National Aeronautics and Space Administration

ICAO RPAS Symposium

NASA RPAS Operational and Research Activities

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UAS-NAS Project

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Subset of NASA Science-Related UAS Efforts

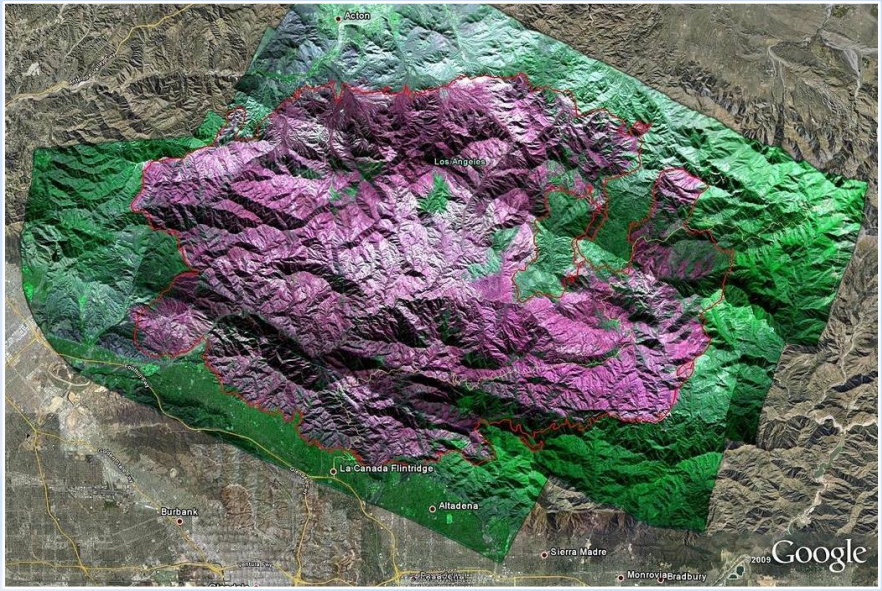
- **Science UAS Flight-Operations Focus:**
  - Conduct operations in collaboration with the FAA, NOAA, US Forestry, and other entities to provide data for advancing societal benefits.
- **Demonstrated Societal Benefits**
  - NASA has collected and delivered infrared images of active fire hot spots in near real-time to fire fighters. This gives critical information directly to the front line to efficiently deploy fire-fighting assets.
  - NASA has collected imagery over time to measure the characteristics of sea ice. This provides data to assess the accuracy of satellite data, and refine models accordingly which enhances the ability to accurately determine climactic changes in the arctic.
  - NASA has collected imagery on hurricane storm formation, structure, and intensification. This provides data to assess the track and intensity of hurricanes as they approach populated areas.
- **NASA Science Approach:**
  - Define Science Mission Requirements.
  - Select Vehicle that best meets the requirement. Only use a UA if it is the best fit.

Ikhana Fire Missions

A collaborative effort between NASA and fire-fighting organizations including U.S., State, and local entities.

Goal of Fire Missions:

- Image multiple fires while either lingering over key fire hot spots, or disparate regional fire areas.
- Provide automated, on-board, terrain, and geo-rectified sensor imagery over horizon satellite communications (SATCOM) links to national fire personnel and incident commanders within 10 minutes of data acquisition.

