Exploring RLAN use in the 5 GHz and 6 GHz bands

Discussion and options paper

APRIL 2021

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Executive summary

The 6 GHz band (5925–7125 MHz) is currently generating substantial interest internationally, with numerous countries opening up access to the band – or parts of it – for use by radio local area network (RLAN) systems, the most common of which are wi-fi networks and devices.

Given this momentum, the important role RLANs play in the broader broadband connectivity ecosystem, and the level of interest indicated domestically through the ACMA’s latest [five-year spectrum outlook](https://www.acma.gov.au/five-year-spectrum-outlook) (FYSO) process, we are investigating the case for similar actions in Australia in the 6 GHz band.

In this paper, we identify a preliminary view on a way forward, along with several additional options. We are also taking the opportunity to look at possible updates to the existing arrangements for RLAN devices in part of the adjacent 5 GHz band, to potentially reflect updates to international regulations made at the International Telecommunication Union (ITU) World Radiocommunication Conference in 2019 (WRC-19).

Regulators in the US and UK have recently made parts of the 6 GHz band available for unlicensed use in those countries under different technical and regulatory arrangements. Changes to UK regulations have mostly been based on studies and recommendations undertaken by the European Conference of Postal and Telecommunications Administrations (CEPT). Other countries have also announced intentions to make parts of the 6 GHz band available for RLAN/wi-fi, including Canada, Korea, Japan, Brazil, Chile, and Argentina.

Some countries have made or proposed arrangements for the lower 500 MHz of the 6 GHz band (5925–6425 MHz), while others are looking at the entire band. Details of the arrangements, such as power limits and additional restrictions to protect incumbent services, also vary between jurisdictions.

Parts of the 6 GHz band will also be considered for International Mobile Telecommunications (IMT, currently most readily associated with 5G) services in Region 1 as defined by the ITU (comprising Africa, Europe and the Russian Federation) by the next WRC in 2023 (WRC-23).

As a starting point for discussion on the future of the 6 GHz band, we believe there is sufficient momentum internationally to propose that the lower 500 MHz (5925–6425 MHz) of the 6 GHz band be made available for RLAN use. This would be done through a variation to the [Radiocommunications (Low Interference Potential Devices) Class Licence 2015](https://www.acma.gov.au/licences/low-interference-potential-devices-lipd-class-licence) (LIPD class licence) to authorise operation of devices operated either indoors at a ‘low power’ limit of 24 dBm and 11 dBm/MHz, or in any location at a lower limit (‘very low power’) of 14 dBm and 1 dBm/MHz. It is not proposed that access be limited to RLANs – other devices that meet these technical conditions, such as ‘unlicensed’ variants of 4G and 5G technologies, would also be enabled under these amendments to the LIPD class licence.

In the 5 GHz band, it was agreed at WRC-19 to update international regulatory arrangements in the 5150–5250 MHz range and we are considering whether to mirror some or all those updates in Australian arrangements.

This paper presents a summary of current arrangements, proposals and studies undertaken for both bands, both in Australia and internationally. It also seeks industry views on the initial proposal for the 6 GHz band, and if there is any interest in making further changes – either additional spectrum, or additional operating modes (such as higher power devices). We also seek views on whether the recent updates to the ITU Radio Regulations in the 5 GHz band should be reflected in Australian arrangements, or if there are other updates that could be made to current class licence arrangements for RLAN use in this band.

# Issues for comment

We welcome comments – general or specific – from interested stakeholders on any of the issues raised in this paper. We specifically invite comments on:

What is the demand for spectrum for RLAN use in the 6 GHz band (5925–7125 MHz)?

Should the ACMA proceed, as proposed, to consult on a formal variation to the LIPD class licence that adds the frequency range 5925–6425 MHz for RLAN use, bounded by the parameters described in the ACMA’s preliminary view section of this paper?

If class licensing arrangements are to be made in the lower 6 GHz band (by variation to the LIPD class licence), should alternative/additional power limits and/or other conditions be considered?

Is it appropriate to consider inclusion of the upper 6 GHz band (6425–7125 MHz) in the LIPD class licence or should this be deferred to monitor future developments (for example, in the wide-area International Mobile Telecommunications (IMT) space) as outlined in the ACMA’s preliminary view? We invite comments from submitters on the utility of the band for IMT use.

1. Should standard power (that is, higher power devices, including for outdoor use) operating under a dynamic spectrum access system such as the automatic frequency coordination (AFC) system adopted in the USA, be adopted in Australia for some or all of the 6 GHz band? Is there an appetite and capability for industry to provide the necessary systems to enable such use? We welcome views and evidence on the commercial and technical feasibility of introducing AFC systems in the band.

Should the higher power regulatory arrangements and associated interference mitigation measures added to the International Telecommunication Union (ITU) Radio Regulations at WRC-19 (see [*Resolution 229 (Rev WRC-19)*](https://www.itu.int/dms_pub/itu-r/oth/0a/06/R0A0600009D0001MSWE.docx)) in the 5 GHz band be included in any amendment to the LIPD class licence?

# Introduction

Over the last 12 months, spectrum in the 6 GHz band (5925–7125 MHz) has been made available in numerous countries for radio local area network (RLAN) deployments under licence-exempt or unlicensed arrangements – that is, arrangements broadly equivalent to Australian class licensing.

Parts of the 6 GHz band are also currently under consideration as part of the study cycle for the World Radiocommunications Conference in 2023 (WRC-23).

In the response to submissions on our draft 2020-24 FYSO work program, we progressed the 6 GHz band from the ‘monitoring’ stage to ‘initial investigation’ – this paper signals the commencement of those investigations. Submissions drew attention to the potential expanded use of the 6 GHz band, and dynamic spectrum access (DSA) arrangements being implemented in the US.

While the 6 GHz band is currently receiving more attention internationally, we are also taking this opportunity to look at relevant parts of the neighbouring 5 GHz band. We consider this is timely, noting that the band already has limited class-licensed RLAN devices as one of its main uses, and was considered in detail by WRC-19, which made updates to the ITU Radio Regulations in the 5150–5250 MHz range that are yet to be implemented in Australian regulations.

The ubiquitous, uncoordinated nature of RLAN systems makes them most conducive for operation under class licensing. We are therefore focusing on the arrangements for RLAN systems currently authorised under the LIPD class licence and expect any future operation to be authorised the same way.

## Scope

This paper presents information on the current state of the 5 GHz and 6 GHz bands both in Australia and internationally, including current regulatory arrangements, results of existing sharing studies, and other proposals and discussions already underway.

It sets out the ACMA’s preliminary thinking on the future use of RLAN devices to begin a discussion with Australian stakeholders about the future of the bands locally, and to gauge the appetite for any changes to Australian arrangements in the bands.

## Case for action

RLAN technology, and specifically wi-fi, has become an integral part of everyday modern life. wi-fi use continues to expand, with more diverse devices utilising these networks demanding higher data rates and lower latency.

According to our [*Communications report 2018-19*](https://www.acma.gov.au/sites/default/files/2021-02/Communications%20report%202018-19.pdf), there were 43.629 million internet subscriptions in Australia as at June 2019, an increase of 4.6% on the previous year. Of these, 35.9 million were mobile subscriptions and 7.729 million were fixed subscriptions. As described in Appendix A, RLANs are commonly used within a premise to connect related devices, including to the internet. They provide the final link between people’s routers and the increasing number of wireless-enabled consumer electronics devices in their homes, including TVs, smart appliances, game consoles, and portable/mobile devices such as smartphones, tablets, remote controllers, 3D visors and laptops.

