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NASA Testbed Aimed At Safe Airspace Integration Of UAVs

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Credit: John Croft

NASA Langley Research Center is now open for business as a third-party evaluation facility for command-and-control technologies for safing unmanned and light aircraft. Officials see the capability as a necessary commodity in the unmanned aircraft sector, where sense-and-avoid (SAA) safeguards will be needed to meet a 2015 congressional deadline for integrating UAVs into civil airspace.

“Our job was to get the capability developed that we knew the community would need,” says Andy Lacher, UAS research strategist for the Mitre Corp., a partner with NASA in developing and offering the simulation-to-flight testbed.

Lacher and Frank Jones, Langley's associate director of research services, provided a close-up view of the capabilities to Aviation Week on Aug. 15.

Three years in development, Langley's sim-to-flight capability allows researchers or companies to first run SAA algorithms with a test-verified dynamic simulation developed by Mitre, followed by flight testing in Langley's UAV surrogate—a highly modified Cirrus SR22 with VHF links to a simulated ground station. NASA is also installing a Globalstar satellite phone system in the SR22 for over-the-horizon testing.

The simulation and the Cirrus can host a variety of surveillance technologies, including automatic dependent surveillance-broadcast (ADS-B), ADS-rebroadcast and traffic information services (TIS-B). Jones says the testbed can also accommodate radar sensors. He notes that “if it can't work with ADS-B, it's unlikely it can work with other surveillance technologies.”

The flight-test portion is critical due to the inherent limitations of simulations. “We added uncertainty in the simulation by varying some parameters, but we will never match the uncertainty of real life,” says Lacher.

The dynamic environment was obvious during a 1.5-hr. observation flight with Langley chief pilot Rick Yasky in the left seat of the Cirrus and engineer Josh Carbonneau operating the flight-control computers from the right rear seat. Modifications to the Cirrus include the general purpose computer in the back seat, a bolt-on autothrottle that drives the Cirrus's single power lever, and a flight-test multifunction display that shifts ADS-B-out surveillance altitude of intruder aircraft down by 2,000 ft. The bias allowed the Cirrus and a NASA Cessna 206 intruder aircraft to safely demonstrate three SAA algorithms with ample vertical separation. Scenarios included one aircraft overtaking the other; head-on approaches; and orthogonal encounters, some with the intruder aircraft turning in toward the Cirrus. The SAA system automatically takes over aircraft pitch and roll through the autopilot and speed through the autothrottle.

Setting up the encounters was an exercise in aerial ballet, with Yasky and the 206 pilot coordinating waypoint arrivals and turns to position the aircraft where the SAA algorithms could be activated to generate the required data.

Unlike traffic-alert and collision-avoidance systems, which give pilots a vertical speed command to avoid other aircraft, the SAA algorithms allow the aircraft to alter its flightpath in roll control, vertical speed and airspeed. The flexibility was noteworthy as the algorithm commanded full throttle early in an encounter in an attempt to keep a safe distance from the intruder while maintaining the original flightpath.

Yasky and the team recently completed a multiyear cooperative automatic SAA demonstration project with Mitre, the University of North Dakota (UND) and Draper Laboratory, showcasing NASA and Mitre's simulation and flight-testing capabilities while generating data for the FAA, industry and military. Overall, more than 380 encounters were completed with the three algorithms, one each from Mitre, UND and Draper, along with “millions” of encounter simulations.

Lacher says one key finding is that a 2-nm, 500-ft. “protection puck” around the aircraft is feasible and that ADS-B is a good surveillance source, though it is “critically important” for algorithms to be robust with respect to losing sensor inputs. “When we had a gap in intruder information, we found that some algorithms worked reasonably well, depending on the length of the gap.” He also notes that small differences in initial conditions can “drastically change” the direction that the aircraft automatically turns, and there should be “damping” to keep the solution from flip-flopping.

Along with “mature discussions” with the FAA for using the sim-to-flight option for testing its next-generation airborne collision avoidance system for UAVs (ACAS-Xu), Jones is also in talks with the U.S. Air Force regarding testing for its UAV applications. NASA does not plan to spin off the venture into a separate business, but will work with companies or other government agencies via Space Act Agreements, contracts through Mitre or other means.