

Dedicated spectrum band plans and licensing for unmanned (remotely piloted) aircraft in New Zealand

Preliminary Position Paper – August 2020



1 Purpose

This is a joint paper between the Civil Aviation Authority of New Zealand (CAA) and the Radio Spectrum Management (RSM) team at the Ministry of Business, Innovation and Employment (MBIE). The CAA manages the rules for operating in New Zealand's airspace and MBIE, radio spectrum resources.

This paper presents preliminary views of the regulators, as we foresee that the status quo of all Unmanned Aircraft (UA) or "Drones" operating on shared, non-protected spectrum is not sustainable. We want feedback on these views from interested government agencies, the Aeronautical Navigation Service Provider (ANSP) and the New Zealand Unmanned Aircraft community on dedicated spectrum for Command and Control (C2)¹ links within the terrestrial domain.

The paper also examines potential licensing options to manage any dedicated spectrum. Unmanned Aircraft risk management, radio technology and spectrum management are the focus of this position paper. We acknowledge that commercial and cost factors are yet to be determined for the deployment of equipment for dedicated unmanned aircraft C2 spectrum.

Feedback from the engagement will help both the CAA and MBIE better understand risk, technology and management factors, and also get an appreciation of the likely considerations important to Unmanned Aircraft stakeholders and industry participants.

¹ ICAO use the term Control and Non-Payload Communications (CNPC) whereas the International Telecommunications Union (ITU) use Command and Control (C2). For the purposes of this paper the two terms are used interchangeably.

2 Status quo

Currently all Unmanned Aircraft operations are undertaken in shared public radio spectrum. These aircraft are typically small (<25 kg) devices that are 'off the shelf' units operating within line of sight of the operator.

Dedicated radio spectrum offers more robust and protected C2 links and better management of spectrum access. We see this as especially important as the demand for increasingly complex unmanned aircraft operations grows. These operations may include beyond line of sight (BLOS) operations and heavier mass aircraft that are taking to the skies over New Zealand

2.1 Overview of Unmanned Aircraft spectrum management

Regulators around the world, including in New Zealand, are increasingly facing the challenge of managing the growth of unmanned aircraft. The CAA manages unmanned aircraft use by taking a risk-based approach. Civil Aviation Rules for Unmanned Aircraft are split into two parts, each corresponding to a different level of risk. Part 101 of the rules covers low risk operation, defined by operating no higher than 120m, in daylight, with landowner permission and within visual line of sight (LOS) of the operator. Any deviation from these specifications pushes operations into the higher risk category - Part 102.

Part 102 rules cover a number of aspects of Unmanned Aircraft operation. As part of the application (exposition) by an applicant, risks to the operation must be considered by keeping:²

11 b (4) a hazard register that—

(i) identifies the known and likely hazards to people, property and other aircraft of the proposed operation; and

(ii) for each of the hazards identified, includes an assessment of the associated risks; and

(iii) includes a description of the measures that can be implemented to mitigate or manage the risk;

In addition, the

(8) details of the control system to be used to pilot the aircraft

must be provided to the CAA. As spectrum is a key part of the control system, access to spectrum resource is a crucial part of the unmanned aircraft C2 links equation.

Currently, C2 links for unmanned aircraft operations typically operate in the Industrial, Scientific and Medical (ISM) bands, in the frequency ranges 2 400-2483.5 MHz, 5 150-5 350, and 5 470-5 875 MHz (commonly known as the Wi-Fi bands). These are shared bands of spectrum where the use and demand is lightly regulated, with no exclusivity or interference protection from other legitimate users of the band built in.

² https://www.caa.govt.nz/assets/legacy/rules/Rule_Consolidations/Part_102_Consolidation.pdf



Figure 1. Examples of users of the ISM bands. RPAS command and control links currently compete with such users.³

Radio spectrum is a valuable resource and no international provision for dedicated unmanned aircraft spectrum has been made to date. It may be possible, however, to repurpose some existing bands that are currently under-utilised to provide dedicated unmanned aircraft spectrum, if needed.

Two of the most promising bands for this use to date are the dedicated aeronautical blocks of spectrum in the L-band (960 -1 215 MHz) and C-band (5 030-5 150 MHz).