A 2021 Wi-Fi Alliance study[[1]](#footnote-2) notes that around 63% of mobile traffic is currently offloaded to wi-fi networks. The ever-increasing demand for, and traffic being carried over, wi-fi networks has been accelerated by the ongoing COVID-19 pandemic, which has resulted in more people working, learning and socialising from home.[[2]](#footnote-3) It has also increased the prevalence of real-time online communications such as video conferencing.

In February 2017, the Wi-Fi Alliance commissioned the [Wi-Fi Spectrum Needs Study](https://www.wi-fi.org/news-events/newsroom/additional-unlicensed-spectrum-needed-to-deliver-future-wi-fi-connectivity), which found the ever-growing number and diversity of wi-fi devices, along with increased connection speeds and data traffic volumes will exceed the capacity of spectrum currently available in the 5 GHz band by 2020. The 2021 study[[3]](#footnote-4) commissioned by Wi-Fi Alliance estimated that the global economic value of wi-fi in 2021 will be US$3.3 trillion, growing to US$4.9 trillion by 2025. For Australia, these numbers are US$34.7 billion in 2021 and US$41.7 billion by 2025. The study also estimates 4.2 billion wi-fi devices will be in use in 2021, with 2.2 billion being Wi-Fi 6 compatible.

The roll-out of 5G and increasing uptake of the National Broadband Network (NBN) could also contribute to increased demand for wi-fi services. Consumers expect wi-fi performance to not be a limiting factor in the overall performance of their home and business fixed and mobile broadband networks. Having access to faster broadband services means consumers expect their wi-fi speeds to commensurately increase, in order to handle a wide range of high data rate applications, such as high definition (HD) and ultra-high definition (UHD) television.[[4]](#footnote-5)

There is also expected to be growth in technologies, such as augmented and virtual reality, that would benefit from very low power wi-fi arrangements using wider channels.

As well as increasing use of wi-fi generally, international developments and domestic interest in the 6 GHz band are being driven by its inclusion in the specification for the latest version of wi-fi (IEEE 802.11ax, also known as Wi-Fi 6). Wi-Fi 6 provides significant improvements in performance and potential data throughput compared to previous iterations, some of which can only be fully realised in spectrum that provides for larger contiguous channels (up to 320 MHz) and that is not shared with older wi-fi devices.

Appendix B summarises international arrangements in the:

various 5 GHz bands (5150–5350 MHz, 5470–5600 MHz, 5650–5850 MHz), which are well-established both internationally and in Australia for use for RLANs

6 GHz band (5925–7125 MHz), which has been identified in some countries as additional spectrum for RLANs, specifically for use by Wi-Fi 6.

Given the increasing demand for wi-fi services in general, and international trends in the adoption of Wi-Fi 6 specifically, we believe there is a solid case for action, and it is timely to review arrangements for RLANs in these bands in Australia.

# Current Australian arrangements

Current arrangements in Australia, and existing services and licences in the 5 GHz and 6 GHz Bands are shown in Figure 1. The details of each item in that diagram are given in Table 1. RLAN use in Australia is authorised via the [LIPD Class Licence](https://www.legislation.gov.au/Details/F2016C00432). The authorised frequency ranges within the 5 GHz band, along with their associated restrictions are as follows. All power levels are given as effective isotropic radiated power (EIRP):

5150–5350 MHz:

indoor use only

maximum 200 mW (23 dBm)

also, between 5250–5350 MHz:

dynamic frequency selection (DFS) required

transmit power control (TPC) required when operating above 100 mW (20 dBm).

5470–5600 MHz and 5650–5725 MHz:

maximum 1 W (30 dBm)

DFS required

TPC required when operating above 500 mW (27 dBm).

5725–5850 MHz:

4 W (36 dBm)

frequency hopping or digital modulation transmitters

not specified as being for RLAN use only.

The use of this band for RLAN purposes was considered at WRC-19 (see [ITU section](#_ITU) in Appendix B) and some limited updates were made to the ITU Radio Regulations. Australia did not take a firm position on this issue at WRC-19, but we consider it prudent to include a discussion on this band alongside that on the 6 GHz band.

Other than RLAN, other current uses of the 5 GHz Band include:

other class-licensed LIPDs

intelligent transport services (ITS)

fixed point-to-point and point-to-multipoint services

satellite services

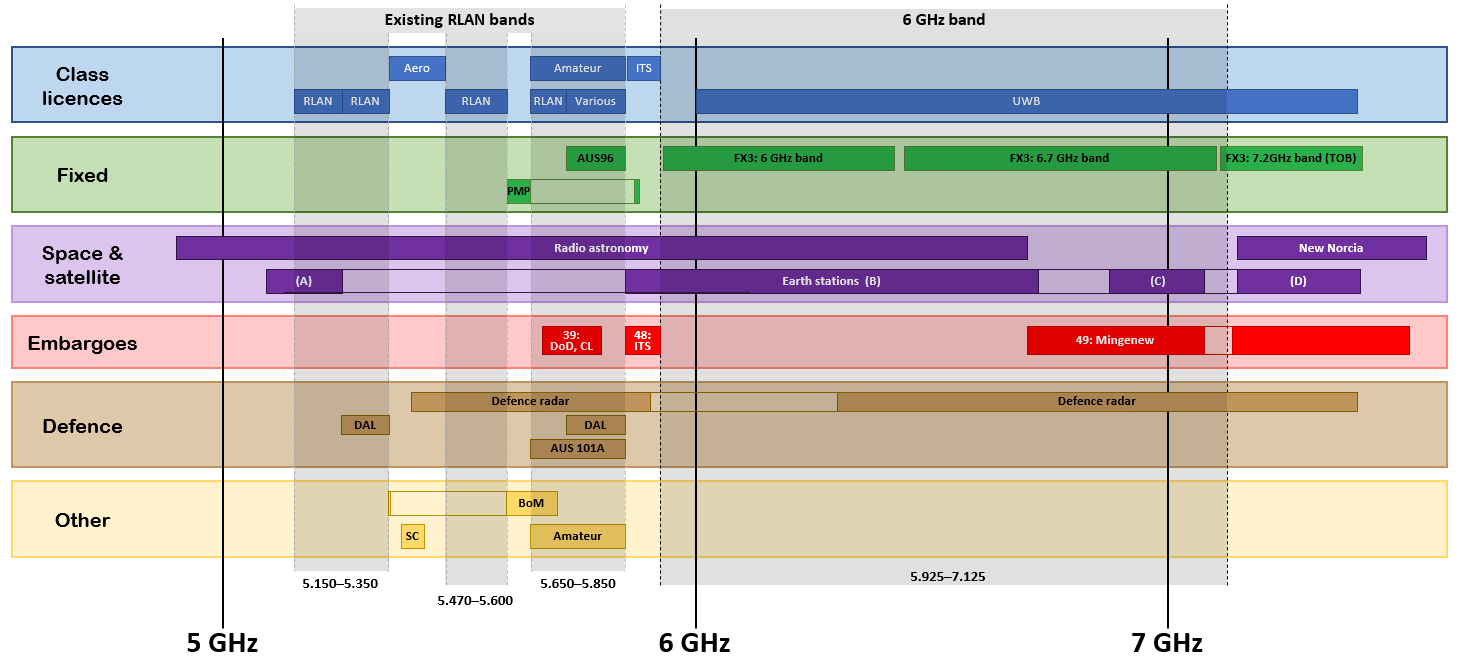
weather radar

radio astronomy

Defence.

