CBO PAPERS

COSTS OF ALTERNATIVE APPROACHES TO SDI

May 1992

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NOTES

Unless otherwise indicated, all years referred to in this paper and its tables are fiscal years, and all costs are in constant 1993 dollars of budget authority.

Details in the text and tables of this paper may not add to totals because of rounding.

Costs for the Administration's plan reflect most of the changes to the budget proposed by the Director of the Strategic Defense Initiative Organization in his testimony before the Senate Committee on Armed Services on May 20, 1992. However, possible rescissions of 1992 funds for strategic defenses are not reflected in the paper. Also not reflected are changes in Strategic Defense Initiative funding for 1993 that the House Committee on Armed Services has recommended.

PREFACE

Last year, the Congress passed the Missile Defense Act of 1991. The act calls for the deployment of defenses--as soon as possible--to protect the United States from attacks by a limited number of long-range ballistic missiles, and to protect U.S. troops and allies from attacks by missiles of less-than-intercontinental range. The act does not, however, specify the size and nature of the defenses that should be deployed. Nor does it specify when a full system of defenses should be in place. The Administration has modified its plans for strategic defenses to respond to the act. But critics have other ideas about what types of defenses are appropriate, when they should be deployed, and how much should be spent on the Strategic Defense Initiative.

This Congressional Budget Office (CBO) paper analyzes the costs of the Administration's plan for strategic defenses and the costs of alternative approaches. All of the alternatives would provide for eventual deployment of defenses but, at least through 1997, would cost less than the Administration's approach. The paper was requested by four members of the House Committee on Armed Services: the Chairman of the Committee; the Chairman of the Subcommittee on Research and Development; the Chairman of the Subcommittee on Seapower and Strategic and Critical Materials; and the Chairman of the Panel on Department of Energy Defense Nuclear Facilities. In keeping with CBO's mandate to provide objective and nonpartisan analyses, the paper makes no recommendations.

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SUMMARY

In the Missile Defense Act of 1991, the Congress declared a new policy goal: the nation should strive to deploy defenses to protect itself against attacks by a limited number of ballistic missiles. The act represented the first time since the inception of the Strategic Defense Initiative (SDI) in 1983 that the Congress has explicitly supported the Administration's aim of deploying a system of missile defenses in the United States.

Defenses against ballistic missiles would consist of three components: sensors, based on the ground or in space, to detect incoming missiles; interceptors, also based on the ground or in space, to intercept and destroy the missiles or their warheads; and a command system to coordinate all activities.

The Missile Defense Act directed the Administration to begin deploying by 1996--or as soon as technically feasible--a limited defense that would comply with the Anti-Ballistic Missile (ABM) Treaty. The act envisions the subsequent deployment of more capable defenses, if needed, that could include additional sites as well as space-based sensors; those defenses would require that the United States renegotiate or withdraw from the ABM treaty.

The Missile Defense Act also declared that, by the mid-1990s, the nation should deploy defenses to provide protection from ballistic missile attacks directed against U.S. troops operating in overseas theaters and against U.S. allies. This system of theater missile defenses (TMDs) would defend against missiles of less-than-intercontinental range (such as the SCUDs used by Iraq).

Although the Congress has asked the Administration to report formally on its blueprint to implement the Missile Defense Act in June of this year, Administration officials have already discussed the broad outlines of the new plan (see Summary Table 1). This Congressional Budget Office (CBO) paper relies on those discussions and other preliminary information to analyze the costs of the Administration's new SDI program and various alternatives to it. The information is needed now because some Congressional action on the SDI budget will take place before the June report is submitted.

Cost of the Administration's Plan

For 1993, the Administration has requested $5.4 billion to begin implementing its new plan for SDI. Based on preliminary data, CBO's analysis suggests that in the years between 1994 and 1997, SDI funding under the Administration's

SUMMARY TABLE 1. DESCRIPTION OF ALTERNATIVE DEFENSE SYSTEMS

Defense Option	Deployment Schedule[a]		Five-Year Reductions in R&D Funding Compared with Administration's Plan (Percent)		
	Grand Forks	Full GPALS	LDS Engineering & Technology	Other Follow-On Systems	Research & Support Activities
Administration's Plan	1997	2000[b]	n.a.	n.a.	n.a.
Alternative I	1997	After 2005	10	30	20
Alternative II	2000	After 2005	40	30	50
Alternative III	2003	After 2005	60	50	60

SOURCE: Congressional Budget Office based on Department of Defense data.

NOTE: R&D = research and development; GPALS = Global Protection Against Limited Strikes; LDS = Limited Defense System; n.a. = not applicable.

a. In all options, theater missile defenses are deployed according to the Administration's plan. Deployment date refers to initial operation; full capability would occur a few years later.

b. According to recent Administration testimony, Brilliant Pebbles may not be deployed for several years after 2000.

new plan could average about $8 billion a year (see Summary Table 2). (All costs in this paper are expressed in constant 1993 dollars of budget authority.)

According to testimony by the Director of the Strategic Defense Initiative Organization (SDIO)--the agency that manages the SDI program-- the new plan envisions deploying a single-site defense at Grand Forks, North Dakota, by late 1997. Grand Forks would constitute the initial site in a larger system of defenses. That system, including additional interceptor sites and space-based sensors, would be deployed around the year 2000. Space-based interceptors would be added a few years later. The Administration also would deploy theater missile defenses; some elements would be deployed in the mid-1990s, others closer to the turn of the century. This larger system of defenses, including the TMDs, was labeled Global Protection Against Limited Strikes (GPALS) by the SDIO last year. Throughout this paper, the term GPALS is used to describe the larger system of defenses in the Administration's new plan.

Costs of the Administration's plan and the alternatives all include funds for theater defenses as well as for defenses to protect the nation against longer-range missiles. Costs shown are for the entire SDI budget and not just the cost of a Grand Forks or GPALS defense. The Administration does not identify the portion of the budget that is allocated to those two systems. Indeed, many activities support both, so they would be difficult to separate. In addition, the total SDI budget includes funds for research on follow-on systems that might not be part of either system.

Costs in the paper include only funds for research, development, and procurement. Costs to operate and support deployed defenses are not addressed, although they would be relatively small through 1997.

Costs of Alternatives Through 1997

In a period of declining defense budgets, it may be difficult to provide enough funding to carry out the Administration's new plan for SDI. Some critics also maintain that it is not necessary to deploy defenses quickly.

To illustrate the costs of different approaches to SDI, CBO analyzed three alternatives. The alternatives differ in how quickly deployments are accomplished and, in some cases, in the nature of the systems that are deployed. They also vary the amount of funding that is provided for research. All three provide less money for the "Brilliant Pebbles" system of space-based interceptors and the "Brilliant Eyes" system of space-based sensors. All the

SUMMARY TABLE 2. COSTS AND SAVINGS OF ALTERNATIVE DEFENSE SYSTEMS THROUGH 1997
(Budget authority in billions of 1993 dollars)

Program	1993	1994	1995	1996	1997	Five-Year Totals[a]
Program Costs						
Administration's Plan: Single-site by 1997; Full GPALS by 2000.	5.4	7.7	8.3	7.8	7.9	37.0
Alternative I: Single-site by 1997; Full GPALS after 2005; Selected research cuts;[b] Theater defenses unchanged.	5.0	6.3	6.9	6.9	6.2	31.2
Alternative II: Single-site by 2000; Full GPALS after 2005; Larger research cuts;[b] Theater defenses unchanged.	4.2	5.1	5.0	5.0	5.3	24.6
Alternative III: Single-site by 2003; Full GPALS after 2005; Largest research cuts;[b] Theater defenses unchanged.	3.3	4.3	4.2	4.2	4.0	20.0
Savings Under Alternatives						
Alternative I	0.5	1.4	1.4	0.9	1.6	5.8
Alternative II	1.3	2.6	3.2	2.7	2.6	12.4
Alternative III	2.1	3.4	4.0	3.6	3.9	16.9

SOURCES: For 1993, Congressional Budget Office based on the Administration's budget request and recent testimony; and for the 1994-1997 period, CBO estimates based on preliminary planning data from the Strategic Defense Initiative Organization.

NOTE: GPALS = Global Protection Against Limited Strikes.

a. The savings in the alternatives through 1997 are primarily generated by delaying the deployment of the full GPALS system and the Grand Forks defense. Much of the money saved in this period would eventually have to be spent if these two systems are deployed. The total cost might actually be higher than the level the Administration plans because program delays can cause inefficiencies. Total costs might also be lower than the Administration's levels if delays obviate the need for the expensive modifications sometimes required in systems that are deployed quickly.

b. See Summary Table 1 for details.

alternatives also assume that defenses against theater missiles are funded at levels the Administration proposes.

The first alternative would establish a defense at Grand Forks in 1997, as the Administration plans. In order to enhance the capability of that site, this alternative would deploy an additional system of sensors--the Ground-Based Surveillance and Tracking System (GSTS). In addition, Alternative I would delay deployment of the remaining components of the GPALS system--except theater defenses--until after 2005. Finally, Alternative I would make selected cuts in research funding related to follow-on systems and other activities (see Summary Table 1).

Under Alternative I, the SDI budget in 1993 could amount to $5 billion, a $500 million reduction from the Administration's plan (see Summary Table 2). From 1994 through 1997, based on preliminary data, CBO estimates suggest that budgets would average $6.6 billion a year, a reduction of about $1.4 billion compared with the Administration's plan.

