# Sense and Avoid for Small Unmanned Aircraft

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**MITRE Sponsored Research**

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# Problem

- ***Can small autonomous craft reliably detect and avoid collision with objects in their path of interest, both stationary and moving, that do not announce their position?***
  - **Many research efforts focus on one or more components of the research question – but few broadly address the combination**

**"Sense and Avoid" Scope**

- **Small UAS missions as driver (remote sensing)**
- **Small payload limitation**
- **Uncontrolled VFR airspace operation, mixed with manned aircraft, without transponders**
- **Reactive timeframe for sensing and avoiding**
- **Fixed, moving, and virtual obstacles**

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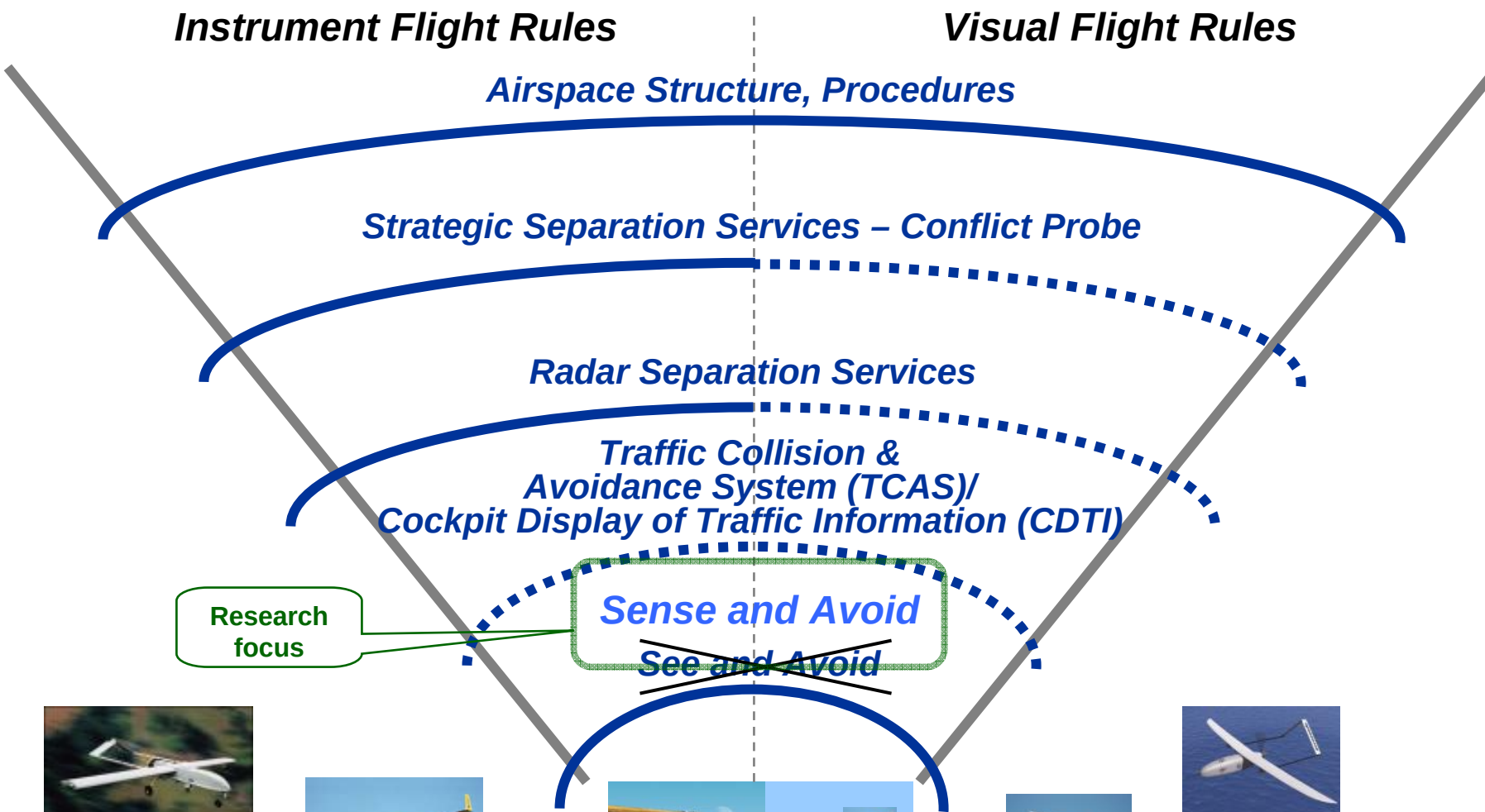
# Background



