DefenseNews

Reprint from
June 15, 2009
Issue of
DefenseNews

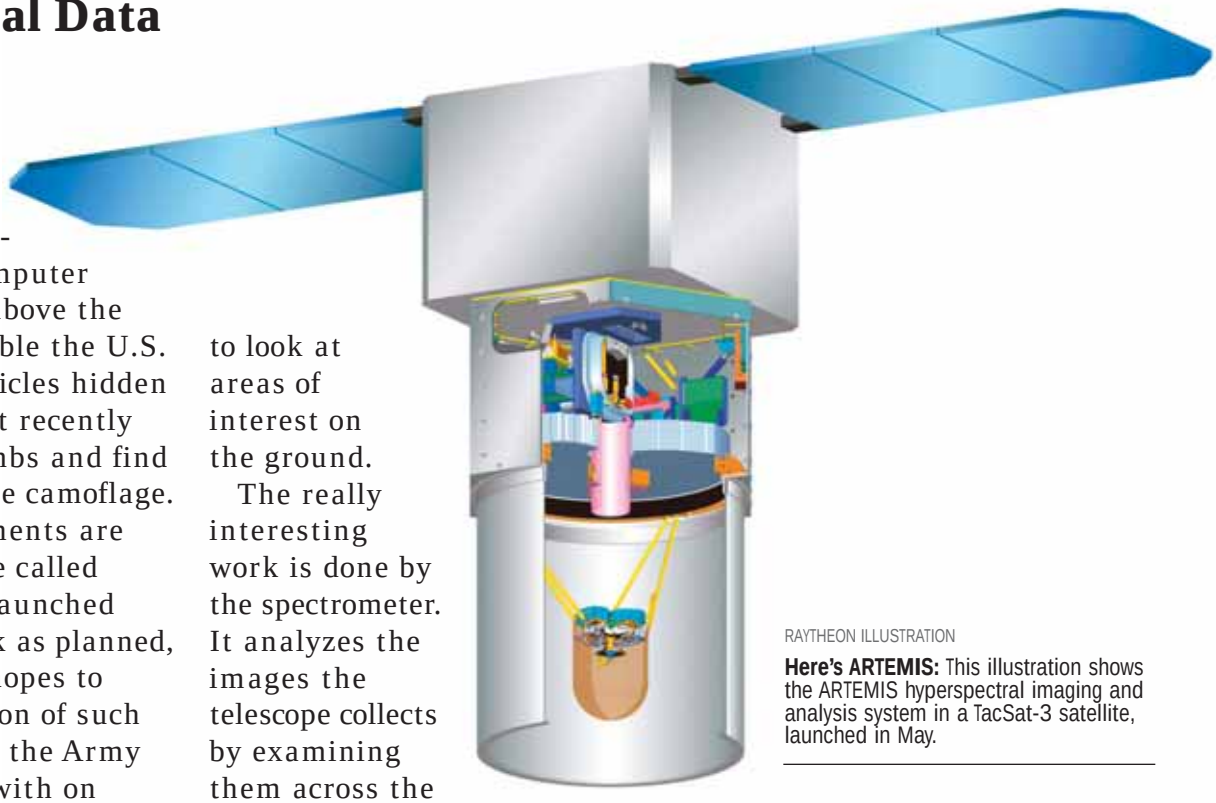
Vol. 24, No. 24 June 15, 2009 A GANNETT NEWSPAPER $4.50

TechWatch

Putting Image Analysis In Space

Satellite Sees, Then Interprets Hyperspectral Data

By WILLIAM MATTHEWS



RAYTHEON ILLUSTRATION

Here's ARTEMIS: This illustration shows the ARTEMIS hyperspectral imaging and analysis system in a TacSat-3 satellite, launched in May.

A telescope, an imaging spectrometer and a computer orbiting 260 miles above the earth may soon enable the U.S. military to spot vehicles hidden under foliage, detect recently buried roadside bombs and find enemy troops despite camoflage.

The three instruments are housed in a satellite called TacSat-3 that was launched May 19. If they work as planned, the U.S. Air Force hopes to launch a constellation of such satellites to provide the Army and Marine Corps with on demand hyperspectral reconaissance from space.

No other military has anything like it.

The instruments are collectively dubbed ARTEMIS, or Advanced Responsive Tactically Effective Military Imaging Spectrometer.

