DARPA’s Aerial Reconfigurable Embedded System (ARES) program aims to develop and demonstrate a modular transportation system built around a vertical takeoff and landing (VTOL) flight module operated as an unmanned aerial vehicle (UAV). The flight module would carry one of several different types of detachable mission modules, each designed for a specific purpose, such as Intelligence, Surveillance and Reconnaissance (ISR) (top left), casualty evacuation (top right) and cargo resupply (top center and bottom). The program seeks to provide flexible, terrain-independent transportation that avoids ground-based threats, in turn supporting expedited, cost-effective operations and improving the likelihood of mission success.
Some of the most exciting wireless technology applications are currently being implemented aboard unmanned aerial vehicles (UAVs). Where wireless design has traditionally been labeled a niche field, new military applications are now relying on wireless components to take technology where it has never gone before. However, with new demands comes many challenges, as wireless systems are called upon to provide greater versatility, while also offering unparalleled ruggedness and precision. North Atlantic Industries (NAI) provides such key components for the aerial reconfigurable embedded system (ARES), an unmanned demonstrator drone being developed by DARPA. ARES will demonstrate how the military can overcome the dangers of rugged terrain, improvised explosive devices (IEDs), and ambushes.

“Many missions require dedicated vertical take-off and landing (VTOL) assets, but most ground units don’t have their own helicopters,” says Ashish Bagai, DARPA program manager. “ARES would make organic and versatile VTOL capability available to many more individual units. Our goal is to provide flexible, terrain-independent transportation that avoids ground-based threats, in turn supporting expedited, cost-effective operations and improving the likelihood of mission success.”

**Flight System Adaptability**

The navigational system for ARES’ VTOL demonstrator, chosen by Lockheed Martin, is made up of a vehicle management computer (VMC) and an actuator interface unit (AIU). The VTOL flight module is capable of transporting a variety of payloads with its own power system, fuel, digital flight controls, and remote command-and-control interfaces.

The UAV will be able to hover and land in compact configuration with quick air-speed changes through twin tilting ducted fans. The VTOL also decreases the size of landing zones, giving the aircraft a finesse over rugged terrain.

The VTOL can also travel from home base to field operations for delivery and retrieval of detachable mission modules for cargo pickup and delivery, casualty extraction, or airborne intelligence, surveillance, and reconnaissance capabilities. The load capability of the VTOL flight module is up to 3,000 pounds, which is more than 40 percent of the take-off gross weight of the aircraft.

What is even more novel is the ability of units to direct the drones via mobile phone apps or tablets. DARPA plans to develop these unmanned vehicles into the creation of optionally manned and unmanned systems for semi-autonomous flight.
Versatile Chassis

The NAI SIU6 sensor interface unit is a configurable rugged system/subsystem designed to support a multitude of mil/aero applications. Photo Credit: NAI

This entire system is fulfilled through the utilization of NAI’s commercial-off-the-shelf (COTS) SIU6 chassis. The SIU6’s are built on NAI’s custom-on-standard (COSA) 6U VME boards, which are personalized from a ‘mix-and-match’ variety of standard processing and high density I/O interface function modules. Multiple SIU6’s act as the VMC and A1U for redundant flight control and status monitoring. This architecture meets the tight SWaP envelope, incorporating up to 300 pins of I/O and a QuadraX dual port gigabit Ethernet interface. The SIU6 versatility provides DARPA’s ARES program with the processing and I/O control necessary for radical drones.

From a design perspective, the creators of the SIU6 were concerned with firmware. An entirely new system was needed, and with NAI COTS-based COSA architecture, the team didn’t have to start from square one because the foundation was already developed.

“NAI created PID loop to control flight surfaces by integrating software LVDT and analog functionality,” explains Lino Massafra, VP Sales and Marketing at NAI. “NAI’s DSP and FPGA-based architecture allowed these control loops to be implemented directly on each board, meeting tight latency requirements.”

Lockheed’s decision to partner with NAI for DARPA’s demonstrator drones was due to NAI’s COSA capabilities. Chief among them is “the ability to configure boards with up to six module slots and 40+ functions without having to spend man-years developing a processing and I/O system from the ground-up,” says Massafra.

An Ongoing Quest

The ARES program is in its third and final phase, but there are still challenges that DARPA will face.

“Transporting and resupplying troops in rugged, austere terrain has become a major challenge, especially as the U.S. military shifts to using smaller and more distributed combat units,” says Kevin Renshaw, Lockheed Martin Skunk Works senior principal engineer for ARES. “ARES seeks to demonstrate several technologies to achieve an operational VTOL system with a more compact footprint than conventional helicopters, but with higher cruise speeds.”

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