916-920.1	10 mW	Four specific channels 916.3, 917.5, 918.7 and 919.9 MHz. ≤ 25% duty cycle	≤ 400kHz	ETSI EN 300 220-1
RFID	915-921	4 W	For ER-GSM protection 918-921MHz where applicable), DAA is required.	≤ 400kHz	ETSI EN 302 208-1

Table A-4: Asian arrangements in the 863-870 MHz and 900 MHz bands

Application	Frequency (MHz)	Max radiated power	Duty Cycle	Bandwidth	Country	Reference
Non-specific (FHSS)	863-870	25 mW ERP	≤ 1% duty cycle or LBT	≤ 100 kHz	Iran	APT Report-07 (Rev4)–2/2016 update (ETSI EN 300 220-1)
(DSS and other wideband)	863-870	25 mW ERP (Power density is limited to -4,5 dBm/100 kHz)	≤ 1% duty cycle or LBT	No requirement		
(narrow band and wide band modulation (NBWBM))	863-870	25 mW ERP	≤ 1% duty cycle or LBT	≤ 100 kHz		
NBWBM	868-868.6	25 mW ERP	≤ 1% duty cycle or LBT	≤ 200 kHz		

Application	Frequency (MHz)	Max radiated power	Duty Cycle	Bandwidth	Country	Reference
NBWBM NBWBM NBWBM	868.7-869.2 869.4-869.65 869.7-870	25 mW ERP 500 mW ERP 10 mW ERP	≤ 1% duty cycle or LBT ≤ 1% duty cycle or LBT Max 100%	 ≤ 25 kHz No requirement		
Unrestricted	864-868	4 W EIRP (≥ 1 W must employ FHSS or Digital modulation techniques)	-	-	New Zealand	APT Report-07 (Rev4)–2/2016 update
RFID	865-865.6 867.6-868	100 mW ERP 500 mW ERP	No restriction	≤ 200 kHz	Iran	APT Report-07 (Rev4)–2/2016 update (ETSI EN 300 220-1)
RFID	865-867	4 W EIRP (unlicensed)	unknown	unknown	India	APT Recommendation-03 (02/2006)
RFID	865-868 865.6-868 865.6-867.6	0.1 W ERP (unlicensed) 0.5 W ERP (unlicensed) 2 W ERP (unlicensed)	unknown	unknown	China (Hong Kong)	APT Report-07 (Rev4)–2/2016 update
RFID	866-868	0.5 W ERP (unlicensed)	unknown	unknown	Vietnam	APT Report-07 (Rev4)–2/2016 update
Radio Telemetry, Telecommand, RFID	866-869	0.5 W ERP (unlicensed)	unknown	unknown	Brunei Darussalam, Cambodia, Lao PDR, Singapore	APT Recommendation-03 (02/2006)
Non-specific	868-868.6 868.7-869.2 869.3-869.4 869.7-870	25 mW ERP 25 mW ERP 25 mW ERP 5 mW ERP	unknown	unknown	Philippines	APT Report-07 (Rev4)–2/2016 update

Application	Frequency (MHz)	Max radiated power	Duty Cycle	Bandwidth	Country	Reference
Determination Telemetry and Telecommand	868-870 869.2 - 869.25	2 mW EIRP 10 mW EIRP	≤ 1% duty cycle ≤ 0.1% duty cycle	-	New Zealand	APT Report-07 (Rev4)–2/2016 update
RFID	869-870.375	500 mW ERP	unknown	unknown	Malaysia	APT Report-07 (Rev4)–2/2016 update
RFID	915-921	1 W EIRP (registration and individual licence required)	unknown	unknown	Fiji	APT Recommendation-03 (02/2006)
Determination Telemetry and Telecommand	915-921	3 mW EIRP	-	-	New Zealand	APT Report-07 (Rev4)–2/2016 update
Telemeter, telecontrol and data transmission	916-928 920.6-928	≤ 2 mW EIRP ≤ 40 mW EIRP	unknown	Various channel size arrangements (max 1000 kHz)	Japan	APT Report-07 (Rev4)–2/2016 update
RFID	916-921	Some segments ≤ 4 W EIRP Some segments ≤ 500 mW EIRP	unknown	≤ 200 kHz Various channel size arrangements (max 1000 kHz)	Japan	APT Report-07 (Rev4)–2/2016 update
RFID	917-923.5	Varies from max of 3mW-4 W EIRP for different segments	unknown	unknown	Korea	APT Report-07 (Rev4)–2/2016 update
RFID	919-923	2 W ERP (unlicensed) 4 W ERP (licensed)	unknown	unknown	Thailand	APT Recommendation-03 (02/2006) APT Report-07 (Rev4)–2/2016 update
RFID	919-923	2 W ERP	unknown	unknown	Malaysia	APT Report-07 (Rev4)–2/2016 update
RFID (tags only)	920-924	100 mW ERP (once off licence fee)	unknown	unknown	Sri Lanka	APT Recommendation-03 (02/2006)
RFID	920-925	4 W EIRP (unlicensed)	unknown	unknown	China (Hong Kong)	APT Report-07 (Rev4)–2/2016 update
RFID	920-925	0.5 W EIRP (unlicensed) 4 W EIRP (licensed)	unknown	unknown	Thailand	APT Report-07 (Rev4)–2/2016 update
RFID	920-925	0.5 W ERP (unlicensed)	unknown	unknown	Vietnam	APT Report-07 (Rev4)–2/2016 update
Non-specific	921-921.5	1 W EIRP	unknown	unknown	New Zealand	APT Report-07 (Rev4)–2/2016 update

Application	Frequency (MHz)	Max radiated power	Duty Cycle	Bandwidth	Country	Reference
	921.5-928	4 W EIRP				
Radio Telemetry, Telecommand, RFID	923-925	0.5 W ERP (unlicensed) 2 W ERP (licensed – RFID only)	unknown	unknown	Brunei Darussalam, Cambodia, Lao PDR, Singapore	APT Recommendation-03 (02/2006) APT Report-07 (Rev4)–2/2016 update
RFID	952-954	4 W EIRP (unlicensed but registration required)	unknown	unknown	Japan	APT Recommendation-03 (02/2006) APT Report-07 (Rev4)–2/2016 update
RFID	950.7-955	0.02 W EIRP (unlicensed)	unknown	unknown	Japan	APT Recommendation-03 (02/2006) APT Report-07 (Rev4)–2/2016 update