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# Airworthiness challenges for sense, detect and avoid systems

## Oct 2022

Michael Maes

# Definitions

# Definitions

**Detect and avoid:** The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action. *(ICAO DOC10019)*

✦ **Cooperative traffic:** expected to actively cooperate to resolve a conflict with full agreement on each others intent and resolution protocol.

✦ **Non cooperative traffic:** either total lack or uncertainty in the intent information and not actively cooperative to resolve a conflict.

*(Cooperative and Non-Cooperative UAS Traffic Volumes by Vishwanath Bulusu, Raja Sengupta, Valentin Polishchuk and Leonid Sedov)*

# Essentials

# DAA Requirement

- *SERA.3201 General (today)*

  Nothing in this Regulation shall relieve the pilot-in-command of an aircraft from the responsibility of taking such action, including collision avoidance manoeuvres based on resolution advisories provided by airborne collision avoidance system (ACAS) equipment, as will best avert collision.

# Detect and Avoid (DAA)

- Obstacles: towers, chimney
  - What with unmapped obstacles?

- Other Aircraft
  - UAS?

- Birds...

# DAA technology

**Active DAA** | **Passive DAA**

**Radar**

**Database**
List of known obstacles

**Audible**

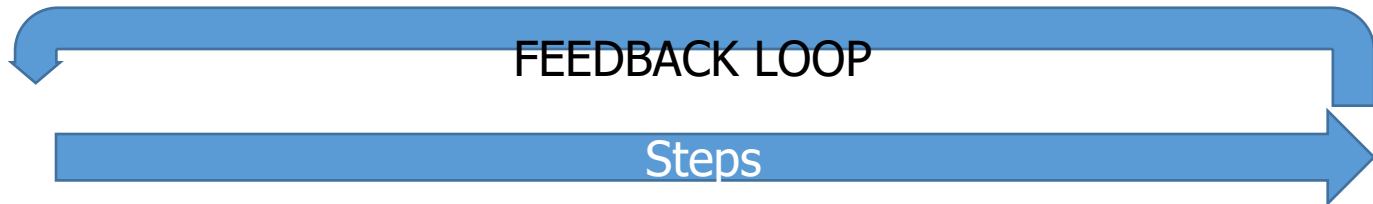**Vision**
Visual spectrum
Infrared
…

**Decentral system**
ADS-B

**Centrally managed**
Using GNSS (GPS,…)

# Feedback Loop

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FEEDBACK LOOP

Steps

| | See/Detect | Decide | Command | Execute |
|---|---|---|---|---|
| Pilot onboard aircraft maintaining separation and collision avoidance by see and avoid | Pilot "sees" conflict | Pilot "decides" what to do | Pilot "command" aircraft manoeuvres | Aircraft "executes" manoeuvres |
| Air Traffic Controller maintaining separation by radar, pilot onboard aircraft maintaining collision avoidance by see and avoid | Radar "Detects" Conflict | Controller "Decides" what to do | | |
| DAA maintaining separation and collision avoidance | Sensors "Detect" Conflict | DAA/Pilot "Decides" What to do | DAA/pilot "commands" UA manoeuvres | UA "executes" manoeuvres |
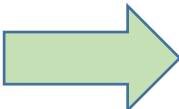
# DAA elements