The C-band frequency range 5 030-5 150 MHz is allocated for aeronautical use in accordance with the International Radio Regulations, but no significant use has been recorded to date in New Zealand, although internationally this band is used for Microwave Landing Systems (MLS) and AeroMACs aircraft connectivity systems at airports.

The L-band frequency range 960-1 215 MHz is occupied by competing aeronautical uses (e.g. Distance Measurement Equipment, Global Navigation Satellite Systems, and Emergency Location Transmitters) that make any attempt at international harmonisation for potential new radio applications difficult. Additionally, no contiguous block of spectrum is available in both New Zealand and elsewhere in the world for these new applications.

There are both advantages and disadvantages of New Zealand making a foray into this area without finalised international alignment and agreement. New Zealand, in general terms, is a 'technology taker'. In the area of spectrum management, however, we have the flexibility of reassigning significant portions of spectrum for different usages not requiring international cross-border coordination if RSM desires to make a country-specific allocation. It therefore allows testing and new uses to be deployed on a reasonably agile basis without international agreement. The CAA and RSM team recognise that a New Zealand-only allocation for unmanned aircraft C2 purposes is not efficient. There are potential benefits, however, if New Zealand can be an early mover in this area. Operators who could access dedicated spectrum, and are therefore able to move away from public spectrum bands, would be able to take advantage of having robust links available for high-risk operations. Also those local manufacturers of unmanned aircraft equipment will be able to test and deploy links early, allowing research and development to take place.

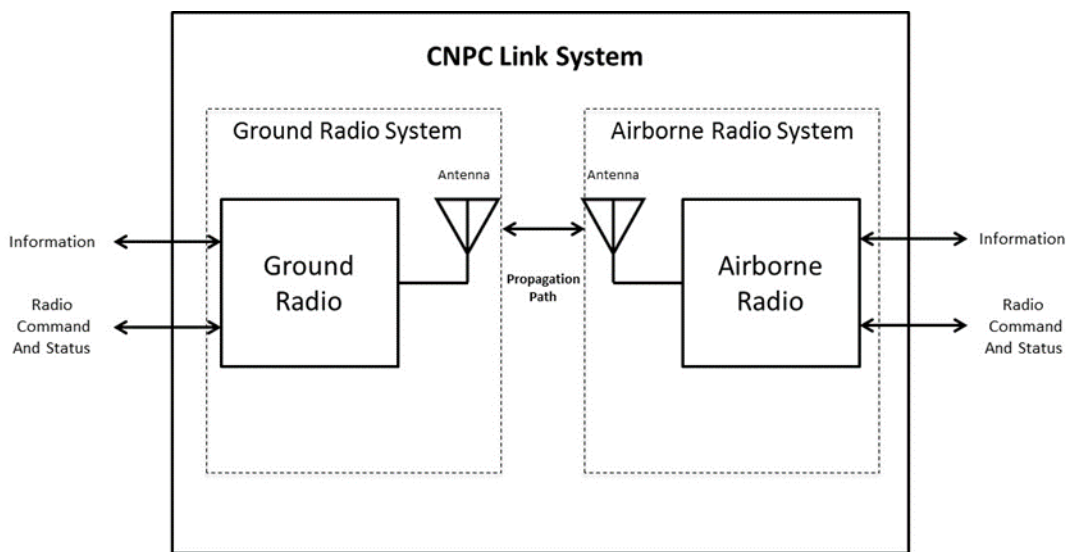
³ Microwave image "Mikro" by vargklo is licensed under [CC BY-SA 2.0](https://creativecommons.org/licenses/by-sa/2.0/). Bluetooth and Wifi logos copyright their respective industry bodies and "Metal tree" by Dushan and Miae is licensed under [CC BY-SA 2.0](https://creativecommons.org/licenses/by-sa/2.0/)

2.2 International developments

There have been moves internationally towards developing the use of the C-Band for C2 purposes. The United States, Australia, Europe and the International Civil Aviation Organization (ICAO) have all made progress in this area. Some of the key work items are noted below.

2.2.1 United States

In the United States, the Federal Aviation Administration has prepared Technical Standard Order (TSO) C213 which covers airborne and ground radio equipment operating in the C-Band for CNPC Terrestrial Link Systems. Note that the current version of this TSO (3/9/18) is limited to aircraft and ground radios operating in the 5040-5050 Mhz sub-band.