The telescope is relatively unsophisticated, as satellite instruments go. Its job is simply to look at areas of interest on the ground.

The really interesting work is done by the spectrometer. It analyzes the images the telescope collects by examining them across the electromagnetic spectrum. Visible light — what humans can see — is just a small portion of the electromagnetic spectrum, which extends from very long waves such as radio waves at one end to very short X-rays and gamma rays at the other extreme.

The ARTEMIS spectrometer can detect about six times more of the electromagnetic spectrum than the human eye can.

The spectrometer converts the electromagnetic images it receives from the telescope into graphs. Different trees, for example, produce different-shaped graphs. Grass produces a distinctive graph, and dried grass produces yet another. The graph produced by concrete is different from that of granite,

which is different from the one created by asphalt.

"It's like a signature," said Edward Gussin, ARTEMIS program manager at Raytheon, the company that built the sensor.

And each substance has a different byperspectral signature and can be identified by it.

ARTEMIS is sensitive enough to detect both the green foliage of trees and the very different green paint of a tank hidden underneath, Gussin said.

The third part of ARTEMIS, the computer, contains a library of hyperspectral signatures. As the spectrometer creates them, the computer compares them with signatures in its library to identify what the telescope is seeing.

That analysis is done on the satellite to avoid transmitting massive amounts of data to be analyzed on the ground, Gussin said.

With the analysis done, the satellites transmits a description of what ARTEMIS has spotted and coordinates indicating its location. The message is brief enough to be received by a hand- held or laptop computer.

The whole process — from the time a commander tells the satellite where to look till he receives the target description and coordinates — takes about 10 minutes, according to the Air Force Research Laboratory, which oversees the TacSat-3 program.

Besides seeing tanks or vehicles hidden under foliage, ARTEMIS can discern freshly dug earth from undisturbed earth, Gussin said, a capability that is expected to help ground troops discover where roadside bombs have been buried. And the sensor can spot enemy locations and troops on the move.

"To get this type of technology in space has been a long-term goal," said Thomas Cooley, TacSat-3 program manager at the Air Force Research Lab at Kirtland Air Force Base, N.M. "The Army specified five years ago their desire for an imaging spectrometer in space."

Why a satellite and not on an aircraft or an unmanned aerial vehicle?

"A couple of reasons," Cooley said.

Planes and UAVs can be shot down with anti-aircraft weapons including missiles; satellites, for the most part, cannot. More importantly, space offers "a much more synoptic view from the highest of vantage points." From space you can see a lot more.

If TacSat-3 performs as hoped, the Air Force hopes to follow up by building a constellation of spectral imaging satellites.

With multiple satellites — just how many are needed is part of what TacSat-3 is suposed to indicate — ground commanders would be able to order reconnaissance images and have a satellite overhead reasonably soon to take them.

With a constellation, "we can be anywhere in the world almost simultaneously," Gussin said. Each spacecraft circles the earth in about 90 minutes, so with several of them aloft, "you can monitor North Korea and Afghanistan" more or less at the same time.

TacSat-3 is part of the Defense Department's Operationally Responsive Space program that aims to make space capabilities available more quickly to those in the military who need them.

A big part of that is making access to space faster and cheaper. So the Air Force gave Raytheon $15 million and a 15-month deadline to build ARTEMIS.

Building specialized instruments for space typically takes several years and can cost hundreds of millions of dollars, Gussin said.

TacSat-3 carries two other payloads in addition to ARTEMIS. The whole satellite cost about $65 million to build and $25 million to launch.

