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THE STRATEGIC DEFENSE INITIATIVE: PROGRAM DESCRIPTION AND MAJOR ISSUES

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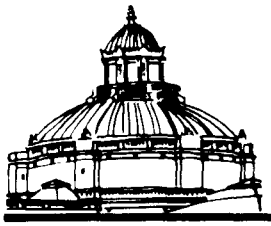

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ABSTRACT

The Strategic Defense Initiative (SDI) has prompted one of the most heated national security debates in recent times. The current debate, within the scientific and technical as well as the defense communities, has already and will likely continue to cause evolution in both program objectives and substance. This report describes the evolution, composition, and major issues of the SDI. Among the issues discussed are technical feasibility, the rate and level of funding, strategic policy and military utility, arms control, NATO Alliance reactions and involvement, technology transfer to the Soviet Union, and the militarization of space.

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INTRODUCTION

In a nationwide address on March 23, 1983, President Reagan described his vision of a world no longer dependent upon the strategy of deterrence based upon the threat of nuclear retaliation. He called for a "comprehensive and intensive effort to define a long-term research and development program" to provide future decision-makers with new defensive technologies and strategic options "to achieve our ultimate goal of eliminating the threat posed by strategic nuclear missiles."

Following the speech, President Reagan commissioned two studies (the so-called Fletcher and Hoffman studies) to examine the feasibility of that goal and to make recommendations on how to proceed. 1/ Among their conclusions, the studies found that new technologies are becoming available that might provide options to defend against ballistic missiles, and that pursuit of those technologies could enhance deterrence and increase strategic stability. 2/

These reports led the Administration, in January 1984, to establish a research program known as the Strategic Defense Initiative (SDI). Its purpose, according to the President, is to find ways to provide a better basis for deterring agression, strengthening stability, and increasing the security of the United States and its allies. According to the Administration, the SDI is designed

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1/ U.S. Dept. of Defense. The Strategic Defense Initiative: Defensive Technologies Study. Apr. 1984. Washington, U.S. Govt. Print. Off., 1984. 27 p. and U.S. Dept. of Defense. Defense Against Ballistic Missiles: An Assessment of Technologies and Policy Implications. Apr. 1984. Washington, U.S. Govt. Print. Off., 1984. 22 p.

2/ The full findings of the Fletcher amd Hoffman studies are listed in appendix A.

to explore, in a manner consistent with all U.S. treaty obligations, the technical feasibility of a number of defensive concepts and technologies. 3/ The technical knowledge gained through the SDI will be used in future decisions by U.S. policymakers on whether to develop and deploy advanced defenses.

Since the President's initial speech on the subject, there has been much confusion and disagreement regarding the ultimate goal of the SDI and the means for attempting to achieve it. A particular point of contention concerns the meaning of the President's call upon the nation's scientific community "to give us the means of rendering nuclear weapons impotent and obsolete." Some infer from this statement that to be successful, the SDI must determine that a 100 percent effective defense against ballistic missiles is possible. The feasibility of attaining such a goal is argued on both sides. However, there are those who contend that a perfect defense is not a necessary condition for the success of the SDI. 4/ They argue that nuclear weapons can be rendered "impotent and obsolete" by defenses that severely reduce their utility (i.e., a rational adversary would not adhere to a nuclear strategy when only a small percentage of its forces would be able to penetrate a defense against them, especially since it would be impossible to know ahead of time which nuclear weapons would actually reach their targets). A related issue, here, is how that position differs from a similar one held during the Antiballistic Missile (ABM) debate of the late 1960s, when the prevailing position was that less than perfect defenses would not enhance deterrence but, instead, would complicate strategic policy issues and promote a potentially destabilizing arms race.

3/ U.S. President, 1981- (Reagan). The President's Strategic Defense Initiative. Washington, U.S. Govt. Print. Off., Jan. 1985. 10 p.

4/ See: Controversy over Star Wars, Pro: A View by Colin S. Gray. The Christian Science Monitor, Aug. 9, 1985. p. 16, 18.

This report is meant to serve as a primer on SDI. It briefly describes the composition, funding, and major issues of the SDI. Among the issues discussed are technical feasibility, the rate and level of funding, strategic policy and military utility, arms control, NATO Alliance reactions and involvement, technology transfer to the Soviet Union, and the militarization of space. All information appearing in the paper is from unclassified sources.

THE STRATEGIC DEFENSE INITIATIVE

STRUCTURE

In addition to beginning new programs, the SDI consolidated and expanded several research efforts that were being conducted separately and with different emphases within the various armed services or under the Defense Advanced Research Projects Agency (DARPA). In March of 1984, Lieutenant General James A. Abrahamson was named Director of the new SDI Organization (SDIO) and given responsibility for focussing and coordinating SDI program activities. He reports directly to the Secretary of Defense.

As envisaged by the SDIO, the research program would cost on the order of $26 billion, over a five to seven year period, leading to a decision in the early 1990s on whether or not to proceed with development. As well as heightened visibility, the program entails considerably more research in both breadth and funding than the earlier, disaggregated effort. 5/

The SDI is organized into five research program elements. The funding levels for these elements plus SDIO headquarters management are as follows:

5/ One estimate is that the Defense Department would have been allocated about $12 billion for research and development on ballistic missile defense for the same time period had the SDI not been formed. See: U.S. Congress. Office of Technology Assessment. Ballistic Missile Defense Technologies. Appendix F: BMD and the Military R&D Budget. Washington, U.S. Govt. Print. Off., Sept. 1985. p. 292-293. And: U.S. Congressional Budget Office. Analysis of the Costs of the Administration's Strategic Defense Initiative, 1985-1989. Washington, U.S. Govt. Print. Off., May 1984. 19 p.

	FY85 Appropriation a/	FY86 Request a/	FY86 Appropriation a/,b/	FY87 Projected a/
Surveillance, Acquisition, Tracking, and Kill Assessment	546	1,386		1,875
Directed Energy Weapons Technology	376	965		1,196
Kinetic Energy Weapons Technology	256	860		1,239
Systems Concepts/Battle Management	99	243		273
Survivability, Lethality and Key Technologies	112	258		317
Total Research	1,389	3,712	2,750	4,900
Management	8	9	9	10
TOTAL	1,397	3,721	2,759	4,910

Source: U.S. Dept. of Defense.

a/ In millions of dollars.
b/ Allocation of the research funds was left to the discretion of the SDIO.

A brief description of each program element follows. 6/

SURVEILLANCE, ACQUISITION, TRACKING, AND KILL ASSESSMENT (SATKA)

The objective of this program element is to investigate sensing technologies that can provide information to activate the defensive system, manage the battle, and assess the status of forces before and during a defense engagement. Space, air, and ground-based technologies are being explored to support these functions.