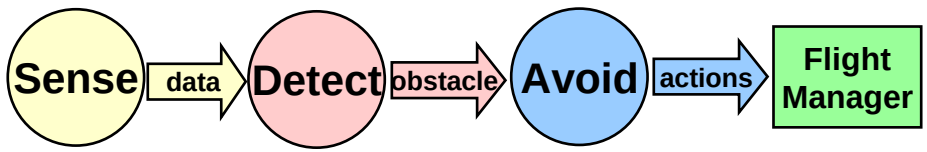
# Objective

- Discover and refine the ***requirements*** for small UAS sense and avoid
- Map the ***breadth*** of sense, detect, and avoid concepts and technology, and scope what is appropriate for small UASs

Big Picture

- Probe the ***depth*** by building, testing, and flying selected promising combinations

Prototype

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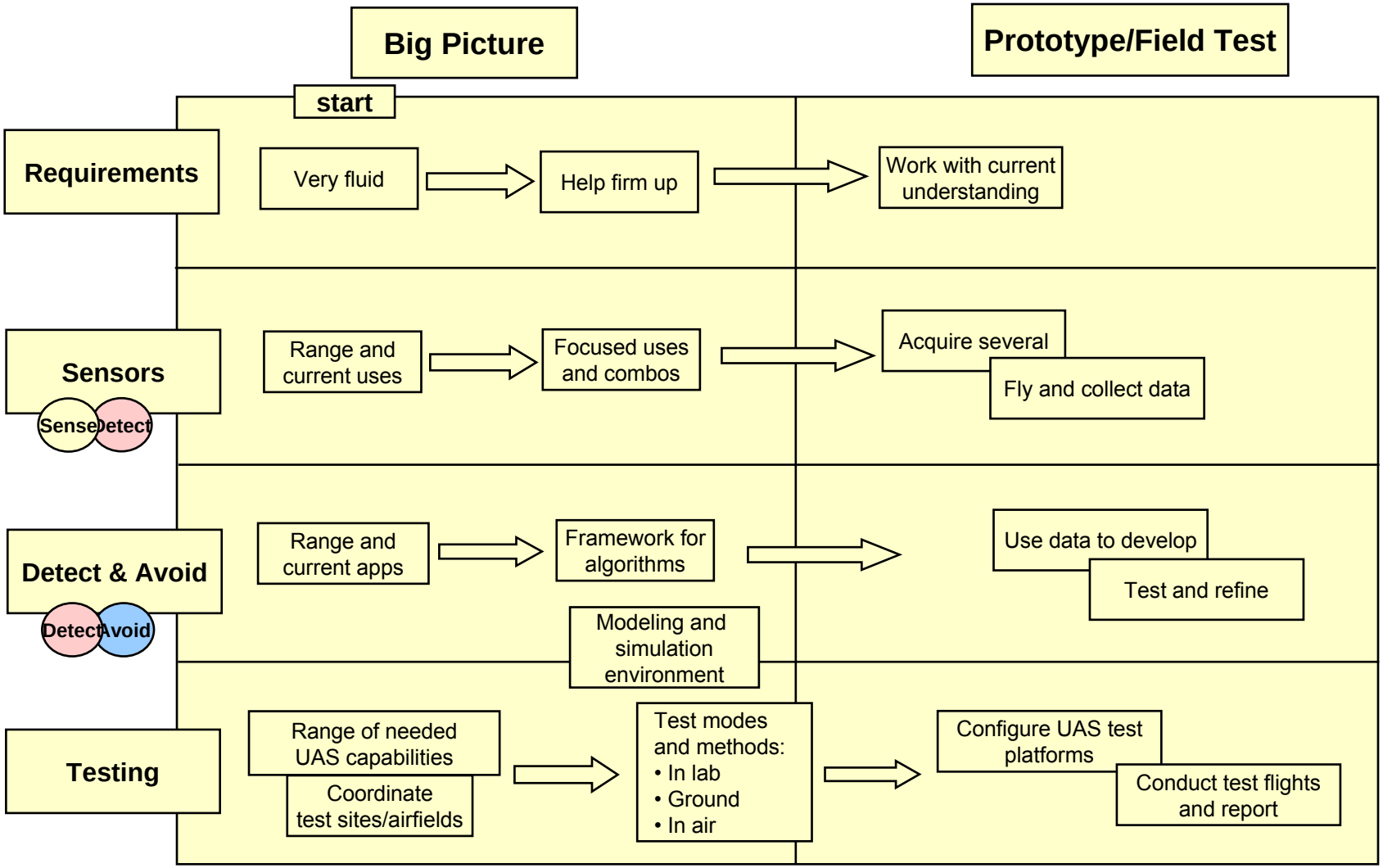
# Activities

