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1992 Report to Congress on the

Strategic Defense Initiative

July 1992

Prepared by the Strategic Defense Initiative Organization

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Chapter 1

Ballistic Missile Defense Policy

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Chapter 1
Ballistic Missile Defense Policy

This chapter describes the policy associated with ballistic missile defense, including the implications of the evolving international security environment, the role that defenses can play in responding to the threats we foresee in the 1990s and beyond, and recent decisions regarding policy for the SDI Program. In addition, this chapter will discuss recent U.S. diplomatic initiatives and developments and the implications of the Missile Defense Act (MDA) of 1991.

1.1 Introduction

The Department of Defense is developing for deployment a ballistic missile defense system that will provide protection to the United States, its forward deployed forces, and allies and friends against limited ballistic missile strikes, whatever their source. The concept under which this system is being developed is called Global Protection Against Limited Strikes (GPALS). The passage of the Missile Defense Act (MDA) of 1991 moved the Administration and Congress close to a consensus on the role of ballistic missile defenses. The goal contained in the MDA is a reflection of the determination of Congress to defend the U.S. against limited ballistic missile attack and defend U.S. forward deployed forces and our friends and allies with highly effective ballistic missile defenses.

1.2 SDI and the New National Defense Strategy

1.2.1 Changes in the Strategic Planning Environment

The past several years have seen historic changes in the strategic environment that have transformed our primary security concerns. The Soviet empire has been replaced by 15 independent Republics; many of the Republics and 5 nations in Eastern Europe are now members of the North Atlantic Cooperation Council (NACC); and Germany has been unified and remains a member of the North Atlantic Treaty Organization (NATO). The threat of a short-warning massive conventional attack against Western Europe leading to global war has ceased to exist.

While the threat of a conventional conflict escalating to global warfare has declined, the potential for major regional threats to U.S. and allied security interests is growing. Although a new era holds the prospect for treating regional issues independent of the East-West context, we have witnessed the sobering truth that local sources of instability and oppression will continue to foster conflict. These conflicts, as the Gulf War has illustrated, can arise suddenly, unpredictably, and from unexpected quarters. The Gulf War presages very much the type of major regional contingency we are likely to confront: a theater of conflict very far from home, against foes well armed with advanced conventional and unconventional weaponry. The proliferation of ballistic missiles, and of weapons of mass destruction, increases the danger associated with these potential conflicts.

1.2.2 Strategic Defense in the New Military Strategy

In 1990, in response to the dramatic changes in the strategic environment, the United States announced a new strategy in which regional conflict replaced global war as the major focus of its conventional defense planning. The new military strategy rests on four essential elements: **strategic deterrence and defense; forward presence; crisis response; and reconstitution.** The deployment of defenses will support these tasks in several unique ways.

Strategic Deterrence and Defense: The United States will continue to rely on its strategic nuclear deterrent capability, including a survivable command, control, and communications system and a modified version of the traditional Triad. Ballistic missile defenses--including space- and ground-based interceptors and sensors--will provide protection for the United States against actions that are by definition undeterrable--accidental and unauthorized launches. They also can provide protection against limited, deliberate ballistic missile strikes which may threaten regional stability or the interests of U.S. allies and friends. Ballistic missile defenses could extend protection to our forward deployed forces and allies. Defenses will become an increasingly important indicator of American strategic capability and military strength-a tangible indicator that we remain committed to providing security assistance to our friends and allies.

Forward Presence: The forward presence of U.S. forces can take many forms. Stationing forces in selected forward bases or aboard naval vessels is perhaps the most visible demonstration of U.S. commitment in key areas. Theater ballistic missile defense systems operating in concert with U.S. early warning systems will provide point and wide area defense and early warning to U.S. forward-based and expeditionary forces; space-based interceptors will provide continuous, global coverage to those forces. U.S. defenses, in combination with those its allies and coalition partners might deploy, would provide protection, on short notice, of U.S. forces, host nation forces, and ports and airfields for arriving forces. These defenses would also be capable of protecting population centers and would permit those at risk additional warning to undertake civil defense measures.