Alternative II would delay a defense at Grand Forks until the year 2000 and would deploy much of the rest of GPALS after 2005. Reductions in expenditures for selected research activities would be larger than under Alternative I. Under this approach, SDI funding could be reduced to $4.2 billion in 1993, a savings of $1.3 billion relative to the Administration's plan. CBO estimates that budgets from 1994 through 1997 would average about $5.1 billion a year, roughly $3 billion less than under the Administration's plan.

Alternative III would delay the installation at Grand Forks still further --to the year 2003--and defer all subsequent GPALS deployments except theater defenses beyond 2005. This alternative would also eliminate all funding for Brilliant Pebbles and, among the alternatives presented in this paper, would make the largest cuts in research funding.

CBO estimates that Alternative III could reduce SDI funding to $3.3 billion in 1993, a savings of $2.1 billion compared with the Administration's plan. SDI budgets from 1994 through 1997 would average $4.2 billion a year under Alternative III, a savings of almost $4 billion.

Additional reductions--amounting to several hundred million dollars a year and perhaps substantially more--might be possible under the alternatives if the Congress decides to focus SDI efforts primarily on theater missile defenses and the 1997 deployment at Grand Forks and to place less emphasis on the subsequent deployments required for the full GPALS. With such an emphasis, additional reductions could be made in funding for systems that are

not to be deployed at Grand Forks (such as Brilliant Pebbles or Brilliant Eyes). Cuts could also be made in funding for certain engineering and support activities. Finally, cuts could be made in research aimed at developing follow-on systems that would be part of successors to GPALS. Although they would save money during the development and deployment of the Grand Forks system, these various cuts would delay deployment of the full GPALS, could increase its development costs, and might entail other risks.

Total Cost of the Alternatives

Compared with the Administration's plan, the alternatives would reduce costs through 1997, but the effect of the alternatives on the total cost to deploy the Grand Forks defense and the full GPALS system is less clear. On the one hand, total cost could remain below the level planned by the Administration if delays under the alternatives allowed more time for development and so avoided the need for expensive modifications sometimes required in systems that are deployed quickly. On the other hand, total costs under the alternatives could well be higher than the cost under the Administration's plan because slowing down a program often leads to inefficiencies that increase with the length of the delay. At a minimum, a substantial amount of the money that is saved through 1997 under the alternatives would eventually have to be spent if the Grand Forks defense and the full GPALS system are to be deployed.

Limitations of Results

The data CBO uses in this paper reflect the Administration's current estimates of costs. CBO's estimates do not attempt to account for cost increases that might occur during development of a technically challenging project such as missile defense. The estimates also rely on a number of rules of thumb. These approximations should provide rough but reasonable guides to future costs.

There are also other possible approaches to SDI that are not examined in this paper. They include options that would reduce costs further by forgoing deployment and confining SDI efforts to research. Still other options would increase costs by deploying larger and more capable defenses than GPALS would provide.

BACKGROUND

The debate over strategic defenses will be heavily influenced by the Missile Defense Act of 1991, which was passed in November of last year.

Missile Defense Act of 1991

The Missile Defense Act states that "It is a goal of the United States to . . . deploy an anti-ballistic missile system, including one or an adequate additional number of anti-ballistic missile sites and space-based sensors, that is capable of providing a highly effective defense of the United States against limited attacks of ballistic missiles . . . ." The act also declares a goal to "provide highly effective theater missile defenses (TMDs) to forward-deployed and expeditionary elements of the Armed Forces of the United States and to friends and allies . . . ."

To achieve the first goal, the Congress directed the Department of Defense (DoD) to deploy a ballistic missile defense at a single site--by 1996 or as soon as possible within the constraints of technology. The system would be designed to defend against an attack involving a limited number of missiles, such as an unauthorized attack by forces of the former Soviet Union or China or a deliberate attack that might someday be launched by a country in the developing world.

The initial deployment at the single site would have to comply with restrictions the Anti-Ballistic Missile (ABM) Treaty imposes. The treaty limits the nature of defensive systems (for example, it prohibits most space-based systems) and also limits the United States to one defensive system--located at Grand Forks--with no more than 100 interceptors.[1] The Missile Defense Act specifically excludes the Brilliant Pebbles system of space-based interceptors--which would violate the treaty--from the initial defense. The act does, however, direct the President to negotiate possible modifications to the ABM treaty with the republics of the former Soviet Union. The modifications could permit the United States to strengthen its defenses by deploying them at more than one site or by adding sensors based in space.

1. The original ABM treaty, signed in 1972, allowed the United States and the Soviet Union to have two ABM sites each--one protecting the nation's capital and one protecting an intercontinental ballistic missile (ICBM) field. In 1974, however, both parties signed a protocol to the treaty that restricted each side to either the capital or a missile field. The Soviet Union chose to keep its defense around Moscow (it still functions today and is improved periodically). The United States chose to defend an ICBM field near Grand Forks, North Dakota, but then deactivated the system in 1976. In the future, either side can deploy a defense at the other site if it notifies the other nation and dismantles the first site. When the ABM treaty is discussed these days, the 1974 protocol is considered part of the treaty.

Other than the requirement to comply with the terms of the ABM treaty, the Missile Defense Act does not specify the precise nature of the Grand Forks installation. The act also is vague about subsequent deployments. It states that additional sites and space-based sensors could be added to make the defense more effective but does not specify their fate if the ABM treaty cannot be modified.

To achieve the TMD goal, the Missile Defense Act directs the Secretary of Defense to provide effective missile defenses by the mid-1990s to protect U.S. forces operating overseas and allied and friendly nations. The act does not specify the exact nature of these theater defenses.

Components of Defensive Systems

Systems designed to defend against ballistic missile attacks typically consist of three main components. Both TMDs and defenses planned to protect the United States would include them. Because the alternatives do not change the Administration's plan for the former, the discussion below will focus on defenses for the United States.

First, there are sensors designed to detect incoming missiles and their warheads and to guide interceptors to them. These sensors can be deployed on the ground or in space. The United States is currently developing a ground-based radar (GBR) as well as Brilliant Eyes (see Box 1). A third approach, the Ground-Based Surveillance and Tracking System (GSTS), consists of a rocket-mounted sensor that would be deployed on the ground and launched into space during an attack.

Interceptors are the second major component. They would be guided toward incoming missile warheads and would destroy them by means of high-speed collisions or nearby explosions. (All of the interceptors currently under consideration for defending the United States would use the collision method.) Like sensors, interceptors can be based on the ground or in space. The Ground-Based Interceptor (GBI) would attack incoming warheads before they reenter the Earth's atmosphere. The more technically challenging Endo-Exoatmospheric Interceptor (E^2I) would also reside on the ground, from where it would intercept warheads both inside and outside the atmosphere.

Box 1.
Components of the Administration's GPALS System

INTERCEPTORS

Ground-Based Interceptor (GBI)

The exoatmospheric GBI is designed to destroy an incoming warhead while it is still outside the Earth's atmosphere. Such an interceptor is simpler to build than one designed to function inside the atmosphere because the sensors that find the attacking warhead and direct the missile to intercept it do not have to contend with the heat and stress caused by rapid flight through the atmosphere. The disadvantage of an exoatmospheric interceptor is that it cannot use much of the atmosphere to discriminate between lightweight decoys and heavier warheads. The GBI is a hit-to-kill interceptor, which means it uses the force of the collision with the incoming warhead to destroy it.

Endo-Exoatmospheric Interceptor (E^2I)

The E^2I is a hit-to-kill interceptor designed to function both inside and outside the atmosphere. Because an incoming warhead spends just a few seconds inside the atmosphere, traditional endoatmospheric interceptors must be located very near the area they are defending. The E^2I surmounts this problem by leaving the atmosphere to travel to the incoming warhead and then reentering with it, using the atmosphere to separate the warhead from decoys. That allows the interceptor to be located much farther away from the defended area than can a traditional endoatmospheric interceptor. The E^2I can also function as an exoatmospheric interceptor, although it is best suited to the other role.

Brilliant Pebbles

Based in space, Brilliant Pebbles are hit-to-kill interceptors that can intercept attacking missiles and warheads shortly after they leave the atmosphere over the attacker's country. That provides an opportunity to destroy the missiles before they have released the multiple warheads and decoys they often carry. The Strategic Defense Initiative Organization also plans to make Brilliant Pebbles capable of intercepting warheads long after they leave the atmosphere. Because

(Continued)

Box 1 (Continued)

they must orbit the Earth, however, few Brilliant Pebbles are ever situated in the correct position for a particular intercept; as a result, roughly a thousand of them must be deployed to achieve adequate coverage in the Global Protection Against Limited Strikes (GPALS) system.

SENSORS

Ground-Based Radar (GBR)

The GBR would be located at each ground-based interceptor site to track incoming warheads and guide the interceptors to them. GBR coverage is limited by the horizon; so other sensors--additional radars or the GSTS or Brilliant Eyes sensors described below--could be used to enhance coverage.

Ground-Based Surveillance and Tracking System (GSTS)

This is an infrared sensor based on the ground but launched into space on a suborbital trajectory to locate and track incoming warheads when they are still over the horizon and cannot be seen by the ground-based radar. Although included in early versions of the GPALS system, GSTS is not part of the current version of GPALS the Administration proposes.