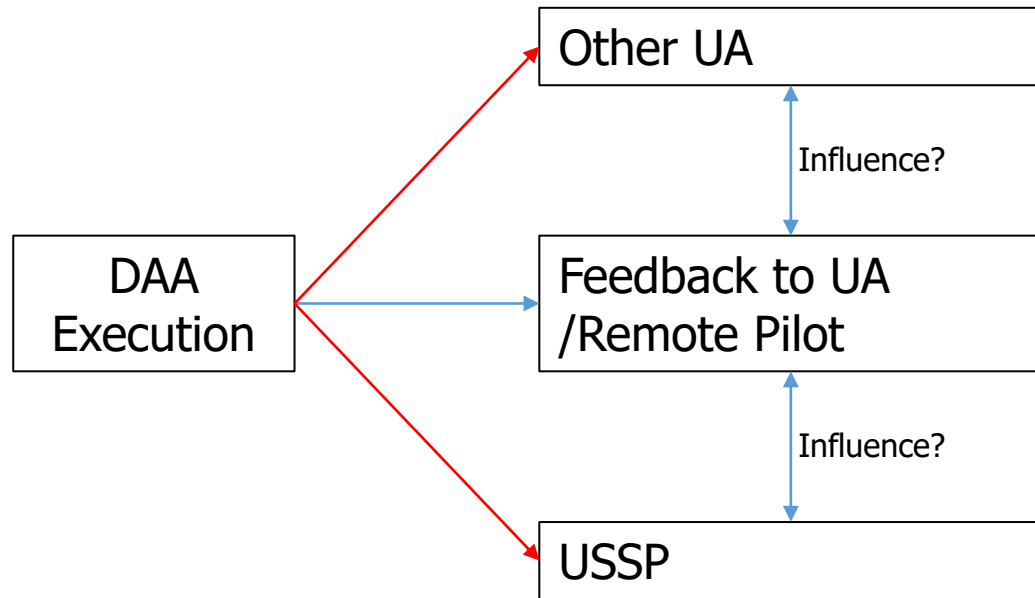- On board capacity

- External capacity
  - External services?

Execute

detect

Decide &
command
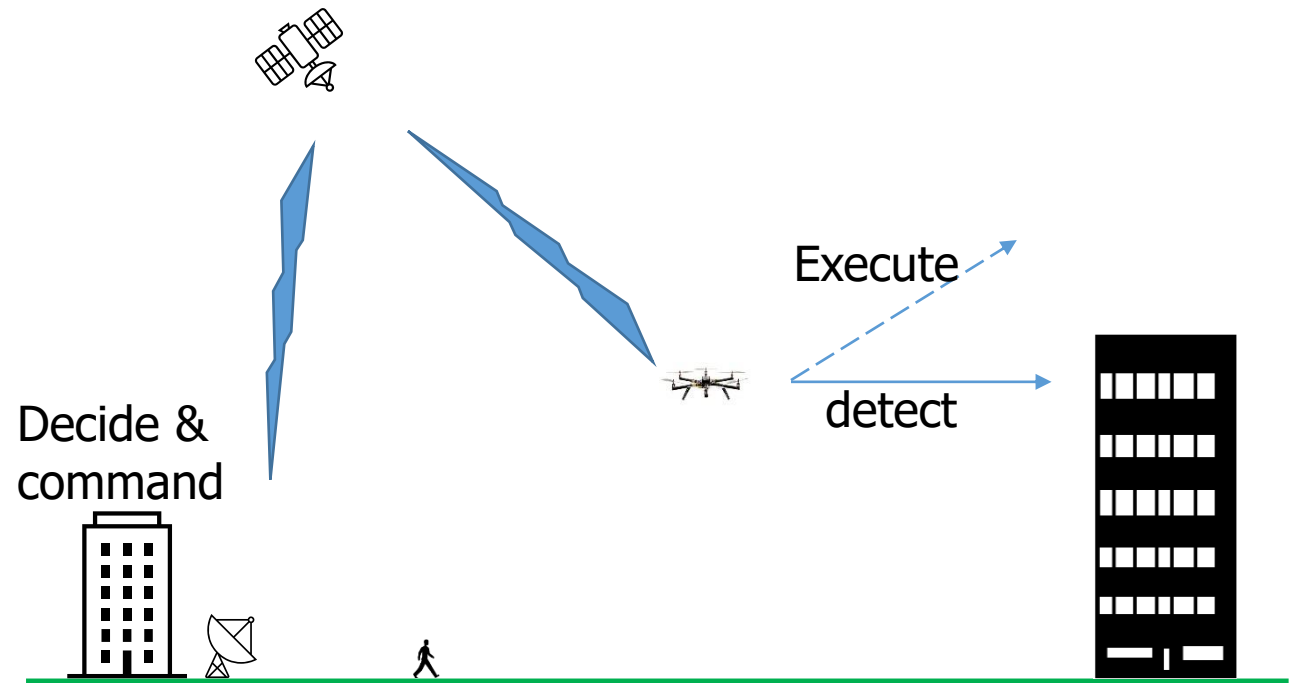
# DAA Airworthiness requirements