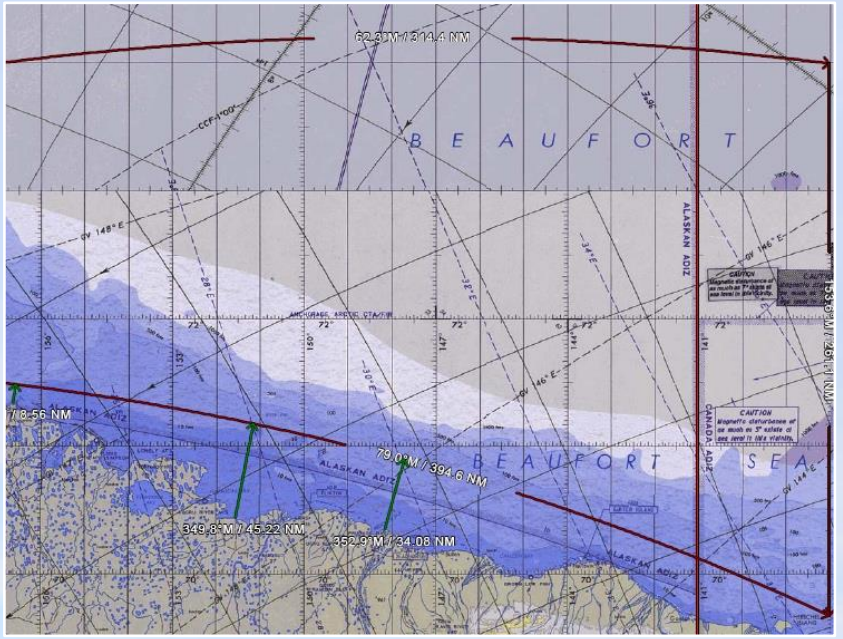


SIERRA MIZOPEX Mission

An interdisciplinary effort of oceanographers, cryospheric scientists, aeronautical engineers, UAS operators, and database/data systems experts.

Goal of MIZOPEX:

- Collect flight data with a UAS to determine whether or not the warming of the marginal ice zone (MIZ) in the Arctic Ocean is being accurately estimated by satellite models.
- Develop and use updated satellite models to better characterize sea ice survival rates in the transition zone between open ocean and permanent ice.

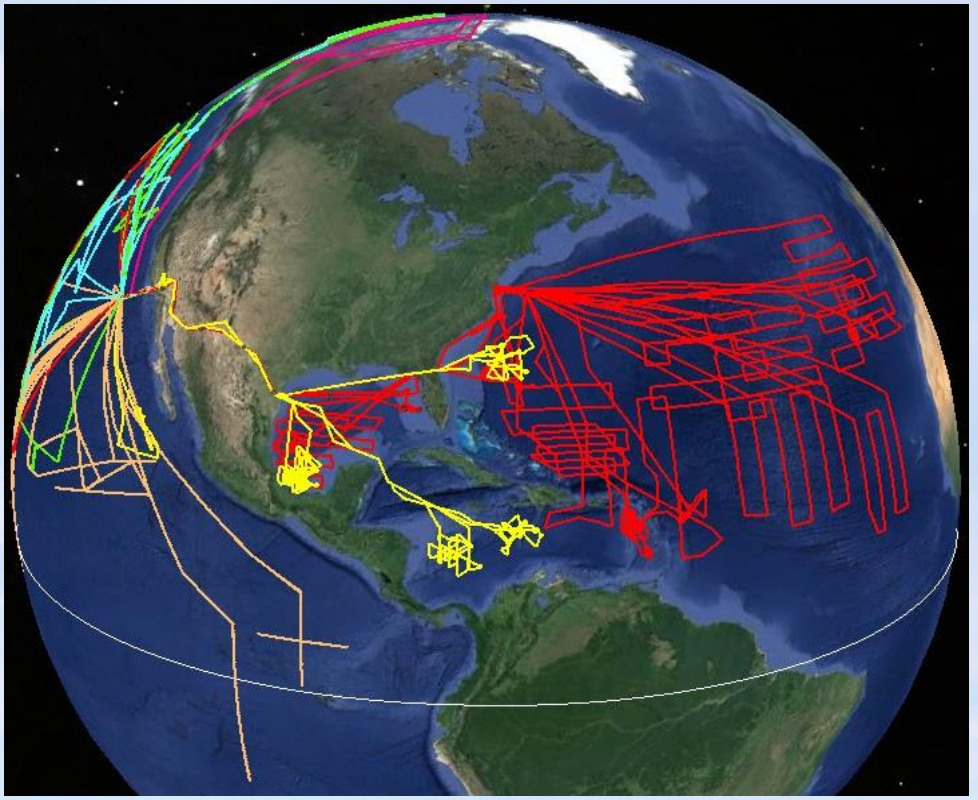


Global Hawk Hurricane Missions

A collaborative effort between NASA, NOAA, NWS, and other meteorological entities.

