Soldier Armed

Ground-Based Sense and Avoid System

By Scott R. Gourley

Unmanned aircraft systems (UAS) have played a critical role on the battlefield over the last 13 years of combat. Now that U.S. Army elements and their supporting aircraft systems are returning to continental U.S. bases, the challenge is how to continue operating and training with these systems in the national airspace.

According to Viva Kelley, product director for Unmanned Systems Aircraft Integration Concepts (USAIC) in the office of Project Manager Unmanned Aircraft Systems (PM UAS), Federal Aviation Administration (FAA) regulations require that systems flying in the national airspace be able to see and avoid other aircraft.

"If you don't have somebody sitting in the cockpit of the airplane, it's difficult to [see and avoid other aircraft] right now," she said, "so we currently use things like chase planes. That means you're chasing an unmanned aircraft system with a Cessna or an Apache or something like that, and the chase plane is performing the 'I can see; I'll tell you what to do to avoid' role."

Ground observers can also be used for UAS operations taking place in "low and slow" environments, but "those were really Band-Aids to get us through not being able to meet the FAA regulation," Kelley said.

Making It Happen

The challenge of UAS operations in the national airspace has stimulated broad interest in various sense-and-avoid technologies across the military and at the FAA. The U.S. Air Force took an early lead in the technology explorations, Kelley said.

"The problem … is that the Air Force flies really large unmanned systems, like Global Hawk," she said, "and what they can put on an aircraft like that is really very different from what you can put on a Shadow or a Raven."

There were also operational differences, in that Air Force UAS platforms often traverse ocean stretches at very high altitudes, while the Army frequently operates its systems in congested, low-altitude airspace that can be replete with helicopters or even private civilian aircraft. "We fly lower and we really just need to get over into restricted airspace or into military operating areas," she said. "We don't need to fly across the country all the time."

The Army's solution is the Ground-Based Sense and Avoid (GBSAA) system. "The Army started looking at putting sensors on the ground that would give you better fidelity than what we could put on an Army aircraft," Kelley explained. "In addition, the design puts the processing power and things that take up size, weight and space on the ground as well." While the Air Force remains in charge of Airborne Sense and Avoid efforts, the Army became the DoD lead for GBSAA.

How It Works

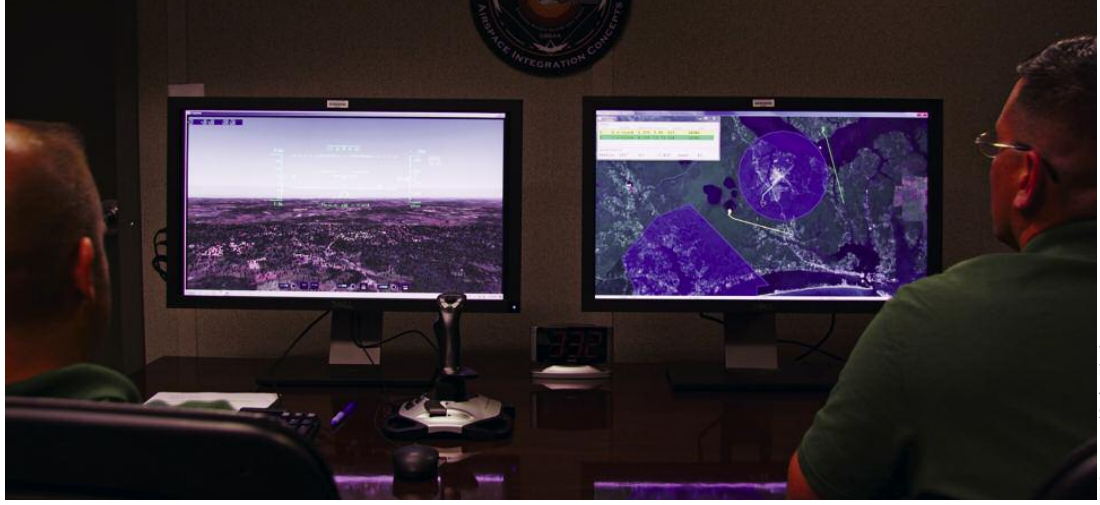
The GBSAA design uses relatively small 3-D radars that can be geographically positioned to provide the best view of the airspace.

"Because we operate in lower airspace and sometimes in congested airspace, we need to see the guys that are not transponding or that are not talking to air traffic control," Kelley said. "You can take off in your Cessna and fly from anywhere in the United States to anywhere else in the United States without telling anybody. You don't have to turn on your beacon. And the only way to see that is if you have eyeballs on it or if you have a radar that can pick up those things."

