

UAS Conflict Detection and Collision Avoidance in Civil Airspace

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FAA MOIE

 MITRE
Technology
Program

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Problem

- **Unmanned aircraft systems (UAS) don't have actual eyes in the cockpit**
- **Aircraft see-and-avoid function must be replaced by a sensor and either:**
 - **Autonomous avoidance maneuver, or**
 - **Remote pilot performing maneuver**
- **The standardized collision avoidance system for aircraft (TCAS II) wasn't designed for UAS**

Background



**Remote Pilot
Response to
Collision Warning**



**Manned Fleet
Equipped with
TCAS**

**UA Profiles and
Maneuverability**

**Diverse
Missions**

**See-and-Avoid
Differences**

Safety Case Must Be Proved

Objective

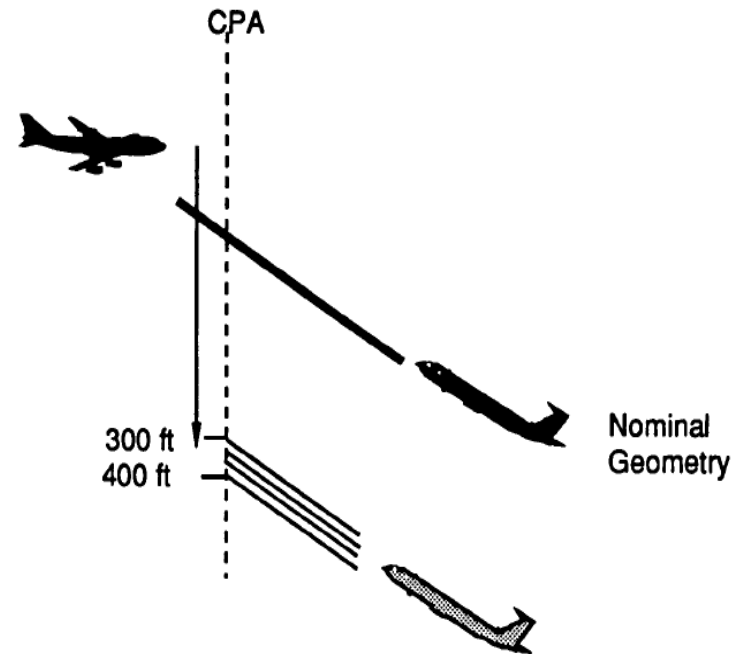
- **Determine collision avoidance requirements for:**
 - **Aircraft vs. UAS**
 - **UAS vs. aircraft or other UAS**
- **Find ways of improving TCAS logic to account for UAS characteristics**
- **Maintain compatibility between collision avoidance and air traffic control separation**

Activities

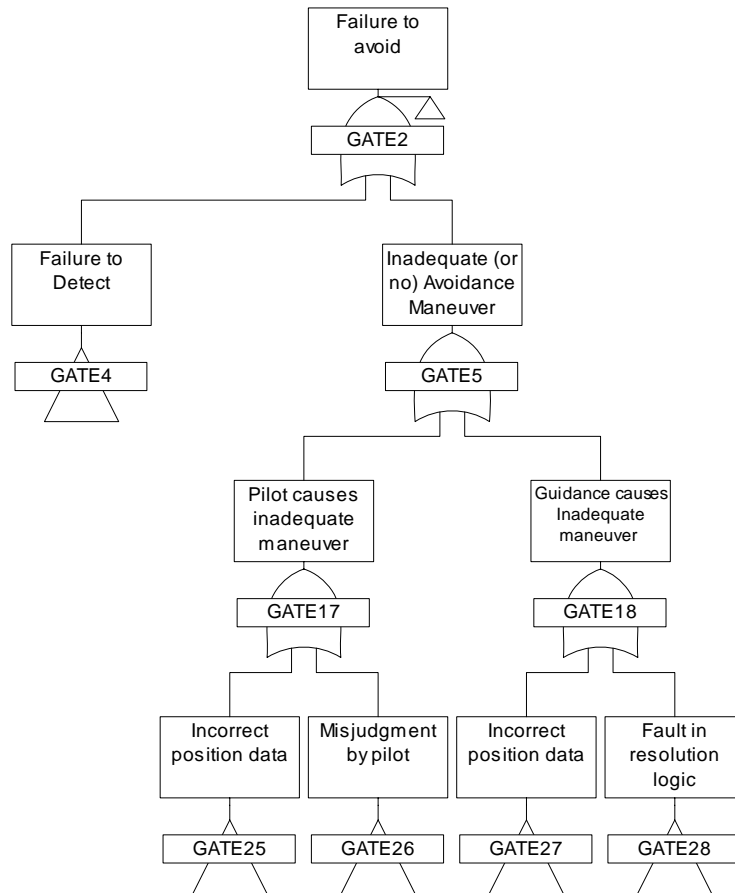
- **Update vehicle models and encounter statistics**
- **Conduct simulation to uncover sensitivities in TCAS logic and address them**
- **Enhance our laboratory capabilities to demonstrate conflict probe and collision avoidance involving UAS**

Highlight: Simulating Collision Avoidance Encounters

- Simulation generates millions of encounters covering each profile class
- Monte Carlo runs vary every parameter, including geometry, measurement noise, pilot response
- TCAS logic is exercised in one or both aircraft
- Resulting separations are combined with proper weighting by class, altitude layer, and altimetry error



Highlight: Fault Tree Analysis



- Evaluate Collision Avoidance Performance

- Sensor Capability

- Link Reliability

- Advisory Logic

- Human Contribution

- Compare to Manned Aircraft

Impacts

Sense-and-avoid function has been identified as a key element in accessing civil airspace

We will:

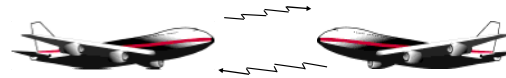
- **Guide the manufacturing community**
- **Inform users (DoD, DHS, commercial) and regulators (FAA)**
- **Provide essential technical input to standards development in SC-203**

Future Plans

Refine Model of Future Airspace



Model Various Sensor Types



Feasibility Trials of Conflict Probe



Real-time Lab Demo of UAS Collision Avoidance

