SDI Delta Launch

U.S. space launch capability revives

by Charles B. Stevens

At 11:08 a.m. on Sept. 5 the United States ended almost a year-long series of space rocket failures with the launch of a Delta from Cape Canaveral in Florida. The payload lofted into near-earth orbit, consisted of two top-secret satellites carrying elements for space-based detection and tracking of offensive nuclear missiles. A 26 Aries missile was launched from White Sands, New Mexico at 12:40 p.m. to provide a target.

In Washington, Lt. Col. Terry Monrad, a representative for President Reagan's Strategic Defense Initiative (SDI) missile defense program, reported that the apparently successful test was designated as a Significant Technical Milestone Experiment. The double-satellite configuration carried out tests for both detecting objects in space—such as warheads—and long-range detection of missiles in their vulnerable boost phase. Laser specialists have previously revealed that some "pop-up" directed-energy weapon systems only require "field" testing of target acquisition and tracking elements before they can be deployed.

The SDI Delta launch consisted of two satellites which were placed into orbits 255 miles above the Earth. According to a June SDI report to Congress: "The vehicles will be maneuvered relative to each other to obtain sensor, guidance and navigation data. The experiment is a multifaceted exoatmospheric experiment involving research into the area of vehicle dynamics, guidance and sensor sciences." In other words the test involved infrared tracking of one satellite by the other.

The *New York Times* quoted an administration official as reporting that the infrared sensors were also utilized to observe the "signature" of the Aries rocket, distinguishing between the infrared radiation from its cool rocket body and that from its hot engine flame.

If these reports are correct, the SDI has indeed demonstrated a major advance in infrared sensor technology. More specifically, the Sept. 5 test demonstrated sensors capable of operating over an extremely wide range of infrared wavelengths and environments—from cold satellites backgrounded by deep space, to hot rocket plumes. But the full scope and implications of the test are top secret.

Nevertheless, leading defense specialists report that the self-destruction of the two satellites, as planned, did not completely make sense. The Delta rocket alone costs $42 million and ordinary communications satellites cost hundreds of millions of dollars. Why didn't the program design provide for a longer period of utilization for further SDI tests and intelligence missions of opportunity? The apparently most rational explanation is that the United States did not wish for the Russians to have an opportunity to observe the tests. This has led some specialists to speculate that the test could have included elements for the sensor system of a pop-up boost phase interception system based on directed-energy weapons.

Some specialists speculate that the Sept. 5 test could have involved demonstration of the type of infrared detection technology needed for boost-phase interception. In particular, the test fits the configuration needed for stereo infrared detection in a dynamic pop-up mode. Stereo detection must involve the use of at least two satellites. A single satellite infrared detector is capable of seeing a missile, but cannot determine its actual location or range. Two satellites can.

Infrared detectors

Since World War II, infrared (IR) detectors and imaging have emerged as the most generally applied means of finding and tracking military targets. This ranges from the battlefield tactical missile to space. The reason is quite straightforward. Unlike radar, which must produce its own detection beam, passive IR—the most widely utilized type—systems detect infrared beams produced by the target itself.

Physically, IR is the electromagnetic, or, "radiant" heat given off by all matter, when that matter is at a temperature of 11,000° Celsius or less. That is, in the range of body temperatures of most objects on earth. The portion of the electromagnetic spectrum covered is from about a wavelength of one micrometer to one millimeter and therefore at much shorter wavelengths than radar. (A specific body temperature can be related to a "peak" wavelength.)

Because of these characteristics, IR provides in many cases a more compact and effective means of detecting targets than that of radar. With IR one can see at night and through the clouds and fog. One can even sometimes detect objects underground—especially hot ones.

The first IR satellites deployed by the United States were the MIDAS series launched in the early 1960s into near-earth polar orbits to provide early warning of Soviet missile, launches. As early as 1962, MIDAS 4 successfully detected and reported on the launch of a Titan missile within 90 seconds of liftoff.