Brilliant Eyes

Much like GSTS in function, these sensors would be based on satellites. From their vantage point closer to the launch location of the attacking missile, Brilliant Eyes would have a longer look at incoming warheads than GSTS would have.

COMMAND AND CONTROL SYSTEM

Battle Management/Command and Control System

This system would continuously collect data from all the sensors, process it to form a detailed picture of the nature of the attack, and provide the necessary information to enable the commander to direct the sensors and weapons to intercept the warheads.

Finally, the Brilliant Pebbles system would be based in space, where it would begin to intercept missiles and warheads shortly after they leave the atmosphere of the attacking country.

The third component is the command element. This system functions as the brain and nervous system of the defense. It would collect and process data from the sensors, and provide the information necessary to enable the commander to coordinate the defense.

THE ADMINISTRATION'S PLAN

In response to the Missile Defense Act, the Administration has modified its plans somewhat. It still intends to deploy most of the components of the Global Protection Against Limited Strikes (GPALS) system unveiled last year, but it has accelerated some programs and delayed or terminated others in order to complete a deployment at Grand Forks more rapidly.

The Administration will not announce the details of its revised plan for strategic defenses until June 1992, when, under the terms of the Missile Defense Act, it must submit a report to the Congress. In order to supply information in time for the Congressional action that will take place before the report is submitted, the analysis in this paper relies on statements SDIO officials made in recent Congressional testimony as well as on various assumptions.

Description of Planned System

The Administration's plan envisions relatively rapid deployment of a single-site system designed to defend the United States, followed shortly by a larger defense that would include multiple sites, space-based sensors, and perhaps space-based interceptors. The Administration also plans to develop quickly a system of theater defenses for troops overseas, expanded eventually by adding a more capable system designed to protect larger areas such as the territories of allies threatened by regional conflict.

Grand Forks Deployment. According to the Strategic Defense Initiative Organization (SDIO), the Administration's plan for U.S. defenses will begin with deployment of an ABM-compliant system at Grand Forks in late 1997. Although the Missile Defense Act stated a preference for 1996, recent statements by the Director of the SDIO before the Congress indicate that the Administration believes such an early deployment would be difficult to achieve. In this paper, CBO assumes that the Administration plans to have

the first components of the Grand Forks system operational by the end of fiscal year 1997.

According to the SDIO, the system deployed at Grand Forks would consist of a ground-based radar, up to 100 Ground-Based Interceptors, and a battle management/command and control system (see Table 1). The Administration has also reportedly made a number of choices about the specific systems for Grand Forks. The initial deployment will apparently use as its sensor only a GBR, although the Administration is actively exploring options that would upgrade existing early-warning radars. The GSTS, a sensor that would detect and track incoming warheads when they are still over the horizon, would not be deployed under the Administration's plan. Instead, the SDIO intends to terminate the program after 1993, although the program could be resurrected if needed.

To provide interceptors at Grand Forks, the Administration intends to deploy initially the Ground-Based Interceptor rather than the more sophisticated Endo-Exoatmospheric Interceptor. That decision reflects the Administration's judgment that the GBI would be easier to deploy quickly because its technology is more fully developed. However, that particular GBI system would not be the same as the one planned last year. Because the GBI would be deployed roughly three years earlier than planned, the SDIO would have to halt development at its current stage, forgoing more advanced technologies. Those technologies could be included in GBI systems deployed later at the additional sites that the Administration plans to establish.

Under the Administration's new plan, the E^2I interceptors would become a technology demonstration effort rather than a system development effort. As a consequence, its funding would be sharply reduced. The results of this effort could be incorporated into a new version of the GBI after 1997.

Theater Missile Defense Deployment. The Administration plans to begin deploying TMDs in the mid-1990s to comply with the Missile Defense Act. They would improve the Patriot antimissile system that was used in the Persian Gulf War. Around the year 2000, the SDIO plans to add a more capable system to its theater defenses--the Theater High-Altitude Area Defense--that would be able to defend much larger areas than could the improved Patriot system. A prototype of this system would be available for use in the mid-1990s.

Deployment of Multiple Sites and Space-Based Interceptors. In the second phase of its plan, to be implemented around the year 2000, the Administration

TABLE 1. INTERCEPTORS AND SENSORS UNDER THE ADMINISTRATION'S PLAN AND ALTERNATIVES

Defense Option	Number of Interceptors			Number of Sensors		
	GBI	E^2I[a]	BP	GBR	BE	GSTS
Administration's Plan[b]						
Grand Forks	100	0	0	1	0	0[d]
Full GPALS	750	0	1,000[c]	5-7	40-60	0[d]
Alternatives I, II, and III[b]						
Grand Forks	100	0	0[e]	1	0[f]	4-7
Full GPALS	750	0	1,000	5-7	40-60	0

SOURCE: Congressional Budget Office based on Department of Defense data.

NOTE: GBI = Ground-Based Interceptor; E^2I = Endo-Exoatmospheric Interceptor; BP = Brilliant Pebbles; GBR = ground-based radar; BE = Brilliant Eyes; GSTS = Ground-Based Surveillance and Tracking System; GPALS = Global Protection Against Limited Strikes.

a. The E^2I program will be terminated after 1992; a technology development effort will continue funding for some portions of the system.
b. Theater missile defenses in all options are deployed according to the Administration's plan.
c. According to recent testimony by the Administration, Brilliant Pebbles may be deployed several years after 2000.
d. The GSTS program will be terminated in the Administration's plan after 1993; no deployment is planned.
e. Alternatives I and II fund research and development for Brilliant Pebbles at reduced levels through 1997. Alternative III terminates all funding for space-based interceptors.
f. Research and development for Brilliant Eyes is funded at reduced levels through 1997.

would expand the system of U.S. defenses by deploying ground-based defenses at additional sites and by adding space-based sensors (see Summary Table 1). This larger system would apparently include 750 GBIs deployed at about a half dozen sites, along with a ground-based radar at each site, a total of 40 to 60 space-based sensors (Brilliant Eyes), and an upgraded battle management/ command and control system (see Table 1). Eventually, the larger system would also include Brilliant Pebbles. According to the Director of the SDIO, deployment of Brilliant Pebbles would be delayed until a few years after 2000 because funding for the program would be reduced to offset the increased costs necessary to achieve an earlier installation at Grand Forks.

The Administration believes this larger system of defenses would satisfy the requirements of the Missile Defense Act. The larger system--including theater, U.S, and space-based defenses--is essentially the same as the GPALS system outlined by the Administration last year; the major difference is that the schedule for deploying some of the components has been altered. (CBO uses the term GPALS throughout this paper to describe the larger system that would be deployed eventually under the Administration's new plan.)

Program Elements of the Administration's SDI Budget

Five program elements within the Administration's SDI budget fund the various deployments. Because these program elements are important in specifying the nature of the alternatives analyzed and in estimating their costs, this section provides a description of each element.

Following the mandate in the Missile Defense Act, the five program elements are Space-Based Interceptors, Theater Missile Defenses, Limited Defense System, Other Follow-On Systems, and Research and Support Activities. The first three--referred to jointly in this paper as the GPALS program elements--include the resources to develop all the components of the system to be deployed at Grand Forks and under the GPALS system (see Table 2).

The Limited Defense System (LDS) would finance most of the defense components that would protect the United States, including Ground-Based Interceptors, ground-based radars, Brilliant Eyes, and the battle management/command and control system. The Space-Based Interceptors (SBI) element would develop Brilliant Pebbles. The TMD element would finance the components of a defense to protect U.S. troops and allies overseas from ballistic missiles of less-than-intercontinental range.

TABLE 2. ACQUISITION COSTS OF THE ADMINISTRATION'S SDI PROGRAM THROUGH 1997
(Budget authority in billions of 1993 dollars)

Program Element	Amended 1993	1994	1995	1996	1997	Total 1993-1997
Space-Based Interceptors	0.6	0.6	0.6	0.6	0.6	3.0
Theater Missile Defenses	1.1	2.0	2.0	1.9	1.7	8.7
Limited Defense System	2.4	3.3	3.9	3.6	3.4	16.6
Other Follow-On Systems	0.6	0.9	0.9	1.0	1.0	4.4
Research and Support Activities	0.8	0.8	0.9	0.9	0.9	4.2
Total	5.4	7.7	8.3	7.8	7.9	37.0

SOURCES: For 1993, Congressional Budget Office based on the Administration's budget request and recent testimony; and for the 1994-1997 period, CBO estimates based on preliminary planning data from the Strategic Defense Initiative Organization.

NOTE: SDI = Strategic Defense Initiative.

The element termed Other Follow-On Systems finances development of technologies that might become available after GPALS has been deployed. That element supports work on directed-energy weapons (lasers and particle beams) and advanced interceptors and sensors.

Finally, the element for Research and Support Activities (RSA) funds those efforts that apply to SDI broadly rather than to the systems being developed under the GPALS program elements. That element supports three major activities: management support for the SDI program--primarily the costs of the SDIO and other agencies; development and maintenance of test and evaluation facilities that would be used by projects in more than one GPALS program element; and small research projects performed principally by universities and small businesses.

