Flying Hand

#1: ISO/IEC 4005-2:2023
#2: ISO 21384-3:2019

TEAM C



Sponsors

Sebastian Scherer

Guanya Shi

Advisors

Dimitrios Apostolopoulos
John Dolan

Team Members



Shubham Saboo



Weerachai Sangiumpaisankij



Shubha Tanaya



Chenyang Mao

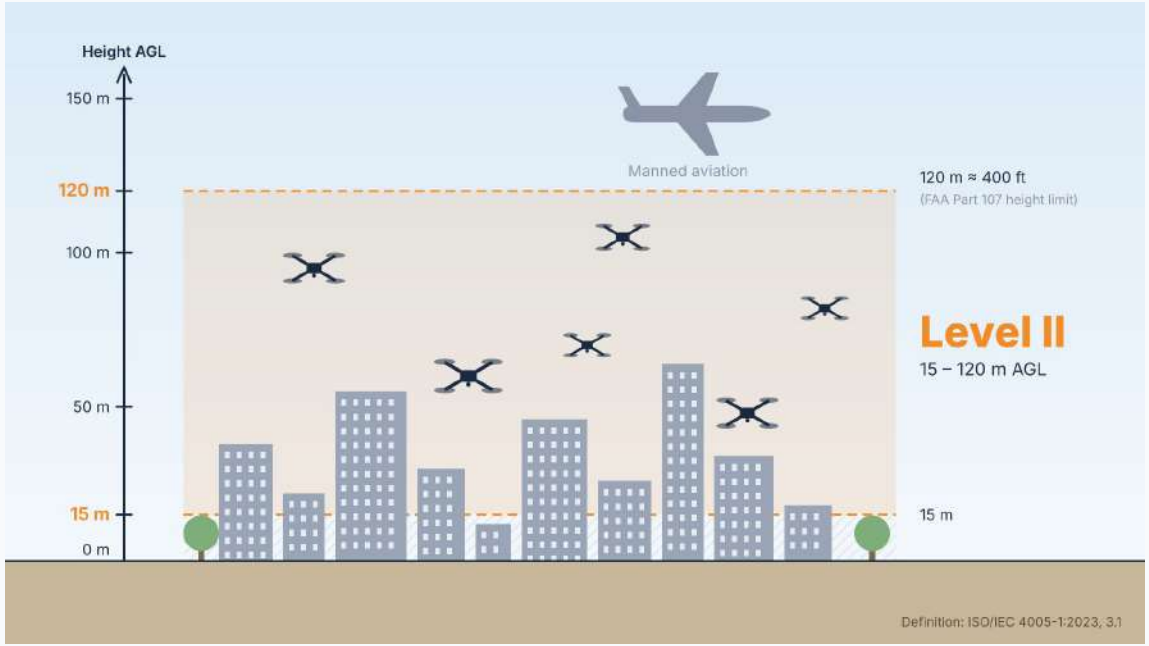


Shunxuan Wang

01

ISO/IEC 4005-2:2023

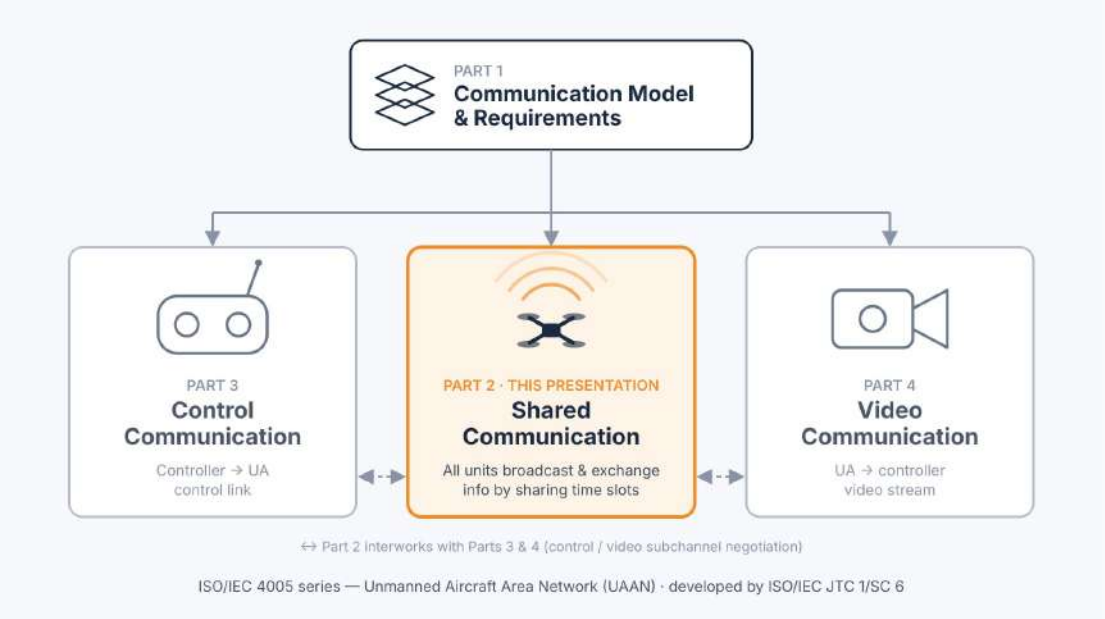
Crowded Skies, No Central Controller



ISO/IEC 4005-2:2023
Telecommunications and information exchange between systems — Unmanned aircraft area network (UAAN) — Part 2: Physical and data link protocols for shared communication

The ISO/IEC 4005 Series

ISO/IEC 4005-2:2023
Telecommunications and information exchange between systems — Unmanned aircraft area network (UAAN) —
Part 2: Physical and data link protocols for shared communication



Part	Content