6/ Full details may be found in U.S. Dept. of Defense. Strategic Defense Initiative Organization. Report to the Congress on the Strategic Defense Initiative, 1985. Washington, 1985. p. 23-74.

The most challenging task for SATKA appears to be developing the capability to discriminate among enemy warheads, decoys, and chaff during the mid-course and early terminal phases of their trajectories. The number of objects requiring at least identification could be in the tens of thousands during a full-scale nuclear attack. Without the capability to identify warheads, an SDI-derived system would, at a minimum, need to be more powerful and extensive, which could be prohibitively expensive.

Passive, active, and interactive techniques are being considered for target discrimination. Passive techniques involve detecting radiation (e.g., light or heat) that emanates from the target. Active techniques (e.g., using lasers or radar) involve analyzing return signals from radiation sent to the target. And, interactive techniques involve directing radiation or material at the offensive threat to strip away essentially all but the shielded, heavy warheads.

DIRECTED ENERGY WEAPONS (DEW) TECHNOLOGY

This program element is designed to explore the potential for using lasers and/or particle beams for ballistic missile defense. Directed energy weapons can deliver their destructive energy to targets at or near the speed of light, making them especially attractive candidates for use against missiles as they rise through the atmosphere--the boost and post-boost phases of ascent. Successful engagement of missiles in these initial phases could allow the defense to destroy missiles before they release multiple warheads on their own independent trajectories. The capability for achieving such a defensive advantage is key to the SDI concept.

Beam weapon concepts now being studied include space-based lasers, ground-based lasers using orbiting relay mirrors, space-based neutral particle beams,

and endo-atmospheric (within atmosphere) charged particle beams guided by low-power lasers. In addition to research on beam generation technologies, advancements are also sought in beam control, optics, fire control, and acquisition, pointing, and tracking technologies. 7/

KINETIC ENERGY WEAPONS (KEW) TECHNOLOGY

This program element involves research on some of the most mature technologies under investigation by the SDIO. Kinetic energy weapons destroy their targets by impact rather than by an explosion. The goal of this program is to study ways to accurately direct relatively light objects at very high velocities to intercept ballistic missiles or their warheads during any phase of their trajectories. Various means of propulsion are being considered for achieving the velocities required for this task.

Ground-launched kinetic energy kill vehicles (KKVs) for endo- and exo-atmospheric interception of nuclear warheads are perhaps the most advanced of the KEW technologies. Other KEW technologies under investigation include space-based, chemically-launched projectiles equipped with homing devices (so-called "smart rocks"), and space-based electromagnetic railguns. 8/

SYSTEMS CONCEPTS/BATTLE MANAGEMENT (SC/BM)

Studies performed under this program element investigate options for defensive architectures that, according to SDIO, are designed to allow for

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7/ For further information see U.S. Library of Congress. Congressional Research Service. Weapons Research: Status and Outlook. Report no. 85-183 SPR, by Cosmo DiMaggio. 1985. 47 p.

8/ U.S. Dept. of Defense, Report to Congress, p. 24, 51-59.

eventual deployment of a "highly responsive, ultra reliable, survivable, endurable, and cost-effective battle management/command, control, and communication (C^3) system." 9/ Factors to consider in designing alternative system concepts include: mission objectives, analyses of offensive threats, technical capabilities, risk, and cost.

An operational system will require sophisticated automation at a level beyond current computer capabilities to: 1) identify and track all targets from launch until they are destroyed; 2) command and coordinate all elements of the defensive system; and 3) allow for human control both prior to and during its engagement. Since the larger the software program, the greater the probability of debilitating errors, the degree of centralization required for such a system is a key issue in this program. Relatively small, independent software programs for distinct BMD components could lead to a more fault-tolerant overall system. Examples of computer hardware and software advances sought under SC/BM include very high speed processing, artificial intelligence, computer written code, and self test and correction techniques.

A facility called the National Test Bed is planned for simulating and evaluating alternative architecture and battle management concepts. Should the United States decide to develop and deploy an SDI-derived defense, the National Test Bed could be modified to allow for test and evaluation of actual system components.

SURVIVABILITY, LETHALITY, AND KEY TECHNOLOGIES (SLKT)

This program element provides supporting research and technology development to improve system effectiveness and to satisfy system logistical requirements. The survivability and lethality study efforts are designed to yield

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9/ U.S. Dept. of Defense, Report to Congress, p. 25.

information about the nature of the expected enemy threat as well as about the ability of an SDI-derived system to survive efforts to destroy or defeat it. Results of these studies drive component and system requirements.

Work on supporting technologies includes, for example, research in space transportation, space power, on-orbit maintenance, and energy storage and conversion. SDI logistical research, especially that concerning the space-based assets of an eventual system, is particularly important for assessing and reducing deployment and operations costs. 10/

10/ U.S. Dept. of Defense, Report to Congress, p. 25, 67-74.

RELATED RESEARCH AND DEVELOPMENT EFFORTS

The following efforts are related to the SDI in that they would likely provide information useful in the development of, or become components of, a ballistic missile defense system. They are coordinated with the SDIO, but not included in SDI funding figures.

DEPARTMENT OF ENERGY (DOE) WORK

DOE currently conducts nuclear weapons research that supports the SDI ($224.1 million was appropriated for this in FY85, and $307.1 million was requested for FY86). The most publicized effort underway is the quest for an x-ray laser powered by a low-yield nuclear explosion. Proponents of this weapon concept (most notably, Edward Teller, one of the original hydrogen bomb designers) believe that it will become a key element of a boost-phase defensive layer. Others believe that if the x-ray laser proves to be workable, more likely it will be a candidate for use in mid-course defense. The primary factor in this debate is the amount of time required for launching the x-ray laser into position before it can be aimed and fired. If the United States continues to abide by existing treaty obligations in peacetime, then it could not be launched until just prior to use in actual battle because the Outer Space Treaty prohibits stationing nuclear explosives in space. 11/ It remains to be seen, however, whether the nuclear pumped x-ray will become workable.

11/ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies. Article IV.

DOE is also considering other nuclear pumped (or fueled) weapon concepts related to the SDI but has not discussed these in an unclassified format. According to the SDIO, these efforts are largely designed to maintain a hedge against comparable Soviet development, rather than for competing with other near-term concepts more closely associated with SDI.

In addition to weapons development, DOE is also conducting survivability studies and threat assessments via nuclear testing and computer simulation modeling. Such information is used for defining certain SDI technology research requirements. 12/

ANTI-SATELLITE WEAPONS (ASATs)

The United States has an active ASAT research and technology development program focused on an air launched miniature homing vehicle (MHV). The MHV is currently undergoing flight tests launched from an F-15. To date, two tests of this system have been conducted against a point in space and one against a U.S. satellite. The test results and the political support for the program have been mixed.