Crisis Response: The need to respond to regional contingencies and crises, and do so on very short notice, is one of the key elements of the new regional strategy. Defenses, in addition to protecting targets, could also serve to defuse regional crises by deterring the employment of ballistic missiles. This combination of defense and deterrent capabilities increases the likelihood that, in regional crises, potential adversaries cannot use ballistic missile attacks to gain an advantage or to deter the United States and its allies or coalition partners from pursuing political, diplomatic, or military initiatives designed to resolve the crisis.

Active defenses also reduce pressures on U.S. military and political leaders involved in a regional conflict to alter their campaign or war plans because of the threat (or actual use) of ballistic missiles. In the absence of effective defenses, such carefully laid plans could be disrupted or delayed. With an effective defense in place, our military leaders are better able to follow their well-constructed plans, thereby retaining the initiative in battle.

Force Reconstitution: The reconstitution concept is not simply to recreate or expand existing forces, but to consider what new forces are most needed for a new or reemerging threat consistent with our strategic concept. A capability to protect against limited strikes represents an appropriate level of defense within our strategic forces structure, based on our current planning assumptions. Forces under consideration for deployment in the GPALS concept should provide the base level of capability to carry us into the foreseeable future in support of our forward presence and crisis response missions. If more ambitious missile defense capabilities are required in the future as a result of changes in the international environment, the SDI program will have developed the systems and technologies required to respond should a decision be made to do so in the future.

1.3 The Ballistic Missile Threat

1.3.1 Ballistic Missile Proliferation

A major implication for future regional contingencies that clearly emerged from the Gulf War is the political and military importance of possessing a capability to counter defensively the threatened or actual use of ballistic missiles and weapons of mass destruction. The United States cannot accept a situation in which these capabilities are allowed to constrain a U.S. president's flexibility in employing military power when necessary to support U.S. national security objectives and commitments abroad or to pose an unconstrained threat to U.S. forces when they are deployed in the field. It also cannot ignore the growing threats posed by ballistic missiles to the territory and forces of U.S. friends and allies.

Figure 1-1 represents an illustrative look at ballistic missile proliferation. Today, over twenty non-NATO nations have ballistic missiles. Additionally, by the year 2000, as many as 20 nations may have weapons armed with chemical, nuclear, or biological warheads. These technologies pose a threat today that is largely regional in character (e.g., shorter-range missile systems). However, the trend is clearly in the direction of systems of increasing range, lethality, and sophistication. Some third world countries are striving to acquire or develop missiles capable of delivering payloads at increasingly longer ranges. Moreover, several countries could achieve intercontinental ranges through the conversion of space launch vehicles. A country pursuing an indigenous space launch capability can exploit rocket 'dual use' technology to develop a ballistic missile. Since 1957, the number of countries capable of building and launching space launch vehicles has increased by about one every 4 years.

Figure 1-1 Ballistic Missile Capabilities: A Representative Look

Ballistic missile proliferation is a matter of concern in a world that may be increasingly affected by diverse geopolitical considerations. The Middle East remains unstable: Iraq continues to challenge UN inspections dedicated to destroy its remaining ballistic missile arsenal and missile production capability; Iran pursues Western missile technology and looks to North Korea for long-range SCUDs and China for missiles and nuclear related technologies; Syria has turned to North Korea for an extended range ballistic missile and seeks aid from China and Western firms for improved capabilities; Libya shops throughout the world for a source of longer range missiles to extend its reach across the eastern Mediterranean. The risk of war continues in South Asia, fueled by the long-standing tension between India and Pakistan with both countries developing ballistic missiles. North Korea threatens the stability of Northeast Asia and by selling SCUDs, including some modified to extend their range, to countries in the Middle East.