Goal of Hurricane Missions:

- Conduct flights over hurricanes and severe storms, including the use of dropwindsonde weather instruments, to collect data on formation, structure, and intensity of hurricanes and other severe storms.
- Disseminate high-definition pictures from the aircraft to meteorological entities and the general public in real time.



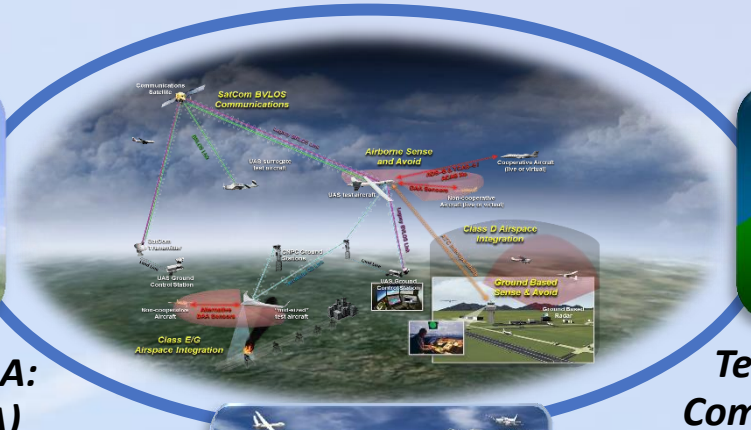
Subset of NASA Aeronautics UAS Efforts

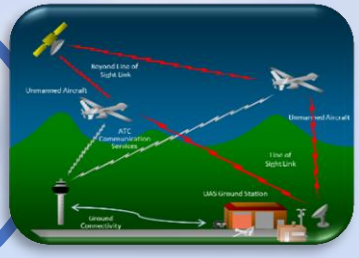
- **Aeronautics UAS Flight Research Focus:**
  - Develop research findings to enable performance-based access for all unmanned and autonomous systems.
- **Expected Societal Benefits:**
  - Enabling access for unmanned and autonomous systems will expand economic opportunities while significantly improving the quality of life for the general public.
- **NASA Aeronautics Approach:**
  - Two Funded Projects – UAS Integration in the National Airspace System (UAS-NAS) and UAS Traffic Management (UTM).
  - Numerous small UAS and autonomy activities.
  - Several standards activities.

NASA UAS-NAS Project Goal

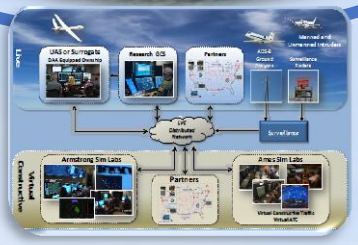
Provide research findings, utilizing simulation and flight tests, to support the development and validation of DAA and C2 technologies necessary for integrating UAS into the NAS.

Technical Challenge-DAA: Detect and Avoid (DAA)





Technical Challenge-C2: Command and Control (C2)



SIO: System Integration and Operationalization for UAS (SIO)

NASA UTM Project Technical Capability Levels (TCLs)

Capability 1: Demonstrated How To Enable Multiple Operations Under Constraints

- Notification of area of operation
- Over unpopulated land or water
- Minimal general aviation traffic in area
- Contingencies handled by UAS pilot

Product: Overall concept of operations, architecture, and roles

Capability 2: Demonstrated How to Enable Expanded Multiple Operations

- Beyond visual line-of-sight
- Tracking and low density operations
- Sparsely populated areas
- Procedures and “rules-of-the road”
- Longer range applications

Product: Requirements for multiple BVLOS operations including off-nominal dynamic changes

Capability 3: Focuses on how to Enable Multiple Heterogeneous Operations

- Beyond visual line of sight/expanded
- Over moderately populated land
- Some interaction with manned aircraft
- Tracking, V2V, V2UTM and internet connected