ASAT research is related to ballistic missile defense in several ways. First, some of the technologies required to meet the objectives of both are similar. For example, directed energy weapon concepts being researched under the SDI may very well attain capability useful for ASATs in the near future. Second, ASAT weapons probably would play a key role in enhancing the survivability of an

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12/ For more information on SDI-related activities of DOE, see U.S. Library of Congress. Congressional Research Service. The Effect of a Comprehensive Test Ban on the Strategic Defense Initiative. Report. no. 85-972 SPR, Cosmo DiMaggio. Washington, 1985. 5 p.

SDI-derived defense system. Finally, arms control issues related to each are inextricably linked. 13/

SP-100

In 1983, the United States began a project, jointly managed by DOE, DARPA, and the National Aeronautics and Space Administration (NASA), to develop a compact nuclear power system for use in space called the SP-100 program. Although designed for both commercial and military applications, the project has attained new significance because of the high electric power requirements envisioned for some of the space-based components of a ballistic missile defense system. The SDIO has since taken the place of DARPA in this effort. The design, fabrication, and testing of a ground-based lithium-cooled reactor is scheduled to begin in FY86 and run through about FY91 or FY92. The current plan calls for a space-based prototype by the mid-1990s. They FY86 appropriation to DOE for the SP-100 program is $15 million.

OTHERS

DARPA and the Armed Services conduct some strategic defense research that organizationally does not fall under the SDI. Examples of this research include some ongoing efforts in terminal defense of offensive forces, in strategic air defense, and in ways to counter Soviet strategic defenses. Concepts arising

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13/ For more information on this topic, see U.S. Library of Congress. Congressional Research Service. ASATs: Antisatellite Weapon Systems. Issue Brief no. IB85176, by Arthur F. Manfredi, Jr., Cosmo DiMaggio, and Marcia Smith, Oct. 1, 1985 (continually updated). Washington, 1985. 23 p.

from these efforts would most likely be integrated with an SDI-derived system if a decision to proceed with such a system were reached. Also, the SDIO has established both formal and informal mechanisms with NASA to coordinate and exchange technical information on space science and space shuttle-related experiments.

SDI ARCHITECTURE

SDI, as a basic research program, is not supposed to pre-judge what defensive concepts are or are not technically feasible. Therefore, it cannot be wedded to a particular system design. However, its lack of an overall concept definition has frustrated proponents and critics alike. The SDIO is working to alleviate this problem. Ten architecture study teams under contract to SDIO have completed the first phase of system design studies. SDIO has recently selected five contractor teams to continue working into the next phase of study. These teams are headed by Sparta, TRW, Science Applications International Corp., Rockwell International, and Martin-Marietta Aerospace.

The SDIO recently discussed an unclassified version of the presently favored architectural design with the New York Times. 14/ The current concept would consist of seven roughly independent layers of defensive interceptors. Ideally, each layer would be designed to permit no more than about 20 percent of the offensive targets to pass through it. This concept calls for two layers of weapons to attack missiles in their boost phase (one of directed energy weapons and one of kinetic energy weapons); three layers of weapons to attack warheads in the mid-course phase (one each similar to that in the boost phase, plus one of undetermined character such as ground-based lasers or devices that fire masses of pellets or aerosols); and two layers of ground-based rocket interceptors to contend with any warheads getting through to the terminal phase.

14/ Mohr, Charles. Antimissile Plan Seeks Thousands of Space Weapons. New York Times, Nov. 3, 1985. p. 1,18.

Although the architecture described above is currently favored, technological and/or political developments may alter the preferred scheme over time. With this in mind, SDIO is considering alternative concepts using differing numbers and locations of the layers. For now, however, SDIO believes that the seven layer concept represents the best solution for accomplishing SDI mission objectives.

CRITERIA FOR SUCCESS

A key issue for the SDI is "how will we know whether it is a success?" The Reagan Administration has proposed two criteria for evaluating ballistic missile defense technologies and concepts that might be derived from the SDI. As enumerated by Special Advisor to the President, Paul H. Nitze, these criteria are that a defensive system must be: 1) survivable and 2) cost effective at the margin. 15/ Of course, an additional, inherent criteria is that the system be effective in performing its intended function. The Administration contends that a system that meets its two criteria would, if deployed, promote strategic stability between the nuclear superpowers. 16/

A brief discussion of each criterion follows.

EFFECTIVENESS

Before a decision to proceed with full scale engineering development and deployment can be made, there must exist a high degree of confidence that the system, once in place, will be capable of destroying oncoming enemy ballistic missiles or their re-entry vehicles. Given the unavoidable delay between R&D and deployment, effectiveness must be judged versus an anticipated threat rather than the one faced at decision time. This criterion raises at least

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15/ Nitze, Paul H. On the Road to a More Stable Peace. United States Department of State, Feb. 20, 1985.

16/ U.S. Dept. of State. The Strategic Defense Initiative. Special Report No. 129. Washington, June 1985. 5 p.

two as yet unanswered questions: 1) What total level of effectiveness is desired?; and 2) How is the actual system effectiveness to be measured or estimated ahead of time to yield the confidence necessary for making a development and deployment decision?

SURVIVABILITY

Strategic defenses must be able to survive a direct attack that might be launched just prior to or during a ballistic missile assault. Space-based systems are particularly vulnerable to such an attack. Hence, SDIO is concentrating its survivability efforts on projected space-based elements of a hypothetical defensive architecture. Typical survival techniques include shielding, distancing the system from its potential attackers, maneuvering, proliferating, and shooting back. However, these and other techniques are not trivial to implement. Survivability represents one of the major technical challenges of the SDI. In addressing this challenge, two critical questions must be resolved: 1) Can sensitive elements of a layered strategic defense (e.g., sensors, C^3 hardware, and reflecting mirrors) be made survivable?; and 2) Can they be made survivable at a cost that does not encourage proliferation of attack weapons to beat the system?

COST

A goal of SDIO is to develop an effective strategic defense for the least cost. However, the Administration has stated a more stringent cost criterion for SDI, namely that "new defensive systems must be cost effective at the margin--that is, they must be cheap enough to add additional defensive capability so that the other side has no incentive to add additional offensive capability to

overcome the defense." 17/ This criterion raises several questions. Since an entire system cannot be deployed instantaneously, is this criterion to be applied for each phase of deployment or only after a complete system is in place? How, if at all, are non-quantifiables like the relative value to society of either having or not having a defensive system factored in? How will an adversary's costs be determined and what factors will comprise their costs? To what degree do we rely upon an adversary's acceptance of a rational economic position? Can we expect that if initially satisfied, this criterion will remain satisfied over time?