The 6 GHz Band is predominantly used for fixed and satellite services, with some radio astronomy. Not all the services shown in Figure 1 are used Australia-wide, and some are only in very specific locations or geographic areas. Among other factors, any updates to the bands would need to take into consideration existing users in the appropriate locations.

1. Current arrangements in Australia



Current arrangements in the 5 GHz and 6 GHz bands in Australia. See Table 1 for details on each item in the diagram.

Details of the services shown in Figure 1

|  |  |  |
| --- | --- | --- |
| Label in Figure 1 | | Description |
| Class licences | Aero | Weather radar operated under the [Radiocommunications (Aircraft and Aeronautical Mobile Stations) Class Licence 2016](https://www.legislation.gov.au/Details/F2018C00927). |
| Amateur | Stations using the [Radiocommunications (Overseas Amateurs Visiting Australia) Class Licence 2015](https://www.legislation.gov.au/Details/F2020C00377). |
| ITS | Devices operated under the [Radiocommunications (Intelligent Transport Systems) Class Licence 2017](https://www.legislation.gov.au/Details/F2018L00026). |
| RLAN | RLAN devices are specifically authorised to operate in the 5 GHz Band with the following restrictions under the [LIPD class licence](https://www.legislation.gov.au/Details/F2016C00432):  **5150–5350 MHz:** indoor use only, maximum 200mW EIRP, DFS and TPC required in some cases  **5470–5600 MHz:** maximum 1 W EIRP, DFS required, TPC for higher powers  **5650–5725 MHz:** maximum 1 W EIRP, DFS required, TPC for higher powers.  They can also operate in the **5725–5850 MHz** range – see the entry for ‘Various’ below. |
| UWB | Ultra-wideband (UWB) transmitters operating under item 78 of Schedule 1 to the [LIPD class licence](https://www.legislation.gov.au/Details/F2016C00432). |
| Various | A range of other types of devices are authorised with various restrictions under the [LIPD class licence](https://www.legislation.gov.au/Details/F2016C00432).  See items 22 (all transmitters at 25 mW), 43 (1 W RFID), 57 (4 W frequency hopping) and 60 (4 W digital modulation transmitters) of Schedule 1 to the LIPD class licence. |
| Fixed | AUS96 | Footnote AUS96 in the [*Australian Radiofrequency Spectrum Plan 2017*](https://www.acma.gov.au/australian-radiofrequency-spectrum-plan) (ARSP) allows fixed services to operate in this band so long as they do not cause interference to other services. These can operate in regional and remote areas, as described in [point-to-point (5.8 GHz) arrangements](https://www.acma.gov.au/options-fixed-licences). The main licensees are gas, coal and mining companies, and the Country Fire Authority in Victoria. |
| FX3 | Bands used for fixed point-to-point links, as described in [RALI FX-3](https://www.acma.gov.au/publications/2019-09/publication/rali-fx3-microwave-fixed-services).  Widely used across all of Australia by many users. |
| PMP | Point-to-multipoint services. See [RALI FX-23](https://www.acma.gov.au/publications/2019-08/publication/frequency-coordination-and-licensing-procedures-point-multipoint-services-56-ghz-band).  The main licensees are BHP, Ace Internet and the Queensland Department of Transport. |
| TOB | Fixed links used for Television Outside Broadcast services. See [RALI FX-3](https://www.acma.gov.au/publications/2019-09/publication/rali-fx3-microwave-fixed-services). |
| Space & satellite | Earth stations | Fixed earth (all segments) and earth receive (segments C and D only).  Segment A contains gateway stations operating as part of the worldwide Globalstar non-GSO MSS system.  Segments A, B and C are covered by [RALI MS-44](https://www.acma.gov.au/publications/2019-08/publication/frequency-coordination-procedures-earth-station-protection-zones) and [RALI MS-45](https://www.acma.gov.au/publications/2019-08/publication/frequency-coordination-requirements-between-microwave-fixed-point-point-links-and-fss-earth-stations). |
| New Norcia | The European Space Agency operates earth station transmitters adjacent to the 6 GHz band at New Norcia. [RALI MS-43](https://www.acma.gov.au/publications/2019-09/publication/rali-ms43-new-norcia-earth-station-and-other-services) contains the ACMA’s current co-ordination policy. |
| Radio astronomy | Radio astronomy observations are made at several sites around Australia. The CSIRO must be notified of any apparatus licences to be issued near any of these sites. Details of this process are in [RALI MS-31](https://www.acma.gov.au/publications/2019-09/publication/rali-ms31-notification-zones-around-radio-astronomy-facilities). See also footnote AUS87 in the [ARSP](https://www.acma.gov.au/australian-radiofrequency-spectrum-plan). |
| Embargoes | 39 | No new fixed link assignments in this frequency range, to help protect Defence radar, and to provide more opportunity for class-licensed devices in areas of higher population. |
| 48 | No new apparatus licence assignments, to support the use of ITS. |
| 49 | No new assignments of any kind around Mingenew, for protection of the space communications site there. |
| Defence | 101A | Australian footnote AUS101A is applied to the radiolocation service in this band. This marks the band as being primarily for use by Defence, and they should be consulted on any other use of the band. |
| DAL | The Department of Defence hold Defence apparatus licences in these bands. |
| Defence radar | Defence radiodetermination licences. Licensed for use in either Exmouth or Australia-wide (lower segment) and Delemare (upper segment). |
| Other | Amateur | Amateur licences, in accordance with the [Radiocommunications Licence Conditions (Amateur Licence) Determination 2015](https://www.legislation.gov.au/Details/F2020C00376). |
| BoM | Radars, which are almost exclusively weather radars licensed to the Bureau of Meteorology. |
| SC | Scientific licences operated by Geoscience Australia in Canberra. |

# Discussion, preliminary views and options

We invite evidence and views from stakeholders on issues relating to the 5 GHz and 6 GHz bands, including potential future uses of the 6 GHz band, potential planning options and/or incumbency/protection issues in the Australian context.

Below we have outlined our preliminary views on the use of the 6 GHz band for RLANs along with some alternative or complimentary options, and some potential changes to arrangements for RLANs in parts of the 5 GHz band.

## 6 GHz band

Given the relative scarcity of available spectrum in RLAN-standardised bands available to support future growth in RALN capacity, we have identified these bands (or parts thereof) as strong candidates for potential class-licensed access. Importantly, we consider such class-licensed access may be achieved in a way that does not impact existing uses and users of the spectrum.

Conversely, a clear case for wide-area International Mobile Telecommunications (IMT) in either band is yet to develop. While the WRC-23 study process is looking at the upper portion of the 6 GHz band for a potential IMT identification (mostly in ITU Region 1), there does not appear to be any immediate demand for these services, noting the significant amount of spectrum currently available (or being made available) for mobile use in Australia.

Furthermore, there is clear momentum for the lower 500 MHz portion of the 6 GHz band to be made available for unlicensed (or class-licensed) access by localised networks, including (but not limited to) RLANs and/or New Radio Unlicensed (NR-U) systems (see [the section on IMT-2020](#_IMT_2020_and) in Appendix A), so it is proposed that this spectrum will be considered for addition to the LIPD class licence at a future time.

