# Unmanned Aircraft Systems: The Known and Unknown

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ANSER

ANALYTIC SERVICES, INC

# What is ANSER?

- Fifty year-old spin-off of the RAND Corporation
- Non-profit government contractor specializing in *decision support*
- Clients include:
  - U.S. Air Force
  - DoD
  - FAA
  - DHS
- Five years' experience with UAS issues supporting FAA's Air Traffic Organization

# What Is an "Unmanned Aircraft System?"

- According to RTCA SC-203:
  - "An unmanned aircraft system is an unmanned aircraft and its associated elements required to operate in the [National Airspace System]"
  - "An Unmanned Aircraft (UA) is an aircraft operated without the possibility of direct human intervention from within or on the aircraft"
  - "The word 'system'… includes all elements that make up a UAS"
- 14 CFR 1.1: "*Aircraft* means a device that is used or intended to be used for flight in the air"

# These Are Unmanned Aircraft

# ... And So Are These...


# ...And So Are These...

# ...And So Are These!


# How Are UAS Different from Manned Aircraft?

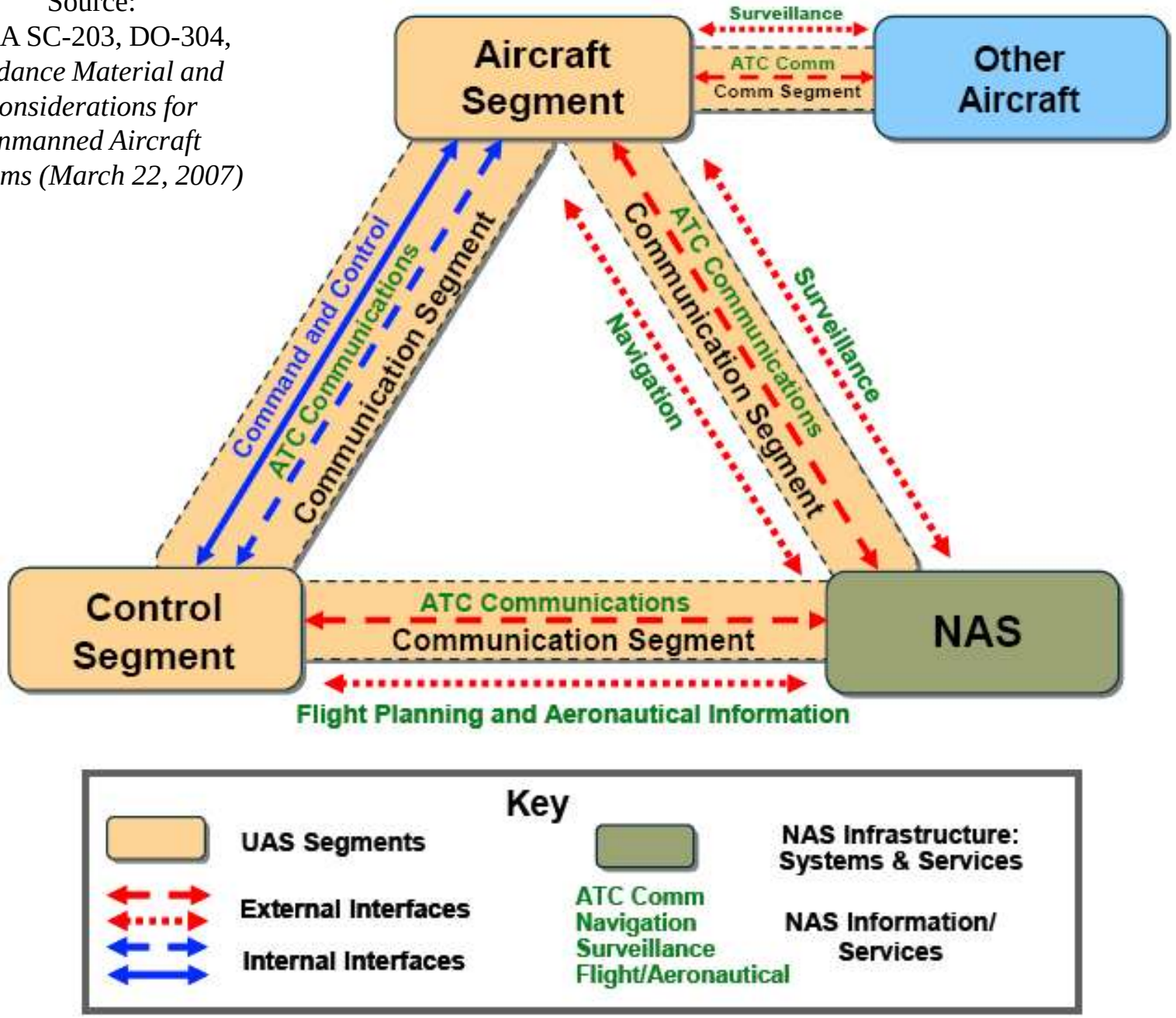
- "See and avoid" (the simplest distinction)
  - Lots of interest in technical solutions
  - Often overlooks the need of the *manned* pilot to "see and avoid"
- Remote presence of the pilot
  - Situational awareness
  - Risk to the pilot
- Economics
  - Expendability of aircraft
  - "Price of admission"