STABILITY

Even if the SDI shows that a strategic defense against ballistic missiles ultimately is technically feasible, generally it is agreed that for some extended period of time (perhaps decades or longer) deterrence would necessarily rely on a mix of offensive and defensive weapons. Managing the transition from offensively to defensively dominated deterrent strategies, such that, throughout the transition neither side has or is perceived to have an incentive to strike the other, will be difficult. Questions regarding stability must be considered almost continuously. Arms negotiations and control will likely have to play vital roles in maintaining stability through this transition. SDIO and other strategic analysts are investigating how stability could be maintained under a variety of scenarios, assuming certain technical breakthroughs in both offensive and defensive technologies. Before policymakers can assess the impact of SDI on present and future stability they must understand and scrutinize the assumptions that

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17/ Nitze, Paul H. On the Road to a More Stable Peace. p. 2.

drive SDI scenarios. For example, scenario outcomes can vary considerably depending upon assumptions of U.S. and Soviet force structures and their levels of effectiveness and survivability.

A DECISION IN THE EARLY 1990s

According to the Reagan Administration, the SDI research program will provide the technical knowledge in the early 1990s necessary to support a decision on whether to develop and deploy advanced defensive systems. Little specific information is currently available concerning the types of options that might be presented to Congress at that time. A popular misconception is that there will be only three options: 1) halt the SDI effort for technical, political, economic, and/or other reasons; 2) postpone a decision and do more research; or, 3) move to development and deployment of a system that, once in place, will meet all U.S. strategic defensive needs for the foreseeable future.

The first and second options are both possible non-deployment outcomes. However, the third option--"a once and forever" deployment--is not likely to be a realistic one for the 1990s (if ever). Instead, it is more likely that there would be a variety of "pro-deployment" options for phasing in different strategic defenses over time. These alternatives might be based, in part, on varying assumptions concerning arms control. Each option might be presented with estimates of costs, risks, and degrees of effectiveness, both for deterring an agressor's attack and for defending against an attack should deterrence fail. An essential element of each of these options probably would be a continued, strong research program for enhancing system effectiveness and for hedging against potential enemy efforts to counter it.

A decision to proceed with one of the "pro-deployment" options would likely lead to additional future options based on more advanced technologies. The

SDIO refers to this evolution of defensive technologies and strategies as the "path to 'thoroughly reliable' defenses." However, SDI's critics would argue that this path is inherently unstable and, therefore, should not be taken.

POLICY ISSUES

The SDI program has raised a host of issues, many of which are reminiscent of those raised in the 1960s before the 1972 Anti-ballistic Missile (ABM) Treaty. They include technical feasibility, countermeasures, funding, military utility, arms control implications, alliance reactions, technology transfer, and the militarization of space. The following sections address these issues.

TECHNICAL FEASIBILITY AND POTENTIAL COUNTERMEASURES

The technical feasibility of defending the entire country and the NATO allies against a ballistic missile attack is a central issue of the SDI program. Scientists have been vocal on both sides of this issue. The feasibility of defending military targets such as Minuteman silos is somewhat less controversial, with most observers believing it to be an easier task. Beyond the issue of technical feasibility per se is the potential effectiveness of the panoply of reactive countermeasures available to potential adversaries.

There seems little doubt that technological breakthroughs can be anticipated that will make specific elements of strategic defensive weapons systems possible. But breakthroughs are needed in many areas. The question is, can the requisite variety of weapons and sensors be brought together into a system--a system that is reliable, under human control, survivable, and cost effective. The sheer scale of the program argues that an answer to that question now is premature.

Severe attack situations would be extraordinarily stressful--many missiles (perhaps thousands), mostly with multiple independently-targeted reentry

vehicles, launched from both land and sea, could (theoretically) be launched almost simultaneously and arrive on U.S. targets in at most thirty minutes.

One of the greatest technical challenges relates to the software (computer code) that will be needed to "manage" the system--the so-called battle management function. 18/ The tasks include: detecting an attack, characterizing the type and size of the attack, tracking the targets, assigning weapons to the targets, assessing the results of engagement, and (presumably) reassigning weapons to replace failures.

Many critics question whether it is possible to write and check the millions of lines of computer code needed, to be sure it is error free. This is especially of concern, they argue, because it will be impossible to test the code realistically, and to anticipate fully all possible attack combinations to which the system might be exposed. Proponents counter that, as on other technical questions, the program now is just a research program to determine feasibility and possible approaches, so failure should not be assumed. On the question of computer codes, for example, techniques such as decentralized parallel processing to develop fault tolerant computer systems are being investigated. 19/

Another technical challenge for SDI is responding to a host of potential countermeasures available to U.S. adversaries. 20/ They range from passive

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18/ See, for example: Snager, David E. A Debate about 'Star Wars'--Can Software Be Designed? New York Times, Oct. 23, 1985, p. D1, D7; Parnas, David Lorge. Software Aspects of Strategic Defense Systems. American Scientist, Sept.-Oct. 1985, p. 432-440; and SDIO Computing Official Says Software for SDI Can Be Developed, Defense Daily, Dec. 5, 1985, p. 169-170.

19/ For further information, See U.S. Library of Congress. Congressional Research Service. Supercomputers and Artificial Intelligence: Recent Federal Initiatives. Issue Brief no. IB85105, by Nancy Miller, Dec. 12, 1985 (continually updated). Washington, 1985. 11 p.

20/ Caravelli, Jack. Soviet Countermeasures to SDI. Journal of Defense & Diplomacy, Mar. 1985. p. 45-47, 62.

countermeasures that degrade the effectiveness of a strategic defensive system, to active countermeasures that attack the system. Representative ones are listed in the following table, along with potential counters to them (i.e., counter-counter measures) and comments.

POTENTIAL COUNTERMEASURES TO STRATEGIC DEFENSES

Category	Potential Countermeasures	Potential Counter-Countermeasures	Comments
Active	Defense Suppression		
	Attack space sensors	Hardening, redundancy, decoys	Soviets already have some ASAT capability; "attack" includes blinding and jamming
	Attack space communications	"	
	Attack space weapons	"	
	Attack ground sites	Security, redundancy, hardening	
Passive	Proliferation		
	Add ICBMs & SLBMs	Robust detection and tracking system	
	Mobile ICBMs	"	Soviets have deployed mobile ICBMs
	Evasion		
	Fast-burn boosters, booster coatings, rotating boosters	Fast reaction system, more powerful weapons, or shift burden to later tiers	All are costly to the offense (e.g., added weight or performance penalty)
	Decoy boosters	Good discrimination capability	
	Penetration aids (penaids), e.g., RV decoys	"	
	Maneuvering RVs (MARVs)	Capable interceptors	
	Avoidance		
	Shift to "air breathers," i.e., bombers and cruise missiles	Enhanced air defense capabilities	SDIO studying this problem; delivery time for air breathers is much longer than for ballistic missiles
	Emulation		
	Develop analogous strategic defensive system	All the other countermeasures in the previous column.	Presumably a desired outcome, if offensive arms are reduced

Given the many possible countermeasures, the SDIO has adopted as one of its criteria for success the concept of "cost effective at the margin." The goal is to develop a system to which it would be cheaper for the United States to add defensive capability than it would for the potential adversary to add to its capability via countermeasures. The defensive system must, as well, be able to add capability faster than the offense, or else it could become temporarily negated. As the above table suggests, the strategic defensive system must be very robust in order to accommodate the variety of possible countermeasures. As with many of the SDI's technical challenges, it is not yet known whether this will be possible. To enhance research management, the SDIO is using so-called "Red Teams" of engineers and strategists to hypothesize potential countermeasures. All research efforts must be critiqued by the Red Teams and demonstrate an ability to accomodate the counters they advance.

