

Swarming UAVs Demand the Smallest Mil/Aero Connectors

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By Ann R. Thyft

In a swarm of robots or a natural swarm of ants or bees, all units communicate with each other and act collectively. Swarm robotics looks to develop primarily software technologies for controlling simple autonomous hardware, both unmanned aerial vehicles (UAVs) and unmanned ground vehicles (UGVs). Although military-sponsored research on swarm technology is several years old, it's only recently come out from under wraps.

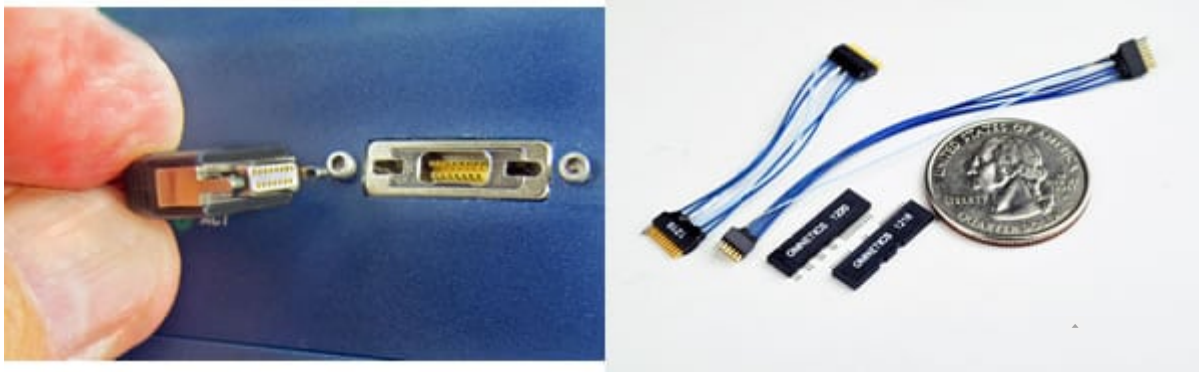
"On the horizon is the future of small UAVs operating in swarms," said Russ Graves, business development manager for [TE Connectivity](#). "This would allow a large cluster of individual UAVs to communicate and function as a team." This approach — a single distributed system of many individual units that adapt to each other and the environment — requires somewhat different hardware and software from unmanned vehicles that are remotely controlled.



TE Connectivity Nano CeeLok FAS-T connector and TE Connectivity Microdot and Nanonics connector family.

Like all [small UAVs](#), also called unmanned aircraft systems (UAS), these tactical swarming drones are highly constrained for size, weight, and power (SWaP). Swarming UAVs need communications hardware and software to enable team behavior, as well as sophisticated obstacle-avoidance and target-following capability from sensors and additional electronics payloads, but they generally have less need for storage. Inexpensive components, including connectors, are also in demand.

“One of the main reasons for using the small, hand-launched military UAVs is surveillance, especially for military operations in urban terrain (MOUT),” said Bob Stanton, director of [Omnetics Connector Corporation](#). “They can take pictures and help soldiers observe and understand the information in those pictures such as the terrain itself, a battlefield, or a situation.”



Omnetics latching Nano-D connector and Omnetics nano-sized strip connectors.

Several types of swarming unmanned vehicles, primarily UAVs, have been under investigation by ongoing armed services programs. For example, the Department of Defense’s Strategic Capabilities Office, partnering with Naval Air Systems Command, [has successfully demonstrated](#) a swarm of 100-plus Perdix micro-drones. The DoD’s concept is to allow large swarms of smaller, less expensive, and more expendable units to perform missions that previously required larger, more expensive drones, and give ground troops the ability to make better decisions faster.

Originally designed by MIT engineering students, these micro-drones have displayed advanced swarm behaviors such as adaptive formation flying, collective decision-making, and self-healing. They are targeted for use in intelligence, surveillance, and reconnaissance (ISR). After several design generations, components of the propeller-driven, fixed-wing Perdix drone are now entirely commercial.

Low-Cost Unmanned aerial vehicle Swarming Technology ([LOCUST](#)) is a program of the US Navy Office of Naval Research to develop a prototype tube-launched UAV. Its goal is for sailors and marines to launch multiple, swarming autonomous UAVs that can overwhelm an adversary. The small footprint of both drone and tube launchers enables launching a swarm from ships, other unmanned platforms, tactical vehicles, and aircraft. The UAVs can be used in either offensive or defensive missions, and reduces the number of operators required.

