"[The Department of Defense/ believes that directed-energy weapons offer promise of making major contributions to the U.S. defense posture.... Our program is dedicated to determining whether directed-energy weapons, deployed in concert with other strategic defense systems, can more nearly balance the offense-defense scale which has been dominated by the offense since the introduction of nuclear weapons."

— Major General Donald L. Lamberson, March 23, 1983, before a Senate Armed Services subcommittee

First of two articles

By JANET RALOFF

Beam weapons, once the domain only of Buck Rogers, Flash Gordon and their ray-gun toting fraternity, now highlight the topical agenda of Pentagon planners, military strategists and arms control analysts. Though functioning beam-weapon systems are still a long way off, serious interest in these futuristic concepts was rekindled overnight by President Reagan's call for the development of technology to render Soviet intercontinental ballistic missiles (ICBMs) "impotent and obsolete" — an address now remembered as the "Star Wars" speech.

In making that speech (SN: 4/2/83, p. 212), the President did not disclose specifically what he had in mind. That was left to administration officials such as Major General Donald Lamberson, an assistant to the Under Secretary of Defense for research and engineering. On the same day Reagan delivered his Star Wars speech, Lamberson testified before the Senate Armed Services subcommittee on strategic and theater nuclear forces, outlining the administration's posture on such technological exotica as directed-energy weapons — laser and particle beams — for defense against Soviet ICBMs. In the administration's view, he said, the potential these weapons hold for deterring strategic attack is "significant."

A single beam-weapon system could be designed to simultaneously lock onto and destroy tens of targets, be they incoming ballistic missiles or orbiting spy satellites. Such weapons "might be used as a stand-alone defense," he said, "or, more likely, as part of a defense-in-depth concept. For example, a constellation of space laser platforms might by themselves defend U.S. satellites from attack and also might possess the capability to negate, say, 50 percent of a large-scale ICBM attack on U.S. strategic forces by engaging [destroying] several hundred missiles in boost phase [before they exit earth's atmosphere] as the first layer of a ballistic missile defense-in-depth." Moreover, he said, they could aid U.S. retaliatory strikes by suppressing air defenses and blinding sensors on enemy spy satellites.

"[Beam weapons] may ultimately take many forms and be applied in many specific missions — perhaps as many as missiles and guns," he said. However, he added, unlike missiles and guns, the technology underpinning any potentially deployable weapon system is still very immature. As a result, DOD's directed-energy research focuses "on two basic issues — are such weapons feasible, and, if they are, can they be made cost effective?"

Lamberson acknowledged there was a high risk that these weapon systems might fail either of those two essential criteria for winning acceptance into the military's future arsenal. However, he noted that should they pass the test, their payoff — especially in strategic arenas — also "could be particularly high."

DOD's Strategic Defense Initiative is a new program, set up this spring. Explicitly aimed at exploring the development potential of those new, futuristic, ballistic-missile defense technologies referred to by the President in his Star Wars

Left: Drawing of laser satellite defense weapon. Though beam is pictured, in actual use it would not be seen until it hit target. Below: Depiction of "Teal Ruby" experiment. This program aims to demonstrate an ability to detect strategic aircraft. A space-based infrared sensor — shown here as beam — would be used to detect weak aircraft signatures against strong earth background clutter, thereby identifying impending attack against North America or naval groups. This year DOD plans to begin mission rehearsals and continue hardware construction.

speech, this program has as one of its priorities a greater scrutiny of the potential for beam weapons.

In part that's due to the findings of an influential panel convened last year at the Pentagon's behest under James Fletcher, former administrator of the National Aeronautics and Space Administration. Behind closed doors, some 50 aerospace experts from industry, DOD, think tanks and research centers considered in detail what it might take to render impotent an attack by Soviet ICBMs. Then they analyzed the current technology base, possible measures the Soviets could take to counter the effectiveness of the defensive strategies, and how long it might take to understand with reasonable confidence whether the United States could ever achieve such a technological fix.

According to Defense Department officials, the Fletcher panel concluded that a comprehensive ballistic-missile defense — probably one relying on beam weapons for at least those intercepts aimed at the boost phase of an ICBM's trajectory — likely was achievable under a long, focused development scheme. Putting such a system in place might take 20 years and cost upwards of $250 billion, they said, but on the bright side there appeared to be no Soviet countermeasure for which there wasn't an effective counter-countermeasure. In the end, the panel — as have many other analyses since then — offered enthusiastic support for continuation of research exploring the potential of technologies, such as directed-energy systems, that they believe hold the most promise for achieving this defense.

