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Satellites at the Beck and Call of Ground Troops

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Military leaders for years have been asking for a capability that would allow ground units to commandeer satellites to obtain imagery of their surroundings. To realize that vision, the Defense Department has developed a system that may one day end up in the hands of troops.

The technology, a new hyperspectral imager, is orbiting Earth aboard an experimental spacecraft called Tactical Satellite-3. The Advanced Responsive Tactically Effective Military Imaging Spectrometer, or ARTEMIS for short, consists of a trio of components: a telescope, a spectrometer and an on-board digital signal processor.

Using a portable device, a tactical commander would be able to communicate with the satellite directly and "call up" a mission for ARTEMIS to look at a particular location. The next time the satellite passed over the area, the sensor would take the images and send him the requested targeting data within 10 minutes.

"That's actionable information that he can use," says Ed Gussin, program manager of ARTEMIS at Raytheon Co. The company developed the $15 million sensor in 15 months for the Air Force Research Laboratory as part of the Defense Department's operationally responsive space effort. Under the initiative, small satellites carrying payloads designed for specific missions would be launched within days of Pentagon requests — a paradigm that is still considered quite ambitious for an industry that normally launches spacecraft in a period spanning years. TacSat-3 is part of a series of spacecraft that are testing and evaluating technologies to validate the concept.

Aboard TacSat-3, ARTEMIS is one such technology. "It can see what other sensors can't," explains Peter Wegner, director of the Pentagon's operationally responsive space office. Hyperspectral data provides a large step forward in multispectral imaging, which typically captures several different frequencies within the visible and infrared spectrum, Gussin says. With finer spatial resolution and better signal-to-noise ratio, hyperspectral sensors can collect significantly more information.

In ARTEMIS's case, the sensor peers at the ground and gathers more than 400 different spectra for each pixel. The resulting data is so accurate that the sensor can determine the chemical composition of materials. For example, multispectral imagers might snap a picture of a tree with a dark green shadow beneath it. A hyperspectral sensor aimed at the same location could discern a tank hiding under the foliage.

"Both of them would look green to your eyes, but by having the 400 elements of the spectrum, it allows you to distinguish things like the green from a tree versus the green from a tank," says Gussin. "You can look at the chemical composition of the paint on the tank as opposed to the chemical composition of the leaves of the tree."

Such precision can help troops determine whether dirt along a highway has been disturbed — a possible telltale sign of a recently buried roadside bomb.

Last month, the team of AFRL scientists responsible for testing and calibrating TacSat-3 and its payloads was impressed by the initial imagery and data received from ARTEMIS.

"We're extremely happy with the performance we're seeing on orbit so far," says Thomas Cooley, the TacSat-3 program manager at AFRL's space vehicles directorate at Kirtland Air Force Base, N.M.

The team will work with the Army Space and Missile Command Battle Lab to integrate the satellite into a series of experiments and exercises. Soldiers will communicate with the satellite from a tactical ground station that houses an antenna, a basic modem and radio components that permit transmissions on a range of frequencies.

Scientists from AFRL, too, will be collecting data to understand the spectral diversity of background and atmospheric conditions, Cooley says. "We're all about trying to mature the technologies so that ultimately a decision can be made as to whether this capability, given its cost and complexity against other capabilities, is

something that the Department of Defense wants to have in its inventory," he says.

Once the Army completes its testing next spring, officials in the Pentagon's operationally responsive space office will assess the technology and determine whether to transition it to an operational system. Gussin says that Raytheon could develop a constellation of satellites that would either be kept on the ground for quick-response launching, or be launched ahead of time to have them on orbit and ready for tasking.

The satellites eventually could become a cheaper alternative to flying Predator unmanned aerial vehicles and other intelligence, surveillance and reconnaissance systems.

"In some cases, it can provide a more economical way to look at the battlefield, because once you get it up there, it just stays," Gussin says. "You don't have to keep flying things up there and navigating them to that location."

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