The results which will derive from the SDI research program are still uncertain. Yet supporters and critics have joined in arguments that a capable BMD system is possible or impossible. In the current context, it is worth noting that history is replete with learned people erroneously predicting the possibility or the impossibility of some scientific or technological breakthrough by making premature judgments. Discussions of fundamental feasibility must of necessity hinge on the precise mission of whatever system concept is under consideration (this can range from a system to defend a few missile silos to a system to defend the entire Free World). Some level of strategic defensive capability is already possible. What is not yet clear is whether the SDI will lead to an enhanced strategic defense that will be sufficient to render "nuclear weapons impotent and obsolete," or even whether it will be survivable, cost effective, and beneficial.

RATE OF FUNDING

Administration officials, Members of Congress, and the public at large currently differ in their views on the need and objectives for the SDI. The range of opinion extends from a minimal program with adherence to the ABM Treaty while conducting basic laboratory research as a hedge against Soviet breakout, to an accelerated program aimed at development and deployment of a defensive system at the earliest possible time (the so-called technology--rather than the resource-limited approach). There are myriad alternatives in between. To date, the issue of how the rate of funding specifically relates to SDI objectives has not been well defined. As noted earlier, current SDIO estimates are that the research program will cost about $26 billion up to the first deployment decision point in the early 1990s. Lower funding levels could delay that decision point. Cost estimates for a deployed system are highly speculative and depend on critical assumptions on the type of system being costed. Some range from several hundred billion to over 1$ trillion. 21/

Even those opposed to the SDI generally believe that some form and level of research in strategic defense is warranted. Accordingly, even without the SDI program, the funding level in this area would not go to zero. Such a minimal funding scenario would essentially revert to the situation prior to President Reagan's speech in March of 1983. It can be argued that for stability to be maintained, this scenario requires that the United States have the ability to monitor Soviet strategic defense efforts to ensure against their negating the deterrent value of our offensive strategic forces. It presumably also

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21/ See, for example: Adam, John A. and John Horgan. Debating the Issues. IEEE Spectrum, Sept. 1985, p. 56 and Schlesinger, James R. Rhetoric and Realities in the Star War Debate. International Security, Summer 1985. p. 4.

assumes that, for long-term stability, the United States and the Soviet Union must agree to meaningful arms reductions, or the United States must find other ways to resolve the problem of ICBM vulnerability.

The short-term funding requirements of this "monitoring" scenario appear to be far less than those proposed by the SDIO in pursuit of strategic defense. And, it can be argued that if a useful BMD should prove technically unachievable, considerable expenditures will have been saved. However, it would be wrong to assume that because the risks in taking this approach are not readily apparent, that they, in fact, are smaller than those of the pro-SDI options. All options include the risk of nuclear weapons use for many years.

Those in favor of SDI do not all have the same concept of what SDI could or should accomplish. Furthermore, proponents vary in their assessments as to how much funding is required and at what rate to meet their own objectives for the program. In a world of countermeasures and counter-countermeasures, time might be the essential factor in achieving technical feasibility. The relationship between SDI goals and funding can be stated as follows.

If the goal of the SDI is to rapidly proceed with research to achieve the capability to develop and deploy, unilaterally or otherwise, a system that is sufficiently ahead of offensive countermeasures such that it provides an effective defense against the offensive threat that is in place at the time of deployment, then SDI probably must be funded at a high rate, even prior to assessing the program's success. This scenario places the greatest burden on technological development, especially in the absence of arms agreements or other solutions limiting the offensive threat over time. However, its appeal derives primarily from the possibility it holds for the United States independently to lead the superpowers to a more strategically stable position. This scenario could require an ongoing, fast paced, highly-funded program for continually

enhancing system effectiveness in the face of presumed rigorous Soviet efforts to counter defenses.

If, on the other hand, the strategic need for some SDI-derived ballistic missile defense exists, but is not imminent (i.e., if strategic stability is not greatly threatened in the near term without such a system), and negotiations with the Soviets can be realized that result in offensive force reductions and verifiable agreements on development and deployment of defensive systems, then the possiblity exists for slowing the rate of funding from an all out technology-limited pace. However, given the premise that new strategic defenses will eventually be needed for stability, it follows that the rate of funding should consider the factors above and should not be slowed by resource constraints alone. If it were, the United States would run the risk of falling behind the Soviets both offensively and defensively, seriously limiting the ability of SDI ever to develop a system that would be effective against an everchanging strategic threat.

Both of these pro-SDI scenarios seem to dictate the need for large near-term funding to accomplish their objectives. If the assumptions behind these scenarios are correct, then a decision to pursue either option without appropriate funding would likely doom them to failure. Nonetheless, the issue of what constitutes appropriate funding for either case remains unresolved.

STRATEGIC POLICY/MILITARY UTILITY

The strategic policy and military utility implications of SDI are as yet arguable because they depend on four speculative issues: 1) the type of strategic defense system that will be deployed, its primary mission, and its effectiveness; 2) the evolution and composition of Soviet offensive and defensive forces; 3) arms control constraints in place at that time;

and 4) the impact of both U.S. and Soviet strategic defenses on U.S. strategic objectives and strategic stability.

President Reagan believes that we can develop strategic defense technologies that can destroy ballistic missiles in flight, thus eliminating the military utility of nuclear weapons and ending U.S. reliance on the strategic doctrine of deterrence by threat of retaliation. These defenses, the Reagan Administration argues, will lead to significant reductions in strategic forces by rendering nuclear weapons "impotent and obsolete." The superpowers would no longer compete in a nuclear arms race and neither side would have an incentive to attack the other in a crisis. 22/

Others, however, believe that the United States can develop, at best, a partial version of the strategic defense system envisioned by President Reagan. Limited defense systems could defend against accidental or small Soviet attacks or attacks from other countries, and protect missile silos or critical military facilities, they argue. These defenses would strengthen deterrence and strategic stability (through threat of retaliation) by ensuring that the United States would retain a strong post-attack retaliatory nuclear force. 23/

Some argue though that strategic defenses are inherently unstable because defenses cannot be made perfect and that the destructiveness of nuclear weapons cannot be changed. Therefore, imperfect defenses that would allow even a few nuclear weapons to penetrate would cause widespread destruction. This ensures that reliance on offensive nuclear weapons to deter Soviet attack on the United States will continue indefinitely. Strategic defenses also could be used to

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22/ U.S. President, The President's Strategic Defense Initiative, 10 p.

