Debate Over SDI Enters New Phase

A clash over goals, strategies, and schedule is expected to dominate congressional discussions; funding restrictions are already refocusing the effort

PRESIDENT Reagan's Strategic Defense Initiative is headed for a political clash in the next few months, as supporters and critics alike strive to redirect the program. As a result, public debate over SDI is likely to shift away from whether Reagan's vision of an "astrodome" defense against ballistic missiles is feasible and focus instead on the technical, military, and political dimensions of less ambitious efforts with more immediate payoffs.

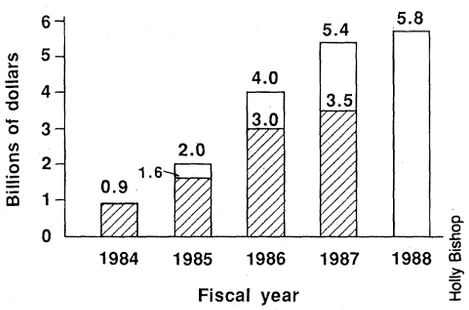
Supporters, anxious to avoid a budgetary Waterloo on Capitol Hill, are pushing for a decision to start deploying some defense technologies in the early 1990s. They argue that Congress would be more likely to support a program that is moving toward a concrete interim goal rather than a research effort with less clear-cut objectives.

A debate has been going on in the Administration over whether to throw White House support behind such a strategy, and on 12 January Defense Secretary Caspar Weinberger told the Senate Armed Services Committee that he would support deployment of SDI technologies "as soon as possible" as the first step toward a comprehensive defense. Such moves could, however, breach the 1972 Antiballistic Missile (ABM) Treaty.

Critics of SDI, on the other hand, are expected to try to maintain the program on a restricted financial diet, which by itself would force major changes in the program, and perhaps refocus the effort on more limited goals. They may also try to keep the program strictly within the bounds of the ABM treaty.

These issues have been lurking in the background of the debate over SDI ever since Reagan's fateful speech of 23 March 1983, when he announced a research program whose goal was to "render nuclear weapons obsolete." They are now being pushed to center stage in part because shortages of funds and technological difficulties may make it impossible to reach the goal Reagan set, which is to provide sufficient information for his successor to decide in the early 1990s whether to initiate deployment of strategic defenses.

The political forces tugging at the program are closely linked to its fiscal problems. In the three full years since SDI was launched, Congress has appropriated some $8.2 billion for the effort. Although a hefty sum that has shot SDI to the top of the Defense Department's research spending priorities, it falls some $3.2 billion short of the amount the Administration requested. For fiscal year 1987 alone, which began on 1 October, Congress slashed the funding request from $5.4 billion to $3.5 billion (the sums include money to be spent by the Department of Energy as well as DOD).



Dreams and reality. *Budget requests for SDI with the amount Congress approved indicated by the shaded portions. Totals include funds channeled through the DOE.*

Last year's congressional battle over the SDI budget is widely regarded as a watershed in the fortunes of the program. In March, Lieutenant General James Abrahamson, the director of SDI, told the House Armed Services Committee that even a $1-billion cut in FY 1987 would have a "very, very major impact on the program" and make a deployment decision in the early 1990s difficult. Not only did Congress cut nearly $2 billion, but 48 senators signed a letter calling for only 3% real growth in expenditures.

Nevertheless, the Administration is making another pitch for a major increase to help put the program back on track. Last week, President Reagan asked Congress to reinstate $500 million of the funds cut from SDI in FY 1987 and requested $5.8 billion for 1988—a 65% increase over the amount Congress approved for 1987.

With the Senate now in the hands of the Democrats and the Reagan Administration politically weakened by the Iran-Contra arms scandal, there is scant chance that Congress will approve these funds. "The fight over the funding level is over," former Defense Secretary James Schlesinger proclaimed at a AAAS arms control seminar last month. "Congress has brought a sense of fiscal reality to the program," he said. Indeed, "this year [FY 1987] may be the high-water mark for SDI," predicts one key Senate staff member on the Democratic side.

Supporters of the program are consequently looking for something dramatic to restore SDI's flagging political fortunes. They are hoping that a commitment to begin deploying strategic defenses in the early 1990s, which would require focusing the effort more on early technological demonstrations, would do the trick. "If the Administration redefines SDI to focus on the near term, I believe they will pick up support," says Senator Dan Quayle (R–IN). But if SDI continues as a research program with no clear objectives, he predicts "there will be big, big cuts." A Republican House staff member puts it more bluntly. "SDI is a dead-in-the-water science project at this stage, and we are looking at another big cut because [the Administration] has not moved the program off the dime," he says.