Product: Requirements for heterogeneous operations

Capability 4: Focuses on Enabling Multiple Heterogeneous High Density Urban Operations

- Beyond visual line of sight
- Urban environments, higher density
- Autonomous V2V, internet connected
- Large-scale contingencies mitigation
- Urban use cases

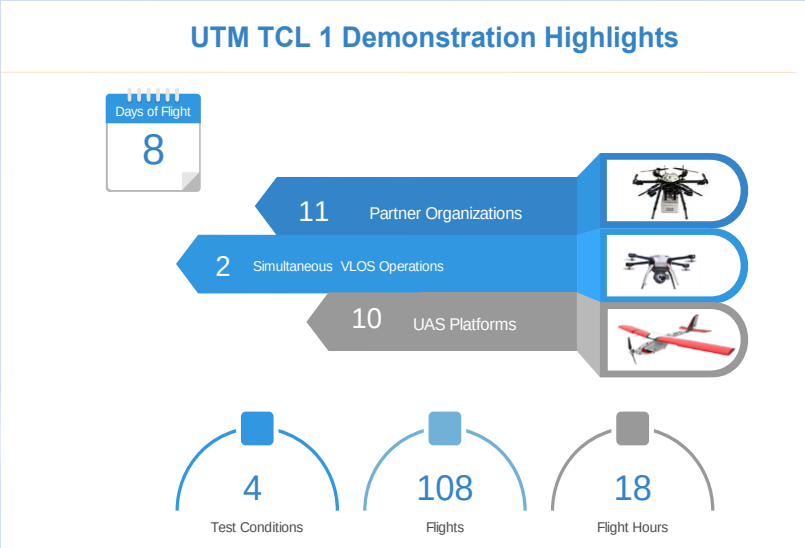
Product: Requirements to manage contingencies in high density, heterogeneous, and constrained operations

Risk-based approach: depends on application and geography

UTM Flight Activities for TCL 1 and TCL 2

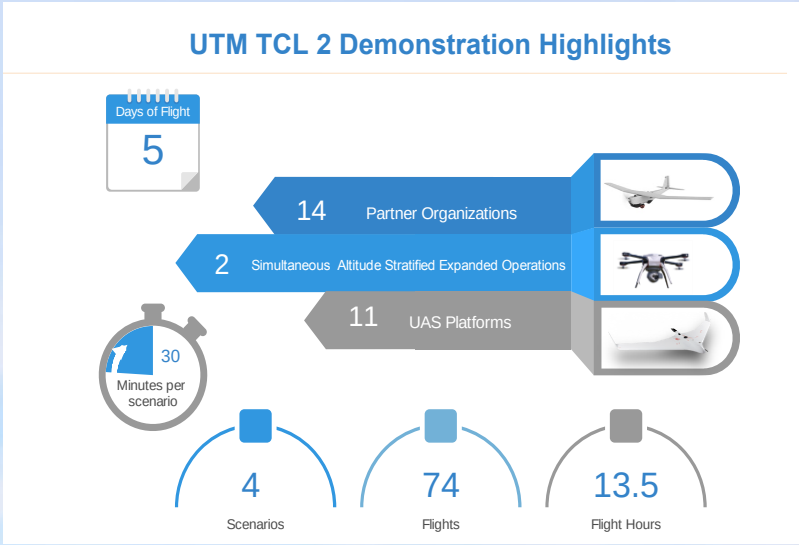
TCL 1 Demonstration Objectives

- Evaluate the feasibility of multiple VLOS operations using scheduling and planning through an API connection to the UTM research platform.

