Directed energy is out. Kinetic energy is in. Futuristic launch vehicles, no longer urgent for SDI, are in trouble.

The Scaled-Down Look of Star Wars

BY JOHN RHEA

THE Air Force for years has planned to consolidate its leadership in space by developing and building a brand-new family of cost-effective launch vehicles. Once, this step seemed assured in light of the massive orbital requirements generated by the Strategic Defense Initiative (SDI) program.

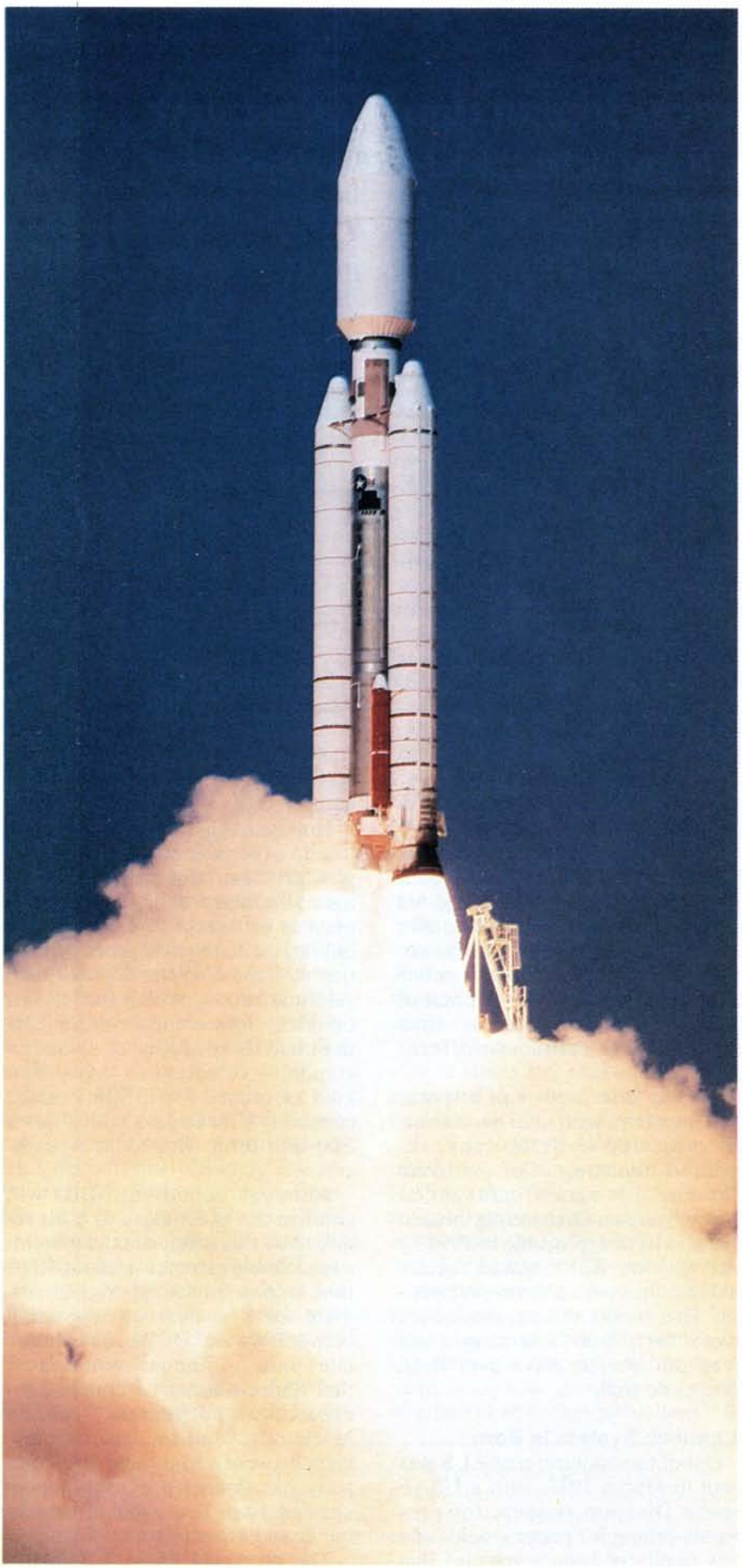
That is no longer the case. SDI has been reoriented, and the Air Force's proposed Advanced Launch System (ALS) is no longer essential to deploy the first phase of a space-based system to defend US intercontinental ballistic missiles (ICBMs) from Soviet attack.