4

Figure 2: Technical Standard Order (TSO) C213 CNPC Link System Components

In 2018, a petition for use of C-Band frequencies (5 030 - 5 091 MHz) to the Federal Communications Commission drew broad support from a number of manufacturers^{5,6}. In parallel, the RTCA⁷ has published DO-362 Command and Control Data Link Minimum Operational Performance Specification (MOPS) Terrestrial, which covers the requirements for C2 links in the 5 030 - 5 091MHz part of the band. TSO-C213 specifically refers to this MOPS which describes the features and characteristics needed by the CNPC Link System airborne and ground radios to achieve terrestrial point-to-point communications functionality and radio LOS UA-operation.

2.2.2 Australia

⁴http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgTSO.nsf/0/BDEFA726EA8CDD8086258250005F071E?OpenDocument

⁵ https://www.fcc.gov/ecfs/search/filings?q=RM%5C-11798&sort=date_disseminated_DESC

⁶ <https://ecfsapi.fcc.gov/file/10529188164500/FAA%20TSO-C213.pdf>

⁷ formally known as the Radio Technical Commission for Aeronautics

In Australia, a whole-of-government approach is being taken towards the regulation of Unmanned Aircraft, including consideration of registration requirements. The Civil Aviation Safety Authority (CASA), has been working towards specifying technical requirements for C2 communications, in conjunction with the Australian ANSP (Airservices Australia). Like New Zealand, currently civilian unmanned aircraft in Australia are almost exclusively operated in ISM bands. The 5 030 - 5 091 MHz frequency range, however, is being considered for longer term use for a subset of possible RPAS use cases which are likely to be confined to larger airframes and/or controlled airspace use. The Australian Communications and Media Authority (the communications regulator) will consider input from CASA when determining a work programme for appropriate licensing arrangements for this band. There is currently no firm timetable for this work. Microwave Landing Systems are not used in this band in Australia.

2.2.3 Europe

The European Organisation for Civil Aviation Equipment organisation (EuroCAE) has working group WG-105 and various sub-groups working on aspects of UAS terrestrial and satellite systems.

The document “ER-016 RPAS 5030-5091 MHz CNPC LOS and BLOS compatibility study” has been published⁸, while two proposed EuroCAE standards were sent out for consultation during 2019:

- ED-265 Minimum Operational Performance Standard for RPAS Command and Control Data Link (C-Band Satellite)
- ED-266 Guidance on Spectrum Access Use and Management for UAS

In particular, the draft of ED-266 considers the use of the C-Band frequencies (5030-5091) for RPAS use.

2.2.4 ICAO

The International Civil Aviation Organisation use term “Remotely Piloted Aircraft System” (RPAS) for larger unmanned aircraft systems that are likely to be covered by ICAO standards, and this paper follows that convention in the discussion below.

The ICAO documentation that covers global spectrum matters is contained in Annex 10 to the Chicago Convention 1944. Following the recent work of the Frequency Spectrum Management Panel and the Remotely Piloted Aircraft Systems Panel, ICAO has proposed amendments to Volume 5 of Annex 10 to allow use of both the C-Band and L-Band for RPAS C2 use, and the creation of a Volume 6 of Annex 10 to cover RPAS-related aeronautical telecommunications services. Selected elements of these proposals are outlined below, with a target applicability date of 28 November 2024.

⁸ <https://eurocae.net/news/posts/2018/march/er-016-rpas-5030-5091-mhz-cnpc-los-and-blos-compatibility-study/>

2.2.4.1 C-Band

Terrestrial and satellite RPAS C2 systems are proposed to share the C-Band according to the following band plan:

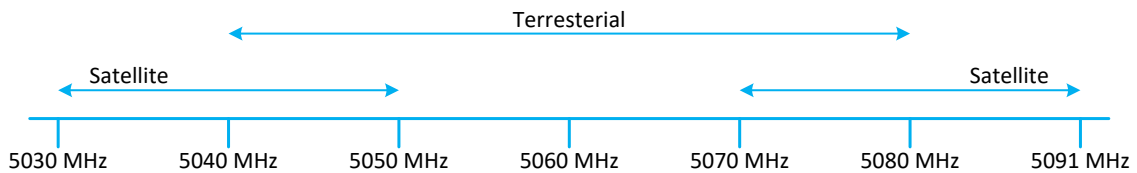


Figure 3: C-Band Sharing

Terrestrial Use Cases:

