INTERNATIONAL STANDARD

ISO/IEC 4005-1

First edition
2023-03

Telecommunications and information exchange between systems — Unmanned aircraft area network (UAAN) —

Part 1: Communication model and requirements

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Télécommunications et échange d'information entre systèmes — Réseau de zone de drones (Unmanned aircraft area network - UAAN) —

ISO/IEC 4005-1:2023
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Partie 1: Modèle de communication et exigences

Reference number
ISO/IEC 4005-1:2023(E)

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Published in Switzerland

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*.

A list of all parts in the ISO/IEC 4005 series can be found on the ISO and IEC websites.

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Introduction

Unmanned aircrafts (UAs) operating at low altitudes will provide a variety of commercial services in the near future. UAs that provide these services are distributed in the airspace. In level II, many people operate their own UAs without the assignment of communication channels from a central control centre. In this case, wireless fidelity (Wi-Fi) is mainly used as a control channel and a video channel in the unlicensed band. However, when using Wi-Fi, level II UAs can experience loss of control and video links due to communication resource collision. In addition, UA-related units, such as vertiports and obstacles, need a way to exchange information with UAs. This document introduces a wireless distributed communication model to solve these problems.

The wireless distributed communication described by this document is intended to be used in licensed frequency bands. By using licensed frequency bands, each unit is able to reliably allocate and use radio resources at the desired time, various UA communications can coexist and cooperate, and the probability of radio resource collision is very small.

Many services are required for UA operations. In order to support these services, communication between units related with UAs, UA control communication, and video communication, are generally needed.

The ISO/IEC 4005 series consists of the following four parts:

— ISO/IEC 4005-1 (this document): To support various services for UAs, it describes a wireless distributed communication model and the requirements that this model shall satisfy.

— ISO/IEC 4005-2: It describes communication in which all units that can communicate with UAs can broadcast or exchange information by sharing communication resources with each other.

— ISO/IEC 4005-3: It describes the control communication for the controller to control the UA.

— ISO/IEC 4005-4: It describes video communication for UAs to send video to a controller.

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Telecommunications and information exchange between systems — Unmanned aircraft area network (UAAN) —

Part 1: Communication model and requirements

1 Scope

This document describes a communication model and requirements for unmanned aircraft area network (UAAN), which is a wireless distributed communication network for units related with UA services in level II.

It describes:

— the communication structure and operation;

— the purpose of the three types of communication and related services;

— the interoperation of the three types of communication;

— the interworking with upper layers.

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2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 4005-2, *Telecommunications and information exchange between systems — Unmanned aircraft area network (UAAN) — Part 2: Physical and data link protocols for shared communication*

ISO/IEC 4005-3, *Telecommunications and information exchange between systems — Unmanned aircraft area network (UAAN) — Part 3: Physical and data link protocols for control communication*

ISO/IEC 4005-4, *Telecommunications and information exchange between systems — Unmanned aircraft area network (UAAN) — Part 4: Physical and data link protocols for video communication*

ISO 21384-4, *Unmanned aircraft systems — Part 4: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions defined in ISO 21384-4 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
level II
airspace where maximum height is between 15 m (above ground level) and 120 m (above ground level)

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3.2
controller
device that controls an unmanned aircraft (UA) and which can also be equipped with a *video receiver* (3.6) device

3.3
obstacle device
device that broadcasts related information, e.g. related obstacle location, radius, and which is mounted to an obstacle that is placed on the ground or in the air

3.4
landing device
device that broadcasts related location information or information tone signals of a landing site and which is mounted to a landing site and leads autonomous landing work

3.5
ground equipment
ground-based equipment that collects the information that unmanned aircrafts (UAs) broadcast and uses the collected information to communicate the location and status of UAs to UA management systems or UA operators

Note 1 to entry: Ground equipment can use shared communication to deliver the necessary messages to UAs.

3.6
video receiver
receiver that is mounted on a *controller* (3.2) and performs one-to-one communication with unmanned aircrafts (UAs)

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Note 1 to entry: For special services, separated multiple video receivers can receive video from a single UA.

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3.7
unit
all objects that have transmitting or receiving functions, e.g. unmanned aircraft (UA), *controller* (3.2), *obstacle device* (3.3), *landing device* (3.4), *ground equipment* (3.5)

3.8
data slot
slot constituting a data channel

3.9
tone slot
slot constituting a tone channel

3.10
slot clearing
transmission of a tone signal in subslot 0 in order to continue to occupy a slot already allocated from the previous frame

3.11
slot map
bit string indicating whether slots are available

Note 1 to entry: In wireless distributed communication, the slot map of each *unit* (3.7) is generally different.

3.12
slot planning
specification by the upper layer on the type, usage, transmission power, and whether to apply a super frame, for all slots of the channel in advance

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3.13
tone subslot
subslot constituting a *tone slot* (3.9)

3.14
tone signal
signal transmitted in a *tone subslot* (3.13)

4 Abbreviated terms

CC	Control Communication
RF	Radio Frequency
SC	Shared Communication
TDMA	Time Division Multiple Access
TRX	Transmission and Reception
UTC	Coordinated Universal Time
VC	Video Communication

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5 Communication model and requirements

5.1 UA communication model

This document describes wireless distributed communication as a communication model. The reason is that UAs and other related units on the surface or at low altitude are randomly distributed in the airspace. These units need a way to communicate with each other. However, the problem with distributed wireless communication is that there is no control station that manages resources efficiently. Therefore, the communication model of this document is designed so that units can allocate resources by themselves, occupy resources by themselves, detect resources collisions by themselves, and return resources by themselves.