1.3.2 Accidental and Unauthorized Strikes

While we are satisfied with the assurances we have received from Russia and the other three nuclear republics with regard to the maintenance of unified control over all the nuclear weapons of the former Soviet Union, the possibility of future political instability still creates concern about the potential for accidental and unauthorized strikes. Political turmoil in the former Soviet Union, however, is not the only reason for concern about accidental and unauthorized strikes. The proliferation of ballistic missiles increases concerns over the possibility of such a strike due to the political instability within the acquiring countries, the lack of adequate command and control safeguards or both.

1.3.3 Missile Defenses and U.S. Efforts to Discourage Proliferation

Ballistic missile defenses also will support our broader efforts to discourage the spread of ballistic missile technologies and weapons of mass destructions. We will redouble our efforts to control the spread of these capabilities. And we will pursue means to deter the use of such weapons, and to destroy them if deterrence fails and they are used against the U.S., its forces, or our friends and allies. But as we learned in the Gulf, active defenses have to be a part of the solution to this urgent problem. Defenses would undermine the military and political utility of such systems and should serve to dampen countries' incentives to acquire ballistic missiles. And where proliferation controls fail, defenses provide an alternative means to respond to ballistic missile threats.

1.4 Toward the Future: Global Ballistic Missile Defense System

1.4.1 U.S. and Its Allies

The U.S. has been discussing the GPALS concept with its NATO allies and other allies and friends for over a year, both bilaterally and in NATO fora. These discussions have included the objectives of a limited deployment of ballistic missile defenses--including, in our view, that such defenses would not threaten existing deterrents--and the willingness of the U.S. to extend protection to allies. We have discussed the possibility of providing allies information from GPALS sensors for both early warning of an attack and to improve the effectiveness of theater based (U.S. or allied) ballistic missile defenses. Our discussions also included an invitation to participate in the development and operation of those defenses. (See Chapter 5 for a description of cooperative programs with allies.)

1.4.2 U.S. and the Former Soviet Union

The Administration is pursuing discussions concerning the deployment of limited defenses and President Yeltsin's proposal for a global defense system. On September 27, 1991, President Bush called "on the Soviet leadership to join us in taking immediate, concrete steps to permit the limited deployment of nonnuclear defenses to protect against limited ballistic missile strikes--whatever their source." Following the announcement, the United States presented a new proposal for presentation at the Defense and Space Talks (DST) in Geneva, which was consistent with our GPALS concept. The U.S. tabled its new position on October 3, 1991.

On 5 October, then-President Gorbachev replied to the President's invitation by stating that: "We are ready to discuss the U.S. proposal on nonnuclear ABM systems." Gorbachev's response signalled a clear change of previous Soviet thinking on the issue of ballistic missile defenses. When additional details of our GPALS concept were provided on October 7 to senior arms control officials representing the central government as well as several Republics, the presentation was positively received.

1.4.3 Shared View on Defenses

President Bush's initiative for cooperation in the deployment of defenses was followed by President Yeltsin's January 29, 1992 announcement that "We are ready jointly to work out and subsequently to create and jointly operate a global system of defense in place of SDI." Two days later, in a speech to the United Nations Security Council, President Yeltsin reiterated his proposal for the "creation of a global system for protection of the world community" which "could make use of high technologies developed in Russia's defense complex." President Yeltsin's remarks represented a major breakthrough. For the first time, a Russian leader publicly acknowledged our shared interest in developing defenses against ballistic missiles.

During their meeting at Camp David on February 1, Presidents Bush and Yeltsin had a constructive discussion about the proposal on global defenses. They agreed to continue this dialogue. When Secretary of State Baker met in Moscow in February with President Yeltsin and Foreign Minister Kozyrev, he stated that the U.S. shared Yeltsin's bold vision on the need for a global ballistic missile defense system, and that we were prepared to work together toward this goal. Secretary Baker proposed that we begin this cooperation by concrete steps in three areas:

- the sharing of early warning information on ballistic missile launches through a Joint Ballistic Missile Early Warning Center that would integrate and display early warning information from all participants;

- the discussion of areas for possible technology exchange, especially the acquisition of former Soviet technology and hardware; and,

- the development of a concept for a global ballistic missile defense system.

