Urban Air Mobility

Grand Challenge Will Bring NASA, FAA And Industry Together On UAM

Aviation Week & Space Technology Sep 18, 2019

Graham Warwick Washington

Boeing

For the many new entrants in the nascent urban air mobility (UAM) market, dealing with the different parts of the FAA responsible for aircraft certification, pilot licensing, operating approval and airspace integration is a challenge.

To streamline that interface, NASA has formulated its UAM Grand Challenge (GC) as both a proving ground for vehicles and procedures and an environment where industry and regulators can work together to understand the requirements and work toward consensus standards for the new market.

Vehicle developers and airspace providers are sought for 2020 test event

U.S.-only testing will pave way for the wider Grand Challenge in 2022

"The Grand Challenge is a conduit to NASA and the FAA as one entity," says Starr Ginn, GC lead within NASA's Advanced Air Mobility project. The research agency has been working with the FAA for the past year, and all the aviation regulator's organizations have been involved in developing the Challenge scenarios, she says.

The agency has launched the Grand Challenge with plans for an initial developmental testing event, GC-DT, in the July-November 2020 time frame at NASA Armstrong Flight Research Center on Edwards AFB in California. This is to be followed by the first full event, GC-1, in May-September 2022. Further, increasingly advanced challenge events are then expected at yearly intervals. “We aim to always be a couple of steps ahead of industry,” says Ginn.

To support its planning, NASA has developed the construct of UAM maturity levels (UML). “We are at UML-0 now, as we have no certified vehicles,” she says. The Grand Challenge is aimed at developing the requirements for UML-4, defined as “medium-density and -complexity operations with collaborative and responsible automated systems”—a maturity NASA expects the industry to achieve by 2028-30.

The primary goal of GC-1 is to accelerate the UAM market by collecting flight data to help the FAA develop test procedures, data requirements and compliance methods for electric vertical-takeoff-and-landing (eVTOL) vehicle and pilot certification as well as operational approval.

The UAM Grand Challenge is part of NASA’s new Advanced Air Mobility project within its Integrated Aviation Systems Program. Credit: NASA

The tests will also enable development of preliminary guidelines for flight procedures and criteria for airspace design; evaluate communication, navigation and surveillance options; demonstrate an airspace operation management (AOM) architecture; and characterize vehicle noise—a key concern with UAM.

GC-DT will help NASA, the FAA and industry to prepare for that first full challenge event. Developmental testing will have two separate parts: live flights by vehicles and simulations by airspace service providers. “In 2020, the vehicles will fly through scenarios and exercise two-way communications while the airspace service providers are put through simulations of routing and separating traffic,” says Ginn.

NASA plans to begin looking for vehicle partners in September, with the goal of having agreements in place with up to three manufacturers by the end of December. This time line is set by the need to take all the vehicles—manned or unmanned—through a flight readiness review. “By the end of 2019, we will have six months to get them ready to test,” she says.

“Envelope expansion needs to be done three months before the GC, so we are looking for operational vehicles,” says Ginn, adding that aircraft will not be certified but will be safe to test. Developmental testing is limited to three vehicle companies, but any and all interested airspace service providers can participate. Only U.S. eVTOL developers and service providers can take part in this first event.

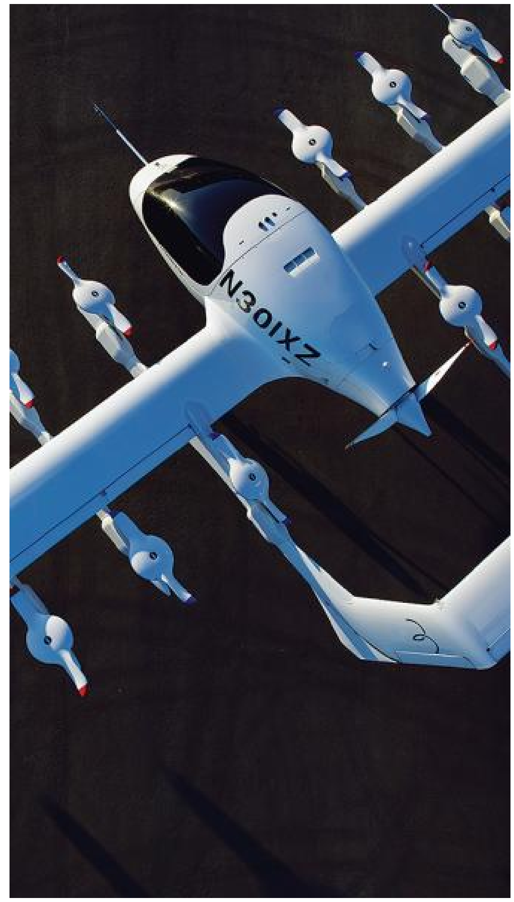
Boeing’s Aurora Flight Sciences is among a handful of U.S. manufacturers that have flown eVTOL vehicles. Credit: Boeing