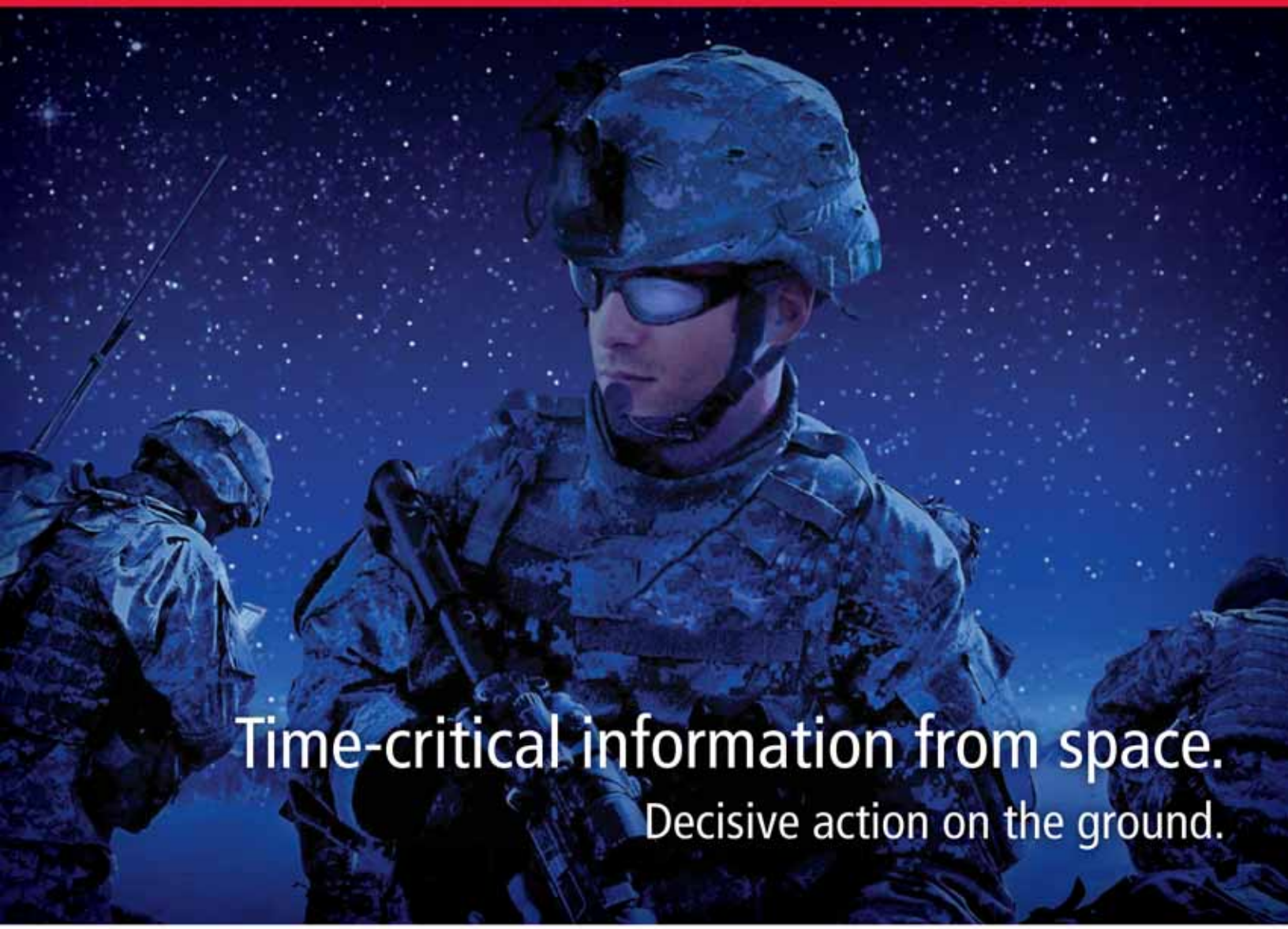
To keep ARTEMIS costs down, "quite a bit of it was off-the-shelf technology. We only had 15 months, so we did not develop a lot of custom stuff," Gussin said.

For instance, mirrors for the telescope were based on those that had already been developed for another program, he said. "So we had very high quality mirrors quickly."

The Air Force is happy with the results so far. "Raytheon did an excellent job" of building a low-cost imaging spectrometer in a short time, Cooley said. "The ability to do spectroscopy from space is a very powerful tool in identifying surface materials."

It's so new that the military doesn't yet know all of its potential uses. This summer the Air Force Research Lab will begin working with the Army to see just what ARTEMIS can do, Cooley said. "We will begin building a database on how it can be best used." ■

Responsive Space Solutions



As a global leader in developing and deploying innovative solutions for Responsive Space, Raytheon can provide timely wide-area support for theater-based operations, precise battlespace characterization, digital terrain maps and more. All to make sure field commanders have the precise knowledge they need to take decisive action.

www.raytheon.com

Raytheon

Customer Success Is Our Mission

Chris Harlambakis
Raytheon Company
Space and Airborne Systems
2000 E. El Segundo Blvd.
E04/E0/C110
El Segundo, California
90245 USA
310.647.4088
chris_harlambakis@raytheon.com

www.raytheon.com

Raytheon

Customer Success Is Our Mission