23/ Sloss, Leon. The Return of Strategic Defense. Strategic Review, v. 12, Summer 1984. p. 37-44.

protect missiles in ways that would prove destabilizing, according to this view. Limited defenses could be used, for example, to defend against any surviving missiles that might be launched by an opponent after the other side had attacked first. This would create strong temptations in a crisis to attack first. 24/

All agree, however, that the potential risks of strategic defenses to crisis stability (the degree to which deterrence is resistant to failure in a major crisis) are high. Therefore, if it is decided to deploy any level of strategic defenses, most agree that carefully crafted offensive and defensive force structures coupled with well-defined arms control constraints will be required to further U.S. strategic policy goals.

ARMS CONTROL

The U.S. debate over arms control and SDI divides into near- and long-term issues. Near-term issues focus on permissible activities and are tied primarily to the ABM Treaty, with which the Reagan Administration says the SDI will comply. The ABM Treaty does not restrict research, although views differ on what constitutes research and whether some planned SDI activities are included. The Treaty does prohibit developing, testing, or deploying air-based, sea-based, space-based, and mobile land-based ABM systems and components; and it limits deployment of fixed, land-based systems or components. Near-term issues can be summarized as follows:

- o The controversy over certain Treaty definitions, including what constitutes an ABM "component", "testing" in an ABM mode, "development", and even "strategic ballistic missiles." At issue is the precise definition of these terms and whether certain SDI activities, especially "technology demonstrations" and future

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24/ Bundy, McGeorge, George F. Kennan, Robert S. McNamara, and Gerard C. Smith. The President's Choice: 'Star Wars' or Arms Control. Foreign Affairs, v. 63, Winter 1984/85. p. 264-278.

tests, are likely to be considered in violation of the Treaty by those who hold to different views of these terms.

o Interpretation of "new physical principles" (e.g., lasers, particle beams, microwaves) as discussed in Agreed Statement D of the Treaty. The Administration argues that a broad view of the Treaty is justified, which allows developing and testing of all systems or components based on future technologies, rather than just land-based systems. Others, who negotiated the Treaty (e.g., Ambassador Gerard Smith), argue that such a view is wrong and that the historical, restrictive view prohibiting testing of such technologies--which the United States and the Soviet Union have been following--is correct. 25/ The Administration has announced it would adhere to the restrictive interpretation for now. 26/

o The so-called non-circumvention provision that prohibits deployment or transfer of ABM components or technology to third parties. This is relevant to potential allied involvement in SDI and related research, particularly the development of theater ballistic missile defenses with the Allies.

o The dual-use potential of certain technologies. These are technologies that have ABM applications, but are employed in systems (e.g., phased-array radars, advanced air defenses, anti-tactical missiles, and anti-satellite weapons) outside the purview of the ABM Treaty.

The debate also considers the longer-term relationship of strategic defense and arms control. Some suggest that strategic defenses can lead to deep arms reductions and a more stable strategic relationship among the nuclear powers. The Reagan Administration takes this position and outlines a three-phase transition to a defense dominated strategy: near-term SDI research, later reductions of offensive forces, and finally deployment of effective strategic defenses that would render nuclear weapons "impotent and obsolete." 27/ An opposing

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25/ Interview with Ambassador Gerard C. Smith. Meet the Press. Nov. 10, 1985.

26/ See: Secretary of State George Shultz speech before the North Atlantic Assembly, San Francisco, Califiornia, Oct. 14, 1985. Excerpts reprinted in New York Times, Oct. 15, 1985. p. A6.

27/ See U.S. Library of Conress. Congressional Research Service. The New Strategic Concept. Report no. 85-134 F, by Robert Jackson, Apr. 18, 1985. 17 p. Also: Nitze, Paul, On the Road to a More Stable Peace.

view is that strategic defenses and arms control are incompatible because, they argue, strategic defenses will lead to an offense-defense arms race that arms control will be unable to contain. 28/ A third view accepts that, although perfect defenses are not likely, limited defenses under certain circumstances can enhance arms control stability--the degree to which opposing force structures are in a balance that is relatively impervious to sudden alteration from new arms deployments or weapons technology innovation--by ensuring a survivable retaliatory force. 29/ Those who adopt the first two approaches, criticize the third approach as dangerous in its potential to increase the likelihood of nuclear war because it could create, through mixing defensive and offensive forces, strong incentives to use nuclear weapons first in a crisis or risk losing them.

ALLIANCE REACTIONS

The Allied response to SDI has evolved over time from opposition, which was initially widespread and non-specific, to one of general ambivalence. On one hand, there is support for SDI research primarily because the Soviets are conducting a vigorous strategic defense research program of their own. But, on the other hand, there are serious reservations about the United States going beyond a research program. The character of allied reservations stems from three main sources: the alliance relationship, European security, and U.S.-Soviet relations. The Allies have also demonstrated concern over the future competitiveness of their "high-tech" industries and have responded with two initiatives of their

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28/ Bundy, Kennan, McNamara, and Smith, The President's Choice: 'Star Wars' or Arms Control, p. 264-278.

29/ Gray, Colin, S. Deterrence, Arms Control, and the Defense Transition. Orbis, v. 28, Summer 1984. p. 227-240.

own: EUREKA (European Research Cooperation Agency) and EDI (European Defense Initiative). These issues are addressed below.

(1) The overall Alliance relationship. The Allies desire equal partnership and early consultation on major decisions that affect the Alliance, such as SDI (which they did not get). They are also concerned that lack of mutually-agreed upon strategic defense objectives for SDI (primarily whether or how Europe would be defended) provides the Soviets with propaganda opportunities to weaken the Alliance by exploiting differences in U.S.-European views over strategic defenses and arms control.

(2) European security. The Europeans are concerned that SDI in the near term will divert attention from conventional defense needs (i.e, materiel to support a conventional war). They also fear that SDI rejects the strategy of deterrence by threat of assured retaliation, which forms the basis of European security, because Soviet strategic defenses eventually will degrade the deterrent role of British and French nuclear forces and U.S. strategic defenses will decouple the United States from European security. Should this occur, it is argued, Europe becomes safe for superpower conventional war.

(3) U.S.-Soviet relations. Many Europeans fear that through SDI the United States seeks strategic and technological superiority over the Soviets, and that existing arms race constraints (e.g., the ABM Treaty and SALT agreements) will be abandoned. Should this happen, superpower relations would become destabilized and Europe would be caught in a dilemma between trying to maintain Alliance commitments with the United States and the desire for stable relations with the Soviet Union. 30/

30/ See U.S. Library of Congress. Congressional Research Service. The SDI and U.S. Alliance Strategy, Report no. 85-48 F, Paul E. Gallis, Mark M. Lowenthal, and Marcia S. Smith, Feb. 1, 1985. Washington, 1985. 75 p.