Internationally, different jurisdictions are introducing or proposing arrangements in the 6 GHz band that are broadly similar to each other, but vary in the amount of spectrum, power limits and other implementation details. Generally, arrangements are trending towards:

operation of radiocommunications equipment without individual licences (that is, unlicensed or licensed exempt), with a focus on RLANs

operating in either the bottom 500 MHz (5925–6425 MHz) or the entire band (5925–7125 MHz)

some combination of 3 different power limits, with different restrictions:

very low power (VLP) devices – commonly 14 dBm

low power devices, indoor use only (LPI) – ranges from 23 to 30 dBm in different jurisdictions and may also require lower limits for client terminals

higher (‘standard’) power, requiring use of an AFC system – either 30 or 36 dBm, again with lower power for client devices.

additional power or frequency range restrictions for protection of satellite receivers and/or ENG.

We note that the existing primary uses of the lower 500 MHz band in Australia (FSS and FS) are consistent with those elsewhere in the world. Accordingly, we have formed the preliminary view, informed by studies in Europe and the UK discussed later in the paper, that RLAN use can coexist with existing primary services.

### Preliminary view

We have formed the preliminary view that to expedite opportunities for 6 GHz RLANs in Australia in a manner compatible with existing uses, adopting the arrangements recently implemented in the UK could be reasonable for Australia. Specifically:

that the bottom 500 MHz (5925–6425 MHz) be made available for use in Australia under the LIPD class licence

that these devices be allowed to operate at 2 different power limits:

24 dBm (11 dBm/MHz), if only used indoors (LPI)

14 dBm (1 dBm/MHz) in all locations (VLP).

These arrangements are similar to those commonly used or suggested in current regulations and/or international proposals and are consistent with outcomes of technical studies. There is widespread acceptance that operation under these broad restrictions is sufficient to protect incumbent services, so long as the details of the regulations are fine-tuned for the jurisdiction in which they are implemented. We have not identified any specific domestic issues that would lead to any further limitations on how these devices should operate in Australia at the moment.

Furthermore, by limiting the proposed RLAN use to the lower 500 MHz band for now, it enables additional time for further developments in the rest of the band to become clearer (for example, possible interest in wide area wireless broadband use) before making any decisions in Australia.

### Options

We acknowledge that the preliminary view on 6 GHz RLAN use outlined above does not go as far as a number of other jurisdictions and, therefore, there are a range of additional options that could be considered. Some alternative options may include:

Continuing to limit RLAN use (at least initially) to the lower 500 MHz but with revised power limits and/or additional limitations.

Making the entire band available for LPI and VLP, rather than restricting operation under the class licence to the lower 500 MHz.

Permitting standard power devices (that is, higher power devices including outdoor operation) under a DSA-like arrangement such as the AFC system adopted in the US.[[5]](#footnote-6) Under this approach, the ACMA would not develop and manage the DSA/AFC system and would instead look to industry to provide this service.

While our preliminary view is to expedite availability of the bottom 500 MHz (5925–6425 MHz) for use under the LIPD class licence, we invite submitters to provide evidence and views about the demand for alternative uses and/or regulatory implementations (for example, AFC) in the broader 6 GHz band, including potential IMT above 6425 MHz.

## 5 GHz band

We have no specific proposals for changes to class-licensed arrangements in the 5 GHz band, however we seek industry views on the following questions:

Should Australia implement the changes introduced to the 5150–5250 MHz frequency range at WRC-19 (see the [ITU section](#_ITU_developments) in Appendix B)?

Are there other arrangements in place internationally that could be beneficial to be incorporated into Australian regulations?

Are there other changes to the LIPD class licence for the 5 GHz band that the ACMA should be investigating?

## Next steps

Our next steps will depend on responses to this paper. We may determine that implementing our preliminary view on including the lower 500 MHz of the 6 GHz band in the LIPD class licence is an appropriate next step, and therefore proceed to consult on a variation to that class licence. Alternatively, or additionally, we may consult further on other specific potential planning options for increased RLAN access to the 5 GHz and/or 6 GHz bands.

# Invitation to comment

## Making a submission

The ACMA invites comments on the issues set out in this discussion paper.

[Online submissions](https://www.acma.gov.au/have-your-say) can be made by uploading a document. Submissions in PDF, Microsoft Word or Rich Text Format are preferred.

Submissions by post can be sent to:

The Manager

Spectrum Planning Section

Australian Communications and Media Authority

PO Box 78

Belconnen ACT 2616

The closing date for submissions is COB, 5 May 2021.

Consultation enquiries can be emailed to [xavier.halliwell@acma.gov.au](mailto:xavier.halliwell@acma.gov.au).

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# Appendix A: Technology overview

## Radio local area networks (RLANs)

An RLAN is a network of computers, or related devices that are connected wirelessly, and are confined to a local geographic area such as a single house, building, school, or place of business.

By far the most common protocols used for wireless connections in RLANs are the IEEE 802.11 family of standards – more commonly known as wi-fi. Advances in wi-fi standards are often drivers for changes in spectrum arrangements for RLAN devices in general. Wi-fi is expected to again be the main driver for any changes in the 6 GHz band, and is the technology that most stakeholders will have an interest in.

Wi-fi, in its various evolving forms, has been around for many years. The IEEE 802.11n standard (now also commonly called Wi-Fi 4) was published in 2009 and is ubiquitous in many households. Wi-Fi 5 and the recently specified Wi-Fi 6 are most relevant to the 5 and 6 GHz bands. Key features of these technologies are transmit power control (TPC) and dynamic frequency selection (DFS). AFC systems are also being introduced as a separate third-party access control measure in some jurisdictions. Wi-fi 5 and 6 also use a specific implementation of advanced antenna systems (AAS) to increase capacity and/or coverage – see below for a description of all of these features.

### Wi-Fi 5

IEEE 802.11ac– known as Wi-Fi 5 – was introduced in 2014. By specifying 80 MHz channels in the 5 GHz band and increasing modulation to 256-QAM, the data throughput was significantly increased relative to its predecessors. Another key improvement over previous technologies was the implementation of multi-user-multiple input/multiple output (MU-MIMO) antenna configurations for downlinks (access point to user terminal), which also added significant capacity increases over existing single‑user MIMO (SU-MIMO) configurations.

### Wi-fi 6 and 6e

The IEEE 802.11ax standard – known as Wi-Fi 6 – is the latest wi-fi standard. Wi-fi devices are expected to be the main users of any existing unlicensed 6 GHz band arrangements worldwide. 802.11ax devices that can operate in the 6 GHz band are being marketed as ‘Wi-Fi 6e’ and are expected to provide further improvements in wireless network speeds and performance due to not having to share the band with older, less efficient devices.

Other than specifying the 6 GHz band as a new operating frequency band, the new standard also includes numerous other features to improve network performance. The major changes are support for larger bandwidths (up to 320 MHz), more clients per access point, higher order modulation scheme, and spatial frequency reuse – a method to help differentiate wanted signals from those produced in neighbouring networks.

Support for many more interconnections and device types will make it another option for Internet of Things (IoT) interlinking. Implementation of an orthogonal frequency division multiple access scheme (OFDMA) – as opposed to the orthogonal frequency division multiplex (OFDM) scheme used by previous generations – will make it far more effective in dense environments. The improved spatial reuse, enabled by significant enhancements in MU-MIMO arrangements (expanding it to uplinks), will contribute heavily to the abovementioned capacity and efficiency improvements.