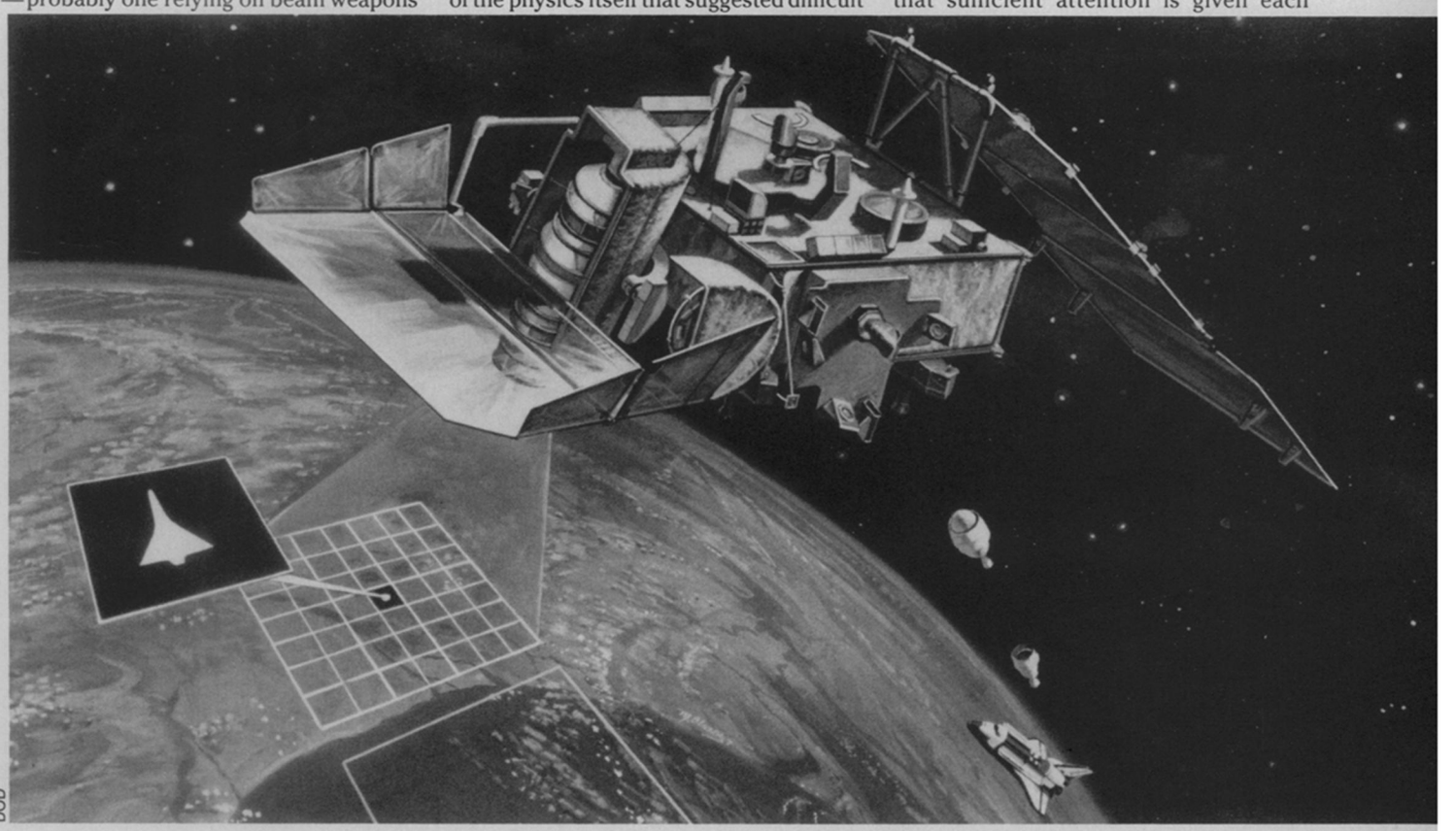
Though the prominence that beam weaponry has garnered is relatively new, DOD's interest and investment in it is not. The agency's Advanced Research Projects Agency (DARPA) initiated its particle-beam research with the Seesaw program in 1958 at Lawrence Livermore Laboratory in California. The goal was to develop an electron-beam generator for use in routing incoming ICBMs. DARPA's investment in laser technology began a year later when it negotiated a $1 million research contract with TRC Inc., a small, Long Island-based firm.

