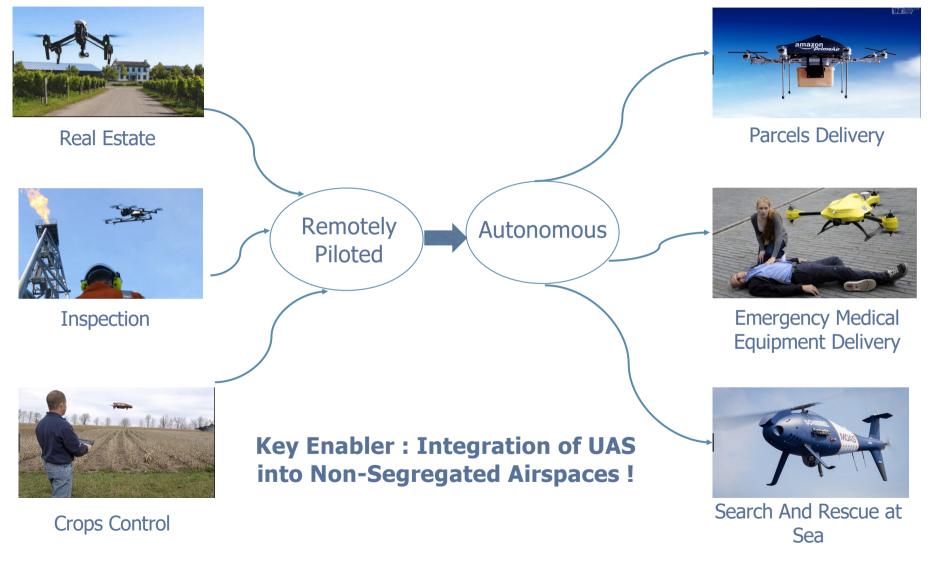
ULB	UNIVERSITE DE NAMUR	FKYANG QI
UAV Detect And Avoid (DAA): State-of-the-art and latest trends		
UAV integration in Air Traffic Workshop and Demo Nivelles, 4 Th October 2022		

John Pyrgies University of Namur John.pyrgies@unamur.be

### UAVs Evolution : Autonomy !



Sources : TU Delft and Gent Universities, Amazon and Branchannels, Schiebel

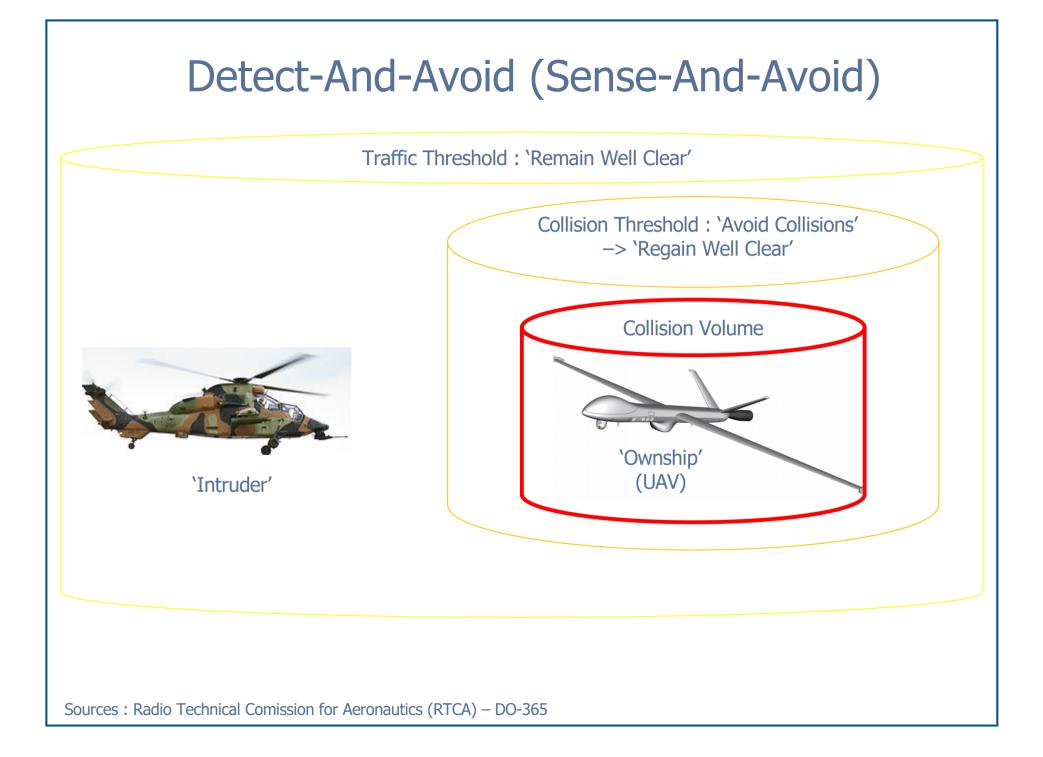
# Close Encounter : The drone & The Rafale