The United States is encouraged by these recent developments, and we will continue to pursue these discussions with our allies, Russia, and others as we move forward.

At the June 16-17 Summit in Washington, Presidents Bush and Yeltsin signed a Joint Statement on a Global Protection System:

> "The Presidents continued their discussion of the potential benefits of a Global Protection System (GPS) against ballistic missiles, agreeing that it is important to explore the role for defenses in protecting against limited ballistic missile attacks. The two Presidents agreed that their two nations should work together with allies and other interested states in developing a concept for such a system as part of an overall strategy regarding the proliferation of ballistic missiles and weapons of mass destruction. Such cooperation would be a tangible expression of the new relationship that exists between Russia and the United States and would involve them in an important undertaking with other nations of the world community.

The two Presidents agreed it is necessary to start work without delay to develop the concept of the GPS. For this purpose they agreed to establish a high-level working group to explore on a priority basis the following practical steps:

- The potential for sharing of early warning information through the establishment of an early warning center.

- The potential for cooperation with participating states in developing ballistic missile defense capabilities and technologies.

- The development of a legal basis for cooperation, including new treaties and agreements and possible changes to existing treaties and agreements necessary to implement a Global Protection System."

In the context of the global ballistic missile defense regime proposed by Russian President Yeltsin, opportunities for cooperation with our allies will increase. The United States considers its allies as one of the cornerstones of any cooperative effort on global missile defenses, and the U.S. has underscored the central role of our allies in this concept to Russia.

1.5 U.S. Contribution to a Global Defense System

1.5.1 Elements of U.S. Contribution

The elements being currently developed under GPALS will comprise the U.S. contribution to a global defense system. Our contribution would consist of surface- and space-based elements to ensure continuous global detection, track, and intercept of ballistic missiles and their associated warheads, including theater missile threats. These defensive elements could be deployed sequentially. The beginning of the deployment process need not await the deployment of the entire system. Nor would the deployment of a GPALS system be contingent on the technical maturity of follow-on systems. The GPALS concept integrates space- and surface-based (ground, sea and airborne) interceptors and sensors in order to enhance the effectiveness of both theater and strategic missile defenses. A GPALS defensive system would consist of the following:

- Space- and surface-based sensors capable of providing global, continuous surveillance and tracking, from launch to intercept or impact, of ballistic missiles of all ranges. The use of space-based sensors would allow for a reduction in the size, cost, and number of the surface-based weapons and sensors, while increasing their performance. In combination, the sensors would provide information to U.S. forces and, potentially, to those of our allies as well.

- Interceptors based in space, on the surface, and airborne, capable of providing high confidence protection to areas under attack. Space-based interceptors could provide continuous, global interdiction capability against missiles with ranges in excess of approximately 500 kilometers (about 300 miles). The surface-based and airborne-launched interceptors, located in the United States, deployed with U.S. forces and, potentially, deployed by U.S. allies, would provide local point and wide-area defense.

Common to all the GPALS interceptors is the use of non-nuclear, hit-to-kill technology for destruction of all types of warheads--nuclear, chemical, biological and conventional. These interceptors are designed to permit destruction of both missiles and warheads well away from the targets being defended. The employment of multi-layered defenses will ensure multiple opportunities to engage hostile ballistic missiles, thereby providing a high level of defense effectiveness.

The current Theater/Tactical elements of GPALS will be able to be deployed globally by the United States. These forward elements of our ballistic missile defense will be transportable and could be deployed with ground-based or sea-based units. Friends or allies may also choose to deploy theater defenses that could be interoperable with those of the United States. It is important to note that the space-based ballistic missile defense sensors will support theater as well as strategic defense operations.

1.6 The Missile Defense Act of 1991

The passage of the MDA represents a significant step toward a consensus between the Administration and Congress on fundamental missile defense goals. The national goal identified in the MDA is to:

(1) 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.

(2) maintain strategic stability; and

(3) provide highly effective theater missile defenses to forward-deployed and expeditionary elements of the Armed Forces of the United States and to friends and allies of the United States.