In the intervening quarter century, serious interest in the technologies has periodically waxed and waned: The physics involved initially stimulated such high expectations of powerful strategic weapons — expectations that were later dashed, or at least cooled, by the high cost of research and uncompromising aspects of the physics itself that suggested difficult obstacles stood in the way of "real-world" applications.

The current resurgence of interest is not fueled by any expectation that the research will become less costly. Quite the opposite. Addressing just this issue in the spring volume of FOREIGN AFFAIRS, William Burrows of New York University notes that two panels that submitted reports to the Pentagon last fall (the Fletcher report was one of them) "came to the conclusion that an effective ballistic-missile defense is so promising that an initial five-year research effort is warranted at a cost of $26 billion (or nearly as much as it took to land men on the moon)." That's just for research to determine whether the multilayered defense-in-depth that Lamberson referred to is technically feasible.

Admittedly, all that money would not go into beam-weapon studies. However, it's generally believed that much of what didn't would go for related technologies, including the development of:

- optics, especially mirrors, to direct laser beams from target to target. Under some scenarios, collapsible mirrors that can be packed aboard rockets — to be popped open umbrella-like once they get into space — are envisioned. Adding to the uncertainty in their performance is the fact that mirrors for use in space might have to be bigger and their surfaces more precisely controlled than any mirrors built for use on earth.
- a systems control to coordinate the multitude of satellite sensors, ground-based tracking stations and individual laser or particle-beam battle stations so that sufficient attention is given each



DOD

weapon, not just the first ones seen,

- artificial intelligence capabilities to almost faultlessly identify where a target is to be hit — often against a chaotic background of non-targets; to recognize when a target that is being zapped is effectively dead so that the beam can be redirected to the next one; and finally, to know when ground-based enemy missile launchers are being prepared for use so that the directed-energy battle systems can be alerted and their optics prepared to train on missiles during the first critical 300 seconds or so of their ascent from earth. It's during that initial boost phase that a missile is most vulnerable to damage and also most valuable: Killing it during this stage will eliminate its full complement of up to 10 MIRVs (multiple independently targetable reentry vehicles, each with its own warhead) and possibly 100 decoys.

Should the United States buy into such an extensive technology development program — discussion of that is starting to build within the Congress — Burrows believes somewhat cynically that the program will almost surely conclude with a positive assessment of the technology's feasibility. As he puts it, "The program manager who will admit that five years of research and more than $20 billion have been wasted on an unworkable system probably has yet to be born."

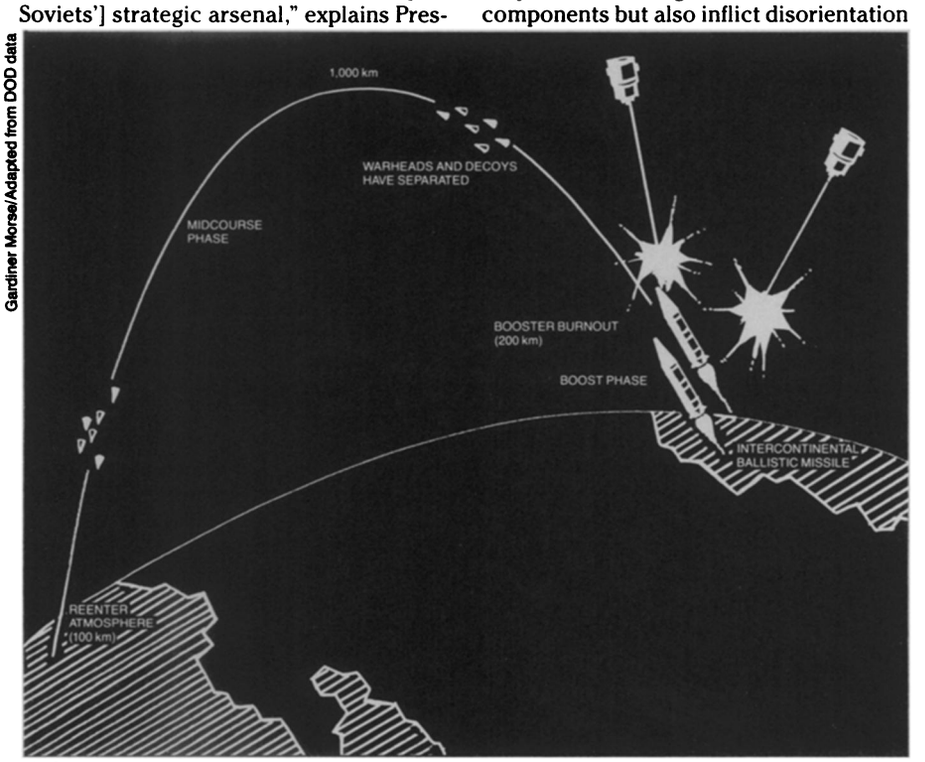
So if not less costly research, what now drives the military's serious interest in beam weapons? "If we can reduce the effectiveness of the ICBM, we make it easier to negotiate its reduction and eventual elimination as the cornerstone of [the Soviets'] strategic arsenal," explains Presidential Science Adviser George A. Keyworth II in the April AEROSPACE AMERICA. In fact, he says, if the United States precedes the Soviets in achieving effective ballistic-missile defense, "we could propose to join the Soviets in methodically eliminating the intercontinental ballistic missile as the premier weapon of strategic war." But the key, he says, is for the United States to be first in rendering ICBMs obsolete. If the Soviets are, "we should expect them to step up their program to expand their sphere of influence and control," he says, "and to blackmail the United States into inaction."

