Licensing of Remotely Piloted Aircraft System (RPAS)

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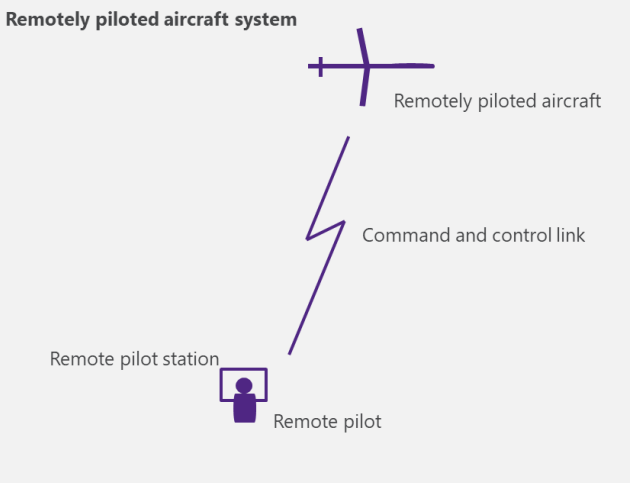
There is growing interest in the use of remotely piloted aircraft systems (RPAS) for a wide range of private and commercial applications. These systems cover a wide variety of types referred to as drones, model aircraft, unmanned aerial vehicles (UAV) or unmanned aerial systems (UAS). As operational use increases rapidly, the provision of safe access to radio spectrum by the equipment deployed in these systems becomes an important issue for the national civil aviation and radio regulators to ensure assurance of service and to avoid interference. This brief paper describes the key elements of RPAS and discusses how RPAS are categorised, which parts of radio spectrum they generally operate in and how they are licensed to operate. It should be noted that RPAS is a developing area and there is significant ongoing work which will inevitably lead to further clarification on the key issues discussed in this paper.

Introduction

The operational use of RPAS is increasing rapidly. Therefore, there is a need to consider how they should be licensed to ensure consistency and coordination with both aviation and spectrum regulatory frameworks. In this context, it is important to clearly define the elements of RPAS.

Figure 1: Elements of RPAS



According to International Civil Aviation Organisation (ICAO), the following definitions apply[1].

- **Remote pilot:** A person charged by the operator (who could be a person, organization or enterprise engaged in or offering to engage in an aircraft operation) with duties essential to the operation of a remotely piloted aircraft and who manipulates the flight controls, as appropriate, during flight time.
- **Remote pilot station:** The component of the remote pilot aircraft system containing the equipment used to pilot the remotely piloted aircraft.
- **Remotely piloted aircraft:** An unmanned aircraft which is piloted from a remote pilot station.
- **Remotely piloted aircraft system:** A remotely piloted aircraft, its associated remote pilot station(s), the required command and control links and any other components as specified in the type design.
- **Command and control link:** The data link between the remotely piloted aircraft and the remote pilot station for the purpose of managing flight.

This document does not address the payload spectrum[2] which is related to the customer sector.

There are two main concepts used to describe RPAS operations:

- **Visual Line Of Sight (VLOS)** where the remote pilot maintains direct unaided visual contact with the remotely piloted aircraft.
- **Beyond Visual Line of Sight (BVLOS)** where the remote pilot does not use visual reference to the remotely piloted aircraft in the conduct of flight.

The regulatory framework for RPAS is set by ICAO and implemented by the relevant national aviation authority[3]. Within the EU, regulatory standards are also set by European Union Aviation Safety Agency (EASA).

[1] Remotely Piloted Aircraft system (RPAS) Concept of OperationS (CONOPS) for Internatlonal ifr operations (icao.int)

[2] Payload spectrum refers to frequency bands used by RPAS payload not associated with the direct operation of the RPAS itself, including cameras and sensors deployed for numerous applications such as mapping, surveillance and monitoring.

[3] UK CAP722 Unmanned Aircraft System Operations in UK Airspace (including CAP 722A, B, C&D

RPAS categories

As RPAS types and applications are extremely diverse, challenges are how to categorise all potential use cases, how to integrate their use within the airspace structure, and coordinating the regulatory responsibilities of the authorising organisations.

At the lower end of the scale is the use of small drones for hobby purposes or limited range aerial photography, surveying and building or installation inspection. These small RPAS need to be registered with the civil aviation authority and piloted by a person holding a certificate of authorisation issued by the civil aviation authority depending on national requirements. For example, the UK CAA has the following requirements:

- If you fly a drone you must pass a theory test for a Flyer ID.
- If you are responsible for a drone, you must register for an Operator ID.
- No Flyer or Operator ID is needed if the drone is less than 250 grams and is a toy or does not have a camera.
- An Operator ID is required if the drone is less than 250 grams, is not a toy and is equipped with a camera.
- Drones weighing 250 grams and above require both Flyer and Operator IDs.