The MDA states that the limited deployment of defenses should be "designed to protect the United States against limited ballistic missile threats, including accidental or unauthorized launches or Third World attacks". Congress and the Administration agree on the need for a defensive capability to protect against these threats.

The MDA directed the Administration to take several measures to implement the Act's goal of a highly effective defense against limited ballistic missile strikes. The Department is moving forward on each of these. In particular, the Department is developing for deployment an ABM defense located at a single site, by the earliest date allowed by technological availability, (discussed below). The Department plans to deploy advanced theater ballistic missile defenses by the mid-1990s. The United States, as discussed above, is continuing its dialogue with Russia on the deployment of highly effective defenses against limited missile strikes. These activities are consistent with the MDA's support for discussions with the former Soviet Union on obtaining relief from the current ABM Treaty regime in order to achieve the missile defense goals stated in the MDA.

1.6.1 Toward the Future

The Administration and Congress share the determination to provide, as soon as feasible, protection against limited ballistic missile attack. It remains for the Administration and Congress to agree on the appropriate combination of forces. In our view, a combination of surface- and space-based interceptors and sensors offers the best approach for addressing the full range of GPALS missions and contingencies. This combination would provide a level of defense effectiveness that could not be achieved by surface- or space-based systems alone. The Congress has endorsed developing for deployment space-based sensors. But it has mandated that space-based interceptors such as Brilliant Pebbles (BP) not be included in the initial plan for the limited defense system architecture described in the MDA. It explicitly endorsed robust funding for research and development of promising follow-on technologies, including BP, however, stating:

> To effectively develop technologies relating to achieving the goals specified in [the MDA] and to provide future options for protecting the security of the United States, robust funding for research and development for promising follow-on anti-ballistic missile technologies, including BP, is required.

While we can continue to discuss Brilliant Pebbles' role in our defensive architecture, we need not resolve the question of their deployment this year. The Department will vigorously pursue the development of space-based sensors for deployment and, funding permitted, continue to develop technologies such as BP as a follow-on option to the deployment specified in the MDA, and to meet existing military requirements.

1.6.2 Deployment Planning

The Department has planned, programmed, and budgeted its resources to support the goals of the MDA and established military requirements. In response to congressional direction, the Department is developing for deployment a defense located at a single site. Depending on the progress made towards agreement to modifying the ABM regime, the restrictions on the location and number of ABM sites, including the number of interceptors, in the United States, as well as the prohibition on the deployment of space-based ABM sensors and interceptors, would be relaxed accordingly. In this eventuality, the site at Grand Forks would be redundant. However, as long as the ABM Treaty remains in force, the single site it permits would remain at Grand Forks. Because the capability provided by this single site is constrained by the ABM Treaty, it cannot defend the continental United States against the full range of threats to the required level of effectiveness. In addition, several Treaty issues have not yet been resolved. The capability of this Treaty-limited deployment would be restricted to intercepting a few tens of RVs launched by ICBMs or long-range SLBMs aimed at the center of the nation. Additional sites, prohibited by the ABM Treaty, are needed to provide the required level of defense for the entire U.S. against the full range of threats.

After ABM Treaty compliance issues are resolved, we can undertake, if appropriate, and after consultation with our allies who would be affected, improvements to existing early warning sensors to bridge the gap until the space-based Brilliant Eyes sensors become operational. We are currently studying this issue.

Consistent with our objectives and expectations for a global defense system, the Department is planning to complete deployment of the full ground-based ABM system, consisting of additional sites and additional ground-based interceptors at the turn of the century. Space-based sensors are planned for deployment by the late 1990s to support the national and theater components of a global defense system. The United States also will deploy advanced, highly effective theater ballistic missile defenses beginning in the mid-1990s. Space-based interceptors (i.e., Brilliant Pebbles) could be available for deployment by the year 2000 to complete the deployment of the overall GPALS system architecture.

