Link Margin

NASA, Rockwell Collins prove out high capacity UAS data link

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NASA and Rockwell Collins are nearing completion of an unmanned aircraft system (UAS) data link waveform and radios that will allow a single ground station to handle command-and-control uplink and telemetry downlink to as many as 20 aircraft.

A NASA Lockheed S-3 Viking and a University of Iowa Beechcraft Bonanza, both equipped with radios built by Rockwell Collins, participated in Phase 2 testing here last month. The aircraft were able to simultaneously send and receive command-and-control data via L-band and C-band satellite frequencies from a cell tower, at a rate of 20 Hz, as well as to automatically switch between towers as the aircraft moved from one test tower to another. The work, targeted at more complex unmanned aircraft systems (UAS) that fly beyond line of sight, is supporting FAA efforts to integrate civil UAS into the national airspace system.

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A NASA S-3 Viking and University of Iowa Bonanza acted as surrogate unmanned aircraft to stress-test a new command-and-control data link on June 25 in Cedar Rapids.

Jim Griner, NASA's communications project engineer on the program, says preliminary data from the test showed that both aircraft maintained simultaneous communications with the same tower during the test, with performance characterized by signal quality, bit error rate and other factors. Tests last year with Rockwell Collins's first-generation radio proved the waveform worked in the L- and C-bands between one aircraft and one ground station. NASA had earlier conducted "channel sounding tests" in nine geographical environments, including mountainous and oceanic areas, to determine any effects on the unencrypted link. The FAA has not yet settled on operating procedures for UAS, but may decide to use the C-band as a hot backup for the L-band data link.

NASA's vision for the control link for such aircraft is similar to a cell phone network, which connects multiple users to a single ground station and transitions them seamlessly to adjacent ground stations as they travel through service areas.

UAS today generally use a one-to-one control link with a unique frequency between the aircraft and the pilot in the ground station; that model could be problematic in terms of frequency congestion and possible link loss as the expected number of domestic UAS operations climbs. Studies by the Radio Technical Commission for Aeronautics (RTCA) predict an average of 10 unmanned aircraft operating within a 70-nm radius of a ground station, a number NASA doubled for its data link design to handle worst-case situations. The 70-nm radius service volume allows for reuse of allotted L- and C-band frequencies by adjacent ground stations. The allotment, granted by the World Radiocommunication Conference in 2012, yields a few hundred frequencies and a 7-kbps uplink rate and 14-300 kbps downlink rate, with options including weather radar and live video driving higher downlink rates. Reuse of frequencies requires sufficient distance for the curvature of the Earth to isolate aircraft using the same frequency.

When complete, the waveform is meant to be the backbone for a new type of low-cost radio design that the FAA will publish in 2017 as a technical standard order (TSO), a minimum performance standard that allows manufacturers to build the equipment. The ground portion of the network will transmit command-and-control messages of varying sizes and speeds to the UAS and receive telemetry back from the aircraft.

The waveform design uses time-division duplexing to uplink 20-Hz command-and-control data serially to as many as 20 aircraft (a bandwidth that allows for hand-flying each aircraft if necessary) as well as a frequency-division multiple-access downlink that is scalable to handle demands ranging from basic aircraft performance telemetry to compressed video from onboard cameras, says John Moore, Rockwell Collins's principal investigator for the project. Moore says pilots can use video for safety purposes, including reading runway signage or monitoring the aircraft for ice. Both uplink and downlink include a required VHF voice link to allow the pilot and air traffic controllers to converse.

Rockwell Collins is providing the prototype radios, now in the second generation, as well as engineering support to develop the waveforms, which NASA says will be nonproprietary and released "as a public resource" when completed. Both test aircraft were equipped with L-band blade antennas and C-band flat disc antennas for the trials, which will continue at NASA Glenn Research Center in Cleveland this summer.

NASA had originally planned to finish the work in October, but has added two additional "spirals" over the next two years to continue verification and validation work on the waveform for RTCA as it evolves minimum operational performance standards for the data link by 2016.