The operations can be limited to authorised areas, in VLOS and during daylight together with maximum speed and height restrictions. In general, public access spectrum is used for these applications.

At the other extreme are larger RPAS capable of long range BVLOS operations with significant payload capability. The capability to deliver medical supplies as demonstrated during the pandemic, supporting mail and supply deliveries as initiated for Orkney and planned for other remote island communities such as Shetland, supporting air-sea rescue operations and ferrying maintenance crews and equipment which is being considered for the offshore energy sector, are all examples of the potential of these systems. In addition, with long range capability, transcontinental operations are feasible when appropriately authorised and roles such as repeater platforms for communications, especially at higher altitudes become a practical proposition. For these larger RPAS, the requirement exists for an airworthiness certificate (as they are operated in a similar context to conventional aircraft) from the civil aviation authority.

For the purposes of this note, small RPAS are those which fall into the Open Category and are below 25 kilograms. This category is further subdivided into those below 250 grams, below 900 grams and below 4 kilograms. This category of RPAS is limited in operation to VLOS within defined lateral and vertical limits.

RPAS greater than 25 kilograms are categorized as Specific or Certified and are subject to stringent regulatory approval. The regulatory requirements are determined by a range of factors including size, nature and location of operation, carriage of passengers and Dangerous Air Cargo (DAC) etc.

Military RPAS applications are not considered within this note.

RPAS and Radio Spectrum

There is significant ongoing work within ICAO, EASA and Eurocontrol amongst others, in respect of RPAS operations and Uncrewed Traffic Management (UTM) development. The spectrum necessary to support conventional interoperability between RPAS and traditional aeroplanes is clearly defined. However, the spectrum necessary to enable critical command and control links is subject to continuing evaluation and development to ensure quality of service and delivery requirements can be met. In addition, current work is exploring how bearers such as SATCOM and 5G can be utilised while meeting aviation's safety and operational performance requirements. Consequently, the RPAS spectrum situation is yet to be fully defined.

In general, small RPAS, which operate only within well-defined constraints including visual line of sight and are not integrated with air traffic management, use spectrum managed effectively within licence exempt criteria, i.e. no-interference and no-protection basis. For example, in the UK, they operate in the following bands providing they meet the technical requirements outlined in the relevant Interface Requirement document[4] where frequency bands, power limits and channel data are provided together with relevant ETSI standards references.

- 26.99 – 27.2 MHz
- 34.945 – 35.305 MHz
- 433.05 – 434.79 MHz
- 458.5 – 459.5 MHz
- 2400 – 2483.5 MHz
- 5725 – 5875 MHz

For large RPAS, command and control telemetry is the subject of aeronautical regulatory requirements and, although still developing, sits within the overall ICAO framework[5].

The non-exhaustive list of bands and uses, detailed below, are potentially available for large RPAS use, subject to ICAO regulation and depending on functional requirements, airspace integration and role. The challenge is to determine the extent to which these are applicable and this depends on the type of RPAS and how it is operated, bearing in mind that some

[4] IR 2030 – Licence Exempt Short Range Devices (ofcom.org.uk)

[5] ICAO Annex 10 Volume VI – Communication Systems and Procedures relating to Remotely Piloted Aircraft Systems C2 Link

potential RPAS are of a similar size to small airliners. As a result, some of these bands and uses will not be relevant but will be determined by the safety and operational requirements to achieve interoperability and effective operation in accordance with the approvals process.

- VOR/ILS Localizer[6] (108 – 117.575 MHz)
- VHF Comms Voice and VHF Data Link Mode 2&4 (117.975 – 137 MHz)
- ILS (328.6 – 335.4 MHz)
- Mobile Network UE Terminal (various frequencies but 4G at 2.6 GHz needs to be avoided to ensure no interference to S-Band PSR[7])
- Navigation Aids – DME/TACAN[8] (960 – 1215 MHz)
- SSR ATC Transponder/ACAS(TCAS)[9]/ADS-B (1030/1090 MHz)
- Electronic Conspicuity Devices (Various bands potentially available) and Sense & Avoid systems.
- Radio Altimeters (4200 – 4400 MHz)
- Telemetry/AeroMACS for BVLOS Command and Control (5030 – 5091 MHz)
- Satellite Links

RPAS spectrum licensing

The lack of a commonly agreed licensing approach means that regulators develop and adopt a licensing framework that suits them best. The challenge is to identify a licensing scheme that will make best use of spectrum and co-exist with co-channel and adjacent band radio services.