By 1968 IR early-warning satellites were lofted into geosynchronous orbits 25,000 miles above the Earth. The early-warning IR detection systems were primarily designed to just detect missile launches. But they performed far better. The IR detectors were able to also provide some tracking data—that is, follow the missile over time. This greatly improved the U.S. overall capability to predict the probable target of the Russian ICBM. The capability also greatly enhanced U.S. observation of Soviet missile tests. And in fact, it was reported in 1975 that the Russians had used a high-power, ground-based laser to blind one of these four satellites.

IR in fact has been at the forefront of the so-called computer chip revolution. This is because the incident IR "light" is generally detected in the form of photoelectrons. That is, the IR is received onto a semiconductor which acts as a photodiode—the process of converting light into an electrical current. The IR-induced electric currents generate the image. The photodiode can either be directly connected or part of a larger integrated computer circuit. The photodiode is considered the fundamental unit of an IR detector; sometimes also called a pixel. The number of pixels—of the same quality—generally determines the resolving power of the detector.

Recent progress by the SDI can be judged by the fact that the most recently deployed TRW Block 647 EW satellites have IR detectors with 2,000 pixels. SDI Chief Scientist Dr. Gerold Yonas told a press briefing last spring that IR arrays with over 1 million pixels had been achieved, more than a 20-fold increase.

The fact that the detecting surface of an IR system can be part of an integrated circuit vastly improves its potential capabilities. Input signals can be scanned in virtually real time. This means that unwanted signals can be screened out, while the system simultaneously focuses on real targets. Vast improvements have been made recently in IR sensor discrimination and reaction time.

Boost-phase IR

In general, ballistic missiles in their boost phase make quite bright objects for infrared detection. But the precise tracking of hundreds—possibly thousands—of missile boosters over long ranges is a difficult task. This is especially true if the existing array of deployed satellites have been disabled by directed energy weapons. Pop-up detectors are therefore required for virtually any form of boost-phase interception. And unlike the geostationary early-warning satellites, the pop-up system must operate when the satellite is undergoing accelerations during launch and after.

A key technology for IR boost-phase sensors is that of stereo detection. This involves detecting a target missile by two separate satellites. When this is done, the missile velocity and location can be determined. The reason for this is as follows:

Ordinary radar is able to detect a target, and determine its velocity and location with a single beam. This is because the radar sends out a beamed pulse of microwaves which travel to the target and are reflected back onto the radar antenna. Since this back and forth takes place at the speed of light, measuring the time between transmission and reception gives the target range. A moving target will change the wavelength of the microwave beam—the Doppler shift—which means that measuring the wavelength change permits a determination of the target velocity.

In the case of passive IR, the detection signal only travels from the target to the satellite sensor—one way. Therefore, neither the travel time nor the Doppler shift can be easily measured. A single IR detector would therefore only measure the rate of angular displacement with respect to the surveillance satellite—that is, a line through the satellite and the missile. The solution to this is to utilize a second detection satellite. In this case, a separate line is determined, and by combining the data, a triangulation can be made which both gives the location and velocity of the missile. This would be then passed on to the interception system, such as a pop-up x-ray laser.

For boost-phase intercept, such missile detection and tracking must be carried out hundreds of times within a few minutes or less.

Pop-up missile defenses are based on the concept of only deploying defense elements into space after an offensive missile launch is detected. In terms of intercepting ICBMs in their boost phase, when they are most vulnerable, pop-up calls for very fast response. Because of its huge firepower and low weight, the nuclear x-ray laser has been put forward as a candidate and is currently being developed by Lawrence Livermore and Los Alamos National Laboratories. Potentially, one x-ray laser module, lofted into space on a small missile, could generate upwards of 100,000 simultaneous pulses, each capable of destroying a missile. Because of this huge firepower, the x-ray laser is particularly effective against massive surprise first strikes. (The x-ray laser can also be utilized quite effectively against nuclear warheads which survive the boost phase.)

X-ray laser experts have previously reported that a full-scale test of the pop-up x-ray laser is not required before its deployment. All weapon-related elements can be fully demonstrated in underground tests. The only element that should be field tested is that of ICBM surveillance and tracking. But it should be noted that even existing surveillance infrared satellites could provide a marginal intercept capability. This is because these infrared detection systems deployed in space have historically always performed well beyond their original specifications.