NASA/FAA Grand Challenge Overview
Starr Ginn UAM Grand Challenge Lead
VFS Electric VTOL Symposium
23 Jan 2020
NASA intends to establish partnerships with government, industry, and academia to collaborate on the critical enabling technologies and vital research relevant to UAM.

NASA plans to partner with Federal/State/Local authorities as well as international & professional associations to develop the policies, regulations, and standards necessary to enable the UAM market.

Grand Challenge Series
A major enabler to inform the UAM Ecosystem

Community Outcome
UML-4 Book of Requirements

Ecosystem-wide partnerships are required to enable UML-4
Roles of the Scenarios Technical Working Group: Data Collection

- **FAA GC Co-Lead**
  - FAA GC Data Manager
  - FAA SMEs

- **Feedback on Scenarios**
  - Scenario Overviews / Details
  - NASA GC Management
  - NASA GC Data Manager
  - NASA SMEs

- **NASA Preparation Meetings**

- **FAA Preparation Meetings**

- **NASA GC Data Manager**
  - FAA GC Data Manager

- **GC Data Collection Meeting**
  - Measurable Data per GC Test
  - Desired Data

- **Desired Metrics per Scenario**
  - Achievable Metrics per GC Test

- **GA ATI**
  - GC Range

- **Desired Metrics per Scenario**
  - Scenario Overviews / Details
  - NASA GC Management
  - NASA GC Data Manager
  - NASA SMEs
Area A to X-33 Route
RVLT Edwards Site Planning

Potential flight routes

- Rough route estimate based on conventional helicopter capabilities
- Depending on vehicle capabilities, approach and takeoff tested along level flyover flight path
- Surrounding area needs to be quiet!
- Proposing weekend testing
November 20 @ 7:08Z WX Station Surface Data

11/20/2019

11/20/2019

Left half dashed lines < 500k iters
Right half dashed lines > 500k iters

Shift in CFD_1 flow direction with increasing solution time

Fair agreement with windspeeds
ATI/ATM-X Airspace Operation Manager (AOM)

USS Information Exchange Network
- NUSS
- FIMS
- Authentication, Authorization, Discovery, Registration, various services

Emulation
- Adaptation
- Virtual Traffic

Data
- Data Pipeline
- Data Management
- Visualization

Operations Manager

Core

Operator

Range

Vehicles
Data Visualization

- Grafana dashboard
- Google earth
- iUTM
## GC DT Flight Test – Scenario 3

<table>
<thead>
<tr>
<th>Description</th>
<th>Airspace Assumptions</th>
<th>ATC Interaction</th>
<th>Background Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manned vehicles will fly from Area A to X-33 site</strong></td>
<td>Class D and Class G</td>
<td></td>
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<tr>
<td><strong>Unmanned vehicles without a FTS will fly from Area A to X-33 site if two GCS are available (beyond line of sight)</strong></td>
<td>Day VFR</td>
<td></td>
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<tr>
<td><strong>Unmanned vehicles with FTS will fly from Area A to Area A</strong></td>
<td>UAM corridor has been established and is in use based on a helicopter-like Letter of Agreement (LOA)</td>
<td>3a: ATC Interaction not required</td>
<td>IFR, GA, and UAM virtual traffic. The IFR and GA traffic will emulate a Class D airport and the UAM virtual traffic will follow route and adjacent routes following a static schedule</td>
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### Scenario 3a: Go Around
- Emulate occupied or obstructed vertipad that requires the UAM vehicle complete a go around and enter a loiter pattern
- USS provides a consistent off nominal approach as part of initial predeparture flight plan submission

### Scenario 3b: UAM vehicle divert to a runway
- Emulate an emergency landing that requires priority sequencing and diversion to alternate landing location
- Vehicle requires a runway landing due to limitations in controllability with given power conditions
- UAM operator and vehicle will initiate interaction with ATC in Class D to obtain clearance for landing
- The handoff and interactions between UAM operator, vehicle, and ATC need to be defined
- Emulated environmental conditions require a balked landing to be executed
- USS provides a consistent off nominal approach as part of initial predeparture flight plan submission