Even so, the United States has encouraged an active Allied role in SDI. Defense Secretary Weinberger solicited their participation in it in March 1985 when he sent a letter of invitation to U.S. Allies. The Allied response has not been enthusiastic, except for some in industry, who are eager to join in a large "high-tech" research program.

Allied governments appear resolved that SDI is going ahead, and have sought to preserve their own interests and industrial potential in several ways. One such way is in their formal response to the U.S. invitation. Several governments (France, Canada, Denmark, Netherlands, and Norway) have strongly criticized the SDI and refused to participate, but have indicated that private industry could do so on its own. Other governments (Greece and Australia) that have refused to participate and are opposed to SDI have not taken a position regarding private industry participation. Finally, there are some government-to-government discussions regarding industrial participation in SDI research. One agreement was recently signed with Britain; while talks with Germany and Italy continue. The Japanese are withholding a response until a German decision is made and further talks are held with the United States. The major obstacles to such agreements revolve around technology transfer restrictions, research rights, and funding levels.

Europe also has responded to the challenges of SDI through a French-led proposal known as EUREKA, which is to stimulate cooperation in "high-tech" research for civilian commercial uses. EUREKA's purpose is to help close the technological gap with the United States and Japan by promoting the competitiveness of European "high-tech" goods in the marketplace, and by supporting the growth of European technological expertise in the face of challenges from SDI and other U.S. "high-tech" research programs. EUREKA will emphasize European collaboration in developing supercomputers, artificial intelligence and

robotics, lasers and particle beams, opto-electronics, new materials, and high-speed microelectronics. Although EUREKA currently lacks a coordinated structure and major funding, several pilot projects have been approved. EUREKA is officially endorsed throughout Europe.

A third major response to SDI is a military program--the European Defense Initiative (EDI). Those countries most committed to this idea are France and Germany, but Britain and the Netherlands are also involved. EDI's objectives are to develop: 1) an integrated theater air-defense system for Europe (with U.S. help), including upgraded surface-to-air missiles and advanced anti-missile technologies; 2) "smart weapons" and modern real-time information and delivery systems for NATO defense; and, 3) a European surveillance satellite. EDI appeals to European interests because it leads to a joint defense strategy, keeps European aerospace expertise in Europe and under European control, and helps keep European industry at a competitive level in the commercial space market.

TECHNOLOGY TRANSFER CONCERNS

The SDI program is a broad-based and fundamental research effort involving advanced developments in science and technology (S&T). According to the SDIO, the program will be conducted "in the open" as much as possible, and Allied participation is actively being sought. The character of the program raises two concerns about technology transfer. One is that the program will be a priority target of the Soviet Union's effort to acquire Western technology that has potential military applications. This will be a problem in both the United States and Allied countries. The other is that Allied participation could give their industries access to technological breakthroughs which could enable them to compete with U.S. industry.

Because of the broad-based nature of the SDI research effort, some of its results will probably have many potential applications, both military (besides strategic defense) and civilian. The Soviets have had for many years a broad scale effort to acquire Western technology which has military applications. 31/ The most recent reporting from the intelligence community categorizes Soviet requirements to be in areas which are applicable to a wide variety of weapons and space systems. 32/ Almost all of the areas are under study by, and are relevant to many aspects of, the SDI program.

The problem of potential Soviet access to Western scientific and technical advances has long been recognized. The United States has a vigorous program of export control law enforcement, public and industrial awareness, and cooperation with our Allies to stem the losses. Concerns over SDI research have been reflected in Allied discussions, but philosophical differences appear to remain. Allied industry is pushing for maximum access and minimal controls, while the United States prefers more stringent safeguards. The Allies want to be sure that their industry will be able to take maximum advantage of research results, without being encumbered by restrictions imposed on work funded by the United States.

Concern in the United States about Allied participation from the standpoint of economic competition seems, at present, less well recognized. Starkly put, will the U.S. taxpayer be funding research efforts in foreign countries that will in part enhance foreign ability to compete with U.S. industry?

The Europeans quickly recognized the inverse problem; U.S. companies receiving SDI research funding could gain considerable competitive advantage

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31/ Soviet Acquisition of Western Technology. Apr. 1982. 15 p.

32/ Soviet Acquisition of Militarily Significant Western Technology: An Update. Sept. 1985. 34 p.

over their firms. While some will participate in SDI, a group of 18 European countries has launched a concurrent civilian research program called EUREKA (see above).

In summary, the United States is thus faced with a difficult balancing act to perform. For political, scientific, technological, and to a lesser extent, financial reasons, the United States wants to conduct the SDI program as much in the open and with as much Allied participation as possible. But, an open program with foreign participation raises two technology transfer concerns--potential Soviet access for military gain and Allied access for commercial gain. These concerns will continue to present demanding challenges for the United States as SDI proceeds.

MILITARIZATION OF SPACE

The issue of the militarization of space often generates considerable emotional reaction. Since the dawn of the space age, many have felt that space should be used for peaceful purposes only. Several international treaties, to which the United States is a party, foster this goal. For example, nuclear weapons and nuclear weapons tests in space are banned, and freedom of scientific investigation is upheld. 33/

Civilian, especially manned, space activities are generally well known. Less well known to the general public are activities in space for national security purposes. Both the United States and Soviet Union recognized the military value of space early on, and have made use of it extensively to support terrestrial

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33/ See: U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Space Law-Selected Basic Documents, Second Ed., Committee Print, 95th Cong., 2d Sess., Washington, U.S. Govt. Print. Off., 1978. 600 p.

military and national security needs. Both countries have military communications, navigation, early warning and weather satellites. And both have photo-reconnaissance and other intelligence collection satellites which are used, among other things, to monitor arms control agreements. Furthermore, the Soviets have tested several military space systems which have no U.S. counterpart. These include operational systems such as a co-orbital antisatellite (ASAT) system and a radar ocean reconnaissance satellite (RORSAT), which has a nuclear power reactor; a now obsolete fractional orbital bombardment system (FOBS); and, a space plane under development. 34/

Thus, space is already heavily militarized. The more salient issue with regard to SDI is whether it should be allowed to become weaponized, that is, whether weapons should be allowed to be placed in Earth orbit. (Note that the 1967 Outer Space Treaty bans only "nuclear weapons or any other kinds of weapons of mass destruction" from space.)

Some argue that we should keep space pristine, not allowing our terrestrial arms race to extend into space. In this view, nations must continue to adhere to peaceful intentions for space. Most who hold this view feel that once even a single weapon is allowed in space, nations will foreclose forever any hope of keeping space weapons-free. 35/

Supporters of SDI generally subscribe to the view that space is merely another realm for human endeavor. As nations have extended their domain to the sea and the air, they have developed a need to deploy weapon systems in

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34/ For more details on ASATs, see Congressional Research Service, Antisatellite Weapon Systems.