Instead of creating an umbrella to protect the civilian population and thus render nuclear missiles "impotent and obsolete," as was envisioned by former President Reagan in his famous "Star Wars" speech of March 23, 1983, the SDI planners have cut their technological coat to fit their budgetary cloth. Expensive and complex directed energy weapons (DEWs), such as lasers and neutral particle beams, are out—at least until well into the twenty-first century—and kinetic energy weapons (KEWs) are in.

As a result, today's generation of expendable launch vehicles (ELVs), such as USAF's Titan, Atlas, and Delta, can do the job of putting the space-based segment of SDI into orbit, according to Air Force Col. Thad Shore, the space propulsion program manager at the SDI Organization (SDIO) in the Pentagon.

This removes a lot of the urgency for proceeding with USAF's ALS program, in which three teams of booster manufacturers are competing to develop the next generation of launch vehicles. The three are Boeing, General Dynamics, and a partnership of Martin Marietta and McDonnell Douglas.

With its original goal of slashing launch costs by ninety percent, ALS continues to be essential for future routine access to space. (Today, NASA's space shuttle and military ELVs have a launch cost of $3,000 to $4,000 per pound to low earth orbit.) Furthermore, ALS would be a family of modular launchers spanning the entire DoD payload spectrum from half a ton to 100 tons, according to Colonel Shore, who calls it a "dial-a-payload" system.



The space-based segment of SDI can be launched into orbit by today's generation of expendable launch vehicles, including Atlas, Delta, and Titan. This is the first Titan IV launch, conducted this past June.

The savings are supposed to come equally from three areas, he adds: improved manufacturing technologies derived from the commercial aircraft industry, reduced ground operations (particularly at the launchpad), and high launch rates (at least thirty a year). Reusability of at least the rocket engines and avionics packages becomes important at these launch rates.

The reductions in operating costs are now projected to be more like fifty percent, according to Col. John R. Wormington, ALS program manager at USAF Space Systems Division in Los Angeles, but that's still better than any savings expected from NASA's space shuttle.

Beyond the Shuttle

Even before the *Challenger* tragedy of January 28, 1986, it was obvious to everybody connected with the SDI program that the shuttle couldn't cut it. In addition to its excessive operating costs, the shuttle can only launch about twenty-five tons into orbit per mission. Even worse is the excessive ground preparation time, which limits the shut-

tle fleet to about a dozen missions a year, down from original estimates of sixty. As a result, the shuttle failed to meet the criterion that an antimissile system be "cost-effective at the margin."

Ironically, the only launch vehicle in the world today that could economically do the whole SDI job is the Soviet Union's reusable Energiya, which can launch 100 tons into orbit. The Soviets have announced that Energiya's payload capability is being upgraded to 200 tons.

Launch costs, along with the necessary computer power to pick out nuclear warheads from the swarm of accompanying decoys, have been the "long poles in the tent" of any SDI-type system for more than thirty years. They still are.

When what is now the Defense Advanced Research Projects Agency took the first steps to look at space-based antimissile defenses by initiating Project Defender on December 31, 1958, the United States had launched only five satellites into orbit (in twenty-one attempts) with a total weight of 240 pounds. Transistors were just beginning to replace vacuum tubes in computers, and integrated circuits were still in the laboratories.

Since then, tremendous strides have been made in shortening both poles. Wernher von Braun and his team of German rocket scientists put the US in space. The microelectronics revolution put more computing power at the disposal of one personal-computer user than existed in the entire world forty years ago.

But the launch costs of a space-based system, with total mass to orbit projected at 7,500 tons, remained daunting. Col. William Zersen, a program manager at Space Systems Division, estimated that a system deployable in 1994 by conventional ELVs would require 600 launches over a three-year period. That works out to one launch every forty-four hours, and not even the Soviets have ever been able to do that.

A Launch System Is Born

Out of this requirement ALS was born in March 1987, with a USAF Space Division request for proposals calling for paper studies of a new family of launch vehicles that would push operating costs down toward $300 a pound, with comparable improvements in reliability and on-time launch performance.

Under the ground rules, the study contractors were to start with a "clean sheet of paper" design and think in terms of a total launch system rather than of a vehicle. Seven firms received $5 million study contracts, and the number was cut to three last August. Hughes, Rockwell, and United Technologies failed to make the cut, and Martin Marietta teamed with McDonnell Douglas.