Designed to handle fairly large launch accelerations, [Raytheon’s low-cost expendable Coyote](#) UAS was developed for the military and operated under the LOCUST program. It can fly up to an hour and payloads are easily interchangeable. The Coyote has completed flight tests for several US government agencies and demonstration programs. Last year, six Coyote systems successfully navigated Hurricane Maria’s winds of greater than 100 miles per hour, gathering and transmitting storm information for the National Oceanographic and Atmospheric Administration’s National Hurricane Center.

DARPA’s OFFensive Swarm-Enabled Tactics ([OFFSET](#)) program aims to give small-unit forces in fast-changing, diverse urban environments the technology to simultaneously control up to 250 UAVs and UGVs, and quickly develop and share swarm tactics. The program, [launched in 2016](#), leverages the existing use of unmanned vehicles for missions like clearing buildings and aerial reconnaissance, to make troops even more effective.



This UAV, a typical example of fixed-wing designs for swarms, was used in a 2017 DARPA Service Academies Swarm Challenge Live-Fly competition at Camp Roberts, California. In these challenges, Army, Navy, and Air Force academy teams compete to develop new swarm tactics, both offensive and defensive. These tactics will be potentially utilized by several different Department of Defense programs.

(Source: DARPA)

To fill this need, OFFSET aims at developing technologies to quickly generate swarm tactics for these large teams of robots, evaluate those tactics for effectiveness, and integrate the best ones into field operations. The program will create a development ecosystem and a supporting open-systems architecture that includes a human-swarm interface so users can monitor and direct hundreds of unmanned robots simultaneously in real time; a real-time networked virtual environment that supports a swarm tactics game to evolve and evaluate swarm tactics; and a limited-access swarm tactics exchange to help create a community for developing the most effective tactics. Frequent live experiments with a variety of UAV and UGV platforms test the swarm architecture and tactics in the real world.

Both fixed-wing and multi-rotor drones are under consideration for several military programs, and both are included in DARPA's [Service Academies Swarm Challenge](#) for developing new swarm tactics, both offensive and defensive. These tactics will be potentially utilized by OFFSET and other DoD programs. OFFSET has its own version: DARPA calls them "sprints." Another initiative, [announced in March](#), focuses on improving swarm autonomy and will utilize a team of 50 air and ground robots.





This UAV is a typical example of rotor-wing designs for swarms and was used in a 2017 DARPA Service Academies Swarm Challenge Live-Fly competition at Camp Roberts, California.

(Source: DARPA)

Most connectors used in the small, hand-launched military UAVs typical of swarming drones are very small, lightweight, low-profile, or nanominiature connectors, such as Omnetics nano-sized strip connectors for board-to-board connections; D-shaped, often with hybridization, such as Omnetics' latching micro-D and nano-D connectors for cable connections to mating connectors and panel equipment; or micro-circulars, such as Omnetics' Micro or Nano-360 for multiple uses. "On these small UAVs, both connectors and cabling to the camera are simple," said Stanton. "Cabling is usually very short and has to fit into and conform to different spaces."

If the camera is taking high-speed video, it can benefit from hybrid connectors that combine power plus signal/ground in one connector, and those signals can be either miniature coax or differential for digital signals, said Stanton. Like all small UAVs, platforms aimed at swarming can take advantage of hybrid connectors that combine power-and-coax or power-and-signal in the same connector and cabling system. Newer hybrid connector designs that combine all three in one will especially benefit these small UAVs.

"There's also the potential of noise from other electronics, so cables need an EMI shield jacket system," said Stanton. "Big UAVs have a big metal shell, so they can be shielded well. But small hand-launched UAVs are running out of room and weight, so shielding management and control should be focused on the cable and the connector. Shielding control and protection must be built into the connector or built through the connector and shell so none of that noise gets in or out."

Swarming UAVs will require software for artificial intelligence, small embedded computing modules, and commercial off-the-shelf (COTS) parts since these UAVs are considered expendable, and small form-factor interconnects for size reduction, said Graves. "In particular, for small form factors and to address some

the data transmission needs, I would recommend our products under the brand names Microdot and Nanonics,” he said. “I would also recommend the Nano CeeLok Fas-T and the Wildcat Micro.”

Ann R. Thryft has been writing about manufacturing- and electronics-related technologies for 30 years, covering interconnect, robotics, machine vision, embedded devices, manufacturing materials and processes, and all kinds of datacom and telecom. She’s written for EE Times, Design News, COTS Journal, RTC Magazine, EDN, Test & Measurement World, and Nikkei Electronics Asia.