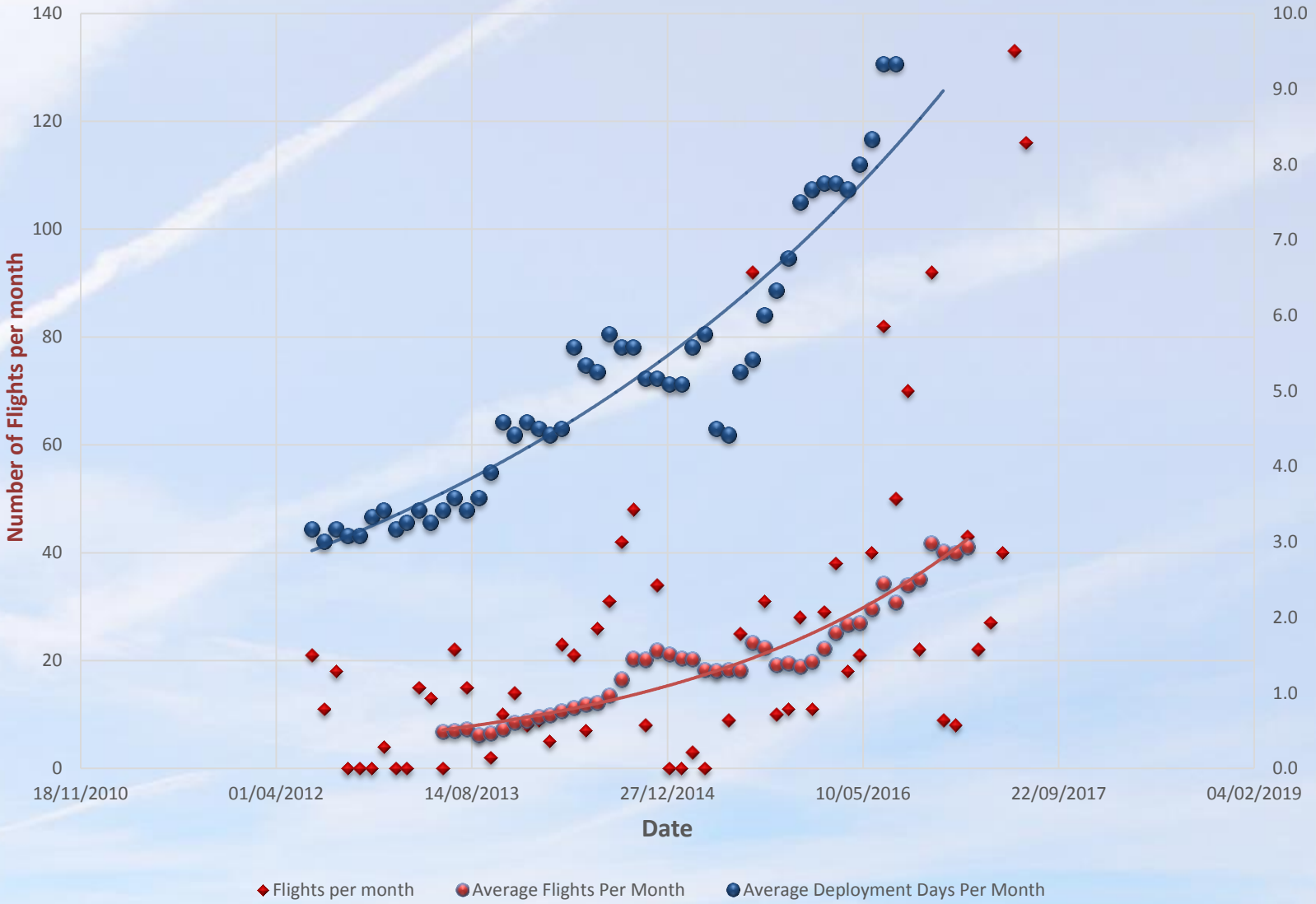


TCL 2 Demonstration Objectives

- Evaluate the feasibility of multiple BVLOS operations using a UTM research platform.