## IMT 2020 and Fixed Wireless Access (FWA)

IMT is a regulatory construct used to describe a group of cellular technologies for the purposes of identification in the ITU Radio Regulations. Those technologies broadly comprise (although are not limited to) 3GPP-standardised technologies such as 3G, 4G and 5G network technologies. IMT 2020 specifically aligns with 5G new radio (NR). While being mobileis obviously a key characteristic of these technologies, and a *mobile* allocation in the ITU Radio Regulations is a prerequisite for identification for IMT in a specific frequency band, the same technologies, or elements of them, may also be applied to FWA networks.

In the 6 GHz band, 3GPP is developing specifications for NR, including ‘unlicensed’ NR (NR-U), for 2 frequency bands – band n69 (5925–6425 MHz) and n97 (5925–7125 MHz). NR-U could conceivably operate under the same regulatory provisions as class-licensed RLANs and is considered a candidate technology for the 6 GHz band.

## Technology features

### Transmit power control (TPC) and dynamic frequency selection (DFS)

TPC and DFS are mechanisms used by some radiocommunications devices to assist with reducing interference to other devices, to extend battery life or make more efficient use of spectrum within a system of multiple devices.

A device using TPC will use information about the signal being received and lower its transmit power to the minimum level needed to achieve a certain signal quality at the receiver. DFS, sometimes known as listen-before-talk, will monitor the frequencies it is able to operate on and select the channel(s) to use based on current channel occupancy.

TPC and DFS are commonly required by existing regulations for RLAN devices in the 5 GHz band and are expected to feature in 6 GHz deployments.

### Automatic Frequency Coordination (AFC)

In the US, several frequency bands that are available for use by unlicensed devices use an AFC system. Under these systems, unlicensed devices seeking to access the spectrum must first contact an accredited AFC service to determine its allowable operating parameters.

The AFC is an online service that accesses the Federal Communication Commission’s (FCC’s) Universal Licensing System (ULS) data and can calculate the maximum allowable power for an unlicensed device based on:

the device’s geographic location

information in the ULS database about nearby licensed services

a predefined calculation method and set of parameters for protecting licensed services.

A device seeking access to certain parts of the spectrum on an unlicensed basis must report its location to the AFC, which then calculates which channels that device is able to use, and the maximum allowed power on each of those channels. Those results are sent back to the device, which must then operate within those restrictions. As well as protecting existing licensed devices, an AFC system allows interference to be more easily traced when it occurs.

The FCC has mandated the use of AFC systems for several frequency bands, including the 6 GHz band and for whitespace between TV broadcast channels.

The Wi-Fi Alliance has recently released a draft proposed specification for the operation of AFC systems in the 6 GHz band.

### Advanced antenna systems (AAS)

All the potential applications that may benefit from new arrangements in the 5 GHz and 6 GHz bands, including more recent wi-fi technologies and localised NR-U networks, employ AAS in some form. AAS are also commonly referred to as ‘active’ antenna systems, a term historically used to describe antenna units that contain active electronic components (usually transistors) at the feed point. In the context of IMT‑2020 and more recent RLAN technologies, the term has been used to describe systems of multiple spatially separated antennas connected to a single device.

Individual AAS antennas can either be fed with different data streams to increase capacity or a single data stream with electronically-controlled phase offsets to create directional beams in the wanted direction – methods known as multiple-input multiple-output (MIMO) and beamforming, respectively.

MIMO works by exploiting path diversity in cluttered environments. In a sufficiently dense multipath radiofrequency environment, small spatial separations of transmit and/or receive antennas (depending on the type of MIMO configuration) can result in significant diversity between the physical environmental channels linking a transmitter and receiver. Applying unique coding to the individual data streams carried over these different physical channels enables multiple parallel streams to be transmitted, which increases overall data throughput.

Beamforming has been around for many years. Dynamic steering of antenna beams through phased array antenna systems has long been employed by a range of military (among other) applications. However, the technology to implement it in small consumer applications has only recently become available. It has been particularly critical in the development of millimetre wave (mmWave) mobile technologies, where the additional gain afforded by mutual coupling of dynamically formed beams helps, in part, to overcome the very high propagation losses at those frequencies. This has helped high-bandwidth spectrum that was once unusable for mobile due to poor coverage to be used, albeit limited to localised applications.

The minimum antenna separation distance in an AAS is wavelength-dependant, so larger, more complex AAS are more likely at higher frequencies for a given equipment size.

Given the higher propagation losses at higher frequencies, it is more likely that AAS will be used for beamforming at higher frequencies (for example, mmWave) to compensate for coverage limitations, noting capacity is generally abundant given the very large bandwidths available. Conversely, it is more likely that AAS will be used for MIMO at lower frequencies, such as 3.6 GHz, given the more favourable coverage but lower available bandwidths.

Ultimately, use of these features are network optimisation decisions for operators. In IMT deployments, for example, there are likely to be various combinations of MIMO and beamforming delivered by AAS at different operating frequencies. At 6 GHz, it is unclear what an optimal MIMO/beamforming combination might look like. Anecdotally, implementation of beamforming is being looked at in jurisdictions considering part of the band for wide-area IMT, but how these networks are practically implemented is unlikely to be clear for some time.

# Appendix B: International arrangements

Internationally, the types of services in use in the 5 GHz and 6 GHz bands are generally similar to those in use in Australia. There are examples of regulation – in the US and UK – that have enabled successful sharing between RLAN and some of the other services in the 6 GHz band, which would need to be considered in Australia if new spectrum were to be made available for RLAN use. Arrangements in the UK are based on a series of studies done by European Conference of Postal and Telecommunications Administrations (CEPT), while the US, which was the first to open the 6 GHz band, based its regulation on studies undertaken by the FCC in consultation with industry stakeholders.

WRC-19 included an agenda item (AI 1.16) that looked at making changes to RLAN use in the 5 GHz band. For WRC-23, there is a related item (AI 1.2) considering allocations for IMT in part of the 6 GHz band (6425–7125 MHz).[[6]](#footnote-7)

Figure 2 illustrates the arrangements for RLAN use that are implemented, recommended, or proposed by various international bodies. Segments marked with \*\* indicate that changes have recently been made or proposed.