# The Known and the Unknown

- **We know:**
  - **How to build aircraft**
  - **How *manned* aircraft pilots should be trained**

- **We <u>don't</u> know:**
  - **How to certify UAS pilots (yet)**
  - **How to certify ground control systems (yet)**
    - **The information UAS pilots need to support their situational awareness**
  - **How the air traffic system will respond to the presence of UAS**

Source:
RTCA SC-203, DO-304, *Guidance Material and Considerations for Unmanned Aircraft Systems (March 22, 2007)*



# Variability Among Systems

- Pilot/aircraft interface
- Lost link behavior
- Compatibility with different classes of airspace
  - Line of sight versus beyond line of sight
- Pilot situational awareness

# Pilot/Aircraft Interfaces

<<< Predator >>>

<<< Raven >>>

# Loss of Control Link


- There is no standard behavior associated with a UAS going "lost link" --
  - Proceed on last programmed heading(s) until timer expires?
  - Climb to re-acquire link?
  - Orbit in place?
  - Proceed direct to pre-designated waypoint?
  - Go ballistic?

# Class D Airspace UAS-Related Hazards

- Loss of control/comm links
  - Sustained loss of control link
  - Sustained loss of data link
  - Lost communications
- Other system issues
  - UA system failures
    - Degraded control
    - Uncontrollable
    - Engine malfunction
  - Positional ambiguity
  - UAS latency
  - Crosstalk (command intended for one UA received and acted upon by another)
- Outside interference or intrusion
  - Wake turbulence on UA
  - Unauthorized aircraft in Class D airspace
  - UAS ops team human performance
- Internal/external visual limitations
  - Lost visual contact with unmanned aircraft (UA)
  - Inability of UA to detect/respond to visual cues (e.g., hold short line, light gun signals, etc.)
  - Other aircraft unable to see UA
- UAS operations team human performance
  - Lack of standardized UAS-specific training and currency
    - Pilot
    - Observer
    - Controller
  - Unrecognized/unexpected meteorological change

# Pilot Situational Awareness

- Easy – *nothing* is standardized!
  - Vehicle position
  - Own position
  - Vehicle health
  - Surrounding traffic
- Everything normally perceived directly by an on-board pilot must be downlinked to a ground control station; implications include:
  - Spectrum requirements
  - Bandwidth requirements
  - On-board power