And the Soviets' status in beam weapons? According to "Soviet Military Power 1984," issued in April by the Defense Department, the Soviet laser-weapons program continues strong, and is complemented by support work in high-quality optics and power sources, such as a 15-megawatt rocket-driven magnetohydrodynamic generator "that has no Western counterpart" and "which could provide a compact, lightweight power source for mobile or transportable laser weapons." While it notes that particle-beam-weapons work is on a par with that in the West, it also notes that unlike the United States, the Soviets are engaged in intensive development of radio-frequency weapons. The report says Soviet work in this area has advanced to the point where "it could support development of a prototype, short-range radio-frequency weapon." Moreover, the report says, "Many Western weapons systems would be vulnerable to such a weapon, which not only could damage critical electronic components but also inflict disorientation or physical injury on personnel."

DOD's 1983 analysis of Soviet military power noted that intelligence data point to a coordinated space-based adjunct to "the world's only operational anti-ballistic missile system," which is based in Moscow. This space-based complement to the Soviets' ballistic-missile defense system, the study said, includes not only "antisatellite [ASAT] vehicles, now operational and designed to destroy low-orbiting satellites," but also "a very large, directed-energy research program including development of laser-beam weapons systems which could be based either in the USSR, aboard the next generation of Soviet ASATs or aboard the next generation of Soviet manned space stations."

So, the reasoning goes, if the Soviets are already developing their own Star Wars defense, and our development of one offers the United States the opportunity of gaining, in Keyworth's words, "a persuasive negotiating posture for arms reduction" — then why not?

Gardiner Morse/Adapted from DOD data



DOD worries that the most profitable arena for "killing" ICBMs — the boost phase, before MIRVs and decoys are deployed — is now inaccessible. Since beam weapons are the best match to that mission, their potential is under review.

Of course it's not really that simple or incontrovertible. Hosts of scholars in the areas of arms control, directed-energy research, foreign affairs and military strategy have criticized aspects of the logic, politics and technology underlying this rationale. Suffice it to say, however, that the administration believes the potential payoff from gambling on continued heavy support for research into these high-risk technologies warrants the investment. "We must explore high-risk, high-payoff ideas," says Keyworth, since they "have historically been the backbone of U.S. technological supremacy."

Defense analysts Colin Gray and Keith Payne, president and executive vice president, respectively, of the National Institute for Public Policy, based in Fairfax, Va., point out why this search for a Star Wars defense has so shaken up the military-strategy community. "Although a small core of strategic defense enthusiasts has always been present within the U.S. defense community, this level of officially expressed interest in strategic defense is an unprecedented development in recent U.S. strategic policy," they write in the spring FOREIGN AFFAIRS. "The goal of actively defending the American homeland in the event of nuclear conflict has not received serious official endorsement since the 1960s."

What is equally unprecedented, they say, "is the fact that the President has set policy in front of technology. If the United States does, in fact, deploy a multilayered system for defense against ballistic missiles, it will be the result of policy leading technology, not the more familiar 'technology creep' generating enthusiasm and a constituency for a weapons system which then 'finds' a policy rationale as it is developed." □

Next: Beam-weapons technology