Subsequent discussions of the alternatives in this paper distinguish between activities within certain program elements that relate directly to the development of systems that would be deployed and activities that provide indirect support for the SDI effort. To illustrate that distinction, CBO has presented the costs for the LDS program element in those two categories. A similar allocation could be made within the other two GPALS program elements--Space-Based Interceptors and Theater Missile Defenses.

The LDS program element includes activities that relate directly to the development of systems--the Ground-Based Interceptor and ground-based radar, Brilliant Eyes, and the battle management system. In Table 3, CBO places those activities within the category labeled LDS Systems. The funding for each system includes all the research, development, testing, evaluation, and procurement necessary to deploy it.

Some activities within the LDS program element relate only indirectly to systems to be deployed; they have been placed under the heading LDS Engineering and Technology, which includes three subcategories. "Systems Engineering" encompasses the engineering, integration, and testing that would enable the different systems to function together as an integrated defense. "Risk Mitigation, Hedges, and Product Improvements" develops technologies that could have several uses: providing substitutes if a program experiences technical difficulties, upgrading defensive systems, or providing a hedge against unforeseen threats that might undermine the effectiveness of U.S. defenses.

The third subcategory--"Threat Evaluation, Phenomenology, and Other Support"--consists of activities designed to improve the ability of the defensive system to survive enemy attacks and to help it distinguish enemy warheads

TABLE 3. FUNDING BY CATEGORY IN THE LIMITED DEFENSE SYSTEM ELEMENT FOR THE ADMINISTRATION'S PLAN (Budget authority in billions of 1993 dollars)

Category	Amended 1993	1994	1995	1996	1997	Total 1993-1997
LDS Systems (Includes BE, GBI, GBR, battle management system)	1.0	1.8	2.1	2.0	1.9	8.8
LDS Engineering & Technology						
Systems Engineering	0.4	0.6	0.9	0.9	1.0	3.8
Risk Mitigation, Hedges, and Product Improvements	0.4	0.4	0.3	0.3	0.3	1.7
Threat Evaluation, Phenomenology, and Other Support	0.6	0.5	0.5	0.4	0.3	2.3
Subtotal	1.4	1.5	1.7	1.6	1.6	7.8
Total	2.4	3.3	3.9	3.6	3.4	16.6

SOURCES: For 1993, Congressional Budget Office based on the Administration's budget request and recent testimony; and for the 1994-1997 period, CBO estimates based on preliminary planning data from the Strategic Defense Initiative Organization.

NOTE: LDS = Limited Defense System; BE = Brilliant Eyes; GBI = Ground-Based Interceptor; GBR = ground-based radar.

from decoys. This subcategory also supports the LDS by providing some of the facilities and targets necessary to test U.S. defenses.

Costs of the Administration's Plan

The Administration's plan would cost more than $5 billion in 1993. Average costs in the 1994-1997 period, though less certain, could amount to $8 billion a year.

Costs in 1993. Costs for 1993 are based on figures that the Administration provided to the Congress in its budget for fiscal year 1993 (as amended in May). Total funding for the SDI program would amount to $5.4 billion in 1993 (see Summary Table 2). Virtually all of those funds would pay for research and development. Except for about $60 million in initial procurement of Patriot missiles for theater defense, no procurement money is included in the 1993 request.

The budget request covers activities in the five major program elements. About $2.4 billion, or almost half of the total request, is allocated to the LDS element (see Table 2). Only about $1 billion of the $2.4 billion goes to develop the systems that would be used at Grand Forks and in GPALS (see Table 3). The remaining $1.4 billion pays for systems engineering and integration ($400 million) and programs for risk mitigation ($400 million) and threat evaluation ($600 million).

Another $600 million of the total SDI budget would fund development of Brilliant Pebbles. Roughly $1.1 billion would finance development of defenses against shorter-range missiles in the element for Theater Missile Defenses. Together, the $4 billion in these three program elements comprise all the resources directly associated with the GPALS program.

The remaining $1.4 billion would finance broader research and support. About $800 million pays for Research and Support Activities that undergird the SDI program but support projects in more than one GPALS program element. The final $600 million funds research on Other Follow-On Systems, which include more advanced technologies that might be employed in systems that succeed GPALS.

Costs from 1994 Through 1997. Although the Administration has provided the Congress with a general outline of its plans for implementing the Missile Defense Act through 2000, it has not been specific about budget details beyond 1993. As a result, for the years 1994 through 1997, CBO has no

official data from the SDIO about the detailed costs of the Administration's revised plan.

CBO estimated the possible costs of the Administration's plan in the 1994-1997 period using methods described below. The estimates suggest that the plan would cost about $32 billion during those four years. Funding would average about $8 billion a year (see Table 2). Most of those dollars would finance research and development. In 1994, however, there would be some procurement funds for components of theater defenses, including the improved Patriot system. Starting around 1995, procurement funds would have to be appropriated in order to buy the systems necessary for the deployment at Grand Forks.

As in 1993, almost half of the total of $32 billion in requested funding for the 1994-1997 period would pay for LDS. Of that amount, LDS systems would consume $8 billion, and engineering and technology would absorb about $6 billion (see Table 3). Research and development (R&D) for space-based interceptors would require another $2.4 billion; defenses against theater missiles, $7.6 billion. The remainder of the funding would finance Other Follow-On Systems ($3.8 billion) and Research and Support Activities ($3.5 billion).

Those CBO estimates are based on preliminary costs for the Administration's plan--the only ones available that reflect changes in the program brought about by the Missile Defense Act beyond 1993. The latest official data available for the period after 1993 stem from the plan sent to the Congress in February 1991, well before the act had even been proposed.

The preliminary data correspond well with the outline of the Administration's plan as recently presented to the Congress. Moreover, as a check on the general validity of the preliminary information, CBO estimated the cost of the Administration's new plan by accelerating last year's plan to incorporate the changes mandated in the Missile Defense Act. Those results come very close to the preliminary data used in this paper, deviating by less than a few hundred million dollars in total through 1997.

Because the source data are preliminary, however, those contained in the final version of the plan the Administration will soon present could differ. Thus, the costs of the Administration's plan presented in this paper for years beyond 1993 represent a CBO estimate and not an official position of the Administration.

Total Costs. The Administration maintains that its new plan, including the accelerated deployment at Grand Forks, will not increase the total cost for the

entire GPALS system. If that is true, the total expense of developing and deploying GPALS, coupled with the costs of other research under the SDI program, would amount to about $85 billion between 1993 and 2005.[2] There would be additional costs to operate and support the systems that are deployed.

The total costs of the Administration's plan could increase, however. Although the SDIO has made plans to minimize the risks, the complexity of the Grand Forks and GPALS defenses suggests that total costs could exceed planned levels. (See the final section of this paper for a discussion of that issue.) The acceleration of the Grand Forks deployment schedule might also increase costs. CBO has not accounted for cost growth in any of its estimates.

Whatever happens to total funding, the Administration's new plan would require more money through 1997 than was required for the same period in the plan submitted in February 1991. The added funds would be required to complete the R&D, procurement, and systems testing and integration necessary to achieve the early deployment at Grand Forks.

MOTIVATION FOR THE ALTERNATIVES

The Congress may debate alternatives to the Administration's plan during the next few months; three possible alternatives are analyzed in this paper. Even though the analysis focuses on costs, a brief discussion of the rationale for the Administration's plan, and criticisms of it, will help guide the choice of alternatives.

A number of arguments favor the Administration's new plan. The early deployment at Grand Forks would provide some defense as soon as possible against an accidental or unauthorized launch from the four republics of the former Soviet Union that still possess intercontinental ballistic missiles (ICBMs).[3] This defense could also provide protection against similar attacks from China. Deployment around the year 2000 of additional sites and space-based sensors might coincide with a nascent missile threat from nations in the developing world.

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2. For an estimate of the costs through 2005 of the Administration's program for last year, see Congressional Budget Office, "The Budgetary Impact of Limiting Strategic Defense Initiative Programs," Staff Memorandum (January 1992).

3. Three republics--Belorus, Ukraine, and Kazakhstan--have recently agreed to eliminate the ICBMs and other nuclear weapons on their territories within seven years after the Strategic Arms Reduction Talks (START) Treaty comes into force. At that time, Russia will retain all remaining ICBMs from the former Soviet Union.

It is unclear when developing nations might begin to acquire ICBMs that could threaten the United States. Henry Cooper, the Director of the SDIO, has stated that it might happen as early as the turn of the century. Robert Gates, Director of the Central Intelligence Agency (CIA), estimates it would not happen for at least another decade. If Director Cooper's more pessimistic estimate is correct, GPALS would be close to completion under the Administration's plan. The addition of the Brilliant Pebbles system in the first years of the new century would provide additional insurance that attacking missiles and warheads could be destroyed. Brilliant Pebbles would also provide some capability to defend U.S. allies and forces abroad and would thus move toward making the system global.

But the Administration's plan is not without critics. It would be costly, they say, requiring a sharp increase in funding in 1993 and even larger increases in the years beyond. Those increases would have to be funded within a declining defense budget. Nor do all military analysts agree that defenses of this type are needed as quickly as the Administration proposes. Finally, the Administration's apparent choices at Grand Forks exclude certain systems that, in the view of some Members of Congress, would make the defense more effective.