1.7 Summary and Conclusion

In response to the dramatic changes in the international security environment, the United States has established a new defense strategy. Missile defense will provide critical support for that new strategy.

In addition, we have seen a significant break from past Soviet policy on ballistic missile defenses which has opened a historic opportunity for cooperation in this area. For the first time, a Russian leader has acknowledged our mutual interests in protection against ballistic missile attack. We are prepared to work with our allies, Russia, and other countries toward the goal of a global ballistic missile defense system. The elements being developed under GPALS will comprise the U.S. contribution to this system.

The U.S. remains a global power with global responsibilities and alliance commitments. Our concept for missile defenses--GPALS--reflects these responsibilities and commitments. Theater and strategic defense programs have been integrated, both conceptually and technically. This will permit the U.S. to develop for deployment by the mid-1990s advanced, surface-based theater defenses and an initial site of the ground-based ABM tier; and, beginning in the late 1990s, to deploy the remaining surface and space-based elements of a global ballistic missile defense system.

With the passage of the MDA, a major step has been made toward a consensus between the Administration and Congress on U.S. ballistic missile defense goals. The national goal identified in the MDA is to deploy ballistic missile defense systems, consistent with stability and capable of providing a highly effective defense of the United States against limited ballistic missile attack, and highly effective theater ballistic missile defense for U.S. forward deployed and expeditionary forces, allies and friends.

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Chapter 2

Strategic Defense Initiative Concepts and Architectures

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Chapter 2
Defense Concepts and Architectures

This chapter responds to subparagraphs (b)(1) and (b)(3) of Section 224 of the National Defense Authorization Act for Fiscal Years 1990 and 1991 (Public Law 101-189), which request a statement of "the basic strategy for research and development being pursued by the Department of Defense under the Strategic Defense Initiative (SDI), including the relative priority being given, respectively, to the development of near-term deployment options and research on longer-term technological approaches." Part (b)(3) requests "a clear definition of the objectives of each planned deployment phase of the Strategic Defense Initiative for defense against strategic ballistic missiles."

2.1 Ballistic Missile Defense--History

The technical problem of defending the United States against attack from long range ballistic missiles has been studied since the mid-1950s. The principal defense concept in the 1960s and 1970s was to equip a defensive missile with a nuclear warhead, shoot it at an attacking warhead, and guide the defensive missile close enough to the attacking warhead so that detonation of the defensive warhead would destroy the attacker. Despite some remarkable progress made in ballistic missile defense technologies during the 1960s, with the technologies available at that time, this engagement could only occur post-apogee when attacking warheads were beginning their descent to targets. Intercepts outside the atmosphere were complicated by decoys so the most reliable intercepts could occur only after atmospheric slowdown.

Development of a multi-site missile defense system based on this concept proceeded into the 1970s. In 1972, the United States and the Soviet Union signed the Anti-ballistic Missile (ABM) Treaty which eventually, following its amendment in 1974, limited each country to building only one ABM system deployment area with 100 ABM interceptor missiles. The American site was completed in 1975, but was rendered inactive shortly thereafter. With so few interceptors, even with intercepts outside the atmosphere, a single site system using the technology available at that time had only a very limited capability to defend a small part of the U.S. against a large Soviet attack. Therefore, the U.S. determined that the expense of maintaining this site did not merit its continued activation. However, the Russians have maintained and improved over time their ABM system deployed around Moscow.

Significant advances in technologies applicable to ballistic missile defense occurred after the 1970s. In 1983 President Reagan challenged the U.S. scientific community to investigate the feasibility of developing a defensive system using these technologies to counter ballistic missiles. In response to the President's challenge, the Department of Defense conducted an intensive analysis of these advanced technologies.