Exactly what an early SDI system would look like is not entirely clear. However, the most mature technologies being pursued under the SDI program involve ground-based rockets that would fire heat-seeking interceptors to collide with warheads in space or in the upper atmosphere (see box). As for space-based systems, the only technologies likely to be ready for deployment before the end of the century consist of small homing rockets that would be placed on satellites in low orbits that take them over Soviet missile fields. The rockets would be used to attack missiles immediately after launch.

Pressure to begin deploying some systems as an initial step toward more complete defenses has been building up for several months. Last October, a group of conservative legislators and supporters of SDI, including Edward Teller and former Secretary of State Alexander Haig, wrote to Reagan calling for deployment as soon as possible. "We are deeply concerned that a SDI research program which has no definite consequences for defense of America and its allies within the next 10 years will not be politically sustainable," it said.

The letter suggested that a start could be made with 100 ground-based interceptors, which would be permitted by the ABM treaty, and that the defense should be continually updated with the latest technology.

The Conventional Look of Near-Term SDI

The only strategic defense systems likely to be ready for deployment in the next decade or so would be based almost entirely on chemical rockets, fired either from fixed bases on land or from satellites in low orbit.

The system that is perhaps closest to development would involve heat-seeking interceptors launched by ground-based rockets to destroy warheads in mid-flight, before they enter the earth's atmosphere. Known as the Exoatmospheric Reentry Vehicle Interception System, or ERIS, it is an outgrowth of an Army program begun in 1977.

A key demonstration of the technologies that form the basis of ERIS took place in June 1984, when the third stage of a rocket launched from the Kwajalein test range smashed into a dummy nuclear warhead that had been released by a minuteman missile fired from Vandenberg Air Force Base in California 3000 miles away. As the two objects streaked toward each other at a closing speed of more than 20,000 miles an hour, sensors on the rocket homed in on infrared radiation from the warhead and guided the rocket toward a collision. The impact completely destroyed both objects.

The test was the fourth and final attempt to hit a warhead with a heat-seeking interceptor in the Army's Homing Overlay Experiment. The three previous attempts had failed. In congressional testimony last March, Lieutenant General James Abrahamson, the director of SDI, noted that Homing Overlay "demonstrated technical feasibility and our challenge is to bring the cost down." It is no small challenge, however. The interceptor used in the 1984 test weighed more than 1 ton; the goal is to bring the weight of the ERIS interceptor down to 5 to 10 kilograms. Such a reduction is essential to keep down the weight and cost of the high-acceleration rocket that will loft it into space.

Even if an ERIS system turns out to be a smashing success, it would not be able to cope with a determined attack, however. The reason is that current technology is incapable of discriminating between real warheads and decoys in space. Although techniques using particle beams or lasers to pick out the warheads are under study, they offer at best a long-term hope of solving the discrimination problem. Thus, an attacker need only launch a large number of cheap decoys along with his warheads to overwhelm the system.

To catch warheads that get past ERIS, SDI is working on a system that would use ground-based rockets, guided either by radar or infrared homing devices and armed with conventional explosives. This so-called terminal defense, like ERIS, is an outgrowth of Army research begun many years ago as part of conventional antiballistic missile systems. Major problems to be overcome include cooling the infrared sensor sufficiently to prevent it from being blinded when the interceptor heats up as it streaks through the atmosphere; protecting the radars and sensors against the effects of high-altitude nuclear explosions; and finding a way to hit warheads that maneuver when they enter the atmosphere. Some experts argue that it may be impossible in the near term to develop an effective terminal defense system using nonnuclear interceptors. However, SDI does not include work on nuclear-tipped rockets, such as those deployed by the Soviet Union in its ABM system around Moscow.

A key part of ERIS and terminal defense systems is likely to be the use of powerful ground-based imaging radars and infrared sensors in high-flying aircraft to track incoming warheads and guide the interceptors toward their targets. A test of one such sensor, known as the Airborne Optical Adjunct, is now scheduled for the late 1980s, and funds have been requested in the 1988 budget for an imaging radar.

The best way to reduce the pressure on ERIS and terminal defense systems is to attack missiles in their so-called boost phase, before they release their warheads and decoys. The most likely near-term candidates for this job are not the laser battle stations and particle beam weapons of "Star Wars" fame but small, fast, heat-seeking rockets fired from satellites.