The C-Band terrestrial system consists of both point-to-point and networked C2 links, as illustrated below:

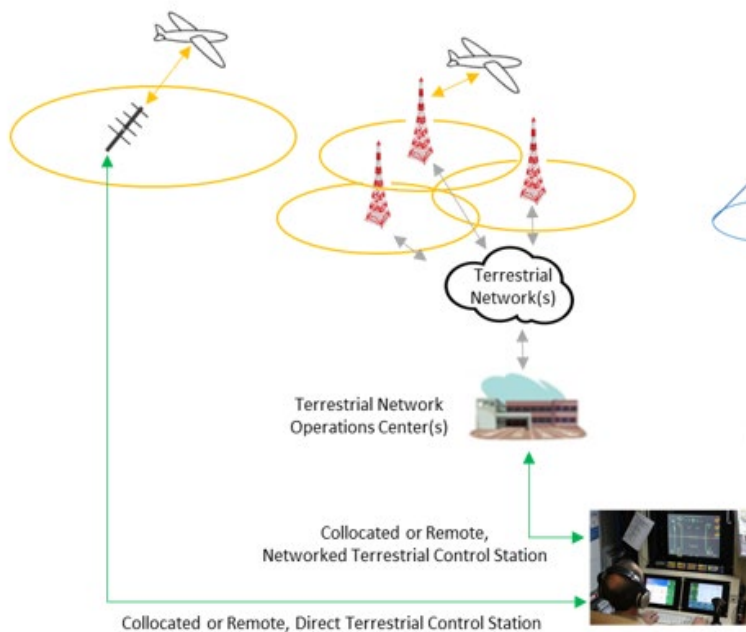


Figure 4: C-Band C2 link use cases⁹

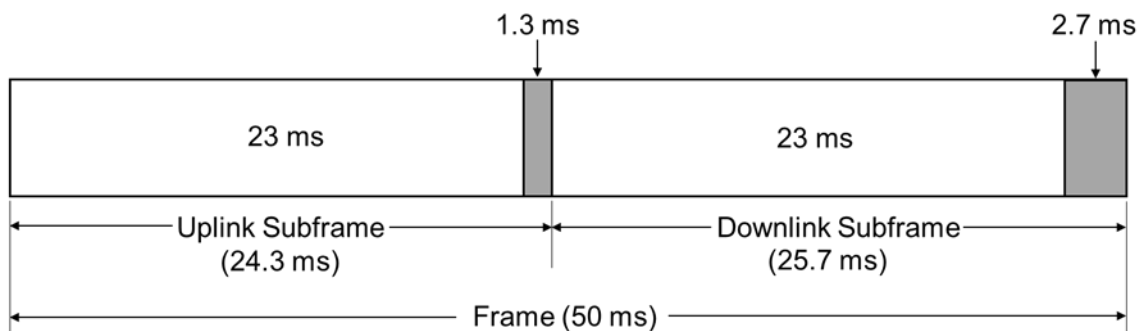
Note that a further ICAO Use Case for relayed links through a High Altitude platform is not considered in the Discussion document.

⁹

<https://www.icao.int/safety/FSMP/MeetingDocs/Forms/AllItems.aspx?RootFolder=%2fsafety%2fFSMP%2fMeetingDocs%2fFSMP%20WG9%2fPresentations&FolderCTID=0x012000556AC038F4589F4281B27ABB7E901CAE>

Channelisation

Terrestrial radio links are further proposed to be divided into Time Division Duplex (TDD) timeslots according to the following structure:



This TDD structure with the 50ms timeslot was chosen for low latency and to provide quick link recovery, particularly in a multipath fading environment.

ICAO also intends to introduce the concept of a C2 communications service provider (C2CSP) – an entity who would provide radio links for RPAS at an acceptable quality of service, and potentially also manage the timeslot allocation (especially in the networked C2 link use case, in a similar manner to a cellular provider). ICAO envisages that it is possible for an RPAS operator to either contract out C2 communications to a C2CSP, or for an RPAS operator to act as their own C2CSP.

