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With the impending shut down of 3G networks and reallocation of spectrum for a range of uses, there is a great deal of discussion about what is spectrum and its essentiality in our daily lives. It is also an issue that many consumers, understandably, know little about. This article aims to provide some high-level information on spectrum, its uses and its importance to all of us, with as little technical jargon as possible.

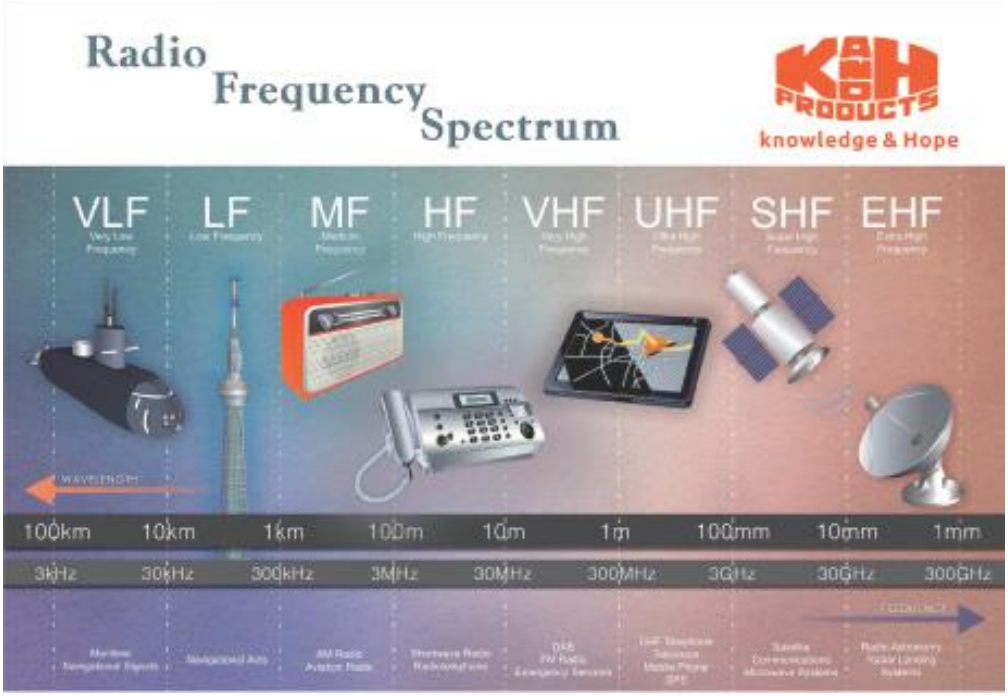
An invisible public resource: why spectrum matters for Australia

Introduction

In this room. On the street. Out in the paddocks. We are surrounded by an invisible public resource. This resource is crucial to how Australians live their lives. It is also finite. There is only so much of this resource available and it needs to be carefully managed so that it can benefit all Australians. That invisible public resource is radiofrequency spectrum.

Radiofrequency spectrum (or "spectrum") is used by a wide variety of technologies to communicate over distance.

Radios use spectrum to communicate. Mobile phones rely on spectrum to carry calls and transfer data. Televisions require spectrum to receive signal from transmitters. Satellites use spectrum to carry information over long distance. Wi-Fi routers use spectrum to provide wireless broadband inside homes and businesses. Bluetooth headphones use spectrum to connect with your phone.



Communicating through radiofrequency only works if services using spectrum coordinate with each other to stop interference. If multiple technologies use the same spectrum in the same area the interference could cause the technology to not work as it should. Coordination of who gets access to what spectrum, and where, is overseen by the Australian Communications and Media Authority (ACMA). The ACMA manages spectrum through spectrum *allocation* (deciding what types of technology can use a certain amount of spectrum) and *assignment* (who has the right for their technology to operate in its allocated band). For example, the ACMA might allocate a certain amount of spectrum to be used for telecommunications, the ACMA will then assign some of that spectrum to a telecommunications company such as Telstra or Optus to use exclusively for their services. This is done through spectrum licences.

As new technologies and services, such as 5G, require more spectrum, competition for the resource is increasing, both within spectrum allocation *and* assignment. Spectrum, as a key input into the delivery of services, impacts the quality of services on offer. Telecoms operators spend millions of dollars on spectrum licenses to offer more coverage and faster download speeds.

While national bodies oversee spectrum allocation, international harmonisation is important to encourage technology to work across national borders. For example, harmonised telecommunications standards allow the same mobile phone handsets to be used around the world. International harmonisation is overseen by organisations such as International Telecommunication Union (ITU).