Four years ago, an organization known as High Frontier proposed a system in which almost 500 satellites equipped with homing rockets would provide boost-phase defense, and last month the George C. Marshall Institute argued for early deployment of a system consisting of between 1000 and 2000 small satellites each armed with five to ten rockets. The satellites would have to be placed in low orbits that take them directly over missile sites to give the interceptors any chance of hitting the boosters before they burn out. However, only about 10% of the satellites would be within range at any given time.

The SDI program has a substantial effort devoted to such space-based rockets, and a supplemental budget request sent to Congress on 5 January includes some $60 million for the development of high-impulse rocket motors. It also includes $112 million to begin work on a heavy-lift launcher that would be useful for lofting the rocket-carrying satellites into space.

Robert Jastrow, an author of the Marshall Institute report, claims that a space-based rocket system could be ready for deployment by the mid-1990s. According to a senior SDI official, however, "the problem is not to build the system, it is to know what you are hitting." This refers to the fact that as a rocket leaves the earth's atmosphere, its plume gradually flattens out and eventually envelops the booster entirely. The problem is thus to find a relatively cold body in a hot environment with a heat-seeking rocket.

Last September, SDI researchers conducted a complex experiment in which two spacecraft collected critical data on plume characteristics in space before being made to collide with each other while they were both firing their rockets. The collision has been touted by proponents as proof that boost-phase intercept is possible. However, since one spacecraft was fitted with radar guidance and the other had a radar reflector, it was "like sending two trains together on the same track," notes John Pike of the Federation of American Scientists.

Even if the homing problems can be overcome, such a system would be vulnerable to attack by antisatellite weapons launched from the ground and by space mines. It could also eventually be defeated by the use of fast-burn boosters that would greatly reduce the time for the interceptors to detect and hit their targets. To help overcome the vulnerability problem, the proponents suggest spreading the homing rockets over large numbers of satellites and making the satellites maneuverable. This would, however, increase the cost of the system. Louis Marquet, a top official in the SDI office, acknowledged recently that survivability of space-based systems remains one of the most difficult problems facing the SDI program. "We have taken a very serious approach to that question, and we don't have the answer," he said. ■ **C.N.**

The signatories also called for deployment "in the next half dozen years" of defenses in Europe and the Middle East against short-range Soviet missiles. (This idea is now attracting considerable attention and will be the subject of a separate article.)

Since then, calls for early deployment have come from a variety of conservative groups, such as the Heritage Foundation. Moreover, Representatives Jack Kemp (R–NY) and James Courter (R–NJ) and Senator Malcolm Wallop (R–WY) have pledged to introduce legislation to begin deployment of SDI systems in the early 1990s.

Nobody expects such proposals to get far in Congress unless the Administration supports them. So far, the Administration has not publicly endorsed a change in the direction of SDI, and spokesmen insist that the goal remains to develop the technical basis for a decision in the early 1990s on deployment of a comprehensive system.

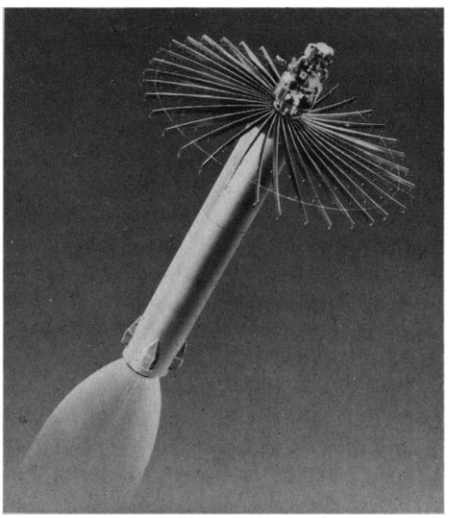
A debate is said to be taking place within the White House, however. Sources say that a report laying out a specific plan has been prepared for the President, and according to one supporter of early deployment, a preliminary draft of the State of the Union address contains language that proponents would consider "extremely helpful."

If the Administration does back early deployment, it would certainly galvanize public debate over SDI. However, a political clash over the program's structure and goals is considered inevitable, whatever the Administration does. For one thing, SDI's managers have already been forced to make major adjustments in response to budget cuts and technical developments; another big cut could force some radical shifts. For another, the program at some point will bump up against limits imposed by the ABM treaty; exactly what is permitted has already become a matter of serious political dispute. Finally, SDI's supporters and critics alike have their sights set on 1989, when President Reagan will no longer be in office to push the program he launched.

Debate is expected to revolve around the following interrelated issues:

■ **Structure of the program.** In past years, Congress has been content to take an ax to the budget total without specifying how the cuts should be apportioned. SDI officials have responded by making early choices between competing programs in order to stick to the original schedule. This has resulted in a narrowing of the technological focus of the effort. "We have essentially killed some programs to allow others to proceed," says Alan Mense, the acting science adviser to the SDI office.