Satellite RPAS C2 links

For satellite radio links, there's a number of bands proposed in Volume 5 to Annex 10, in addition to the C-Band described above. In addition to Ka and Ku band systems, these include:

- 1 545 – 1 555 MHz
- 1 610 – 1 626.5 MHz
- 1 646.5 – 1 656.5 MHz

There's also a different channel structure proposed for satellite systems. The CAA and RSM team will publish a separate discussion paper on satellite RPAS C2 links at a future date.

2.2.4.2 L-Band

Annex 10 Volume 5 will allow the L-Band 960-1 125 MHz to be used for C2 links, however no work items are currently under action within ICAO for this frequency range.

2.2.4.3 Other terrestrial bands

In addition to the C-Band and L-Band allocations, there are also proposals for Annex 10 Volume 5 to allow use for terrestrial C2links in the VHF band, specifically 136.925 MHz and 113.250 MHz.

A separate discussion paper on VHF RPAS C2 Links will be published at a future date, once the specific applications for these frequencies are better developed.

Question 1.

Given the status quo in New Zealand, are there any other international developments that New Zealand should investigate regarding spectrum for command and control links?

Question 2.

What are the benefits of more secure, robust command and control links to your terrestrial unmanned aircraft operation, either currently in use or on the horizon?

Question 3.

Do you agree with adapting ICAO concept of having a C2CSP. If not, why not?

Question 4.

Do you think the networked C-Band RPAS links use case has applicability in New Zealand?

Question 5.

How do you think the idea of a C2 communications service provider in the C-Band would translate into New Zealand?

3 Current New Zealand band plan

One possible decision for determining the use of spectrum for unmanned aircraft is a rigid band plan. In the frequency range 5 030 – 5 150 MHz, there is the potential for the aeronautical allocation to accommodate both terrestrial and satellite services. To date, no band plans have been developed for worldwide deployment of unmanned aircraft C2 links within the frequency range 5 030-5 150 MHz, or parts thereof.

The satellite component of the aeronautical allocation would help with BLOS operations of unmanned aircraft/ RPAS. The terrestrial component of the aeronautical allocation could provide C2 opportunities without reliance of space-based infrastructure and may be useful for prompt initial deployment.

Table 2 below is an extract from PIB 21¹⁰ (the New Zealand Frequency Allocation Table) for this block.

Frequency Range	International Region 3 Allocation	New Zealand Allocation	Summary of Usage	References and Policies
5 030-5091 MHz	AERONAUTICAL MOBILE (R) 5.443C AERONAUTICAL MOBILE SATELLITE (R) 5.443D AERONAUTICAL RADIONAVIGATION 5.444	AERONAUTICAL MOBILE (R) AERONAUTICAL MOBILE SATELLITE (R) AERONAUTICAL RADIONAVIGATION	Microwave Landing System (MLS)	
5 091-5150 MHz	FIXED-SATELLITE (Earth-to-space) 5.444A AERONAUTICAL MOBILE 5.444B AERONAUTICAL MOBILE SATELLITE (R) 5.443AA AERONAUTICAL RADIONAVIGATION 5.444	FIXED-SATELLITE (Earth-to-space) AERONAUTICAL MOBILE AERONAUTICAL MOBILE SATELLITE (R) AERONAUTICAL RADIONAVIGATION	Microwave Landing System (MLS)	

Table 2 – extract of PIB 21, Frequency Allocation Table of New Zealand

¹⁰ <https://www.rsm.govt.nz/online-services-resources/publications/pibs/21>

There are no current or planned licences for MLS in New Zealand and we are not aware of any future deployments of these systems in New Zealand. Although in New Zealand, the frequency range 5 030 – 5 150 MHz is available for aeronautical purposes, we are proposing to consider that portion of 5 030 – 5 091 MHz. This is due to the 5 091 – 5 150 MHz band being used in other countries for fixed-satellite services, and it may not be available on a worldwide basis for aeronautical purposes.

Question 6.

What are your likely future needs in spectrum resources to provide command and control links?

4 Licensing options

If 5 030 – 5 091 MHz is to be a key RPAS C2 link band, allocating and controlling access to the spectrum needs to be managed as well. In New Zealand, radio spectrum is managed by the Radiocommunications Act 1989 (the Act). There are a number of options for managing access to spectrum that are available within the current framework of the Act. There may be preferences by the New Zealand aviation sector on how to best to control access to this band.