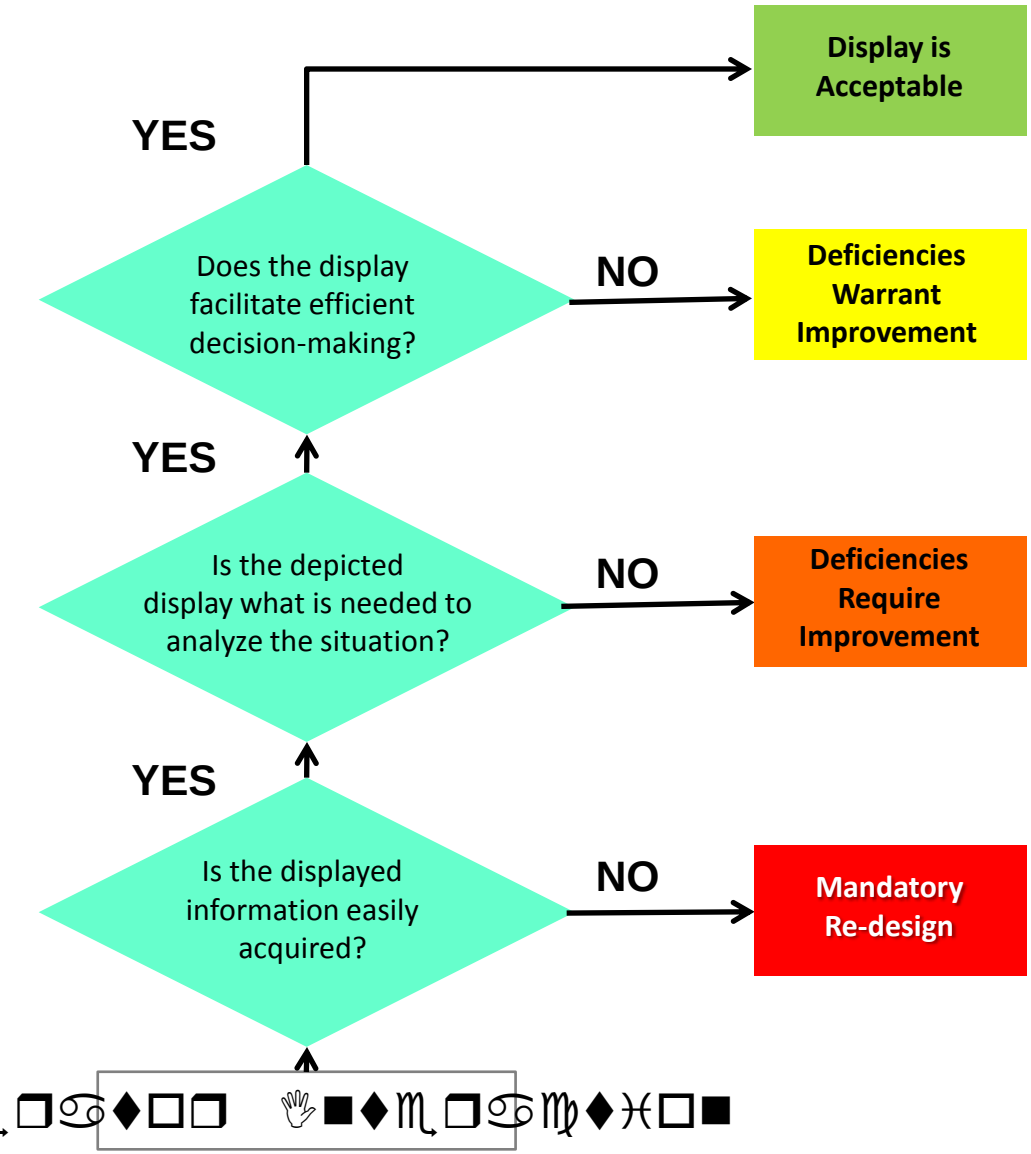
# UAS "Integration" Issues

- **Frequently expressed goal of UAS development and regulation is "integration" into shared airspace**
  - **Variously portrayed as operating on non-interference basis, "file and fly," operating at will, etc.**
- **Regulators' challenge:**
  - **Develop UAS pilot certification standards**
  - **Develop UAS airborne and ground-based component certification standards**
  - ***Bridge the gap between the above and the capabilities of all other pilots and aircraft in the skies today***

# UAS Test and Evaluation Issues

- **Operational:**
  - **Where can UAS be tested safely?**
  - **What does each *system* need to be tested for?**
  - **How can UAS be evaluated for impact on the existing aviation system?**
- **Process:**
  - **How can the T&E community avoid being an afterthought in fast-moving UAS development efforts?**
  - **How can UAS manufacturers with minimal aerospace experience be educated in proper T&E practices?**