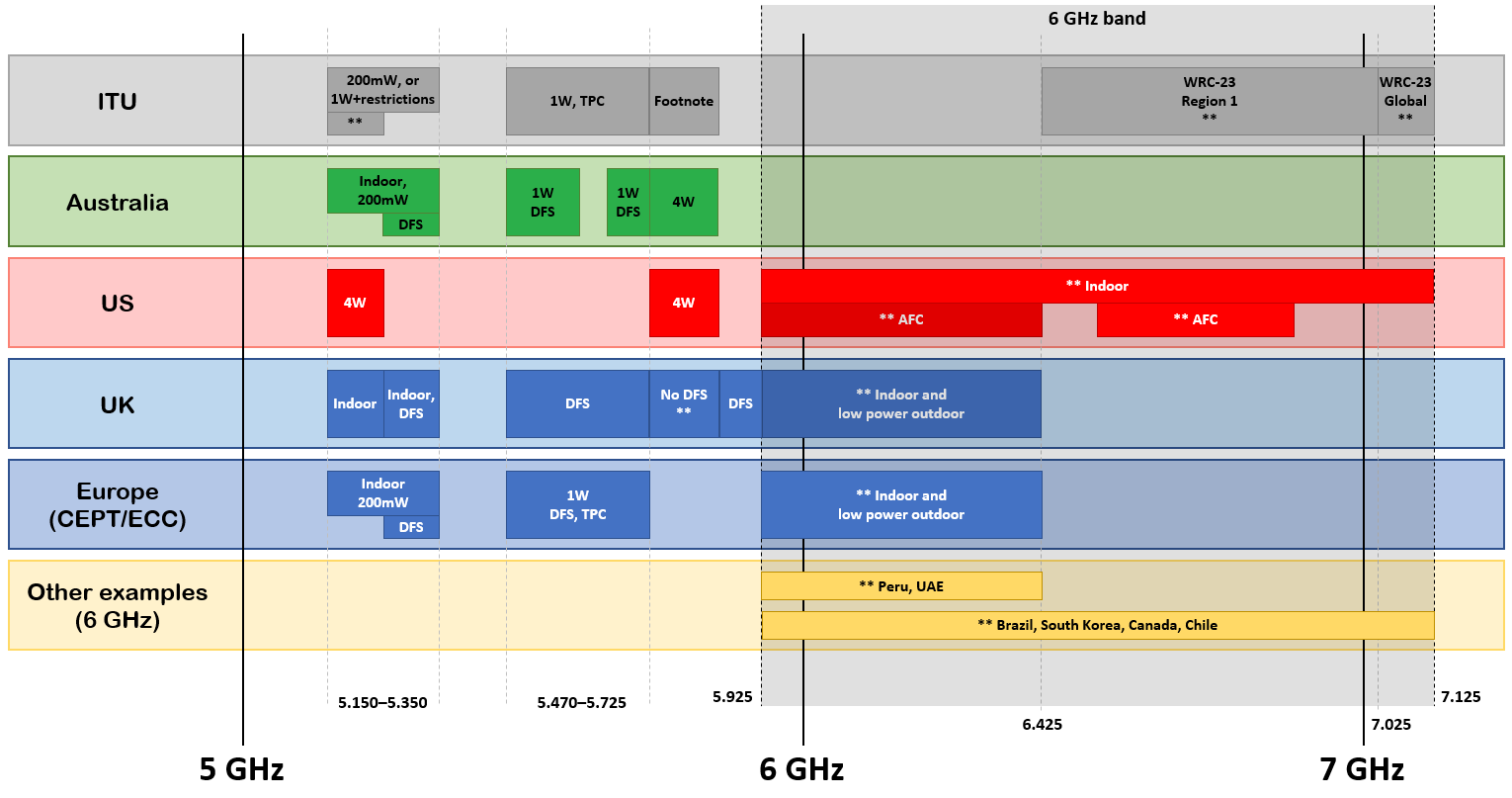
Allocations have been made in the ITU Radio Regulations in 3 different frequency ranges in the 5 GHz band for wireless access services (WAS) and RLAN use. Parts of the Radio Regulations relating to the 5150–5250 MHz range were updated at WRC‑19. Parts of the 6 GHz band are being investigated as part of the agenda for the WRC‑23.

There are 2 bands available in the US for 5 GHz RLAN use, which allow operation at 4 W. The entire 6 GHz band has also recently been made available for unlicensed use, some segments of which requires the use of an AFC system.

In the UK, most of the 5 GHz band is available for RLAN use, and in most cases, devices are required to implement DFS. In July 2020, the UK regulator, Ofcom, made 2 changes to arrangements in the band: opening up part of the 6 GHz band, and removing the DFS requirement from one segment of the 5 GHz band. Most of the UK arrangements are based on recommendations and reports from CEPT (or its European Electronics Commission, the ECC).

Several other countries have also recently announced their intentions to allow RLAN use in the 6 GHz band including Canada, South Korea, and Brazil.

1. International arrangements and proposals for use of RLAN in the 5 GHz and 6 GHz bands

   
Segments marked with \*\* indicate where changes have recently been made, or current proposals are being considered.

## ITU developments

### 5 GHz band

Agenda item 1.16 at WRC-19 was a general consideration of issues relating to the use of WAS/RLAN in the 5 GHz band, which are set out in [ITU-R Resolution 229 (Rev. WRC-19)](https://www.itu.int/oth/R0A0600009D/en). The outcome was an update to the 5150–5250 MHz range. The changes allow higher power and outdoor devices to operate but impose restrictions to protect satellite receivers from aggregate interference from the expected large number of devices that would operate in the future.

Following is a summary of the requirements in ITU Resolution 229 (Rev. WRC-19).

#### 5150–5250 MHz

Prior to WRC-19, ITU Resolution 229 (Rev. WRC-15) provided for:

indoor use only, with maximum EIRP of 200 mW (23 dBm) or 10 mW/MHz (10 dBm/MHz) measured within any 1 MHz

maximum EIRP 40 mW (16 dBm), when used in vehicles.

The WRC-19 outcome was to add the following options for administrations using RLAN systems in this band:

individual administrations can choose to allow outdoor use with a maximum EIRP of 200 mW (23 dBm).

the EIRP limit can be increased to 1 W if an appropriate antenna pointing mask is applied. Appropriate masks are:

200 mW (23 dBm) limit in any direction above 5 degrees of elevation,

125 mW (21 dBm) limit in any direction above 30 degrees of elevation[[7]](#footnote-8)

a specific (and more detailed) emission mask, which is set out in ITU Resolution 229 (Rev. WRC-19).

to protect satellite receivers from aggregate interference, either:

no more than 2% of all devices should be operating with the 1 W limit, or

the total unwanted power from all devices should not exceed the current level.

#### 5250–5350 MHz

No changes at WRC-19.

Maximum EIRP of 200 mW (23 dBm).

Maximum EIRP density of 10 mW/MHz (10 dBm/MHz) in any 1 MHz band.

Appropriate measures should be taken to ensure most RLANs are operated indoors.

Maximum EIRP is increased to 1 W (30 dBm) and density limit to 50 mW/MHz (17 dBm) if a specified mask is used.

Devices must either use dynamic power control or impose power limits 3 dB lower than they would otherwise be.

Administrations may choose to use mitigation techniques other than those listed, so long as the Earth exploration satellite and space research services are adequately protected.

The radiolocation service should be protected using the techniques and parameters from ITU-R M.1652-1.

#### 5470–5725 MHz

No changes at WRC-19.

Maximum transmitter power of 250 mW (24 dBm).

Maximum mean EIRP of 1 W (30 dBm).

Maximum EIRP density of 50 mW/MHz (17 dBm) in any 1 MHz.

Devices must either use dynamic power control or impose power limits 3 dB lower than they would otherwise be.

The radiolocation service should be protected using the techniques and parameters from ITU-R M.1652-1.

### 6 GHz band

Agenda item 1.2 for the next WRC (WRC-23) will consider additional frequencies for IMT in various bands. This includes 2 sections of the 6 GHz band:

6425–7025 MHz in ITU Region 1 (Europe, Russia, Africa, Middle East)

7025–7125 MHz in all regions

China, Russia and the African Telecommunications Union (ATU) were the main proponents at WRC-19 for inclusion of this agenda item. Although some of these bands had previously been studied, it was argued that the introduction of 5G may give rise to different outcomes.