The semifinalists in the winner-take-all competition—Boeing, General Dynamics, and Martin Marietta/McDonnell Douglas—are under contract until the end of 1990, awaiting a Defense Acquisition Board (DAB) review and input from NASA next June on whether to proceed to the full-scale-development phase. The winner is expected to be selected by the following year, and USAF is now projecting the first ALS test flights for 1998 and initial operational capability for the year 2000. The latter two dates both represent a two-year slip from the original schedule.

However, ALS increasingly looks like an expensive solution in search of a problem. Colonel Shore estimates the total cost of ALS development at between $8 billion and $14 billion, including new ground facilities at Cape Canaveral. The Bush Administration, which has shown markedly less enthusiasm for SDI than had its predecessor, is understandably reluctant to invest that kind of money for a future space capability if it can get a scaled-down SDI into orbit with today's boosters.

Although nobody at SDIO will confirm the exact mass to orbit required by this version of the system, a reasonable estimate is about 1,500 tons, or one-fifth of the original estimate for a system incorporating both KEWs and DEWs. This translates into an annual requirement that Shore puts at "a couple hundred thousand pounds." Martin Marietta's Titan IV can routinely launch twenty tons, and the company has floated proposals for an uprated Titan V capable of launching nearly seventy tons.

The proposed Phase 1 Strategic Defense System that emerged from a DAB review last October anticipates spending $69.1 billion for a two-layer defense that would first attack Soviet missiles from space during their boost phase before they could release their warheads and accompanying decoys, then mop up the remaining incoming warheads with ground-based interceptors. The deployment decision will be made "in the mid-1990s," according to SDI officials, who maintain that the system can be fully deployed by the year 2000.

President Bush accordingly cut the SDI request he inherited for Fiscal Year 1990, which begins this month, from $5.6 billion to $4.6 billion and the projection for FY '91 from $6.7 billion to $5.4 billion. Future cuts are expected to be even deeper: The five-year SDI projection has been scaled back from $40 billion to $33 billion.

Although the initial system uses only KEWs, its system architecture would still be sufficiently open-ended to phase in DEWs later, according to Dr. O'Dean Judd, SDIO's chief scientist. "We do the easy stuff first and get experience and then build on it to improve our capability," he says.

Rocks Versus Pebbles

There is internecine warfare raging in the SDI community, however, over which kind of KEWs. The establishment favors the "smart rocks" approach of clustering small rockets with nonnuclear warheads in orbiting spacecraft, while the mavericks led by the indefatigable Lowell Wood of Lawrence Livermore National Laboratory are promoting the "brilliant pebbles" concept, in which individual rockets would be dispersed in space to attack on command.

Dispersing the rockets reduces their vulnerability—and also their launch requirements—but would require a major overhaul of SDI system architecture. The whole space-based interceptor (SBI) issue was turned over to the Jasons, a group of fifty academic scientists that does high-level studies for DoD, to thrash out at this year's annual gathering in La Jolla, Calif. The group will make its recommendation on the pebbles-vs.-rocks issue to the Bush Administration this fall. Sig-

nificantly, last year's summer study at La Jolla focused on free-electron laser propagation and discrimination and countermeasures.

Launch costs now are projected to account for only $8.6 billion, or about one-eighth of the scaled-down initial Strategic Defense System, and can no longer be considered one of the big-ticket items. The major reduction at last year's DAB review was in the SBI portion of the system. When the total costs of the Phase 1 system were cut from $115.4 billion to $69.1 billion, SBI was cut from $52 billion to $17.7 billion, the bulk of the decline.

Dr. Judd explains that this reduction was made possible by miniaturizing the homing warheads. The entire package of warhead, cryogenically cooled infrared sensors, computer, and rocket engine has been reduced to ten pounds. This reduction improves performance and lowers costs. These missile killers—"low hundreds" of them, according to Dr. Judd—would be housed in carrier satellites waiting for commands to tell them to attack.