The alternatives would respond to some of those concerns. To varying degrees, the alternatives would reduce SDI costs in the 1993-1997 period. To hold down costs during this period, all three alternatives assume that deployment of the full GPALS system would be delayed until after 2005. That delay would be consistent with the judgment that a large system of defenses is not needed urgently. Some of the alternatives also delay deployment at Grand Forks beyond 1997, a decision that holds down near-term costs but may not fully comply with the provisions of the Missile Defense Act. All three alternatives also assume that the GSTS sensors would be deployed at Grand Forks, increasing the capability that could be provided by a single-site defense; that could be important if the full GPALS system is delayed. Congress explicitly suggests GSTS in the Missile Defense Act. The alternatives would deploy TMDs according to the schedule the Administration proposed.

ALTERNATIVE I: GRAND FORKS BY 1997, FULL GPALS AFTER 2005, AND SELECTED RESEARCH CUTS

Like the Administration's plan, and consistent with Congressional directives in the Missile Defense Act, Alternative I would deploy a Grand Forks defense and a theater missile defense quickly. Unlike the Administration's plan, however, Alternative I would add GSTS sensors to the Grand Forks defense,

delay deployment of the full GPALS system until after 2005, and make selected cuts in research funds. These various assumptions affect the costs of Alternative I.

Funding Unchanged for Those Systems Deployed at Grand Forks

For those systems that would be deployed at Grand Forks under both Alternative I and the Administration's plan (ground-based radar, Ground-Based Interceptors, and battle management/command and control system), funding is unchanged from the Administration's planned levels. Because Alternative I also leaves unchanged the Administration's plan to develop TMDs, funding for this component of the SDI program is identical to the levels the Administration proposes.

GSTS Added to Grand Forks Deployment

By 1997, Alternative I would deploy several GSTS sensors at Grand Forks. According to the Administration's statements and data from the GSTS contractor, developing and deploying GSTS sensors would add about $1 billion to the costs of the Administration's plan in the 1993-1997 period. GSTS would enhance the capability of a single-site system by improving the ability to track incoming warheads and distinguish them from debris and decoys.

The Administration would terminate the GSTS program beyond 1993 (but could reinstate it if the need arose). Instead, the Administration plans to deploy the Brilliant Eyes sensors, which would perform the same function as well as help defend troops stationed overseas. The Administration also plans to improve existing early-warning radars--expanding the area defended by the Grand Forks system while Brilliant Eyes is being developed. In addition, the Administration is considering expanding the coverage the initial site provides by installing two additional ground-based radars in the northeastern and northwestern corners of the United States. The SDIO estimates the cost of two radars at about $800 million over the next five years.

In contrast, the development and deployment of GSTS would cost more than $1 billion through 1997. The system would not provide data unless launched, and it would have to be replaced or retrieved and refurbished after use. Also, if GSTS became the only sensor to supplement the ground-based radar and if Brilliant Eyes were delayed significantly, additional GSTS sensors would probably have to be purchased, increasing the cost of this approach. Thus, according to the Administration, GSTS would be the most expensive

approach. Indeed, if an option other than GSTS were adopted, the costs of Alternative I would decline somewhat.

The Administration also views GSTS as undesirable because it plays no role in the Administration's plan for the full GPALS. In contrast, the two additional GBRs could become sites in the multiple-site GPALS system.

All of these interim sensor options--improving existing early-warning radars, adding radars, and GSTS--might require renegotiation of or withdrawal from the ABM treaty. Brilliant Eyes, the Administration's long-term approach to increasing coverage, would also require changes to the treaty.[4]

Funding Reduced for Other GPALS Systems

For the components of GPALS not deployed at Grand Forks--Brilliant Pebbles and Brilliant Eyes--Alternative I would eliminate all procurement funding and reduce the R&D funding through 1997 relative to the Administration's plan. For Brilliant Eyes, annual R&D funding would be kept constant at roughly the 1992 level ($200 million annually) through 1997; for Brilliant Pebbles, the funding would be reduced slightly below the 1992 level to about $300 million per year, essentially relegating space-based interceptors to the role of a follow-on system.

Funding Reduced for Research and Engineering Efforts

Alternative I also assumes reductions in funding for some research and engineering activities that relate in varying degrees to deploying systems whose schedule is accelerated or delayed. The next few sections describe those changes in detail.

Some Engineering and Technology Reduced. The Engineering and Technology (E&T) effort--activities that support deployment but are not directly related to the deployed systems--has been reduced in the program elements for the Limited Defense System and Space-Based Interceptors through 1997. The reductions reflect the cuts in the systems that would not be deployed in the Grand Forks defense.

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4. The complex debate over which systems comply or do not comply with the ABM treaty is beyond the scope of this paper. However, the Administration maintains that additional ground-based radars would violate the treaty and that improvements to existing early-warning radars may violate it and would require approval of the nations that host some of these radars; the compliance status of GSTS has not yet been determined.

Specifically, the E&T effort within the SBI element is assumed to be reduced proportionally to the cuts in the Brilliant Pebbles program. Within the LDS element, reductions vary by subcategory (see Table 3 and associated text for a discussion of the subcategories). The Systems Engineering subcategory would be maintained at the Administration's planned levels through 1997. Alternative I would deploy defenses by 1997 and therefore might well need the systems engineering, testing, and integration funds the Administration anticipates. CBO has assumed that all LDS funding for systems engineering through 1997 is allocated to the Grand Forks deployment. Less money might be required for Grand Forks; but with the available data, CBO cannot separate it from the costs for LDS components that would be deployed later in the full GPALS. However, Alternative I reduces the other two subcategories--Risk Mitigation and Threat Evaluation--by roughly 10 percent through 1997 to reflect the curtailed Brilliant Eyes program and the delay in the GPALS schedule.

Follow-On Systems Research. Alternative I also reduces the funding for research aimed at developing systems that might be deployed a decade or more from now. The program element for Other Follow-On Systems contains funding for this type of research. Under Alternative I, these funds remain constant in real terms at the 1992 level of $600 million, compared with funding that ranges between $600 million and $1 billion under the Administration's plan. The slowdown reflects the assumed delay in deployment of the remaining components of GPALS, which presumably would also delay the date when follow-on systems would be deployed.

Research and Support Activities Reduced. The RSA element encompasses activities that do not relate uniquely to the work being done in other elements but apply to the broad SDI program. Under Alternative I, the real level of funding for those activities has been maintained through 1997 at the $700 million level the Congress established in 1992. That would reduce the cost through 1997 by nearly 20 percent from the Administration's plan, in accord with the overall reduction in the SDI program. Cuts of this magnitude in this element seem generally consistent with the assumption under Alternative I of a delay in full deployment of GPALS until after 2005. If systems are delayed, research and support can be done over a longer period, thereby reducing the funding required in each year.

Implications of Costing Assumptions

As the previous sections suggest, CBO has reduced the funding for both systems development and research and support efforts to be consistent with delays in deployment. This method seems appropriate in light of the preliminary data about the Administration's plan that are now available.

CBO does not, however, have detailed information about each of the many technology projects that could be affected by the changes assumed under Alternative I and subsequent alternatives. It is possible, for example, that the cuts assumed under Alternative I would provide insufficient dollars to develop certain systems that are necessary at Grand Forks.

Even if shortfalls occur, the deployment date for the Grand Forks site might not be delayed. Research money could be reallocated from systems that only support the full GPALS to those that support Grand Forks. If funding for systems that lose support were not made up in years beyond 1997, the deployment date for the full GPALS system would be delayed.

Savings Under Alternative I

Savings under Alternative I would amount to about $500 million in 1993 and could grow more than $1 billion a year beyond 1993. Although savings would be achieved through 1997, the total cost to deploy the remaining components of GPALS would probably be no lower than the Administration's planned cost and could be higher. A program that is stretched out often costs more in total because some annual overhead expenses cannot easily be reduced.

Savings in 1993. Alternative I would require an SDI budget of $5 billion in 1993 (see Summary Table 2 and Table A-3). Savings of about $400 million would be realized from specific systems, principally from reductions in funding for Brilliant Pebbles but also from reductions in Brilliant Eyes. Additional savings of about $300 million would come from reductions in LDS Engineering and Technology, and in Research and Support Activities. Alternative I would continue funding for the GSTS sensor, which adds roughly $200 million to costs in 1993. Thus, net savings would be about $500 million compared with the Administration's plan (see Table A-2).

Savings from 1994 Through 1997. As noted above, savings in the 1994-1997 period are based on CBO estimates of the Administration's plan rather than on official Administration data. According to the estimates, Alternative I would save $900 million to $1.6 billion a year from 1994 through 1997, an annual average of $1.3 billion.

The sources of the 1994-1997 savings resemble the sources in 1993: cutbacks in Brilliant Eyes, Brilliant Pebbles, and follow-on systems research, offset by added costs for the GSTS sensors.

Potential Additional Savings from Alternative I

The Missile Defense Act of 1991 called for deployment of a single-site system of defenses at Grand Forks as soon as that is technically feasible. The act left somewhat vague the nature and timing of deployments of larger systems, especially if difficulties are encountered in renegotiating the ABM treaty. Even under Alternative I, however, many dollars would be spent in the 1993-1997 period that are designed to develop the capability to deploy larger systems of defenses.