4005-1	Communication model and general requirements; also where “**Level II**” is defined
4005-2	**Shared communication: all related units broadcast and exchange information over a shared channel**
4005-3	Control communication: the controller commands the UA
4005-4	Video communication: the UA streams video to the controller

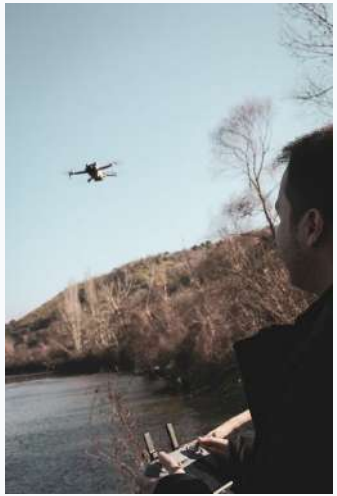
Who Uses It? Products & Markets

Products that implement it (named in the standard)

- Unmanned aircraft
- Controllers & ground equipment
- Landing devices / drone ports
- Obstacle beacons







Markets (our interpretation)

- Drone delivery, infrastructure inspection, aerial survey & filming
- RF module / chipset makers, licensed-spectrum operators

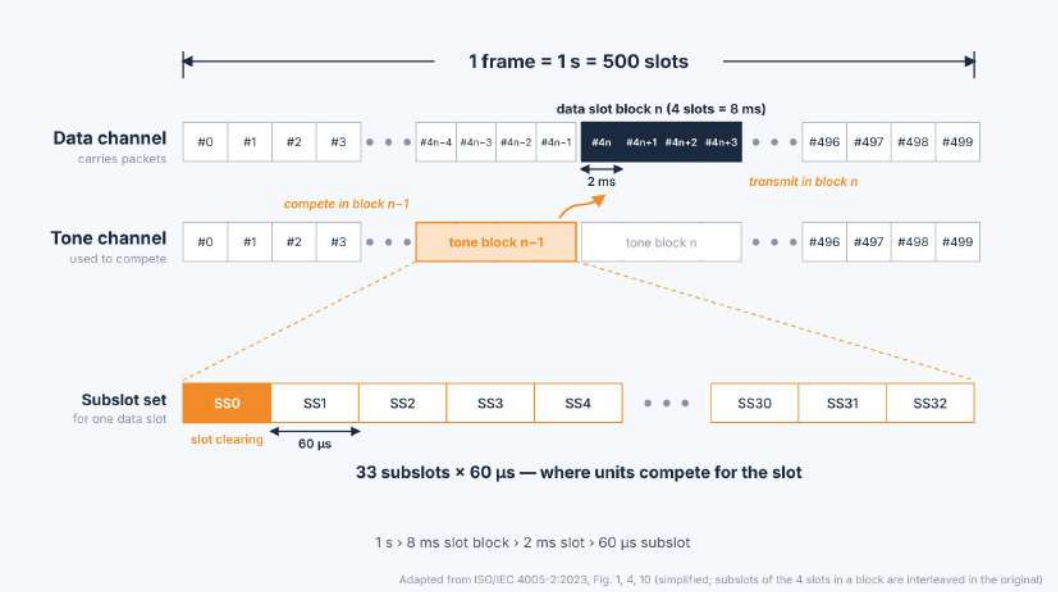
Note: designed for licensed frequency bands, not Wi-Fi or Bluetooth