# Modified Cooper-Harper (MCH-UVD) Scale



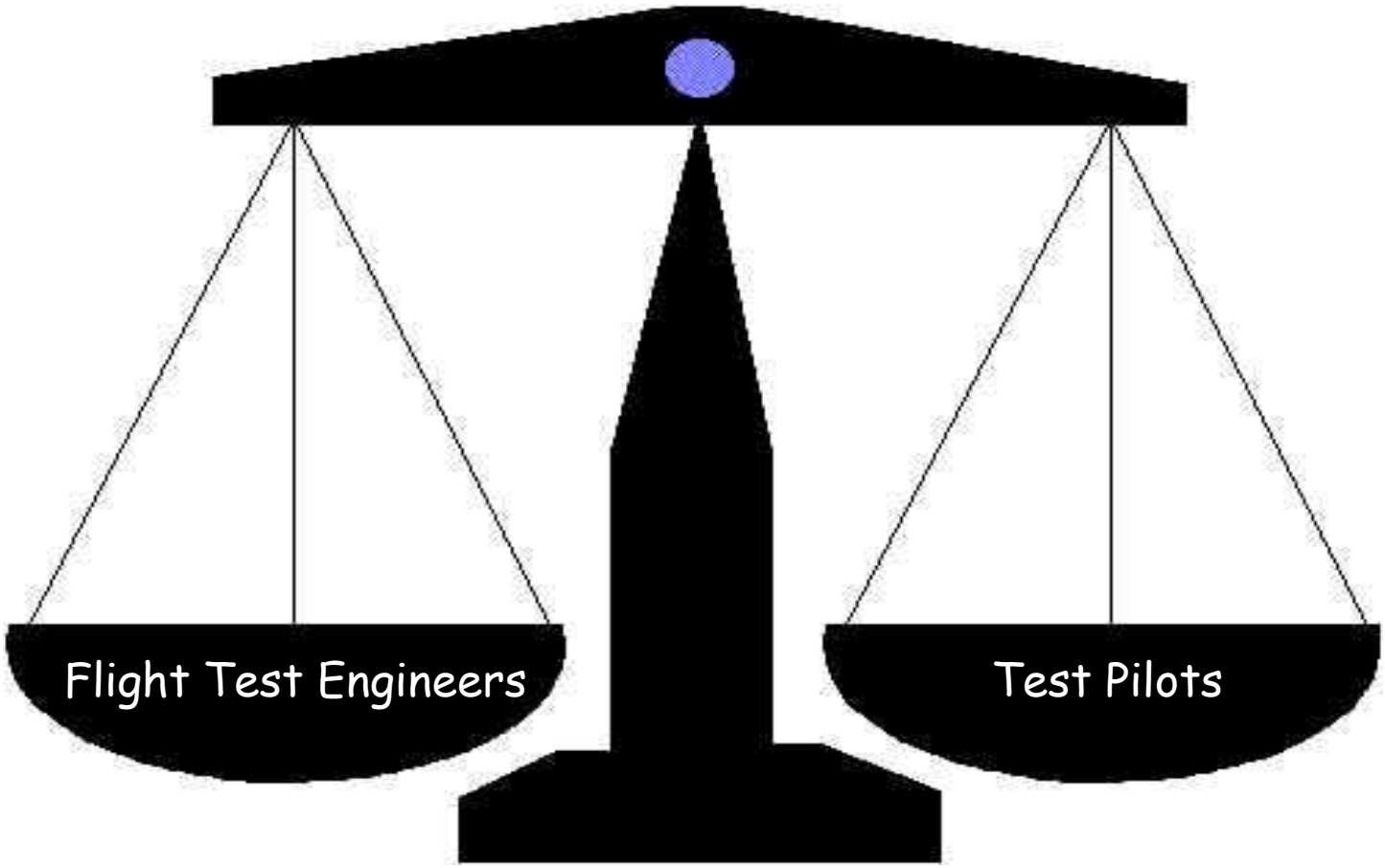

Excellent and Highly Desired — 1
Good w/Negligible Deficiencies — 2

Minor, Tolerable Deficiencies — 3
Moderately Objectionable Deficiencies — 4
Very Objectionable Deficiencies — 5

Major Deficiencies (unclear, slow) — 6
Major Deficiencies (excess overhead) — 7
Major Deficiencies (requires interpretation) — 8

Major Deficiencies (cause degraded human performance) — 9
Major Deficiencies (critical info is missing/not possible to retrieve) — 10

# T&E Community Engagement in UAS Challenges



# Thanks for your attention!