+ Redundancy?
+ Variation?
+ Latency? (external decision)
+ Security?
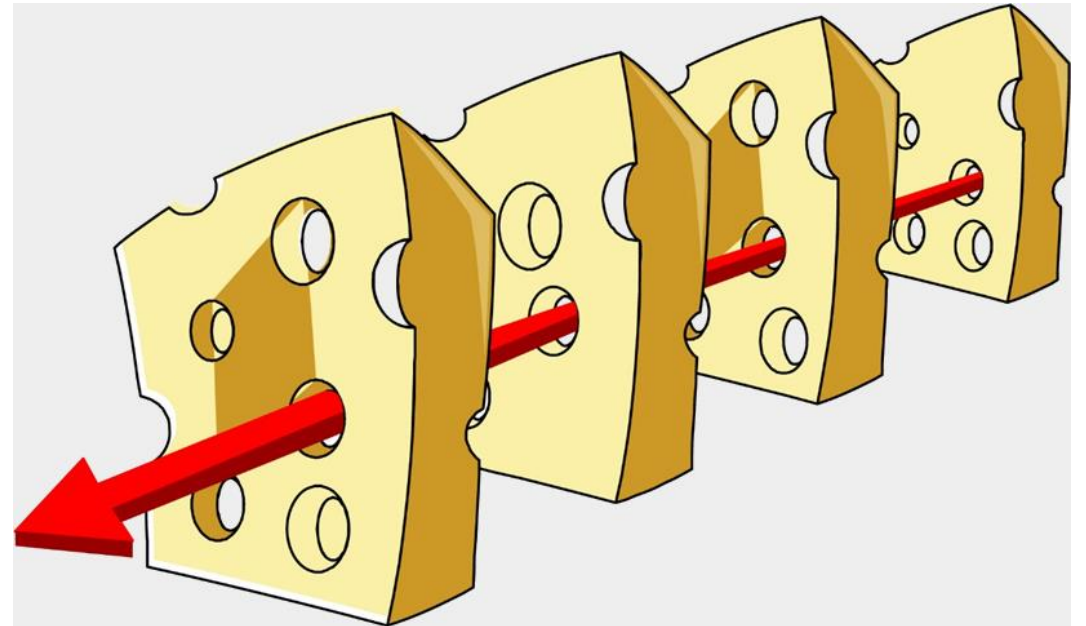
# DAA third party impact

✦ DAA

# Airworthiness Requirements

DAA

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# DAA Airworthiness Requirements

- SORA as basis
  - Tactical Mitigation Performance Requirements
  - Currently quantitaive requirements

- Depending airspace requirements

# DAA Airworthiness Requirements

+ Detect

| ARC-b | ARC-c | ARC-d |
|---|---|---|
| 50% aircraft in detection volume | 90% aircraft in detection volume | A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements. *ED-271 (Class A-C IFR)* |
| • Use of (web-based) real time aircraft tracking services<br>• Use Low Cost ADS-B In/UAT/FLARM/Pilot Aware aircraft trackers<br>• Use of UTM/U-space Dynamic geofencing<br>• Monitoring aeronautical radio communications | • Ground based DAA /RADAR<br>• FLARM<br>• Pilot Aware<br>• ADS-B In/ UAT In Receiver<br>• ATC Separation Services<br>• UTM/U-space Surveillance Service<br>• UTM/U-space Early Conflict Detection and Resolution Service | |

# DAA Airworthiness Requirements

✦ Decide

| ARC-b | ARC-c | ARC-d |
|---|---|---|
| Deconfliction Scheme | See ARC-b and | A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements. *ED-271 (Class A-C  IFR)* |
| tools or methods will be used for detection and what the criteria are that will be applied for the decision to avoid incoming traffic | • Human-Machine assessment<br>• Tool and method effectiveness assessment<br><br>• 5 second decisionmaking<br>• Failure rate or availablility of method or tool | |

# DAA Airworthiness Requirements

✦ Command

| ARC-b | ARC-c | ARC-d |
|---|---|---|
| Latency | Latency | A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements. *ED-271 (Class A-C  IFR)* |
| ≤ 5sec | ≤ 3 sec | |

# DAA Airworthiness Requirements

✦ Execute

| ARC-b | ARC-c | ARC-d |
|---|---|---|
| Seek coverage from obstacles | Avoidance manoeuvres | A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements. *ED-271 (Class A-C  IFR)* |
| | Suggested minimum performance criteria:10<br>• Airspeed: ≥ 50 knots<br>• Rate of climb/descend: ≥ 500 ft/min<br>• Turn rate: ≥ 3 degrees per second | |

# DAA Airworthiness Requirements

✦ Feedback loop

| ARC-b | ARC-c | ARC-d |
|-------|-------|-------|
| Performance info feedback to improve decision making | See ARC-b and | A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements. *ED-271 (Class A-C IFR)* |
| Set distance and information update rate<br>Eg. For an assumed 3 NM threshold, a 5 second update rate and a latency of 10 seconds is considered adequate | assessment of closure rate of information expectation<br>≤ 3sec update rate | |