Time Slots and Synchronization

- **Time-slotted shared channel**
  - 1 frame = 1 s = 500 slots × 2 ms
  - Each data slot ↔ a set of 33 tone subslots (60 µs each) used for competing
- **Everyone must agree on the clock**
  -

State	Time source	Time error
A sync	UTC (e.g., GPS)	±0.4 µs
B sync	A-sync unit nearby	±4 µs
C sync	Holdover ≤ 20 s after losing sync	±5 µs

- **Unknown slot number ⟶ no transmission**



Grabbing a Slot Without a Referee

- **Compete**
  - earliest subslot wins
  - tie → last to pause wins
- **Hold**
  - tone in subslot 0 every frame → newcomers always lose
- **Collision check**
  - collision tones reveal a double-booked slot → release



What Every Drone Broadcasts



Application: relevance today & at commercialization

Written for makers of drones, controllers, drone ports, RF modules and spectrum operators. It is voluntary unless a market adopts it (the UK and Gulf states have).

Today: prototype in the RIC cage

- Not a requirement; the cage has no other aircraft.
- No Part 2 radio; Herelink and Futaba controller.
- Useful as a design reference for our data and timing.

Later: as we commercialize

- Customers and regulators may expect shared-channel broadcast.
- We would add a licensed-band radio module to the X6.
- Position and waypoints go out at 1 Hz in the 0x8D and 0x8E formats.

What our stack covers and what commercialization adds

Standard requirement	What we have today	What commercialization needs
A-sync time, UTC within 0.4 µs	GPS and RTK GNSS give UTC time	Keep GNSS as the time source and verify timing accuracy
No slot, no transmit	PX4 on Cube Orange (no radio to gate)	Failsafe: if time or slot is lost, stop broadcasting
Block 0x8D, position and velocity at 1 to 2 m	VIO and PX4 estimate, checked against RTK	Fill from the PX4 estimate and keep validating with RTK
Block 0x8E, next 4 waypoints with arrival times	QGC missions on PX4	Fill from the active mission, with ETAs from PX4
1 Hz broadcast per slot	MAVLink telemetry stream	A dedicated 1 Hz output through a Part 2 radio

Path from prototype to product

1. Prototype (now)

- Fly in the RIC cage; no other traffic.
- Build 0x8D and 0x8E from PX4 data and log them.
- Check position accuracy against RTK.

2. Pre-commercial

- Test with a Part 2 capable radio or simulator.
- Add the stop-transmitting failsafe.
- Show nearby units in the targeting UI.

3. Commercial

- Licensed-band radio on the X6 and spectrum approval.
- Fly real Level II airspace, 15 to 120 m.
- Meet conformance rules where the standard is adopted.

Key limit: timing depends on GNSS. VIO cannot supply UTC, so you'd need to convert to global latitude, longitude and altitude above sea level.

02

ISO 21384-3:2019

A Safe Drone Isn't Enough



Questions before takeoff:

- Can we legally fly here?
- Who is responsible?
- What if the control link fails?