### UAM Corridor
- Has been established and is in use based on a helicopter-like Letter of Agreement (LOA)
- Allows for multiple UAM flights in the corridor
- No 2-way VHF/UHF communication required in nominal ops
- UAM operator will resequence vehicle performing a go around into stream of virtual traffic
## Elements

<table>
<thead>
<tr>
<th>Balked landing</th>
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<th>Services</th>
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<tr>
<td>• USS discovery</td>
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<tr>
<td>• Operational plan negotiation</td>
</tr>
<tr>
<td>• Flight position updates</td>
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<tr>
<td>• ATC clearance</td>
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<tr>
<td>• State maintenance</td>
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<td>• Conformance monitoring</td>
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<table>
<thead>
<tr>
<th>AOM Component</th>
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<td>NUSS FIMS</td>
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<tr>
<th>Minimal Information Requirements</th>
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<tr>
<td>• Operational state notifications (Cancel)</td>
</tr>
<tr>
<td>• Operational boundaries</td>
</tr>
<tr>
<td>• Aircraft position</td>
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<tr>
<td>• Flight plans</td>
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<tr>
<td>• Static and dynamic constraints</td>
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<tr>
<td>• Terrain and weather</td>
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<td>•</td>
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PRE-FLIGHT
Flight planning and communication.

Industry Services
AOM
USS
Discovery Service
UAM Pilot
Scenario 3:
UAM Ports and Approaches
Obstacle MSL elevation ft.  
E = OCS start elevation MSL  
D = Distance (NM) OCS origin to obstacle

\[ CG = \frac{O - E}{0.76D} = \frac{2526 - 2285}{0.76 \times 1.47} = 157.1 \approx 216 \text{ ft./NM} \]

Assumed: 200 FPNM CG = OCS 40:1  
300 FPNM CG = OCS 20:1  
400 FPNM CG = OCS 15:1

Variable based on CG.

AFRC South Base Elev. = 2285 ft.

8931.9 ft. (1.47NM)

Calculating Clear Gradient

All mean tracks are for a vehicle agnostic containers surface  
95% and 99.9% Containment with YPAC Surfaces
APPROACH DECOUPLING

\[ FSL = \frac{\left( \sqrt{V_{\text{avg}}^2 + 10} \right) \times 15}{3600} \]

\[ \text{HMAS} = \text{LTP}_{\text{dev}} + \frac{\text{dca} - \text{dwa} - \text{dheightloss}}{8.1 \times \text{OCS}_{\text{type}}} \]

PROCEDURE RECOVERY

1. TOLA OEA
   Operation Agnostic
2. Recovery Entry Fix
   Calculated
3. Standard Holding
   OEA

\[ A = 1 \times \text{XTT} \]
\[ B = 2 \times \text{XTT} \]
Grand Challenge Mission Task Elements (MTEs)

Mission Task Elements are discrete test points which we will mix into the Grand Challenge Operational Scenarios

Required Performance:
• Included for NASA’s consideration as a minimum entry parameter for safety of flight
• Generally is far less than what will eventually be required for FAA certification

Desired Performance:
• Denotes level of performance that are approaching levels likely* required to gain FAA certification
  o *The FAA has not yet decided on applicable regulations nor minimum design standards for this emerging class of aircraft
• Similar performance level to conventional fixed or rotary wing aircraft

* MTEs are designed to shed light on operational challenges that will drive future acceptable certification standards

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<thead>
<tr>
<th>All Azimuth</th>
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<tr>
<td>Taxi</td>
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<tr>
<td>Takeoff Performance</td>
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<tr>
<td>Level Flight Decel/Accel</td>
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<tr>
<td>Flight Path Changes</td>
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<tr>
<td>Steep Turns, Pull Up, Push Over</td>
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<tr>
<td>Approach/Landing</td>
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<tr>
<td>Land-Quick Charge-TO</td>
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<tr>
<td>Energy Storage/Reserves</td>
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<td>Function &amp; Reliability</td>
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<td>Precautionary landing</td>
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<tr>
<td>Balked Landing</td>
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<tr>
<td>Takeoff Failure Case</td>
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<tr>
<td>Landing Failure Case</td>
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