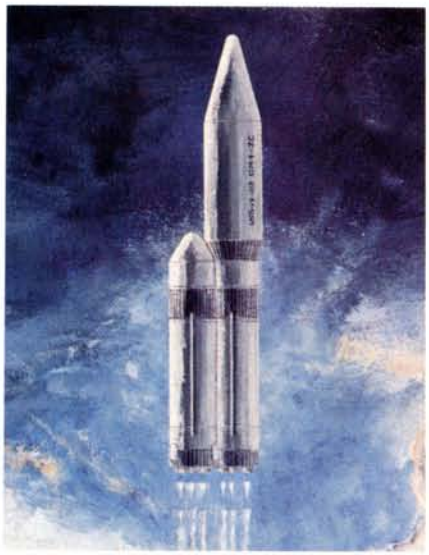
The commands would come from another space-based segment of SDI, the Boost Surveillance and Tracking System (BSTS). This is an estimated $8 billion program to deploy a constellation of satellites (the exact number is classified) with infrared sensors to detect Soviet missile launches. Initiation of full-scale development has slipped six months into 1991. These are the heaviest payloads in the entire system, and Colonel Shore says they have always been carried on Titan launch vehicles.

BSTS is particularly important because it could also replace today's Air Force missile early warning satellites and thus might survive any cancellation of SDI. Grumman and Lockheed are doing preliminary designs on competing concepts.

The other half of the scaled-down SDI is the ground-based missiles (also with nonnuclear warheads) to attack the incoming nuclear warheads that "leak" through the SBI network. These are intended to provide area defense rather than point defense, as was envisioned in the Safeguard antimissile system studied in the 1960s to protect US ICBMs, but they will have much longer legs than the Nike-Zeus, Spartan, and Sprint antimissile missiles planned for Safeguard.

Hitting a Bullet with a Bullet

The new approach is known as the Ground-Based Interceptor (GBI) and is projected to cost $5.8 billion. GBI is based on the Exoatmospheric Reentry-vehicle Interception System, being developed by Lockheed, which gave the whole SDI program a big boost with the now-famous homing overlay experiment in June 1984. In that test, a ground-based missile at Kwajalein successfully hit an incoming dummy missile warhead—what the Pentagon called "hitting a bullet with a bullet."



With SDI being cut back, there is less urgency to develop the very-heavy-lift Advanced Launch System. General Dynamics' proposed ALS (shown here in artist's concept) uses liquid fuel.

These KEW programs are responsible for reducing the launch requirements to the point where ALS becomes increasingly less attractive, but there is another complicating factor. NASA will need something more efficient than the shuttle to get its space station Freedom into operation before the end of the century, and it has a strong institutional bias against depending on USAF.

ALS would be perfect for that job, and it is even a joint DoD-NASA program with a NASA deputy manager, Harold W. Hallisey. Nonetheless, NASA has been studying an unmanned version of the shuttle known as Shuttle-C (the C stands for cargo) that could launch at least forty tons. Development cost is estimated at upward of $1.5 billion, but the congressional Office of Technology Assessment projected that the program would pay for itself on deployment of the space station alone. In March 1988, NASA awarded Shuttle-C study contracts to Martin Marietta, a Rockwell-Boeing team, and United Technologies.

Without commitments by SDIO or NASA, where does this leave ALS? If ALS is to be developed, it probably requires faith that this country will have enough traffic in space, civilian as well as military, to justify investing the money up front in a new family of launch vehicles that won't begin returning savings for at least a decade. This is the same kind of decision the Nixon Administration faced when it cut corners on shuttle development costs. "It's pay me now or pay me later," Colonel Shores comments.

"If SDI were to go away tomorrow, the country would still need it [ALS]," he maintains. "The philosophy behind ALS is to 'operationalize' space."

Dr. James Ionson, former Director of SDIO's Innovative Science & Technology Branch, puts it more bluntly. He calls some of the highly publicized SDI spinoffs so many "laser potato peelers" and says DoD should stress key enabling technologies that will create entire new industries.

He has a candidate industry in mind, space transportation. "The NASA spinoffs were not so much widgets and gadgets as they were access to a place, space," he says. "ALS can change the world. It can be our railway into space. The situation is analogous to that of oil. Today the price of a barrel of oil drives the entire economy. A hundred years from now, it will be the price of a barrel of rocket propellant." ■

John Rhea, a frequent contributor to Air Force *Magazine, has written about space-based antimissile defense since he began covering the issue in 1962 as editor of the defense and aerospace systems section of* Electronic News. *His first book,* SDI—What Could Happen: 8 Possible Star Wars Scenarios, *was published last year.*