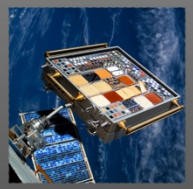
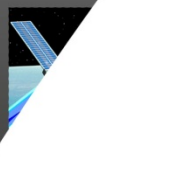




National Aeronautics and Space Administration

NASA

NASA sUAS Vehicle Technologies

STEReO Stakeholder Workshop

Robert McSwain, *AST, Aerospace Flight Systems*

Feb 11-13, 2020

(757).864.9639

Robert.G.McSwain@NASA.gov

Outline

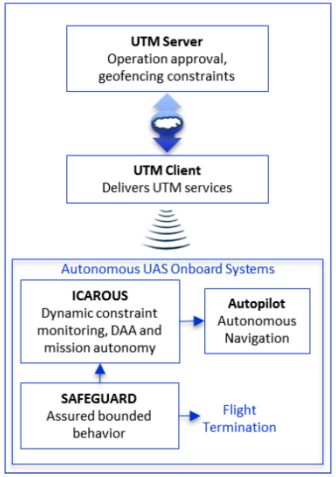
- Safe2Ditch
- ICAROUS- Independent Configurable Architecture for Reliable Operations of Autonomous Systems
- Safeguard
- RAAVIN – Radar on Autonomous Aircraft to Verify ICAROUS Navigation
- DANTi – Detect and Avoid iN The Cockpit
- UTM Enabling Vehicle Technologies
- HDS – Human Detection System

Safe 2 Ditch (S2D)

- **S2D is designed to enable sUAS to self-monitor the vehicle state and effectively execute emergency landings in populated areas.**
- **Features**
  - Machine Vision
  - Health Monitoring
- **Additional Information**
  - https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20180008439.pdf

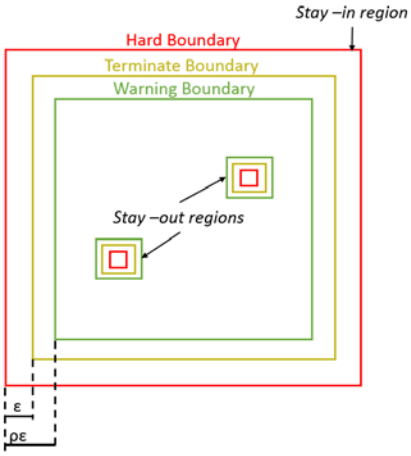
Independent Configurable Architecture for Reliable Operations of Autonomous Systems (ICAROUS)

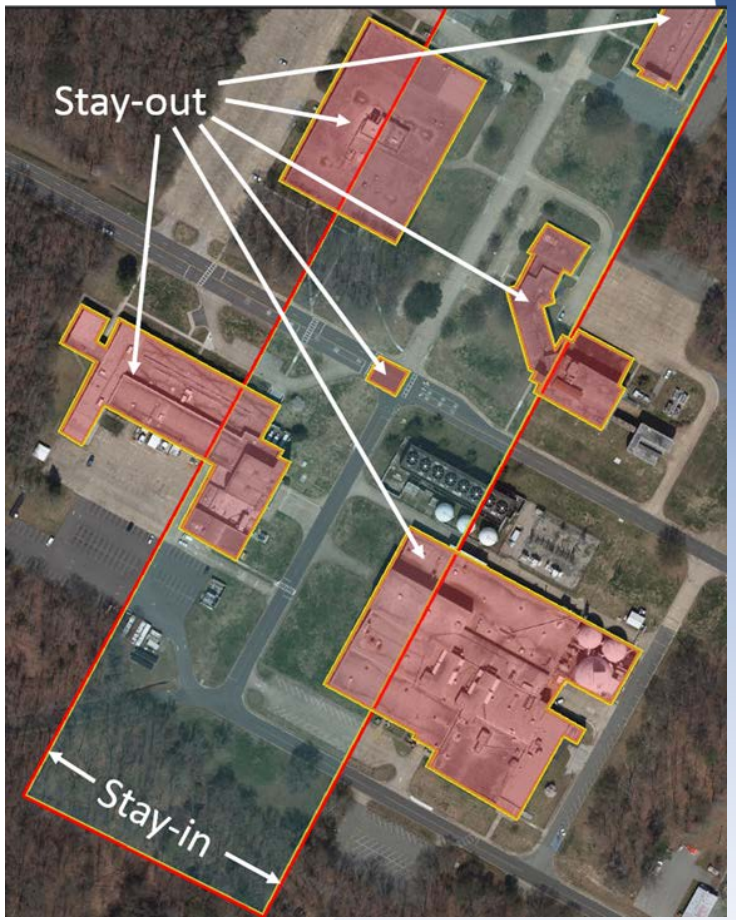
- **ICAROUS is a software architecture comprised of highly assured algorithms for building safety-centric, autonomous, unmanned aircraft applications**
- **Features**
  - Detect and Avoid
  - Geofence Monitor
  - Obstacle Avoidance
  - Stand-off Distance
  - Return to Mission
- **Additional Information**
  - https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170001936.pdf



