UTM 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 con ops, 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
## Urban Air Mobility Maturity Levels (UML)

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<tr>
<th>Maturity Level</th>
<th>Description</th>
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<td>UML-1</td>
<td>Early Operational Exploration and Demonstrations in Limited Environments</td>
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<tr>
<td>UML-2</td>
<td>Low Density and Complexity Commercial Operations with Assistive Automation</td>
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<td><strong>INTERMEDIATE STATE</strong></td>
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<td>UML-5</td>
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<tr>
<td>UML-6</td>
<td>Ubiquitous UAM Operations with System-Wide Automated Optimization</td>
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### UML-1: Early Operational Exploration and Demonstrations in Limited Environments
- Aircraft certification testing and operational evaluations; traditional airspace procedures; exploratory community demos and data

### UML-2: Low Density and Complexity Commercial Operations with Assistive Automation
- Type certified aircraft; initial Part 135 operation approvals; limited markets with favorable weather and regulation; small UAM network serving urban periphery; UTM as possible, UAM corridors through controlled airspace

### UML-3: Low Density, Medium Complexity Operations with Comprehensive Safety Assurance Automation
- Operations into urban core; operational validation of airspace, UTM inspired ATM, CNS, C², and automation for scalable, weather-tolerant operations; closely space UAM pads, ports; noise compatible with urban soundscape; model-local regulations

### UML-4: Medium Density and Complexity Operations with Collaborative and Responsible Automated Systems
- 100s of simultaneous operations; expanded networks including high-capacity UAM ports; many UTM inspired ATM services available, simplified vehicle operations for credit; low-visibility operations

### UML-5: High Density and Complexity Operations with Highly-Integrated Automated Networks
- 1,000s of simultaneous operations; large-scale, highly-distributed networks; high-density UTM inspired ATM; autonomous aircraft and remote, M:N fleet management; high-weather tolerance including icing; high-volume manufacturing

### UML-6: Ubiquitous UAM Operations with System-Wide Automated Optimization
- 10,000s of simultaneous operations (limited by physical infrastructure, scaled ATM); essential ownership models enabled, ad hoc landing sites; noise compatible with suburban/rural operations; societal expectation

*Draft*
Urban Air Mobility (UAM) Vision
Revolutionize mobility around
metropolitan areas by enabling a safe,
efficient, convenient, affordable, and
accessible air transportation system for
passengers and cargo
NASA UAM Grand Challenge Timeline

**GC-1 SAAs**

This activity includes drafting Space Act Agreement (SAA) templates, participants identifying the desire to sign an SAA, the negotiation and signing of specific SAAs.

**Industry Day**

Discuss GC-1 plans, objectives, & execution strategy. Outline participation requirements, objectives, expectations, execution strategy, & schedules.

**RFI Responses Due**

Nov 1, 2018

**Webinar/Set Up Working Groups**

Nov 16

**Jan 2019**

**Qualification and A/W**

Participants signing SAAs will begin qualification scenarios and NASA's Airworthiness (A/W) process. The process has to be completed prior to flying in GC-1. There are additional follow-on requirements that will occur before each GC flight.

**Jan 2020**

GC-1 is anticipated to challenge industry and other community participants to address foundational UAM vehicle design readiness and robustness for UAM operations.

**Jan 2021**

**GC-2**

Future challenges in this series are anticipated to address key safety and integration barriers across the UAM ecosystem while also emphasizing critical operational challenges.

**GC-2 SAAs**

This would be for participants new to the Grand Challenge desiring to participate in GC-2 or, if needed, to update SAAs with GC-1 participants continuing on to GC-2.
2020 Grand Challenge (GC-1) Overview

**Vehicles**
functional UAM vehicles with threshold level of demonstrated airworthiness

**NASA Systems & Interfaces**
UTM interfaces through Testbed

**Airspace Management**
airspace and air traffic management technologies and services built and simulated to a threshold level of UAM ATM requirements

**Safety and Integration Scenarios**
airworthiness processes, realistic UML-4 scenarios, and a range(s) designed in concert with the FAA to support UAM testing

**Stakeholder Integration**
societal integration and acceptance of UAM Operations including public acceptance, supporting infrastructure, operational integration, standards organizations, the local regulatory environment, etc.
GC Vehicle and Airspace Management Participants

**Vehicles**

- Provide vehicle design and development data to support airworthiness approvals
- Conduct “experimental” class flights to benchmark vehicles and demonstrate ability to handle simple failures and contingencies
- Conduct Safety and Integration Scenarios for Grand Challenge including pre-defined interfaces with Airspace Management systems

**Airspace Management**

- Provide UAM ATM technologies that meet initial ATM-X provided requirements and Interface Control Documents (ICD)
- Demonstrate capabilities will meet the ICD benchmark and contingency simulations or live testing
- Conduct Safety and Integration Scenarios for Grand Challenge including pre-defined interfaces with vehicle systems