Sources : Defense Aero, CentreFrance

### Detect-And-Avoid (Sense-And-Avoid)

- Improves/transposes See-And-Avoid (VFR)
- Detect-And-Avoid (DAA) covers 2 Functions:
  - Traffic Avoidance : Allows keeping a safe distance from other aircrafts
  - Collision Avoidance : Allows last moment manoeuvre to avoid Near Mid Air Collision (NMAC)



- RTCA SC-228: Minimum Performance Standards for UAS
  - Objective : Safe UAS integration into National Airspace System
  - Minimum Operational Performance Standards (MOPS)
    - Detect-And-Avoid (DAA)
    - Command and Control (C2) Data Link Systems
  - Key Dates
    - Established in 2013
    - Next meeting : October 2022

Sources : Radio Technical Comission for Aeronautics (RTCA)

- RTCA SC-147: Traffic Alert and Collision Avoidance System
  - Objective : Define and update TCAS/TCAS II Standards
  - Minimum Operational Performance Standards (MOPS)
    - Airborne Collision Avoidance System ACAS X
    - ACAS Xa is the replacement of TCAS II
    - ACAS Xu is dedicated to UAS (current working on small UAS)
  - Key Dates
    - Established in 1980
    - Next meeting : November 2022

Sources : Radio Technical Comission for Aeronautics (RTCA)

- EUROCAE WG-75 Traffic Alert and Collision Avoidance Systems (TCAS)
  - Objective : Develop ACAS X MOPS
  - Minimum Operational Performance Standards (MOPS)
    - ACAS Xa
    - ACAS Xo (specific procedures)
    - ACAS Xu (UAV)

- EUROCAE WG-105 SG-1 Detect And Avoid
  - Objective : UAS integration into Non-Segregated Airspaces
  - Minimum Operational Performance Standards (MOPS)
    - Detect-And-Avoid (DAA)
      - Under IFR
      - In Very Low Level Operations
      - In Class A-C Airspaces (en route and large/moderate airports)
      - Position report on SC-147 ACAS Xu

- American Society for Testing and Materials Committee F38 on UAS
  - Objective : Address issues related to design, Acceptance tests and safety monitoring for UAS

- US Standards related to DAA RTCA
  - DO-185: MOPS for Traffic Alert and Collision Avoidance System II (TCAS II)
    - Published on March 2013
    - Scope:
      - Improved efficiency of TCAS Surveillance Function
      - Allow TCAS to implement Mode S reception
      - Various improvements

Sources : Radio Technical Comission for Aeronautics (RTCA)

- US Standards related to DAA RTCA
  - o DO-365: MOPS for DAA Systems
    - Published on March 2021
    - Scope:
      - Transiting through Class B,C,D,E and G
      - Operations > 400 Feet AGL in Class D,E and G
      - Operations in Terminal Areas in Class C,D,E and G and off-airports locations

- US Standards related to DAA RTCA
  - DO-366: MOPS for Air-To-Air Radar (ATAR) for Traffic Surveillance
    - Published on September 2020
    - Scope:
      - Meet Non-Cooperative sensor requirements for DAA
      - Collision Avoidance Functions as described in ACAS Xu

- EU Standards related to DAA EUROCAE
  - ED-143: MOPS for Traffic Alert and Collision Avoidance System II
    - Published on April 2013
    - Scope:
      - Document published jointly by WG-75 and SC-147 (DO-185)

- EU Standards related to DAA EUROCAE
  - ED-267: Operational Service and Environment Definition (OSED) for DAA in Very Low Level Operations
    - Published on August 2020
    - Scope:
      - High Level Operational Requirements for candidate capability in line with ED-78 Process

- EU Standards related to DAA EUROCAE
  - ED-271: Minimum Aviation System Performance Standard (MASPS) for DAA in Class A,B,C
    - Published on May 2022
    - Scope:
      - DAA Functions to operation in in Class A,B,C under IFR

- Industry Standards related to DAA ASTM
  - F2411-04: Standard Specification for Design and Performance of an Airborne Sense-And-Avoid System
    - Last Update on August 2017
    - Scope:
      - Design and performance of airborne Sense-And-Avoid (S&A) systems
      - Detection of and safe separation from manned and unmanned aircrafts

Sources : ASTM