Safeguard

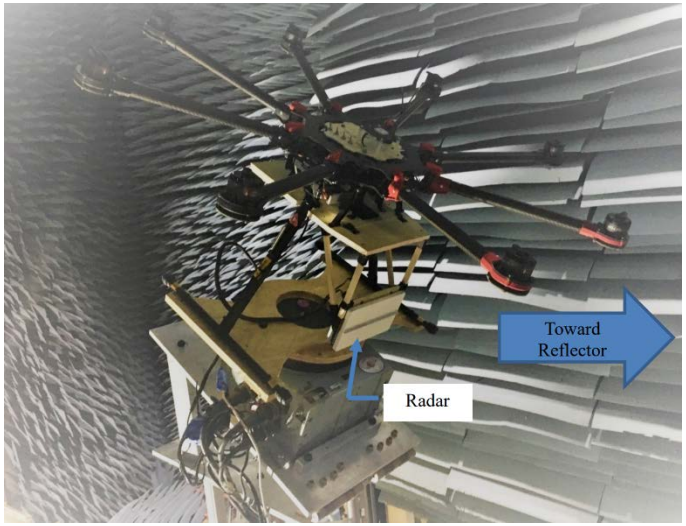
- **Safeguard is designed to monitor and enforce conformance to a set of operational rules defined prior to flight (e.g., geospatial stay-out or stay-in regions, speed limits, and altitude constraints).**
- **Features**
  - Assures conformance to a set of constraints
  - Based on simplex architecture
  - Independent, autonomous system
  - Can be configured for degraded GPS environments
  - Formally verified algorithms
  - Safety assurance emphasis
    - *current version developed to NASA Class B software standards (D207)*
  - Approved for safety credit by LaRC ASRB
- **Additional Information**
  - https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170009617.pdf





Radar on Autonomous Aircraft to Verify ICAROUS Navigation (RAAVIN)

- **Utilization of new airborne radar systems for DAA applications on sUAS**
- **Features**
  - DAA
  - Radar
- **Additional Information**
  - https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20190026497.pdf
  - George Szatkowski
  - NASA LaRC Researcher
  - george.n.szatkowski@nasa.gov