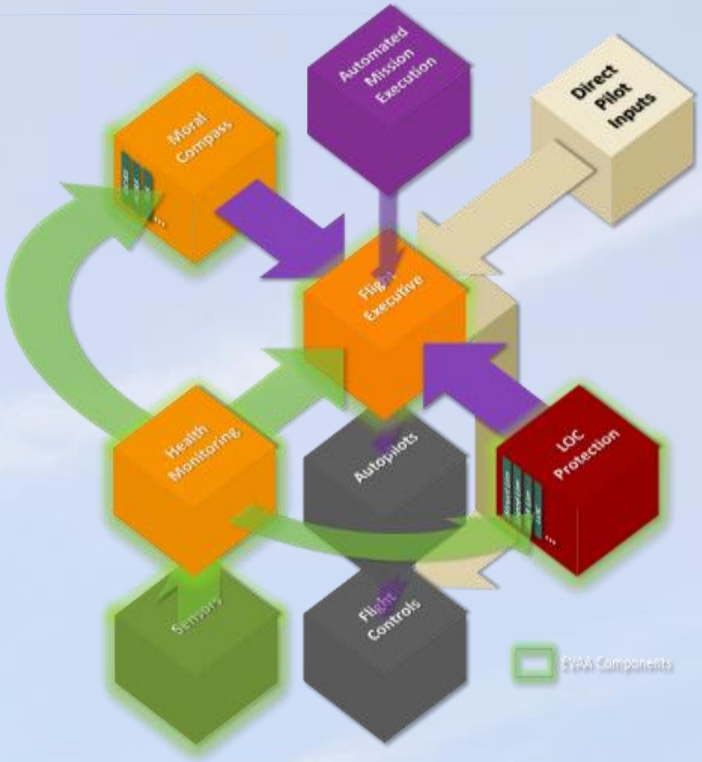
Small UAS Operations at NASA Langley Research Center

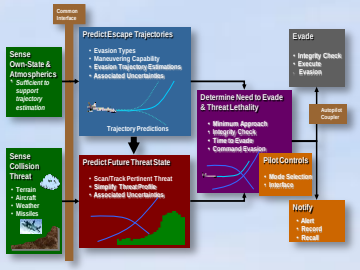


MM-RTA Research at Armstrong Flight Research Center

Research Goal: Develop a methodology for certifying unmanned and autonomous systems using software architecture testbeds.

- Develop Multi-Monitor Run Time Assurance (MM-RTA) research findings using the Low Altitude Small UAS Test Range (LASUTR) and the Expandable Variable Autonomy Architecture (EVAA).
- Use the research findings to develop a methodology for generating the artifacts necessary to support an airworthiness case for unmanned and autonomous systems.
- Use the artifacts to inform standards and best practices, which will accelerate the certification of unmanned and autonomous systems.





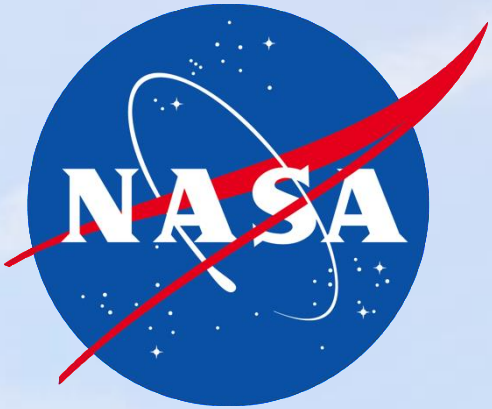
Improved Ground Collision Avoidance System (*iGCAS*)

NASA is Engaging the Standards Community

- NASA is contributing research findings to RTCA Special Committee 228 to inform DAA and C2 Minimum Operational Performance Standards (MOPS).

- NASA is sharing research findings, techniques, best practices and lessons learned throughout the development of MM-RTA with ASTM International to develop a standard practice that safely bounds the flight behavior of autonomous UAS.

- NASA and the UAS Test Site in New York (NUAIR) have developed a Space Act Agreement whereby NUAIR is making a significant investment in a National UAS Standardized Testing and Rating Facility (NUSTAR) capability to conduct performance assessments of small UAS. These performance assessments will include scenarios, such as wind/weather impacts, GPS degraded conditions, sense and avoid performance, hacking, etc. NUSTAR will offer a credible and comprehensive self-regulatory structure for small UAS.


NASA