## US

### 5 GHz band

The US has arrangements in place allowing both indoor and outdoor use of RLAN devices in the 5150–5250 MHz and 5725–5850 MHz bands with an EIRP limit of 36 dBm. In the 5150–5250 MHz range, this is a higher power limit than other administrations allow. There are also restrictions on power levels directed above certain elevation angles. These are designed to protect satellite receivers from aggregate interference due to the large number of devices that may be operating on the ground within a satellite’s field of view. The power limits and mask are the same as the FCC later implemented for ‘high power’ devices in the 6 GHz band – see the next section.

The US was the main proponent of the WRC-19 agenda item that considered this band. It had been domestically permitting the operation of outdoor RLAN systems since 2014 and sought updates to the ITU Radio Regulations to match its own domestic arrangements. The US’s proposed changes to the ITU Radio Regulations were not fully adopted by WRC-19 due to concerns that they did not do enough to protect satellite receivers, especially if – as is expected to happen – the number of RLAN devices operating in the band greatly increases in the future.

The updates made to the 5150–5250 MHz band at WRC-19 (as described in the previous section) were informed by the US arrangements but proposed lower maximum power limits.

### 6 GHz band

In April 2020, the FCC implemented changes in the 6 GHz band in the US, allowing unlicensed use of the entire 6 GHz band (5925–7125 MHz).[[8]](#footnote-9) The whole band is available for low power indoor use, and most of the band also can be used by devices at higher power levels – both indoor and outdoor – by making use of an AFC system (as described in the [Technology features](#_Automatic_Frequency_Coordination) section of Appendix A).

Devices that do not meet the criteria for indoor low power operation must be able to automatically contact an AFC service on a regular basis (every 24 hours) to report its geographic location and check its allowable operating frequencies and power levels.

The power limits on unlicensed devices in the 6 GHz band are shown in Table 2. The high-power limits are the same as the existing US limits for unlicensed devices in the 5 GHz band. There are also different limits for devices depending on whether they are access points or client devices.

Maximum power levels for 6 GHz unlicensed devices in the US

|  |  |  |  |
| --- | --- | --- | --- |
| Device type | | Power limit (EIRP) dBm | Power density limit dBm/MHz |
| High power | AFC device | 36 | 23 |
| Client | 30 | 17 |
| Low power |  | 30 | 5\* |
| Client | 24 | -1 |

\* Ongoing consultation has proposed increasing this value to 8 dBm/MHz.

The AFC is designed to protect devices with fixed locations registered with the ULS – these are mainly fixed links. The fixed satellite service (uplink) is protected from receiving interference from aggregate signals from a large number of devices on the ground via antenna pointing restrictions – higher power devices must not radiate more than 21 dBm in a direction 30 degrees or more above horizontal. Radio astronomy sites are protected via geographic exclusion zones.

The portions of the band for which only low power indoor use is permitted are those that contain existing mobile services – used for electronic news gathering (ENG) – that cannot be reliably protected via the AFC. This indoor use is envisaged to be for wi-fi networks in homes and businesses, and for IoT devices. Adjacent services, particularly ITS and federal government services – are protected via the imposition of prescribed out-of-band emission limits on RLAN devices.

High power devices cannot be mobile, as they must remain at fixed at the location they report to the AFC system. However, the bottom part of the band (5.925–6.425 GHz) can be used on large passenger aircraft when flying above 10,000 feet to enable high-capacity wi-fi on planes.

When the FCC announced its changes in the 6 GHz band, it also made additional proposals for the use of the band.8 Some of these proposals are to:

allow ‘very low power’ devices to operate at a maximum 14 dBm (in all locations, without AFC use)

increase the permitted power spectral density (PSD) of low power devices to 8 dBm/MHz (see Table 2)

allow mobile devices to be used if they are under control of an AFC-connected device

allow higher powers for devices that are used only for a fixed point-to-point application.

## Europe

### 5 GHz band

[ECC decision (04)08](https://docdb.cept.org/download/3948246a-1552/ECCDEC0408.PDF) sets out the CEPT position on WAS/RLAN operation for the 5 GHz band. That decision was published in 2004 and came into force in 2009. The main elements of that decision are:

#### 5150–5350 MHz

Indoor use, with a mean EIRP limit of 200mW (23 dBm).

DFS and TPC required in the upper half of the band (5250–5350 MHz).

#### 5470–5725 MHz

Indoor and outdoor use.

EIRP limit of 1W (30 dBm), and power density limit of 50mW/MHz (17 dBm) in any 1MHz.

DFS and TPC required.

The requirements for DFS and TPC stemmed from ITU-R Recommendation M.1652. DFS requires devices to check for radar emissions – mainly for protection of military radars. This was the requirement that the UK recently removed from part of their 5 GHz band that is not covered by this ECC decision (see next section).

The TPC must provide, on average, a mitigation factor of at least 3 dB on the maximum permitted output power. If TPC is not employed, a device must operate at least 3 dB below the maximum power limit.

### 6 GHz band

Since 2017, the ECC and European Telecommunications Standards Institute (ETSI) have both been looking into the possibility of introducing WAS/RLAN in parts of the 6 GHz band. ETSI was investigating the 5925–6725 MHz range, however the ECC’s consideration was limited to below 6425 MHz.

CEPT was subsequently tasked with studying and identifying interference scenarios to identify possible coexistence conditions for RLANs operating within the 5925–6425 MHz band. The first output from this process was [ECC report 302](https://docdb.cept.org/download/cc03c766-35f8/ECC%20Report%20302.pdf), which presents sharing studies between WAS/RLAN devices and:

fixed services, fixed satellite services (FSS) and mobile services in 5935–6425 MHz

ITS and communication-based train control (CBTC) services in the adjacent 5850–5925 MHz band

radio astronomy in the range 6650–6675.2 MHz

UWB devices across the whole band.

Based on that report, CEPT developed [Report 73](https://docdb.cept.org/download/0d0696a1-89ae/CEPT%20Report%2073.pdf), which was consulted on and approved during 2019–20. It referred to the ECC sharing studies to develop recommended parameters for WAS/RLAN devices in order to allow them to operate alongside the abovementioned existing services. Key conclusions of this work included:

indoor use of devices operating at up to 250mW (24 dBm) is feasible

aggregate interference into FSS satellite receivers will be significant – high enough to prevent co-existence with these services without some further mitigation measures in place

CBTC and ITS in the adjacent band can be protected by using guard-bands and/or placing out-of-band emission limits on the WAS/RLAN devices.

In May 2020, [ECC report 316](https://docdb.cept.org/download/8951af9e-1932/ECC%20Report%20316.pdf) was published, looking in more detail at sharing with fixed links, using short-term interference criteria. It used CEPT’s recommended power limits – 200mW (23 dBm) indoor and 25mW (14 dBm) outdoor – and found the calculated interference levels to be acceptable based on the parameters used in the study. The ECC also produced several other reports[[9]](#footnote-10) looking at interference into ITS and CBTC.