GC-1 will close the loop between the vehicles and the airspace service providers, and involve flights and live simulations. The event will be a distributed challenge, taking part at several test sites across the U.S., and both domestic and foreign companies will be able to participate. The timing of GC-1, in 2022, “is set by the maturity level of the companies, instead of just being one year later than GC-DT,” says Ginn.

GC-DT is to be conducted in restricted airspace at Edwards, with the vehicles flying between two remote NASA facilities about 15 mi. apart. “We are trying to understand what these vehicles can and cannot do,” she says, noting that eVTOL aircraft can have limited yaw authority, and their battery capacity means they do not like to hover. “What will be the reserves when you only have 30-min. battery life? And how much battery reserve do you use in an emergency?” she asks, citing questions to be answered.

NASA, the FAA and industry have developed a series of scenarios for the Grand Challenge. The first of these, Scenario 0, is qualification testing to document vehicle performance and demonstrate connectivity to the airspace operations management system. Vehicles can be manned or unmanned, but manned will go through a pilot safety review, and unmanned will need a flight termination system.

Scenario 1 is planning and executing a flight and demonstrating compliance with the planned trajectory. NASA will install a differential GPS and inertial measurement unit onboard to collect precise trajectory data for analysis. Scenario 2 is data exchange and coordination between the aircraft and AOM system to enable inflight replanning.



Kitty Hawk's autonomous Cora is in advanced stages of flight testing in California and New Zealand. Credit: Cora

Scenario 3 involves procedures at the vertiport, including approach and landing, turnaround operations, takeoff and departure, avoiding stationary obstacles and performing a balked landing. Scenario 4 is to characterize noise, measure its variability, demonstrate flight profiles that minimize noise and assess community response to the sound.

Scenario 5 will involve responding to the degradation or loss of aircraft communication, navigation and surveillance (CNS) and will demonstrate a robust, reliable and fault-tolerant CNS system that enables a safe landing in an emergency. Scenario 6 is air-to-air conflict management, involving assuring separation and avoiding collision with other UAM vehicles as well as interoperability with legacy aircraft and air traffic control.

The final test, Scenario 7, involves constrained conflict management, which will look at how the aircraft and AOM handle simultaneous issues—"such as an air-to-air conflict in an urban canyon," says Ginn, where there are multiple constraints on how the aircraft can respond to resolve the conflict. This will bring in detect-and-avoid and cooperative tactical collision-avoidance maneuvers.

An underlying theme of the Grand Challenge is the increasing automation and autonomy that is expected as the market matures. "Over time, the density of operations will increase. The more vehicles we have, the more automation we will need," says Ginn. "Talks are underway with the FAA Air Traffic Organization to understand what it is we need to automate for air traffic control."

Over successive events, the UAM Grand Challenge will move into more realistic airspace and airports. Ginn expects there will be a need for UAM test sites, similar to the FAA-approved unmanned aircraft system test sites now in existence. "And a lot of cities are leaning forward to offer the opportunity," she says.

Related Articles

NASA Rolls Out Urban Air Mobility 'Grand Challenge' Plan

NASA Readies For Urban Air Mobility 'Grand Challenge'

NASA Readies For Urban Air Mobility 'Grand Challenge'

NASA Plans For Urban Air Mobility 'Grand Challenge'

EASA And NASA Moves Emphasize Safety Requirements For Urban Air Taxis

Close