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.
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 Data Manager
  NASA SMEs

- Scenarios Technical Working Group Meeting

- FAA Preparation Meetings

- NASA Preparation Meetings

- Measurable Data per GC Test
- Desired Metrics per Scenario
- Achievable Metrics per GC Test

- FAA GC Data Manager
- NASA GC Data Manager

- GC Data Collection Meeting

- FAA SMEs
- GC ATI
  GC Range
Area A to X-33 Route
• 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

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

Fair agreement with windspeeds

Shift in CFD_1 flow direction with increasing solution time
ATI/ATM-X Airspace Operation Manager (AOM)

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

Operations Manager

Core

Operator

Data
- Data Pipeline
- Data Management
- Visualization

Emulation
- Adaptation
- Virtual Traffic

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><strong>Class D and Class G</strong></td>
<td><strong>Scenario 3a: ATC Interaction not required</strong></td>
<td><strong>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</strong></td>
</tr>
<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><strong>Day VFR</strong></td>
<td><strong>Scenario 3b: ATC interaction required with vehicle and UAM operator</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Unmanned vehicles with FTS will fly from Area A to Area A</strong></td>
<td><strong>UAM corridor has been established and is in use based on a helicopter-like Letter of Agreement (LOA)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Emulate off nominal conditions during UAM port approaches and landings in Class D airspace and the associated interactions with UAM operators (USSs) and ATM along with the associated timing of messages and interactions</strong></td>
<td><strong>o Allows for multiple UAM flights in the corridor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scenario 3a: Go Around</strong></td>
<td><strong>o No 2 way VHF/UHF communication required in nominal ops</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Emulate occupied or obstructed vertipad that requires the UAM vehicle complete a go around and enter a loiter pattern</td>
<td><strong>o UAM operator will resequence vehicle performing a go around into stream of virtual traffic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• USS provides a consistent off nominal approach as part of initial predeparture flight plan submission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scenario 3b: UAM vehicle divert to a runway</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Emulate an emergency landing that requires priority sequencing and diversion to alternate landing location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Vehicle requires a runway landing due to limitations in controllability with given power conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• UAM operator and vehicle will initiate interaction with ATC in Class D to obtain clearance for landing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• The handoff and interactions between UAM operator, vehicle, and ATC need to be defined</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Emulated environmental conditions require a balked landing to be executed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elements</td>
<td>Services</td>
<td>AOM Component</td>
<td>Minimal Information Requirements</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------------------</td>
<td>---------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Balked landing</td>
<td>• USS discovery</td>
<td>NUSS</td>
<td>• Operational state notifications (Cancel)</td>
</tr>
<tr>
<td></td>
<td>• Operational plan negotiation</td>
<td>FIMS</td>
<td>• Operational boundaries</td>
</tr>
<tr>
<td></td>
<td>• Flight position updates</td>
<td></td>
<td>• Aircraft position</td>
</tr>
<tr>
<td></td>
<td>• ATC clearance</td>
<td></td>
<td>• Flight plans</td>
</tr>
<tr>
<td></td>
<td>• State maintenance</td>
<td></td>
<td>• Static and dynamic constraints</td>
</tr>
<tr>
<td></td>
<td>• Conformance monitoring</td>
<td></td>
<td>• Terrain and weather</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>•</td>
</tr>
</tbody>
</table>
PRE-FLIGHT
Flight planning and communication.
Scenario 3:
UAM Ports and Approaches
Obstacle MSL elevation ft.  
E = OCS start elevation MSL  
D = Distance (NM) OCS origin to obstacle  

\[ CG = \frac{O - E}{0.76D} \approx \frac{2526 - 2285}{0.76 \times 1.47} = 215.71 \approx 216 \text{ ft./NM} \]

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

Variable based on CG.

**Flight Path “Desired”**

ROC  
AAO 2526 ft. MSL  

AFRC South Base Elev. = 2285 ft.
**APPROACH DECOUPLING**

- $\delta_{\text{height loss}} = \frac{50}{\tan(\theta)}$

**HEIGHT LOSS**

- $\delta_{\text{height loss}}$

**FSL**

- $\text{FSL} = \frac{(\text{VertAx} + 10) \times 15}{3600}$

**HMAS**

- $\text{HMAS} = \frac{\delta_{\text{ea}} - \delta_{\text{mg}} - \delta_{\text{height loss}}}{\text{OCS}_\text{type}}$

**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.
  - *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.**

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

---

---

---

---