If the Congress elected to follow the general approach to defenses outlined under Alternative I, but eliminated or further reduced some activities not needed to deploy a single-site system at Grand Forks in 1997, larger savings could be achieved through that year. Table 4 illustrates the potential additional savings. CBO does not have the detailed information necessary to estimate their exact size. Nevertheless, CBO can estimate the general magnitude of the savings and identify their likely effects on the overall SDI program.

Elimination of Specific Systems. One way to cut costs under Alternative I--without affecting the schedule for Grand Forks--would be to eliminate or reduce funding for Brilliant Pebbles and Brilliant Eyes systems that would not be deployed there. Eliminating those two systems alone would reduce costs under Alternative I by about $500 million in 1993 and an average of $500 million a year in the 1994-1997 period. Eliminating or curtailing those systems would, however, reduce the options available when the time came to deploy the full GPALS. The GSTS program could also be terminated, saving roughly $200 million in 1993 and an average of almost $300 million per year from 1994 through 1997.

Cuts in Research and Support. Further savings might also be achieved by curtailing activities within the Limited Defense System element that are not directly related to systems slated for Grand Forks (see Table 3 and accompanying text for a discussion of these types of funds). For example, in Alternative I, the LDS element provides resources for risk mitigation, hedges, and product improvements in the amount of $300 million in 1993 and $1.4

TABLE 4. POTENTIAL ADDITIONAL SAVINGS FROM ALTERNATIVE I
(Budget authority in billions of 1993 dollars)

	Savings If Activity Is Eliminated					
Policy Decision	1993	1994	1995	1996	1997	Total 1993-1997
Activities Not Necessarily Required for 1997 Deployment [a]						
Eliminate Specific Systems						
Brilliant Pebbles	0.3	0.3	0.3	0.3	0.3	1.5
Brilliant Eyes	0.2	0.2	0.2	0.2	0.2	1.0
GSTS	0.2	0.3	0.3	0.3	0.2	1.1
Eliminate Research Funding						
LDS Risk Mitigation	0.3	0.3	0.3	0.3	0.2	1.4
Follow-On Systems Research	0.6	0.6	0.6	0.6	0.6	3.0
Activities at Least Partly Required for 1997 Deployment [b]						
Eliminate Engineering and Support Funding						
LDS Systems Engineering	0.4	0.6	0.9	0.9	1.0	3.8
LDS Threat Evaluation	0.5	0.4	0.4	0.3	0.3	1.9
Research and Support Activities	0.7	0.7	0.7	0.7	0.7	3.5

SOURCES: For 1993, Congressional Budget Office based on the Administration's 1993 amended request and recent testimony; for the 1994-1997 period, CBO estimates based on preliminary planning data from the Strategic Defense Initiative Organization.

NOTE: LDS = Limited Defense System; GSTS = Ground-Based Surveillance and Tracking System.

a. Large reductions in these categories could affect the deployment schedule for the Global Protection Against Limited Strikes system assumed in Alternative I.

b. Large reductions in these categories could affect the deployment at Grand Forks scheduled for 1997.

billion through 1997. Because those activities are not directly related to the 1997 deployment, they could be reduced or eliminated. However, reduced funding would mean delaying or forgoing product improvements that might otherwise be available shortly after the 1997 deployment. It would also mean accepting the risk that fewer alternative technologies would be available in the event that a system in the Grand Forks defense experiences developmental difficulties or that an unexpected missile threat emerges.

Increased focus on Grand Forks might also permit cuts in research for follow-on systems beyond those assumed under Alternative I. Under this alternative, expenditures for Other Follow-On Systems would amount to $600 million annually from 1993 through 1997. Some or all of those dollars could be eliminated without jeopardizing the 1997 deployment at Grand Forks. Eliminating or curtailing these activities might, however, reduce U.S. flexibility to respond to new types of missile threats. Total costs could also be higher if the programs were restarted later.

Other Potential Reductions. Other reductions could also be considered, although they would pose more risk of delaying or hindering the 1997 deployment. Within the LDS element, funds are provided for systems engineering, integration, and testing; they amount to $400 million in 1993 and grow rapidly to almost $1 billion annually by 1995. The LDS systems engineering effort could be cut in order to achieve larger savings, but significant reductions would be likely to delay the Grand Forks deployment beyond 1997 because it depends on many of those engineering activities.

The LDS element also includes resources under Alternative I for threat evaluation, phenomenology, and other support. Those activities receive roughly $500 million in 1993 and about $1.9 billion through 1997. The extent to which they could be cut without hindering the Grand Forks deployment depends on one's view of how sophisticated an attacker might be in terms of decoy technology and the ability to find and exploit vulnerabilities in the defense.

Finally, funding for activities within the Research and Support Activities element could be reduced below their Alternative I level of about $700 million a year. Large reductions, however, might delay the installation at Grand Forks because testing facilities and management support needed for deployment by 1997 might not be available.

Rationale for Alternative I

Alternative I is consistent with the view that a ballistic missile attack on the United States caused by an accidental or unauthorized launch of missiles from the former Soviet Union or China remains a sufficiently large danger to warrant quick deployment at Grand Forks. Doing that might also provide a deterrent to proliferation: developing nations might be less likely to acquire long-range ballistic missiles if the United States were perceived as capable of defending effectively against them. In those respects, the rationale for Alternative I parallels that for the Administration's new plan.

But proponents of Alternative I would argue that a single defensive site--enhanced with sensors such as GSTS or improved early-warning radars so that it could defend a wider area--would suffice to meet likely threats until the middle of the next decade. Thus, completion of the full GPALS could be delayed, and the delay might defer the need to renegotiate the ABM treaty.

Critics of this alternative would respond, however, that GPALS still requires substantial funding in 1993 and large funding increases in the following years. The critics would also question the need to deploy defenses at Grand Forks hastily in order to defend against perceived threats from the former Soviet republics and China.

ALTERNATIVE II: GRAND FORKS BY 2000, FULL GPALS AFTER 2005, AND LARGER RESEARCH CUTS

To respond to concerns prompted by the first alternative, the second would delay the deployment at Grand Forks until 2000 and make larger cuts in some research activities. In most other respects, the two alternatives are similar (see Summary Table 1). Both assume the same reduction in funding for Brilliant Eyes and Other Follow-On Systems, and both leave funding for Theater Missile Defenses unchanged at the Administration's proposed level.

Compared with Alternative I, the three-year delay in the deployment at Grand Forks would lead to funding reductions for specific systems beyond 1993. CBO assumed that the systems that are to be deployed (GBRs, GBIs, GSTS, and the battle management/command and control system) would be financed at the Administration's requested level for 1993 and maintained there through 1996. In 1997, funding would begin to increase in a pattern similar to the one the Administration proposed for the years after 1993.

Funds in program elements for the Limited Defense System and Research and Support Activities would be reduced to account for delays in deployment.

The method is the same as the one discussed under Alternative I except that all portions of the LDS Engineering and Technology effort--including systems engineering--would be reduced in proportion to the reductions in the LDS systems.

Savings Under Alternative II

Through 1997, savings under Alternative II would be more than double those achieved under Alternative I. Less clear are the effects of this alternative on total costs to deploy a single-site defense and the full GPALS. Total costs could be higher because of program delays, but those delays may also permit more time for development and so avoid the need for modifications sometimes required on systems that are deployed quickly.

Savings in 1993. Alternative II would reduce the total SDI budget to $4.2 billion in 1993--roughly the same amount that the Congress appropriated in 1992. That reduction would save $1.3 billion compared with the Administration's plan and $800 million compared with Alternative I (see Summary Table 2 and Table A-4).

Relative to Alternative I, some of the additional savings ($200 million) would result from delaying the GSTS schedule (see Table A-2). Alternative II also achieves additional savings by further reducing resources for Research and Support Activities and for E&T within the element for LDS. Those cuts are consistent with delays in the deployment dates for Grand Forks and the full GPALS.

Savings from 1994 Through 1997. Under Alternative II, based on preliminary data CBO estimates suggest that total budgets for SDI would average $5.1 billion in the 1994-1997 period. During that period, the cost of SDI would reach a maximum of $5.3 billion in 1997. In contrast, funding under the Administration's plan and Alternative I would peak in 1995 at $8.3 billion and $6.9 billion, respectively. The higher maximum costs under the Administration's plan and Alternative I reflect the decision to deploy the defense at Grand Forks in 1997 instead of three years later.

Between 1994 and 1997, Alternative II would save an average of almost $3 billion a year compared with the Administration's plan. The annual savings would be much larger than those under Alternative I, which would average about $1.3 billion a year during that period.

In 1993 and later years, the total SDI budget could be reduced below the level Alternative II envisions and still permit a Grand Forks system to be

deployed by 2000. The sources of the additional savings would be the same as those in Alternative I: terminating Brilliant Pebbles, Brilliant Eyes, or GSTS; reducing LDS Engineering and Technology funding; and reducing research for Other Follow-On Systems and Research and Support Activities. However, the sum of the possible additional savings would be lower under Alternative II because E&T and RSA activities have already been reduced below the levels under Alternative I.

Rationale for Alternative II

Alternative II would be inconsistent with parts of the Missile Defense Act, which calls for deployment at Grand Forks by 1996 or as soon thereafter as possible. It is, however, consistent with the view that the United States need not rush to deploy defenses because of a perceived threat from the upheaval in the former Soviet Union; ultimately, the turmoil there may not weaken the central control of nuclear weapons. In any case, the situation may be more stable by 1997, the earliest year that these defenses would be available under the Administration's plan and Alternative I.