35/ Justin, Joseph E. Space: A Sanctuary, the High Ground, or a Military Theater? In International Security Dimensions of Space. Medford, Massachusetts, the Fletcher School of Law and Diplomacy of Tufts University, 1984. p. 102-115.

those realms. By extension, in the view of supporters, it is inevitable that space be used in like fashion; some aver nations would be foolish to deny themselves the chance. 36/

The lack of national boundaries in space has permitted a host of peaceful, civilian space endeavors to proceed unimpeded. One can make an analogy with Antarctica, noting that international agreements have kept it weapons-free. (Note, it is, like space, an inhospitable environment.) On the other hand, one can also make an analogy with the sea, noting that international law and agreed procedures allow many military ships to operate in a generally peaceful manner. "Rules of the road" for space, some suggest should be developed along similar lines. For example, nations could agree on a "keep-out zone" around satellites. Any approach of an object to a satellite which came within the zone would be considered a hostile act.

As technologies advance, as nations become more adept at space operations, and as our dependence on space systems grows, the military utility of maintaining assured access to space will undoubtedly increase. Even without SDI, then, it will likely become increasingly attractive from a military standpoint for the United States to possess some types of weapons to assure both the launch of new satellites and the defense of those already in orbit. Some weapons, such as ASATs, could undoubtedly be based on Earth (the Soviets' ASAT already is). But, ASATs alone may not meet all of these potential military needs. If the United States refrains from deploying weapons in space, will it be foreclosing an opportunity to improve national security by using space in the long term to eliminate

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36/ Ibid., p. 104-106.

nuclear weapons on Earth? Or, would U.S. long-term national security interests be better served by continuing to preclude weapons in space? A key element in the U.S. decision whether or not to deploy weapons in space is the confidence placed in the United States' ability to monitor the space activities of the Soviet Union and other countries for evidence of their clandestinely placing weapons in orbit, or developing a capability to do so quickly.

CONCLUDING REMARKS

Congress directs the rate and focus of the SDI primarily through the DOD authorization and appropriations process. The SDI has enjoyed substantial funding increases in FY85 and FY86. Nonetheless, appropriated amounts have fallen significantly short of DOD requests. In FY86, $2.75 billion was appropriated out of a requested $3.7 billion, following a $1.4 billion appropriation the year before. Allocation of FY86 money across the research programs was left to the discretion of the SDIO Director.

Many issues will probably influence SDI policy. Assessment of these issues, together with a better understanding of SDI program definition and objectives, will likely lead Congress to scrutinize SDI program elements more closely than in the past. Furthermore, future congressional actions affecting the SDI are likely to be affected by two additional factors that are somewhat extraneous to SDI. They are: 1) fiscal constraints imposed by efforts to reduce the Federal budget deficit; and 2) the presence or absence of new arms agreements between the United States and the Soviet Union.

APPENDIX A: COMMISSIONED STUDIES

Two studies were commissioned by the President to make recommendations on how to proceed following his speech. They were the Defensive Technologies Study and the Future Security Strategy Study. The former, also known as the Fletcher Study (headed by former NASA Administrator James Fletcher), assessed technical issues. It concluded that:

(1) technology does not now exist to provide a basis for a decision to produce and deploy actual weapon systems that are capable of satisfying the President's goals;

(2) powerful new technologies are becoming available, however, that justify a major technology development effort to provide future technical options to defend against ballistic missiles;

(3) research and technology development should be initiated of a multi-layered defense to destroy incoming ballistic missiles at any and all stages of their trajectory (e.g., boost, during which the missile is launched and ascends into space; post-boost, during which up to perhaps 10 independently targeted warheads might be released from the missile; mid-course, during which the warheads or re-entry vehicles (RVs) and perhaps decoys travel on ballistic trajectories through space; and terminal, during which the RVs plummet toward their targets on Earth);

(4) the ability to develop sensors and battle management systems many times more effective than those now in use would be needed for an effective multi-layered defense;

(5) the defensive system ultimately should have the capability to destroy missiles in the boost phase before multiple warheads are deployed, necessitating that certain system components be based in space; and

(6) an informed decision on system development cannot be made before the end of the decade, but there are near-term demonstrations that would indicate progress as well as U.S. resolve to explore the potential of a new ballistic missile defense (BMD) system. 37/

37/ U.S. Dept. of Defense. The Strategic Defense Initiative: Defensive Technologies Study. Apr. 1984. Washington, U.S. Govt. Print. Off., 1984. p. 2.

The latter study, also known as the Hoffman Study (headed by Fred Hoffman of Pan Heuristics), addressed policy issues. It concluded that:

(1) pursuit of advanced defensive technologies could offer options to enhance deterrence and increase strategic stability;

(2) some uncertainties remain regarding stability and deterrence that will not be resolved fully until more is known about the technical characteristics of defensive systems and how the Soviet Union will respond to the U.S. initiative;

(3) these uncertainties notwithstanding, options for deployment of advanced BMD should be studied further and a broad-based research and development (R&D) effort would provide a necessary and vital hedge against the possibility of a one-sided Soviet deployment;

(4) defensive systems must afford security to U.S. allies and cannot reduce America's capability to maintain commitments around the world so that, even as R&D is pursued, a strong and modern offensive deterrence capability will still be required; and

(5) initially, a broad research program on defensive technologies will be entirely consistent with existing U.S. arms control obligations. 36/

38/ U.S. Dept. of Defense. Defense Against Ballistic Missiles: An Assessment of Technologies and Policy Implications. Apr. 1984. Washington, U.S. Govt. Print. Off., 1984. p. 1-7.

APPENDIX B: CHRONOLOGY OF EVENTS

12/19/85 -- FY86 DOD appropriations passed House and Senate as part of H.J. Res. 465 and was signed into law (P.L. 99-190). The SDI was appropriated $2.75 billion plus $9.222 million for SDI Headquarters management.

11/19/85 -- President Reagan met with Soviet Premier Gorbachev in Geneva.

11/08/85 -- FY86 DOD authorization bill was signed into law (P.L. 99-145). The SDI funding level authorized was $2.75 billion.

03/12/85 -- New arms control talks between the U.S. and U.S.S.R. began in Geneva.

01/07/85 -- Secretary of State Shultz and Soviet Foreign Minister Gromyko met in Geneva. They agreed to new arms control talks in the strategic, theater, and space arenas.

05/18/84 -- Representative Fascell released an interim report from the House Foreign Affairs Committee calling for a new space arms control policy.

03/27/84 -- Lt. Gen. James Abrahamson was named director of the Strategic Defense Initiative.

03/23/83 -- President Reagan made a nationally televised address in which he announced the initiation of a comprehensive and intensive effort to define an R&D program leading to a defensive system to destroy ballistic missiles.

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