Kelley said the GBSAA system algorithms are being done by the Massachusetts Institute of Technology (MIT) and are derived from the algorithms for the FAA's Traffic Collision Avoidance System (TCAS). MIT was also involved in the TCAS algorithm development.

A lightweight surveillance radar that provides 360 degree, three-dimensional scanning capabilities is part of the Ground-Based Sense and Avoid (GBSAA) test bed at Dugway Proving Ground, Utah.

U.S. Army



During a demonstration at Dugway, computer screens of an aircraft operator, left, and a GBSAA operator display the flight of an unmanned aircraft system.

U.S. Army/Sofia Bledsoe

"I would characterize GBSAA and TCAS as second cousins," she said. "The TCAS algorithms are generated for manned aircraft, and they assume that there is someone still in the aircraft [who is] seeing and avoiding. The GBSAA algorithms were generated from that, but they have much greater fidelity because we don't have a man in the cockpit, so they are subsidized with other things. But one of the really good things about being second cousins is that it means GBSAA algorithms are compatible with TCAS aircraft."

With the government service as lead systems integrator, other contractor support includes software certification activities by Kutta Technologies, Inc.

Past, Present and Future

The first UAS flight conducted within the national airspace utilizing an FAA-approved GBSAA prototype system took place on April 27, 2011, at El Mirage, California. Follow-on efforts involved the establishment of a GBSAA test bed at the PM UAS Rapid Integration Acceptance Center (RIAC) at Dugway Proving Ground, Utah. Following completion of software integration at MIT, the GBSAA program will begin system testing at RIAC in the first quarter of fiscal year (FY) 2015 and progress toward system certification.

Currently, the Army has funded five Gray Eagle sites for GBSAA: Fort Hood, Texas; Fort Riley, Kansas; Fort Campbell, Kentucky; Fort Stewart, Georgia; and Fort Drum, New York. Fort Hood and Fort Riley are both slated for first unit equipped milestones in FY 2015.

Surveys for system installation and radar placement were completed at all five locations in May. Installation design for radar, tower and communications is complete at Fort Hood; tower construction and radar installation will begin at Fort Hood in the fourth quarter of FY 2014; and three lightweight surveillance target acquisition radar systems have been delivered and placed in storage for use at Fort Hood and Fort Riley.

The GBSAA design features a four-block "incremental" approach. The initial configuration, Block 0, slated for fielding in FY 2015, will present a contractor GBSAA operator (GBO) with air traffic information and require the GBO to determine recommended maneuvers based on air traffic control or pilot experience. For Block 1, planned for fielding in FY 2016, the system will present the GBO with traffic information and recommended maneuvers as calculated by internal algorithms.

The system architecture envisions follow-on Block 2 and Block 3 designs, although both are currently unfunded requirements. The Block 2 design, projected for FY 2017, eliminates the GBO requirement and provides recommended maneuvers on a separate display located in the ground control station. Block 3, with possible fielding in FY 2022, envisions the recommended maneuvers integrated on the main display in the ground control station.

"Ultimately, we want to be in the UAS ground control station with just the soldier operator doing it," said Mary Ottman, deputy product director at USAIC. "But before we get there, we've got to make sure that we do not increase that soldier's workload."

"We're working the human factors piece right now," she added. "We're making sure we've got pilots, manned operators and unmanned operators involved, and we're looking at it now so that when we get there, it's not a huge jump to a new display."

Other long-term goals include establishing a link with the other services between both Airborne Sense and Avoid and GBSAA designs.

Getting to the Good Part

In addition to the obvious benefits for military training and testing, the future expanded ability to operate UAS in the national airspace will provide significant benefits in National Guard disaster-response operations.

Although the first five Army sites are "hardwired" in place, Kelley said her office has begun to look at a "deployable" system design that could be used in those response operations.

"There is a concept," she said, "and we are currently working unofficially with the Air National Guard in Syracuse [New York] to try to come up with a mobile solution. That has not been approved yet, but we are working with them to come up with something. They are going to use our Ground-Based Sense and Avoid system and then use their scenarios to start testing out a mobile solution."

Both Kelley and Ottman emphasized that the government's role as lead systems integrator on the GBSAA program is keeping down costs, ensuring government data rights and keeping the program on schedule commensurate with the available technology.

"The problem is that everyone wants this capability so fast," Kelley said. "So you've got these little [ground-based designs] sprouting up that get a little bit of publicity. But we've taken our time. We're certifying the software and making sure the technology is mature."