Alternative II might also provide timely defenses against the possibility of attacks from regional powers. CIA Director Gates has stated that, in his estimate, it is unlikely that a hostile country in the developing world could threaten the United States with long-range ballistic missiles for at least another 10 years. If Director Gates is correct, a single-site defense deployed by the year 2000 would be ready several years before such a country could launch a long-range strike. Even if ballistic missiles from the developing world could threaten the United States a few years earlier, as the Director of the SDIO estimates, the deployment under Alternative II would probably still meet this threat--although with only a single site rather than the multiple sites that the Administration plans to have deployed around 2000.

Finally, Alternative II would allow time to develop and deploy defenses in a more measured manner than does either the Administration's plan or Alternative I. The extra time should reduce the chances of deploying a system that would not work well or that would require expensive modifications.

Alternative II would not require an immediate increase in the $4.2 billion budget for SDI that the Congress appropriated for 1992. In the years beyond 1993, however, the alternative would still require about $1 billion more per year than the amount appropriated for 1992.

ALTERNATIVE III: GRAND FORKS BY 2003, FULL GPALS AFTER 2005, AND LARGEST RESEARCH CUTS

To reduce costs by a larger amount through 1997, the final alternative in this paper assumes further delays in the deployment at Grand Forks. Among the options in this paper, Alternative III also assumes the largest reductions in funding for the development of selected systems, follow-on research, and research and support.

Specifically, Alternative III would delay deployment of a single-site defense until 2003--six years later than the Administration's plan and three years later than under Alternative II (see Summary Table 1). The deployment would be accomplished with the same systems as those planned under Alternatives I and II. Alternative III, however, would halt the development of Brilliant Pebbles. The full GPALS system would still be deployed, but not until after 2005.

Those assumptions have important ramifications for the budget. For the systems that would be deployed at Grand Forks, funding would remain at 1993 levels through 1999 to reflect the delayed deployment. Money for Brilliant Eyes, which would not be deployed at Grand Forks, would remain at the same level as in Alternatives I and II in order to retain the option to deploy that system at a future date. Brilliant Pebbles would be eliminated.

Like Alternative II, this one would reduce funding for LDS Engineering and Technology in proportion to cuts in funding for LDS systems. Because of deployment delays, fewer funds would be needed each year to support the LDS program. Research and Support Activities would be reduced in proportion to the overall SDI effort. Resources for research on Other Follow-On Systems are assumed to be reduced by one-third compared with planned expenditures under Alternatives I and II; if deployments at Grand Forks and the full GPALS are delayed, deployment of follow-on systems would probably be accorded the same treatment.

The concerns noted earlier about the implications of using rules of thumb apply most strongly to the far-reaching changes in Alternative III. The alternative might not provide sufficient funding to accomplish all of the planned deployments in the periods assumed. Adequate funds must be invested in research, development, production, and systems engineering and integration to make deployment possible at that point. Because of delays in deployment assumed under Alternative III, the dollars it would require to develop and deploy systems can be paid out over a longer period than under the Administration's plan. But total funding could well be higher because a program that is stretched out often costs more. If that occurs under

Alternative III, resources might have to be reallocated to systems necessary for deployment at Grand Forks at the expense of those needed only for the full GPALS--resulting in delay for the latter well beyond the year 2005.

The reductions in funding for research and support under Alternative III would also slow progress on new technologies. The reduced efforts would leave fewer technologies available to meet any future threats to U.S. security.

Savings Under Alternative III

In return for delays in deployment, Alternative III would yield substantial savings through 1997. The effect of this alternative on total costs is unclear. The lengthy development period could add to total costs because of the slow pace of the work, but it might avoid the need for later modifications.

Savings in 1993. In 1993, the SDI budget would be reduced to $3.3 billion, $2.1 billion less than the Administration's plan and $900 million below the 1992 budget (see Summary Table 2 and Table A-5). That level of funding is not much higher than the amount the Congress appropriated for SDI in 1991, and it would be lower than in any other year since 1985.

Savings would come from all of the sources mentioned above in connection with Alternative II. In addition, there would be savings of $300 million from the termination of Brilliant Pebbles and $600 million from further reductions in LDS Engineering and Technology, Other Follow-On Systems, and Research and Support Activities (see Table A-2 for details).

Savings from 1994 Through 1997. Between 1994 and 1997, CBO estimates that SDI budgets would average slightly more than $4 billion a year, compared with an average of about $8 billion under the Administration's plan. Because that level roughly equals the amount appropriated in 1992, Alternative III would reduce the need for increases in SDI funding--an important consideration in a period when overall Department of Defense budgets will probably be reduced sharply. Sources of savings in the 1994-1997 period would be similar to those in 1993.

As was the case under the first two alternatives, the total SDI budget could be reduced--in both 1993 and later years--below the level Alternative III envisions and still permit a Grand Forks deployment by 2003. The reductions would focus on those expenditures that are related to the full GPALS system but are not required for the Grand Forks deployment.

Rationale for Alternative III

Alternative III would not comply with the Missile Defense Act of 1991, which calls for rapid deployment of defenses at a single site. As noted above, there might also be some risks of additional delays in deployment beyond those assumed in this paper.

Nonetheless, Alternative III represents one way to hold down annual costs while implementing a wait-and-see strategy for strategic defenses. Although not deploying defenses for roughly another 10 years, this alternative would continue to develop relevant technology--but at a slower pace than under the Administration's new plan. Thus, if defense needs become acute in less than 10 years, available technology would allow some acceleration in the date of deployment.

Such a strategy would be consistent with the view that, whatever the current threat of an accidental or unauthorized attack from the former Soviet republics, increased stability and further arms reductions in Central Eurasia would diminish it before any defenses could be deployed in 1997. Under that interpretation, rushing to deploy defenses in 1997 makes little sense.

In this view, the threat of missile attacks on the United States after 1997 would probably come from a nation in the developing world that had acquired ballistic missiles. According to CIA Director Gates, such a threat is not likely to occur for at least 10 years, the point at which--in this alternative--the Grand Forks system would be deployed. Also, diplomacy and earnest efforts to reduce ballistic missile proliferation in the intervening years could moderate the threats such long-range weapons pose. Resources the Administration plans to devote to SDI might be better spent on improving capabilities to monitor the proliferation of weapons of mass destruction. Even if nations eventually acquire nuclear weapons and ballistic missiles, proponents of this alternative would argue, acquisition of long-range missiles--particularly of those with enough range to reach the United States--would be evident sufficiently far in advance to permit the strengthening of U.S. defenses.

Finally, this alternative fits the view that the United States should de-emphasize defenses against long-range ballistic missiles because such missiles do not pose the most immediate threat. They are difficult to develop and unreliable unless tested repeatedly. Hostile nations intent on attacking the United States with nuclear weapons might prefer to employ more reliable means of delivering them: commercial shipping, aircraft, low-flying cruise missiles, or even smuggling.

OTHER ALTERNATIVES

The alternatives analyzed in this paper were selected in conjunction with committee staff as representative of key options that may be debated by the Congress during the next few months. The alternatives represent only some of the possibilities for altering the Administration's SDI plan. The paper does not, for example, analyze an alternative that would forgo deployment of defenses altogether, perhaps providing only enough SDI funding to pay for continued research.[5] Nor does the paper examine the cost of proceeding quickly to a system of defenses even larger than GPALS. A much larger system, which the Administration has termed Phase I, would protect against an attack by more than 1,000 warheads. As of 1991, such a system remained part of the Administration's long-term goals for SDI.

CAVEATS TO THE COST ESTIMATES

There are two key sources of uncertainty about the cost estimates in this paper.

Uncertainties in Near-Term Cost Estimates

Because CBO has used preliminary data as the basis for its cost estimates of the Administration's plan beyond 1993, changes the Administration will report in June could alter the cost estimates in this paper for the 1994-1997 period. But because the Administration's recent statements about its long-term plans generally agree with the program assumed in CBO's estimates, those changes are not likely to alter substantially the overall pattern of costs and savings the paper shows.

Uncertainties Regarding Total Costs

The potential for cost increases above the Administration's planned levels probably poses a greater source of uncertainty. In this paper, CBO has not attempted to factor in the potential growth in costs of SDI programs. Many of the systems to be deployed at Grand Forks and in the full GPALS will expand the frontiers of technology. If experience with other weapon systems

5. For two examples of options that defer a decision on deployment, see Congressional Budget Office, "The Budgetary Impact of Limiting Strategic Defense Initiative Programs"; and "Selected Spending and Revenue Options," CBO Paper (June 1991), p. 14.

is any guide, the cost of such systems could increase above the levels currently planned.

A lack of definition of the systems could also increase costs. The family of ground-based radars provides an example: as system requirements have changed, Department of Defense estimates of the cost for developing and deploying GBRs over the next five years have grown by almost $2 billion. According to the Director of the SDIO, that new DoD estimate probably overstates the costs of the modified GBR program. Nevertheless, costs for GBRs are likely to be higher than those in the original estimate.

The risk of cost growth is exacerbated for those systems whose development both the Administration's plan and Alternative I would accelerate. Compressing a development schedule increases technological risk, which can in turn increase costs.