5.2 UA communication requirements

There are three commercial requirements for UA communication:

— safety;

— economy;

— convenience.

UA communication shall also meet this requirement in a wireless distributed communication environment.

First, safety is the most important aspect in UA communications. Many UA services cannot be provided without safety. Therefore, the UA communication link shall have the necessary functions and performance. The necessary function is that all units that communicate with UAs can communicate with each other when necessary. The main means of communication for UAs are control communications and video communications. In addition, communication between UAs, communication between UAs and ground equipment, communication between UAs and landing devices, and communication between UAs and obstacles are also required. In particular, communication between UAs can provide an optimal solution for small UAs to detect each other. Wireless distributed communication is best suited to supporting these functions for UAs distributed in the airspace. In order for wireless

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distributed communication to operate effectively, low probability of resource collision, real-time resource collision detection, and rapid communication environment investigation are required. UA communication is provided in an environment where multiple units are moving simultaneously. The real-time movement of various units changes the communication environment in real time. Therefore, the UA communication needs to quickly investigate such changes in the communication environment, allocate necessary resources with a low probability of collision, and detect collisions in real time for the occupied resources.

Second, this document supports many communication links simultaneously. Many communication links are required to operate UAs. If each communication hardware supports communication between UAs, communication between UAs and ground equipment, communication between UAs and landing devices, and communication between UAs and obstacles, it is economically burdensome, so it should be supported with as little hardware as possible.

The third requirement is convenience. Convenience can be divided into convenience from a manufacturer's point of view and convenience from a user's point of view. Users want as many services as possible with one communication device. Also, users generally want long battery life. Manufacturers prefer the lowest hardware complexity. Low hardware complexity means smaller size and less weight.

Therefore, the requirements for UA communication are as follows:

a) All units that can communicate with UAs shall be able to communicate with UAs when necessary.

b) The wireless distributed communication with features of low resource collision probability, real-time resource collision detection, and fast communication environment investigation shall be used.

c) Communication devices shall support as many services as possible with as little hardware as possible.

d) Communication devices shall have as low a hardware complexity as possible.

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5.3 Communication structure and operation

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A new communication model is required to meet the UA communication requirements mentioned above. It is a synchronous wireless distributed communication model. Among three types of communication, video communications and control communications use a lot of communications resources. Therefore, separate frequency channels are required. All communication except video communication and control communication is supported as shared communication.

Therefore, the minimum required channels are shared channels, control channels, and video channels. These channel configurations are shown in Figure 1.

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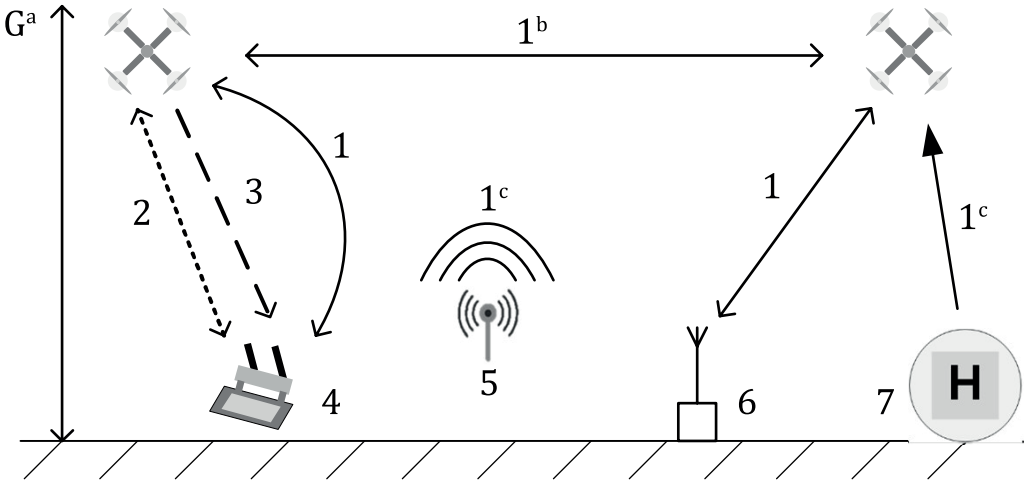

Key

1 shared link
2 control link
3 video link
4 controller
5 obstacle device
6 ground equipment
7 landing device
G level II
[a] The altitude of level II.
[b] Location broadcast and data exchange.
[c] Broadcast.

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Figure 1 — Three types of communications

As mentioned in 5.2, all three wireless distributed communications should feature low probability of resource collision, real-time resource collision detection, and rapid communication environment investigation.

To this end, three wireless distributed communications perform resource allocation, occupation, collision detection and communication environment investigation using a tone channel. Data are transmitted through a separate data channel with a centre frequency that is different from that of the tone channel as shown in Figure 2. This multi-channel structure features low resource collision probability, real-time resource collision detection, and fast communication environment investigation.

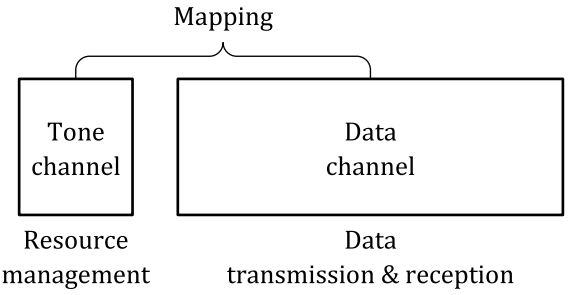

Figure 2 — Multichannel structure and the role of each channel

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