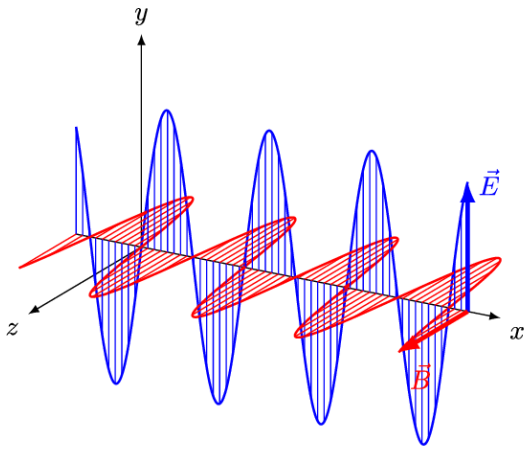
To ensure that spectrum is managed in the public interest, more stakeholders need to understand what it is, but most importantly what interests are at stake. The ACMA states that it manages spectrum to support "*the government's social and economic policy*". The ACMA is guided by The *Radiocommunications Act 1992* (Cth) which outlines the government's vision for how spectrum should be managed. This involves encouraging the use of spectrum to benefit the Australian public, encouraging competition and generating revenue from spectrum licensing.

Spectrum is a natural public resource and decisions need to be made about how spectrum is allocated and assigned in the public interest. ACCAN would like to encourage greater community engagement with spectrum, Internet researchers note that the "*discussion of the spectrum is off-putting because it is even more heavily cloaked by jargon than other technology topics*".

This article is designed to provide a simple overview of spectrum management in Australia, including what spectrum is and why it is important to wireless communications, how spectrum is managed by the ACMA, emerging issues with spectrum, and why more community voices are needed in spectrum management.

What is spectrum?

Radiofrequency spectrum refers to a part of the electromagnetic spectrum within 0 Hz to 3,000 GHz. Electromagnetic waves in these frequencies can be called radio waves. Radio waves are what wireless devices use to communicate with each other. They are electromagnetic waves which travel at a certain frequency, between 0 Hertz to 3,000 gigahertz . Hertz measures the number of times



that the wave goes up and down per second. Radio waves used for wireless communications move quickly, they can move up and down 3 billion times per second. Radio waves are measured in Hertz. Hertz refers to the number of times that an electromagnetic wave cycles through per second. A wave that cycles once per second, or goes up and down once per second like in the diagram above, is 1 Hertz. Radio waves for wireless communication are almost always much faster than this.

Radio waves of different frequencies (Hertz) behave differently and are useful for different kinds of wireless communication. Low frequency radio waves can travel longer distances and can go through certain objects like walls. High frequency radio waves travel shorter distances and have can be stopped by objects like walls, trees or rain. However high frequency radio waves can carry more information. In industry terms they have more “throughput”. High frequency waves also have a shorter wavelength and so can be received by smaller antennas, this makes them ideal for small devices such as smart phones. Here are some examples of products and the approximate frequencies they typically use.

Application example	**Hertz**
AM Radio	1000 KHz
FM Radio	100 MHz
Television	Approximately 500 MHz
Wi-Fi	2.4 GHz
Bluetooth	2.45 GHz

As you can see in the box above, broadcast communication like AM and FM radio uses lower frequency spectrum while short range devices such as Wi-Fi use higher frequency spectrum. Mobile communication uses a wide range of different frequencies to achieve both reliability and data speed. Follow this link to see an illustrated chart from the ACMA that shows what kinds of products use different kinds of spectrum.

Spectrum is grouped into different bands based on frequency. Below are some common bands for wireless communication. If you have used a radio in a boat, car or truck you may have come across the term VHF and UHF before.

Acronym	Meaning	Frequency band
VLF	Very low frequency	3 to 30 kHz
LF	Low frequency	30 to 300 kHz
MF	Medium frequency	300 to 3000 kHz
HF	High frequency	3 to 30 MHz
VHF	Very high frequency	30 to 300 MHz
UHF	Ultra high frequency	300 to 3000 MHz
SHF	Super high frequency	3 to 30 GHz
EHF	Extremely high frequency	30 to 300 GHz

Follow this link to see a chart of the kinds of applications that the ACMA allocates to different bands.

How is spectrum managed in Australia?

The ACMA is guided by The *Radiocommunications Act 1992* (Cth) which outlines the government's framework for how spectrum should be managed. The ACMA manages spectrum in Australia through three different types of licence: spectrum licences, apparatus licences and class licences.

Spectrum Licences

Spectrum licences are for a particular area and frequency for a specified number of years. Spectrum licences can be given through auction, tender, set price, negotiation, and direct allocation. Spectrum licences are often be used for mobile communication.

Apparatus Licences

Apparatus licences are linked to specific equipment for a specified area. Apparatus licences are typically issued for one year. Examples of apparatus licences include amateur radio or devices that allow aircraft to communicate.