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# Highlight

**Sensors**

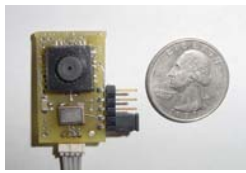
Sense Detect

**Sensing Modalities**

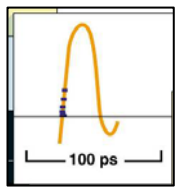
- Electro-optical
- Infrared
- Laser
- Radar
- Sonar
- Thermal
- Motion detection

- Active and passive

**Laser Rangefinder (manufacturer?)**



**Optical Flow (Centeye)**

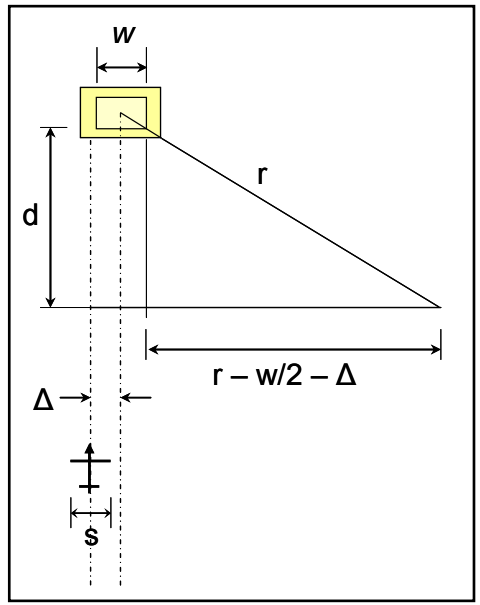



**UltraWideBand Ranging (prototype)**

**Focus on currently available technology**

**Detect & Avoid**

Detect Avoid




**Use flight geometry to categorize detection range and azimuth requirements**

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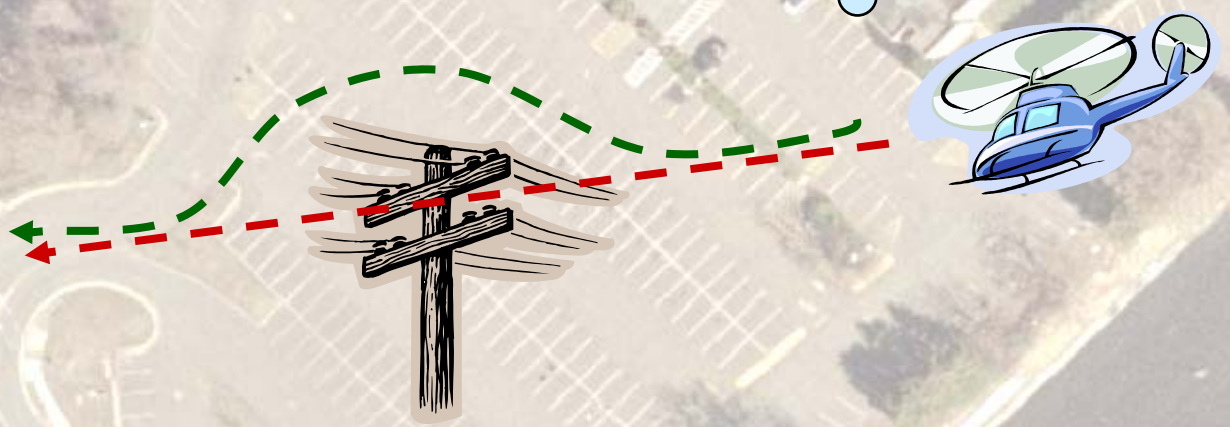
# Demonstration

**CY2006 demonstration goal is to have a small UAS detect a static object and take action to avoid striking it using on-board sensing and off-board computing.**



- **Assess multiple sensor types and combinations of sensors**
- **Develop a variety of simple detect and avoid algorithms**
- **Prototype lightweight computing configurations**
- **Test against fixed and moving obstacles**
- **Assess how civil “sense and avoid" requirements are fulfilled or must be modified**

# Impacts

- **Enable UAS access to airspace by developing safe interaction of manned and unmanned aircraft**
- **Build corporate expertise with innovative UAS research and applied technology**
- **Directly leverage MITRE Meteor investment**

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# Future Plans

| FY06 | FY07 | FY08 |
|---|---|---|
| • Study aviation (TCAS, etc) algorithms for CD and CA<br>• Evaluate sensor modalities for CD, including visual, thermal, sonar, and radar<br>• Complete construction of current RC planes and autopilots<br>• Perform initial field trials<br>• Build simulation support for algorithm development | • Acquire new platforms<br>• Acquire new sensors for CD<br>• Integrate new sensor combinations into platforms<br>• Extensive field tests<br>• Formulate system design for CD and CA<br>• Continue simulation work to refine CA algorithms | • Work with D300 on single-chip CD & CA solution<br>• Present design to FAA and military sponsors<br>• License design and transition system development to partner (TBD)<br>• Document and report results |

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