# DAA OSO impact

# DAA Airworthiness Requirements (Δ OSO)

| | Active DAA | Passive DAA | | | | |
|---|---|---|---|---|---|---|
| | **Radar** | **Database** | **Audible** | **Vision** | **Decentral System** | **Centrally Managed** |
| Weather | #22-24 | N/A | #22-24 | #22-24 | N/A | N/A |
| SpaceWeather | #22-24 | #11-#13 | #22-24 | #22-24 | #11-#13 | #11-#13 |
| C3 Link | If onboard N/A | #06 #13 | If onboard N/A | If onboard N/A | If onboard N/A | If onboard N/A |

All DAA systems are to be mentioned in all other OSO not mentioned above except #01, #02, #03, #17

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# DAA efforts

# DAA efforts

### ✈ EUROCAE WG-105 SG-1

| Ref. | Name | Status | Publication target date |
|------|------|--------|-------------------------|
| ED-xxx | MOPS for Detect and Avoid (Traffic) under IFR | Draft | 28/06/2024 |
| ED-xxx | Minimum Operational Performance Standard for Detect and Avoid in Very Low Level Operations | Draft | 30/06/2024 |
| ER-xxx | European Industry Position Report on RTCA SC-147 ACAS sXu | Draft | 31/12/2022 |
| ED-271 | Minimum Aviation System Performance Standard for Detect and Avoid (Traffic) in Class A-C airspaces | Published | 11/05/2022 |
| ED-271A | MASPS for Detect and Avoid (Traffic) under IFR | Draft | 30/06/2023 |
| ED-271 Corr 1 | MASPS for DAA (Traffic) for Remotely Piloted Aircraft Systems in Airspace Classes A-C under IFR | Published | 01/06/2022 |

# ERICA-project

- SESAR JU

- Development and valdiation of DAA

- Two timeframes:
  - 1. initial RPAS demand i non-complex structures
  - 2. full integration in civil/military airspace in cooperative environment

# Summary

- DAA depends on
  - Airspace
  - Aircraft to be encountered

- Airworthiness now to include (compared to manend aviation)
  - External/automatic decisionmaking
  - External systems
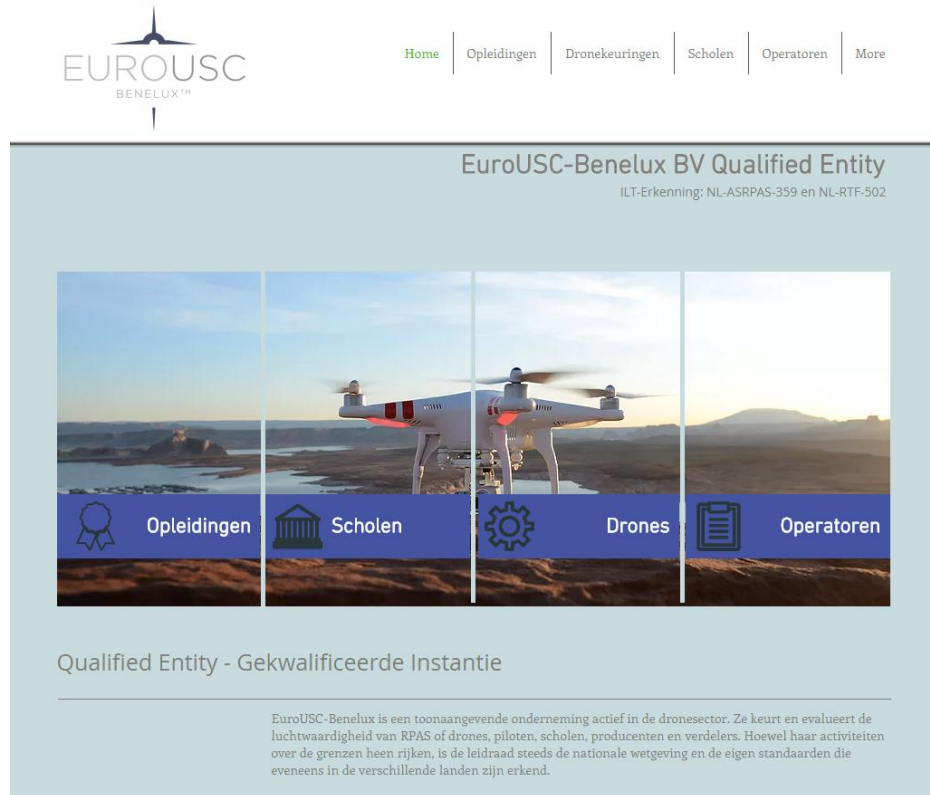
# BCDC

- WG2: Airworthiness

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