Class Licences

Class licences are not restricted to one geographic location and do not require fees. They are typically for low powered radio equipment that shares frequencies. Examples of these devices

include Wi-Fi routers, car fobs and Bluetooth speakers. These devices are manufactured to international standards to share spectrum with each other and minimise interference.

While class apparatus licences attract fixed fees (or no fees at all for entities with exemptions, such as the coast guard), spectrum licences are often commercially valuable and in high demand. Since the 1990's Australia has sought to assign spectrum licences for high demand spectrum through different auction formats. The aim of these formats is to efficiently distribute spectrum to benefit public use while maintaining a competitive market and generating revenue from a public resource. As the ACCC recently stated,

> *The ACCC recognises that allowing the market to determine the price of spectrum through an auction means that spectrum is acquired by the highest value bidders, with the expectation that this encourages that spectrum be put to its highest value use, thus promoting allocative efficiency.*

In 2021 the ACMA auctioned 16 lots of spectrum in the 850/900MHz range. The ACMA stated that the "successful allocation of 850/900 MHz band spectrum is another important step forward for Australia's transition to 5G, and the deployment of new technologies". As we now know that frequency of spectrum is useful because it hits a sweet spot of travelling over distance while being able to carry lots of information. The telecommunications companies seem to think so too because Optus and Telstra together paid over two billion dollars for a twenty-year license for the 16 lots.

What are the emerging issues with spectrum management?

Spectrum policy reflects our values as a society. Where we as a society choose to prioritise spectrum allocation and assignment influences who benefits from a public resource. Different industries also compete for spectrum allocation. The Government is currently considering policies that would reallocate spectrum from TV broadcasting to telecommunications in exchange for less regulation. This section outlines some concerns with allocation and assignment of spectrum from research.

The growing need for spectrum for mobile and broadband including 5G.

Demand for spectrum for wireless communication will continue to grow, and 5G will require a large amount of spectrum. The Australian Mobile Telecommunications Association (AMTA), which represents telecommunications companies, recently called "*on the Government to set a target of 8 GHz in total spectrum assignments for mobile by 2030 to be actioned by the Australian Communications and Media authority (ACMA)*". This indicates the increasing needs that will have to be managed in allotting frequency spectrum between users.

One way to manage finite spectrum to maximise public utility is through spectrum sharing. To make sure that spectrum is being used to the fullest public benefit possible, dynamic spectrum sharing has attracted growing interest. This allows spectrum to be shared amongst multiple operators to ensure it is being used to the fullest extent possible. Spectrum sharing requires careful technical planning and use of automated systems to reduce interference but could provide major benefits to consumers if it is implemented effectively.

In 2020 the ACMA reported that, "*there is some support for the consideration of potential regulatory options to increase shared access to spectrum*" but "*the introduction of any non-traditional spectrum sharing regime will be challenging in the absence of a commitment from a number of often competing sectors*". However, the regulator noted that incumbents were less than enthusiastic

about relinquishing exclusive licencing. Instead arguing that sharing should be voluntary and industry led.

The future of spectrum sharing is not clear in the short term. As the ACMA concluded, *"[w]ithout commitment from a range of sectors, and without a clear 'champion' … it is hard to see where the momentum for this type of change will come from*".

Assignment, auctions and the public interest.

Even when spectrum is allocated to a particular use, there are still questions about the best policy tools to maximise spectrums use as a public resource. For example, spectrum auctions are popular globally but researchers have recently noted that there may be concerns with using auctions to achieve public aims. They argue that an auctions may have some weaknesses in mature markets that can impact or obstruct competition.

Regulators are aware that auctions can cause issues with competition. The ACMA does use spectrum caps to encourage competition in spectrum and since 2021 was required to consult with the ACCC before imposing assignment limits. For example, The ACCC recently recommended "a limit of 140 MHz of spectrum between 3.4 and 3.8 GHz" for "both metropolitan and regional areas".

Addressing concerns about auctions and spectrum assignment more generally will require greater community engagement in spectrum management. A cursory review of submissions to the ACMA's consultation demonstrates a lack of consumer representation in a debate dominated by industry organisations. The Government and the ACMA should engage with the to ensure that public concerns are foregrounded, particularly for digitally excluded groups that could benefit most from better wireless communication services.

The Australian Communications Consumer Action Network (ACCAN) is Australia's peak communication consumer organisation. The operation of ACCAN is made possible by funding provided by the Commonwealth of Australia under section 593 of the Telecommunications Act 1997. This funding is recovered from charges on telecommunications carriers.

ACCAN is committed to reconciliation that acknowledges Australia's past and values the unique culture and heritage of Aboriginal and Torres Strait Islander peoples. Read our RAP