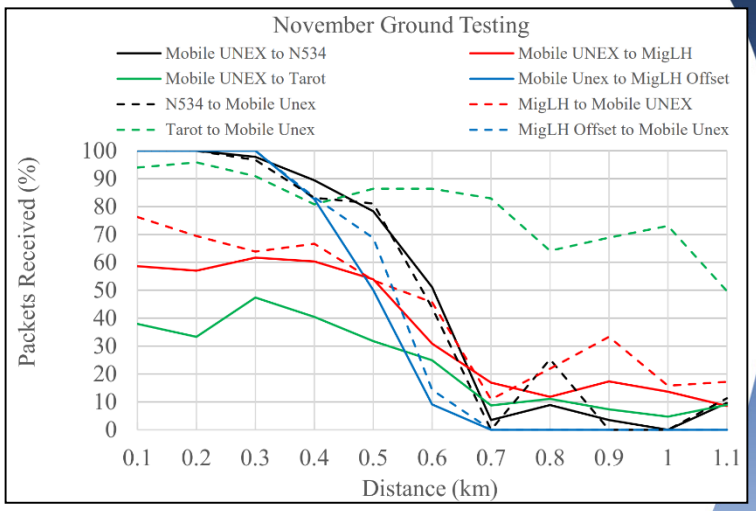


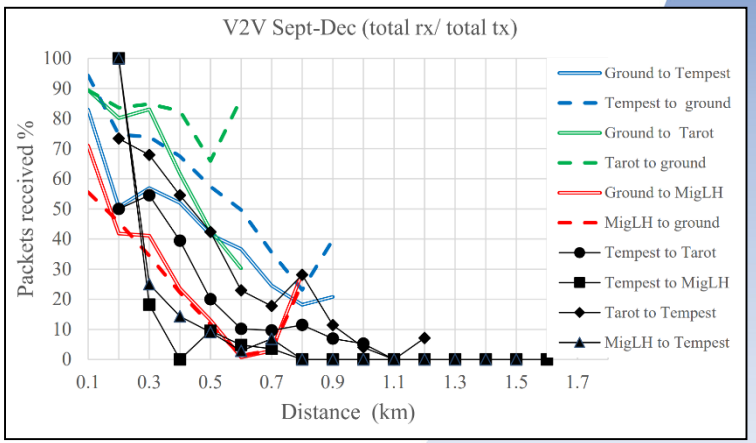
Detect and Avoid iN The Cockpit (DANTi)

- **Display traffic alerts and maneuver guidance to manned aircraft pilots on a portable tablet device.**
- **Features**
  - ADS-B Traffic Input
  - Ownship Aircraft State Data
  - NASA developed DAA Software
  - Traffic Alerts
  - Maneuver guidance
- **Additional Information**
  - https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170005874.pdf

UTM Enabling Vehicle Technologies

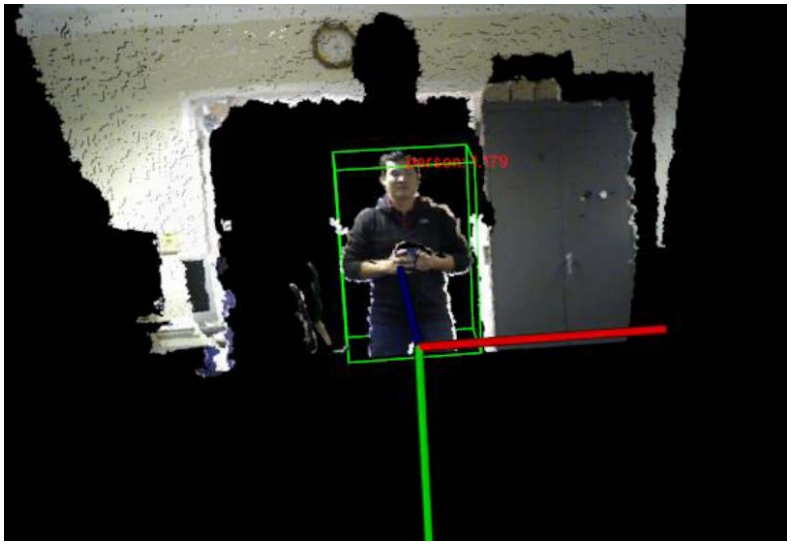
- **Dedicated Short Range Communications (DSRC)**
  - Systems for potential sense and avoid sUAS applications.
- **Features**
  - Vehicle to vehicle communications
- **Image-based Object Detection (IOD)**
  - Onboard non-cooperative SAA for sUAS utilizing visual-based sensors.
- **Features**
  - Machine Vision
- **Additional Information**
  - https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20180003200.pdf





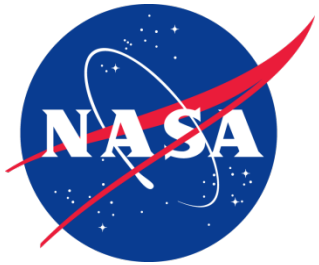
Human Detection System (HDS)

- **Identify humans in the landing site prior to landing.**
- **Features**
  - Machine Vision
- **Additional Information**
  - Dr. Loc D. Tran
  - NASA LaRC Researcher
  - loc.d.tran@nasa.gov



S2D Flight Video Utilizing Mask R-CNN Algorithm
https://arxiv.org/abs/1703.06870

BACKUP


NASA