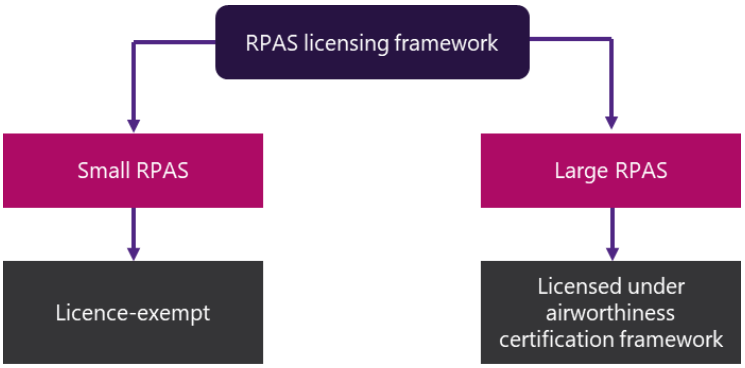
For example, the use of small RPAS operated within visual line of sight is generally regulated under the short-range devices regulatory framework of the radio regulator where there is no licensing requirement providing that minimum technical conditions are satisfied and the safety regulations defined by the civil aviation authority are respected.

However, in the case of large RPAS, access to frequencies needs to be managed through the aeronautical spectrum and frequency management processes and aircraft airworthiness certification framework in accordance with ICAO to achieve safe interoperability. Currently, large RPAS operating BVLOS are authorised on a case-by-case basis. As such, and in addition to the use of aeronautical spectrum for the same purposes as conventional aircraft, the key issue from the safe operation point of view is the spectrum required to support the command and control link. This will be determined by the purpose of the operation and the areas in which the RPAS is to be operated. The operator will determine the effective and safe options and will submit the proposals through the safety case process to support the approvals process.

In practical terms, there are several options how the licensing might be managed:

- Individual equipment licensing – this is comprehensive but it might have a significant administrative burden given the significant numbers and cost in relation to proportionate fees that may realistically be charged.
- Each remotely piloted aircraft – this would be consistent with individual aircraft licensing. However, it would require robust individual remotely piloted aircraft registration marking and may not easily accommodate the command and control links for the remote pilot station.
- Each RPAS fleet – this could offer a practical solution and could include all elements of RPAS. This approach could also potentially include the licensing of the payload spectrum where appropriate.

Figure 2: RPAS licensing



Other considerations

Although the technologies employed on RPAS will in general be consistent with the more conventional aviation requirements, as previously highlighted, there are alternatives to support the necessary communications links. The main challenge is then how this can be accommodated within the RPAS regulatory framework.

Some technologies used by RPAS, such as sense and avoid systems or electronic conspicuity (such as SSR, ADS-B or UAT)[10], may differ significantly from conventional aircraft requirements and may not use traditional aeronautical spectrum. For example, ICAO has advised that ADS-B at 1090MHz should not be used for RPAS operations below 500ft AGL due to spectrum congestion at that frequency. There needs to be a clear guidance for such uses to ensure safe operation.

[6] VOR: VHF Omnidirectional Range; ILS: Instrument Landing System
[7] PSR: Primary Surveillance Radar
[8] DME: Distance Measuring Equipment; TACAN: Tactical Air Navigation
[9] ACAS: Airborne Collision Avoidance System; TCAS: Traffic Alert and Collision Avoidance System
[10] SSR: Secondary Surveillance Radar; ADS-B: Automatic Dependent Surveillance–Broadcast; UAT: Universal Access Transceiver

It is recommended that the potential electro-magnetic compatibility (EMC) issues between the command and control systems and payload spectrum use must be supported by the RPAS regulatory framework. Proposals have been made to consider the use of mobile user equipment terminals as the bearers for command and control. This would require agreement and approval of the mobile network operator and may present some additional spectrum challenges, e.g., interference to S-Band radars if 4G user equipment (UE) is employed.

Summary

This brief paper provides an overview of how RPAS are categorised and allowed access to the radio spectrum, and raises some of the challenges and options associated with a growing number of use scenarios. Small systems are subject to civil aviation safety regulations and most of their use can be handled under licence exempt approach (e.g. VLOS operation of small RPAS in uncontrolled airspace). Operation of large RPAS, on the other hand, should be part of the airworthiness certification and spectrum licensing frameworks to establish a consistent approach with conventional aircraft.

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We can help regulators to improve their radio service regulatory frameworks by taking account of international best practice. We have considerable expertise in drafting policies, regulations and guidelines related to a range of radio services including aeronautical, space, terrestrial mobile/fixed and maritime services.

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