As discussed earlier, in New Zealand the current frequency ranges supporting C2 links are largely in shared spectrum bands (under open access by general user licences, typically as licence-exempted in other countries). We believe that it's not a robust solution to continue using shared spectrum bands for higher-risk profile unmanned aircraft operations. While shared spectrum has some benefits, yet another shared spectrum band will not provide a more robust mechanism to manage spectrum access.

To help with risk management, the CAA and the RSM team believe that more overt management and authorisation of C2 links is needed. We propose limiting the access to the frequency range 5 030 – 5 091 MHz. This would decrease the chance of interference and correspondingly increase the reliability of C2 links.

Question 7.

Do you agree with this aim of managing access to the band to reduce risk?

We believe there are a number of management options to consider, that are not a publically shared band. Currently, the RSM team seeks advice and takes recommendations from the CAA on aviation-related licensing matters. This arrangement is known as licensing agency (LA) approval under the licensing policies of the RSM team¹¹. Both organisations are comfortable for this arrangement to continue. Any licensing of aeronautical services in this (or any other band) would continue to be by mutual agreement between the two organisations.

In section 2.4.1.1 we noted the ICAO concept, C2CSP. This refers to a RPAS operator contracting out C2 communications to a C2CSP, or for an RPAS operator to act as their own C2CSP.

For the concept of a C2CSP we suggest there are five variables that should be considered when establishing a new band for C2 use. They are:

- Who would manage the access? Would it be the CAA, the RSM team, the ANSP, a cellular operator, or another party?

¹¹ <https://www.rsm.govt.nz/online-services-resources/pdf-and-documents-library/publications-and-guides/pibs/pib58> section 3.4

- What type of licensing would be used? Would it be a radio licence, or a 'Management Right'¹² with a corresponding spectrum licence?
- Who would hold the licence to transmit? Would it be the RSM team, the CAA, the ANSP, the RPAS pilot or another party (i.e., permission to use)?
- How long in duration would the access be granted to the user? (E.g. per flight, fixed short-term or long-term basis?)
- What would be the mechanism for granting access? Would it be through a Part 102 exposition, an Airshare authorisation, UA Traffic Management (UTM) designation, the register of Radio Frequencies (managed by the RSM team) or through a third party?

The band for terrestrial use could be split into two. One half would allow for direct C2 links to the unmanned aircraft, while the second half would be used by networked parties who may provide regional or national network access. From these five variables, the CAA and the RSM team have considered seven possible licensing scenarios, listed below and summarised in Table 3. This is not, however, an exhaustive list:

- 1) One option for managing access to spectrum would be to provide access to a dedicated C2 band as part of the Part 102 certification process. The CAA could hold the licence for the whole band and then authorise Part 102 users. One specific risk with this method is the lack of specific dedicated channelling (at the present time), and that unmanned aircraft operators would need to coordinate with their peers in some way or have technical requirements that could sense and avoid other legitimate users. This would be at a lower risk than public spectrum allocations as there are only a few hundred Part 102 operators that are certificated and active coordination would take place.
- 2) A somewhat related option would be that the CAA holds the licence for the band and then issues authorisations to Part 102 operators on a short-term basis. This could be on a daily, weekly or monthly basis, depending on the demands of unmanned aircraft users and the hands-on management requirements of the CAA.
- 3) A similar option would be the Crown, through the CAA, having a management right and the CAA choosing to issue spectrum licences to Part 102 operators. These licences could be short term – days or weeks for example, or for a longer period such as a year. This would allow Part 102 operators or network providers to get licence-specific frequencies that may be used in either a specific area or nationwide.
- 4) An extension of the above option would be for the CAA to engage an outside agency to manage C2 spectrum allocations on its behalf. This could be similar to television white space access, where overseas spectrum regulators have authorised third parties to run access databases. Alternatively, it could be similar to cellular mobile where network operators hold a management right and licence services through the current register of radio frequencies.

¹² A Management Right is ownership of a block of spectrum for a period of up to 20 years. It is equivalent to a property right under New Zealand law.