The SDIO is attempting to minimize cost growth. The agency maintains an active program of technology development that, it argues, will minimize the risks of cost increases in technically challenging programs by providing alternatives for any systems whose costs grow unacceptably. Modifying requirements might also reduce the cost of a program if it involves compromises, such as reducing the complexity or capability of the system. Finally, new and more effective technology could reduce the cost of the defenses. Nevertheless, the risk of cost growth remains real; for both the Administration's plan and the alternatives presented in this paper, it could result in larger funding requirements than those shown.

APPENDIX

The tables in this appendix provide details of the costs for the Administration's plan and the alternatives.

TABLE A-1. DETAILED COSTS OF THE ADMINISTRATION'S PLAN BY PROGRAM ELEMENT THROUGH 1997
(Budget authority in billions of 1993 dollars)

Program Element	Amended 1993	1994	1995	1996	1997	Total 1993-1997
Space-Based Interceptors	0.6	0.6	0.6	0.6	0.6	3.0
Theater Missile Defenses	1.1	2.0	2.0	1.9	1.7	8.7
Limited Defense System						
LDS Systems						
Brilliant Eyes	0.3	1.0	0.9	0.6	0.8	3.5
GBI	0.2	0.2	0.4	0.5	0.2	1.5
GSTS	0.1	0	0	0	0	0.1
Other systems	0.4	0.7	0.9	0.9	0.9	3.7
LDS Engineering and Technology	1.4	1.5	1.7	1.6	1.6	7.8
Subtotal	2.4	3.3	3.9	3.6	3.4	16.6
Other Follow-On Systems	0.6	0.9	0.9	1.0	1.0	4.4
Research and Support Activities	0.8	0.8	0.9	0.9	0.9	4.2
Total	5.4	7.7	8.3	7.8	7.9	37.0

SOURCES: For 1993, Congressional Budget Office based on the Administration's budget request and recent testimony; and for the 1994-1997 period, CBO estimates based on preliminary planning data from the Strategic Defense Initiative Organization.

NOTE: LDS = Limited Defense System; GBI = Ground-Based Interceptor; GSTS = Ground-Based Surveillance and Tracking System.

TABLE A-2. RELATIVE COSTS OF ALTERNATIVES BY PROGRAM ELEMENT THROUGH 1997
(Budget authority in billions of 1993 dollars)

	1993	1994	1995	1996	1997	Total 1993-1997
Administration's Plan as Amended	5.4	7.7	8.3	7.8	7.9	37.0
Alternative I						
Changes from Administration's Plan						
Space-Based Interceptors	-0.3	-0.4	-0.4	-0.2	-0.3	-1.5
Theater Missile Defenses	0	0	0	0	0	0
Limited Defense System						
LDS Systems						
Brilliant Eyes	-0.1	-0.8	-0.7	-0.4	-0.6	-2.5
GSTS	0.2	0.3	0.3	0.3	0.2	1.1
Other systems	0	0	0	0	0	0
LDS Engineering and Technology	-0.2	-0.2	-0.1	-0.1	-0.1	-0.7
Other Follow-On Systems	-0.0	-0.3	-0.3	-0.4	-0.4	-1.4
Research and Support Activities	-0.1	-0.1	-0.2	-0.2	-0.2	-0.7
Total	-0.5	-1.4	-1.4	-0.9	-1.6	-5.8
Costs of Alternative I	5.0	6.3	6.9	6.9	6.2	31.2
Alternative II						
Changes from Alternative I						
Limited Defense System						
LDS Systems	-0.2	-0.4	-1.0	-1.0	-0.1	-2.7
LDS Engineering and Technology	-0.4	-0.5	-0.7	-0.6	-0.6	-2.7
Research and Support Activities	-0.3	-0.3	-0.3	-0.3	-0.3	-1.3
Total	-0.8	-1.2	-1.9	-1.8	-1.0	-6.7
Costs of Alternative II	4.2	5.1	5.0	5.0	5.3	24.6
Alternative III						
Changes from Alternative II						
Space-Based Interceptors	-0.3	-0.3	-0.3	-0.3	-0.3	-1.5
Limited Defense System	-0.3	-0.3	-0.3	-0.3	-0.7	-1.8
Other Follow-On Systems	-0.2	-0.2	-0.2	-0.2	-0.2	-1.0
Research and Support Activities	-0.1	-0.1	-0.1	-0.1	-0.1	-0.3
Total	-0.8	-0.8	-0.8	-0.8	-1.3	-4.7
Costs of Alternative III	3.3	4.3	4.2	4.2	4.0	20.0

SOURCES: For 1993, Congressional Budget Office based on the Administration's budget request and recent testimony; and for the 1994-1997 period, CBO estimates based on preliminary planning data from the Strategic Defense Initiative Organization.

NOTE: LDS = Limited Defense System; GSTS = Ground-Based Surveillance and Tracking System.

TABLE A-3. DETAILED COSTS OF ALTERNATIVE I BY PROGRAM ELEMENT THROUGH 1997
(Budget authority in billions of 1993 dollars)

Program Element	1993	1994	1995	1996	1997	Total 1993-1997
Space-Based Interceptors	0.3	0.3	0.3	0.3	0.3	1.5
Theater Missile Defenses	1.1	2.0	2.0	1.9	1.7	8.7
Limited Defense System						
LDS Systems						
Brilliant Eyes	0.2	0.2	0.2	0.2	0.2	1.0
GBI 0.2	0.2	0.4	0.5	0.2	1.5	
GSTS	0.3	0.3	0.3	0.3	0.2	1.2
Other systems	0.4	0.7	0.9	0.9	0.9	3.7
LDS Engineering and Technology	1.3	1.4	1.6	1.5	1.5	7.1
Subtotal	2.3	2.7	3.4	3.3	2.9	14.5
Other Follow-On Systems	0.6	0.6	0.6	0.6	0.6	3.0
Research and Support Activities	0.7	0.7	0.7	0.7	0.7	3.5
Total	5.0	6.3	6.9	6.9	6.2	31.2

SOURCES: For 1993, Congressional Budget Office based on the Administration's budget request and recent testimony; and for the 1994-1997 period, CBO estimates based on preliminary planning data from the Strategic Defense Initiative Organization.

NOTE: LDS = Limited Defense System; GBI = Ground-Based Interceptor; GSTS = Ground-Based Surveillance and Tracking System.

TABLE A-4. DETAILED COSTS OF ALTERNATIVE II BY PROGRAM ELEMENT THROUGH 1997
(Budget authority in billions of 1993 dollars)

Program Element	1993	1994	1995	1996	1997	Total 1993-1997
Space-Based Interceptors	0.3	0.3	0.3	0.3	0.3	1.5
Theater Missile Defenses	1.1	2.0	2.0	1.9	1.7	8.7
Limited Defense System						
LDS Systems						
Brilliant Eyes	0.2	0.2	0.2	0.2	0.2	1.0
GBI	0.2	0.2	0.2	0.2	0.2	0.8
GSTS	0.1	0.1	0.1	0.1	0.3	0.7
Other systems	0.4	0.4	0.4	0.4	0.8	2.2
LDS Engineering and Technology	0.9	0.9	0.9	0.9	0.9	4.5
Subtotal	1.8	1.8	1.8	1.8	2.2	9.2
Other Follow-On Systems	0.6	0.6	0.6	0.6	0.6	3.0
Research and Support Activities	0.4	0.4	0.4	0.4	0.4	2.2
Total	4.2	5.1	5.0	5.0	5.3	24.6

SOURCES: For 1993, Congressional Budget Office based on the Administration's budget request and recent testimony; and for the 1994-1997 period, CBO estimates based on preliminary planning data from the Strategic Defense Initiative Organization.

NOTE: LDS = Limited Defense System; GBI = Ground-Based Interceptor; GSTS = Ground-Based Surveillance and Tracking System.

TABLE A-5. DETAILED COSTS OF ALTERNATIVE III BY PROGRAM ELEMENT THROUGH 1997
(Budget authority in billions of 1993 dollars)

Program Element	1993	1994	1995	1996	1997	Total 1993-1997
Space-Based Interceptors	0	0	0	0	0	0
Theater Missile Defenses	1.1	2.0	2.0	1.9	1.7	8.7
Limited Defense System						
LDS Systems						
Brilliant Eyes	0.2	0.2	0.2	0.2	0.2	1.0
GBI	0.2	0.2	0.2	0.2	0.2	0.8
GSTS	0.1	0.1	0.1	0.1	0.1	0.5
Other systems	0.4	0.4	0.4	0.4	0.4	2.0
LDS Engineering and Technology	0.6	0.6	0.6	0.6	0.6	3.2
Subtotal	1.5	1.5	1.5	1.5	1.5	7.5
Other Follow-On Systems	0.4	0.4	0.4	0.4	0.4	2.0
Research and Support Activities	0.4	0.4	0.4	0.4	0.4	1.9
Total	3.3	4.3	4.2	4.2	4.0	20.0

SOURCES: For 1993, Congressional Budget Office based on the Administration's budget request and recent testimony; and for the 1994-1997 period, CBO estimates based on preliminary planning data from the Strategic Defense Initiative Organization.

NOTE: LDS = Limited Defense System; GBI = Ground-Based Interceptor; GSTS = Ground-Based Surveillance and Tracking System.