For example, space-based lasers and particle beams—the technologies most prominently associated with "Star Wars" in the public mind—have been deemphasized while research on homing rockets has been stepped up. According to Mense, the space-based laser program is "almost on hold." Instead, research is focusing on ground-based lasers whose beams would be reflected onto targets by mirrors in space. And even this effort has effectively been whittled to one approach—the free electron laser (*Science*, 2 January, p. 27). In contrast, a program to examine the feasibility of putting rocket interceptors on low-flying satellites is the only space-based weapons project whose momentum is being maintained at the planned level, says Mense.



Heat-seeking interceptor. *In a 1984 test, the final stage of a ground-based rocket was guided to a collision with an incoming warhead at a closing speed of 20,000 miles an hour. The spines are unfurled just before impact to increase the chances of a successful intercept.*

Changes in direction have also taken place as a result of technical difficulties. For example, researchers have concluded that it may not be possible to use infrared sensors or radar to discriminate between warheads and decoys in space. Consequently, a major project to develop a space-based tracking system has been stopped. Attention is now focusing on the use of relatively low-powered lasers or particle beams to detect heavy warheads in a cloud of decoys.

Similarly, efforts are also being stepped up to overcome what are widely regarded as central problems—finding ways to make space-based systems survivable against counterattacks, managing the defenses during an attack, and developing the capacity to loft large amounts of hardware into space. These activities are scheduled to rise from 15% of SDI's budget in FY 1985 to about 30% in 1988, according to the budget proposals.

Some critics have argued that promising lines of research have been dropped because too much of SDI's budget has been devoted to expensive demonstration projects. A Senate Democratic staff report last year, for example, argued that the program was already being pushed too heavily toward demonstration projects to support an "arbitrary" decision schedule.

Any move toward early deployment without a major boost in funds would force the program even more in the direction of early demonstrations, and "raise the problem of balance [between research and development] in spades," says Doug Waller, an aide to Senator William Proxmire (D–WI) and one of the authors of the report. Another major cut in the budget without any change in schedule could have the same effect.

Even some of the program's supporters concede that a deep cut in the 1988 budget request could force a reassessment of SDI's schedule. "By the early 1990s we would not have an adequate database on which the President and Congress can decide on deployment," says one SDI official.

■ **SDI's overall goals.** From the start, critics have questioned whether President Reagan's vision of developing defenses capable of protecting cities against missile attack could ever become reality, and many have urged that the program be directed toward more feasible goals. Last year, the Senate Armed Services Committee took an important step in this direction.

The committee, by a vote of 10 to 9, adopted a policy statement that said the "major emphasis" of SDI should be to develop protection for military targets such as missile sites and command centers. Such defenses would preserve U.S. capacity to retaliate after a first strike, thereby increasing the deterrence value of American nuclear forces. A key drafter of the statement was Senator Sam Nunn (D–GA), who is now the committee chairman.

The statement was the first attempt by Congress to redirect SDI, instead of simply cutting the program's budget. With Nunn in the driver's seat of the committee, the technical, economic, and military implications of limited defenses are likely to get increased attention—especially if the Administration does propose early deployment of SDI technologies.

The committee also said that attention should be paid to defenses that could be deployed quickly if the Soviet Union were to break out of the ABM treaty by building a nationwide defense of its own. To determine what options might be available, the committee directed DOD to prepare a report on what technologies could be developed and deployed within 10 years.

As Congress begins to look more closely

at the goals of SDI, a report prepared recently by a bipartisan committee of defense experts, cochaired by former national security adviser Brent Scowcroft and former defense undersecretary William Perry, is likely to be influential. The committee, known as the Aspen Strategy Group, concluded there is "virtually no prospect of building a significant and effective population shield against a responsive enemy inside this century, and there is great uncertainty about the long term."

Calling SDI's goals unclear and confusing, the report recommended a robust long-term research program concentrating on experimental work and technology development rather than engineering and demonstrations of doubtful legality under the ABM treaty. Near-term efforts should be focused on research designed to counter a possible Soviet breakout from the treaty, including work on technologies that would enable U.S. warheads to get through Soviet defenses, it said. In addition, the committee suggested that research on nuclear-tipped interceptors, which are currently excluded from SDI, should be resumed.

■ **Arms control.** The Reykjavik summit meeting, at which President Reagan refused to accept Soviet demands for limits on SDI research in exchange for an agreement on major reductions in offensive forces, has brought arms control issues to the forefront of the debate over SDI. There are two facets to the discussions: potential conflicts with the ABM treaty and SDI's role as a bargaining chip in arms control negotiations.