- 5) It is conceivable that a UAS Traffic Management (UTM) system could be capable of providing frequency management. One option would be to allocate a channel for C2 operation to tie in with permissions from the UTM that manages the flight in the relevant controlled airspace in the future.
- 6) The website, airshare.co.nz,¹³ can be used to log flight requests and get ANSP approval for RPAS operations. This approvals process could potentially also offer the RPAS operator a C2 channel for the duration of the flight that's logged and approved through the Airshare website (or any other future equivalent service).
- 7) A final option would be similar to the current licensing situation for VHF aeronautical licensing. A radio licence could be issued to a Part 102 operator and would be for either a named area or for nationwide use. The CAA would provide oversight via the existing LA arrangement in the RSM register of radio frequencies. Frequency use may be on a shared basis depending on how many licence holders are authorised for that channel or block of spectrum. Some protections exist but exclusivity is not guaranteed. This would be a long-term allocation similar to the long-term VHF licensing arrangements for aeronautical services.

¹³ Airshare.co.nz is jointly run by the CAA and Airways New Zealand , and currently offers the ability to log RPAS flights in New Zealand

Option	Primary right holder	Primary right type	Secondary right holder	Secondary right type	Specific channel, or right to range of channels?	Period of access right	Other parties
1- Tie into Part 102 auth	CAA	Radio licence	Pilot	Permission from the CAA	No	Length of 102 authorisation	CAA
2 - Tie into Part 102 auth	CAA	Radio licence	Pilot	Permission from the CAA	Yes	At the CAA's discretion	CAA
3 – The CAA issues spectrum licences	Crown (via the CAA)	Management right	Pilot or network operator	Spectrum licence	Yes	At the CAA's discretion	CAA
4 - Agency approach (e.g. TVWS or cellular)	Crown (via the CAA)	Management right	Pilot	Permissions from agency or network operator	Yes	As long as frequency is authorised by agency	Agent/s
5 - Tie into UTM	UTM Provider	Management right or radio licence	Pilot	Permission from ANSP	Yes	Duration of logged flight	ANSP
6 - Tie into airshare.co.nz	ANSP	Management right or radio licence	Pilot	Permission from the ANSP	Yes	Duration of logged flight	ANSP
7 - VHF licensing arrangement equivalent	Pilot	Radio licence	N/A	N/A	Yes	As long as frequency is licenced by RSM and CAA	CAA

Table 3 proposed licensing options for 5 030 – 5 091 MHz

Question 8.

Do you have a preference for one of the licensing scenarios outlined in section 4? If so, why?

Question 9.

If you agree with none of the licensing options as outlined in section 4, how would you manage spectrum access for C2 links for complex unmanned aircraft use?

5 Next steps

The CAA and the RSM team acknowledge the work that our colleagues at the Ministry of Transport are undertaking on potential updates to the current drone regulatory regime. This work helps to define an infrastructure and technology building block in the pathway for integration of drones, as laid out in the Ministry of Transport paper “Taking Flight: an aviation system for the automated age”¹⁴. This preliminary position paper aims to foster discussion in the New Zealand aviation sector and provide technical guidance to this initiative.

Once feedback has been received, we expect further engagement with the ANSP, the international community through such forums as ICAO; the ITU, and industry consultation to determine workable systems for the New Zealand aviation landscape.

Please send feedback by October 31 2020 to David.Wills@caa.govt.nz

Post: Attn: David Wills
Aeronautical Services – Telecommunications
Civil Aviation Authority
PO Box 3555
Wellington 6140

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¹⁴ <https://transport.govt.nz/air/unmanned-aircraft-systems-or-drones/drone-integration-paper/>

7 Abbreviations and Definitions

Abbreviation	Definition
(R)	On Route operation
ANSP	Air Navigation Service Provider
C2	Command and Control
C2CSP	Command and Control Communications Service Provider
BLOS	Beyond line of sight operation
CAA	The Civil Aviation Authority of New Zealand
CASA	The Civil Aviation Safety Authority (Australia)
CNPC	Command Control and Non-Payload Communications – see C2
ICAO	International Civil Aviation Organization
ISM	Industrial, Scientific and Medical frequency bands
ITU	International Telecommunications Union
LOS	Line of sight operation
MLS	Microwave landing systems
MOPS	Minimum Operational Performance Specification
RPAS	Remotely Piloted Aircraft Systems.
RSM	Radio Spectrum Management (part of the Ministry of Business, Innovation, and Employment)
UA	Unmanned Aircraft (also known as “Drones”)
UAS	Unmanned aircraft systems
UTM	UAS Traffic Management (System)