ISO 21384-3:2019 — Safe Commercial UAS (Unmanned Aircraft Systems) Operations

The ISO 21384-3 Safety Framework

Official Scope — §1

Requirements for safe commercial UAS operations

- **Safety & Security**

  Risk management, cybersecurity and data protection

  §5–6

- **Operator & Airspace**

  Responsibilities, documentation and airspace compliance

  §7–8

- **Equipment & Operations**

  Registration, flight planning and flight procedures

  §9–10

- **Maintenance**

  Hardware, software and configuration management

  §11

Who Uses It? Products & Markets

Scope: All Commercial UAS

Products:

- Multirotor UAS
- Fixed-wing UAS
- Hybrid VTOL UAS





Markets:

- Infrastructure inspection
- Mapping & surveying
- Precision agriculture
- Delivery & logistics



Main prescriptions

UAS - Part 3: Operational procedures



Source: AI-generated illustration created using ChatGPT

01 Safety management

Assess hazards and verify that risk controls remain effective.

02 Manuals and documentation

Keep current procedures, checklists and required operating documents.

03 Competent people

Assign accountable roles and maintain training, fitness and proficiency.

Main prescriptions

UAS - Part 3: Operational procedures



Source: AI-generated illustration created using ChatGPT

04 **Risk assessment and flight plans**

Assess each operation type.
Document planning for every flight.

05 **Preflight checks and limits**

Check the aircraft and control link.
Respect weather and aircraft limits.

06 **Emergencies and autonomy**

Prepare failure responses and retain human intervention in autonomous flight.

Main prescriptions

UAS - Part 3: Operational procedures



Source: AI-generated illustration created using ChatGPT

07 **Maintenance and records**

Maintain serviceability and track configuration, updates and flight logs.

08 **Airspace, security and privacy**

Follow airspace rules, protect data and hold appropriate insurance. Protect systems and data. Respect people’s privacy.

Applying ISO 21384-3 to Flying Hand

Pilot qualification

- For Part 107 outdoor flights, obtain certification or supervised by qualified RPIC. Or continue indoor testing under RIC requirements.
- ISO §10.5.2.4. p.14; FAA §107.12

Custom firmware

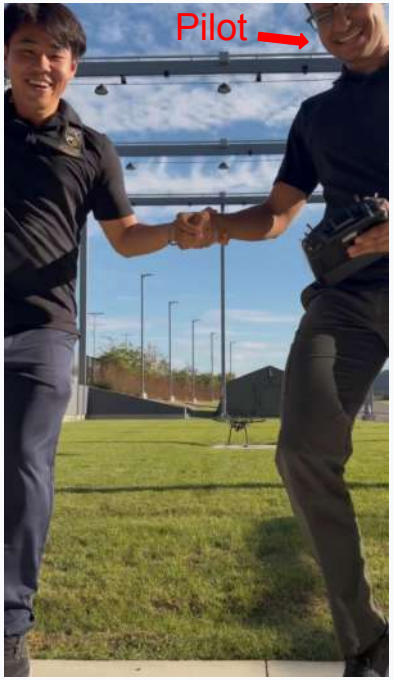
- Test safe operation; document test results, firmware versions, and hardware configurations.
- ISO §§11.3–11.5. pp.15–16

GPS-denied recovery

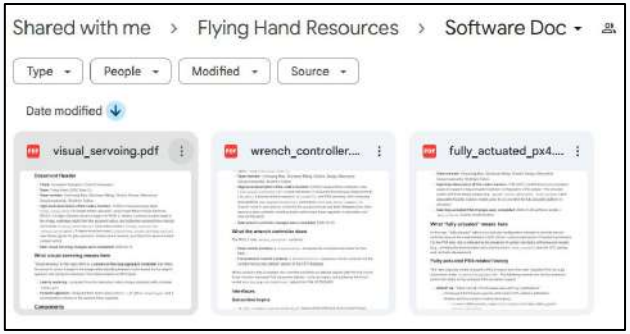
- Immediate switch to manual control on high position variance; safety pilot ready on RC.
- ISO §§10.4.5, 10.4.10. pp.10–11

Contact inspection

- Currently evaluating contact stability, safe withdrawal, and rotor clearance through testing.
- ISO §§5.2.2, 9.3, 10.4.2. pp.3, 6, 9







Thank You!

TEAM C