As for the ABM treaty, the argument centers on what types of development and testing are permitted. The treaty permits the United States and the Soviet Union to deploy up to 100 ground-based interceptors at a single site, and it permits research and development associated with such systems. But it forbids deployment of space-based missile defenses. That much is almost universally agreed. The debate is largely over experiments in space (*Science*, 31 October 1986, p. 533).

According to an interpretation that was widely accepted in the United States until recently, the treaty permits research on all ABM technologies but prohibits development, testing, or deployment of sea-based, air-based, space-based, or mobile land-based "systems or components," and precludes testing non-ABM systems "in an ABM mode." Not surprisingly, these somewhat fuzzy terms have been subject to a wide range of definitions, which in turn have prompted debate within the United States over the legality of some proposed SDI experiments.

The debate abruptly shifted in October 1985, however, when the State Department offered a new interpretation of the treaty. A reading of the classified negotiating record indicates that the treaty only covers technologies that were "current" at the time it was written, the department said. This would permit new technologies to be developed and tested to the point of deployment. This reinterpretation caused such a furor, however, that the Administration subsequently announced that it would abide by the earlier, more restrictive reading, although it explicitly reserved the right to use the new interpretation at any time.

Members of the Senate Armed Services Committee are currently reviewing the negotiating record. Senator Carl Levin (D–MI) has already concluded that the State Department's new reading is "fatally flawed." Staff members say that if that turns out to be the majority opinion, the committee may try to force the Administration to adhere to the restrictive interpretation of the treaty by inserting binding language into the military authorization bill.

Meanwhile, at Reykjavik, Soviet leader Mikhail Gorbachev attempted to fence SDI research in by calling for a ban on all SDI-related experiments in space. President Reagan refused to consider this, arguing that it would effectively kill SDI.

Some observers believe there is room for negotiating an understanding on the treaty limits, perhaps as part of talks on arms cuts. "If the United States is prepared to modify its position that all development and testing of space-based systems is allowed, and if the Soviet Union is willing to drop its demand that nothing beyond laboratory research is allowed, major progress toward a new agreement should be possible," the Aspen Strategy Group concluded.

Joseph Nye, a professor at Harvard's Kennedy School of Government who directed the Aspen study, argues that the United States "could adhere to the traditional interpretation of the treaty without seriously hampering a research program for a decade." However, any move toward early deployment of SDI systems would probably force a severe conflict over the treaty because demonstration projects of at best doubtful legality would be required.

So far, the Administration has resolutely refused to consider any concessions on SDI. However, the Senate Armed Services Committee's policy statement said "we should be prepared to consider adjustments in the pace and scope of SDI if the Soviet Union agrees to significant, stabilizing, and verifiable reductions in strategic offensive forces."

The debate over SDI, which has dominated strategic discussions over the past 4 years, is clearly not going to die down. Indeed, it appears to be entering a new and critical phase. ■ COLIN NORMAN

Briefing:

House of Lords Wants U.K. Research Assessed

Britain's House of Lords has suggested that 1% of the United Kingdom's research and development budget should be spent on the evaluation of research results. The proposal was made last week in a report published by the House of Lords select committee on science and technology, which claimed that the scientific community's current approach to evaluation is "less scientific than the science and technology it is designed to assess," and argued that evaluation "must be approached as a discipline and not as a threat."

The committee said that Britain's scientific effort currently suffers from a major lack of coordination, and suggested the creation of a new body to finance strategic research, which falls between the traditional categories of fundamental and applied research. It also proposed that, in order to raise the visibility and attractiveness of research to the banking community, all companies should be required to make an annual statement of their spending on R&D, a recommendation that is already being considered by the government's scientific adviser. ■ **D.D.**

New French Minister

Jacques Valade, professor of organic chemistry at the University of Bordeaux since 1963, is being tipped in Paris as a likely successor to Alain Devaquet, the minister for research and higher education who resigned in December following widespread student protests against his proposals for the reform of universities. Valade is currently a member of the French Senate, and is also the chief deputy to the powerful Mayor of Bordeaux, former Prime Minister Jacques Chaban Delmas. Devaquet's successor is expected to be named as part of a reshuffle of ministers to be announced in Paris within the next week. Other names being cited in addition to Valade include Michèle Alliot-Marie, the deputy minister for education who was Prime Minister Jacques Chirac's chief spokesman for research during last year's general election campaign, and Jean-Pierre Soisson, the minister responsible for universities in the mid-1970s. ■ **D.D.**