CEPT Report 75 (November 2020) presented final recommendations on technical conditions for operating WAS/RLAN in the 6 GHz band:

unlicensed use in the band, with 2 different power levels:

low power (23 dBm, 10 dBm/MHz) for indoor use only

very low power (14 dBm, 1 dBm/MHz).

operation starting at 5945 MHz, giving a 20 MHz guard band to protect urban rail ITS

‑22 dBm/MHz or ‑45 dBm/MHz (for LPI and VLP uses respectively) out-of-band emission limit below 5935 MHz. The VLP value is temporary and will be re-evaluated for 1 January 2025 – the default new value will be ‑37 dBm/MHz if no new information is available by then on the use of ITS

no geolocation feature should be required for enforcing what is operating ‘indoors’, but individual administrations should consider how to effectively enforce that criterion.

## UK

### 5 GHz band

In July 2020, Ofcom removed the requirement for some devices operating in the 5725–5850 MHz frequency range to scan for radar transmissions before operating (that is, DFS). This change applies only to low power (up to 200 mW) indoor devices. The requirement had been in place to protect military and meteorological radars. The rationale for these changes was:

Lower power indoor devices were found to be a very low risk to radars. It was also noted that road toll applications use that frequency range outdoors without the DFS requirement.

The UK was the only jurisdiction to mandate the requirement to scan for radars, meaning most devices manufactured for the rest of the world could not be used there. Consequently, that portion of the band was lightly used in the UK.

In the UK, the band is primarily used by similar services to Australia and the US. Ofcom referred to studies undertaken by CEPT to inform its decisions around protecting the FSS, Radio astronomy and UWB, as well as adjacent channel protection of Road-ITS and CBTC. Ofcom also conducted its own studies on compatibility with fixed links, which were based on the CEPT report but used real links registered in the UK.

### 6 GHz band

In January 2020, Ofcom consulted on the potential introduction of RLAN devices into the ‘lower 6 GHz’ band (5925–6425 MHz).

In July 2020, proposals made during that consultation were implemented.[[10]](#footnote-11) The UK now allows devices to operate unlicensed in the lower 6 GHz band but restricted to indoor use with a maximum mean EIRP 250 mW (24 dBm), or very low power 25 mW (14 dBm) outdoor. The maximum allowed power density for indoor use is 12.6 mW/MHz (11 dBm/MHz), allowing 20 MHz channels to be used.

## Canada

In January and February 2021, the Canadian regulator released a consultation paper on the future of the 6 GHz band, proposing arrangements similar to those in the US. It proposed unlicensed use across the entire 1200 MHz range, with 3 different power levels available across different portions of that range:

14 dBm ‘very low power’

30 dBm ‘low power’ for indoor use only

36 dBm for devices making use of an AFC.

The AFC is to be compatible – as much as possible – with the US version, to help deal with cross-border coordination.

‘Listen-before-talk’ protocols are to be implemented on all low and very-low power devices. The higher power devices will not be able to operate above 6875 MHz to protect ENG services. To protect satellite receivers, there will be restrictions on radiated power in directions above 30 degrees elevation, similar to the ITU outcomes from WRC-19.

## South Korea

In July 2020, South Korea’s Ministry of Science and ICT proposed to enable unlicensed access to the entire 6 GHz band for RLAN use. The proposal was limited to low power indoor use – maximum 250 mW (24 dBm) and 2 dBm/MHz – on an interim basis until a frequency sharing system is introduced in 2022. It is part of a broader plan termed ‘5G+’, which is considering making more spectrum available for both licensed (for example, 5G) and unlicensed (for example, wi-fi) systems.

On 15 October 2020, the Ministry announced that the proposal would be implemented, enabling the 6 GHz band for RLAN use in South Korea. Very low power (14 dBm) devices were also included but limited to operate in the lower 6 GHz band.

## Brazil

In April 2020, Brazilian regulator Anatel announced a review of its domestic regulations, which included floating the possibly of making the whole 6 GHz band (5.925–7.125 GHz) available for RLAN use. In March 2021, they announced that the entire band would be made available for LPI (30 dBm) and VLP (17 dBm) devices

## Other jurisdictions

Chile decided in October 2020 to allow RLAN devices to operate in the whole 5925–7125 MHz range with a 30 dBm limit on indoor devices and 24 dBm for user terminals connected to those devices.

Peru has consulted on use of the bottom 500 MHz (5925–6425 MHz) with the 3 different power levels being used elsewhere – low power indoor, very low power, and standard power (30 dBm) with the use of an AFC system.

Russia is planning full-scale tests of 6GHz IMT equipment in 2021. It is also one of the main proponents of agenda item 1.2 at WRC-23, for allocating the upper part of the 6 GHz band to IMT.

Some European countries are considering following the CEPT/ECC recommendations by opening the frequencies up to 6425 MHz for unlicensed use, while leaving the upper part of the band for now, for possible licensed use – for example, commercial 5G networks.

This is far from a comprehensive list of administrations who have started planning for changes in the 6 GHz band. Japan, Saudi Arabia, Jordan, Mexico and Argentina are some of the other countries also already looking at arrangements in the band, all of which are proposing arrangements that are similar to one or more of the countries already discussed.

1. Wi-Fi Alliance, [Value of Wi-Fi](https://www.wi-fi.org/discover-wi-fi/value-of-wi-fi), accessed 31 March 2021. [↑](#footnote-ref-2)
2. Ofcom, [Improving spectrum access for wifi – spectrum use in the 5 and 6 GHz bands](https://www.ofcom.org.uk/consultations-and-statements/category-2/improving-spectrum-access-for-wi-fi#:~:text=We%20have%20decided%20to%3A,(5725%2D5850%20MHz).), 24 July 2020, accessed 1 April 2021. [↑](#footnote-ref-3)
3. Wi-Fi Alliance, [Value of Wi-Fi](https://www.wi-fi.org/discover-wi-fi/value-of-wi-fi), accessed 31 March 2021. [↑](#footnote-ref-4)
4. Ofcom, [Improving spectrum access for wifi – spectrum use in the 5 and 6 GHz bands](https://www.ofcom.org.uk/consultations-and-statements/category-2/improving-spectrum-access-for-wi-fi#:~:text=We%20have%20decided%20to%3A,(5725%2D5850%20MHz).), 24 July 2020, accessed 1 April 2021. [↑](#footnote-ref-5)
5. Federal Register, [Unlicensed Use of the 6 GHz Band](https://www.federalregister.gov/documents/2020/05/26/2020-11236/unlicensed-use-of-the-6-ghz-band), 26 May 2020, accessed 1 April 2021. [↑](#footnote-ref-6)
6. ITU, [ITU-R Preparatory Studies for WRC-23](https://www.itu.int/en/ITU-R/study-groups/rcpm/Pages/wrc-23-studies.aspx), accessed 1 April 2021. [↑](#footnote-ref-7)
7. This mask has been used in the US for outdoor RLAN devices in this band since 2014. [↑](#footnote-ref-8)
8. FCC, [FCC Opens 6 GHz Band to Wi-Fi and Other Unlicensed Uses](https://www.fcc.gov/document/fcc-opens-6-ghz-band-wi-fi-and-other-unlicensed-uses-0), 24 April 2020, accessed 1 April 2021. [↑](#footnote-ref-9)
9. ECC reports 101, 228 and 290. [↑](#footnote-ref-10)
10. Ofcom, [Statement: Improving spectrum access for wifi – spectrum use in the 5 and 6 GHz bands](https://www.ofcom.org.uk/consultations-and-statements/category-2/improving-spectrum-access-for-wi-fi), 24 July 2020, accessed 1 April 2021. [↑](#footnote-ref-11)