This analysis, known as the Fletcher Study, concluded that new technologies made possible the ***actual intercept*** of an attacking missile. This capability represented a significant improvement over previous concepts and would permit destruction of an attacking missile without need of a nuclear detonation. In addition, the Fletcher Study recognized the feasibility of intercepting attacking missiles much earlier in their flight path, thus giving a defensive system more opportunities to intercept an attacking missile. Based on these and other findings, the Fletcher Study outlined an approach for designing a defensive system that remains the conceptual cornerstone of modern ballistic missile defense, and noted that the technologies required to develop such a system were either in hand or on the horizon. The Fletcher Study concluded that the most effective ballistic missile defense system would be a ***multilayered*** system that could intercept missiles in any phase along the missile's flight path, thus increasing the probability that an attacking missile would be destroyed.

Since its initiation in 1983, the SDI program has evolved through three distinct phases: 1) a broad based technology exploration and demonstration program to identify those technologies ready for development to support an initial multi-layer comprehensive defense system, and those promising follow-on technologies that could provide resilience against a full range of responsive countermeasures, 2) a focused development program called "Phase I", initiated in 1987, and aimed toward a significant layered defense capability to augment and strengthen deterrence, and 3) the 1991 refocusing of the program by the President toward protection of the U.S., our forces overseas, and friends and allies against limited ballistic missile strikes, whatever their source. The latter is the continuing focus of the current program.

In his 1991 State of the Union Address, the President stated:

> "...Looking forward, I have directed that the SDI Program be refocused on providing protection from limited missile strikes, whatever their source. Let us pursue an SDI program that can deal with any future threat to the United States, to our forces overseas, and to our friends and allies."

As a result, the program presented to Congress during 1991 was structured to provide by the end of this decade many of the same space- and ground-based elements of the previous SDI architecture--but in substantially reduced numbers. Rather than being sized to help deter a massive Soviet attack (now judged to be substantially less likely) involving thousands of ballistic missile weapons, a GPALS deployment, involving half the ground-based interceptors and one-fourth the space-based interceptors previously planned in the Phase I Architecture, would protect the United States against limited attacks involving up to 200 ballistic missile warheads.

Consistent with the mandate in the FY 91 Defense Appropriations Act, the Administration also proposed an accelerated program to develop and deploy advanced theater ballistic missile defense systems (potentially based in-theater or transported there when needed, or based on ships). This capability would be significantly more effective than the Patriot defense demonstrated in the Gulf War, and would be highly efficient against theater missiles with ranges longer than the Scud, as well as shorter range missiles.

The Administration has integrated its plans for strategic and theater missile defenses through a concept called Global Protection Against Limited Strikes, or GPALS. Global means protecting U.S. worldwide interests with theater defenses as well as defenses for the American homeland. Protection means the objective is high confidence of extremely low or no leakage. Limited means up to 200 attacking ballistic missile warheads in a variety of scenarios.

The scale of limited strikes depends on their source. For Third World threats we might expect one to a few tens of missiles launched simultaneously. For an accidental launch, we might be concerned with the launch of a single ICBM or SLBM having 10 nuclear warheads or with the launch of a few such missiles. For an unauthorized launch, it might involve a regiment of ICBMs (*e.g.*, 10 ICBMs with 10 warheads each) or of a full submarine of SLBMs (*e.g.*, 20 SLBMs with 10 warheads each), launched within a short time. For advanced missiles, penetration aids could accompany the nuclear warheads. Missiles from some Third World countries might have primitive penetration aids, or none at all.

The Missile Defense Act of 1991, contained within the FY 1992 National Defense Authorization Act and discussed in greater detail in the previous chapter, gave further direction to the SDI program by accelerating the deployment of the first ground-based missile defense site for the United States by three to four years. We view this deployment to be the initial step toward deployment of the elements under development as part of the GPALS concept capable of providing a highly effective defense of the U.S. against limited ballistic missile attacks. The Act also reiterated the Congressional desire to field improved theater ballistic missile defenses by the mid-1990s.

2.2 Description of the GPALS Concept

Under the GPALS concept, a ballistic missile defense system which could protect against limited strikes would consist of surface-, airborne, and space-based elements. Figure 2-1 depicts the integrated nature of the three segments of GPALS. The Brilliant Pebbles piece is separated slightly to reflect the fact that, unlike the other two pieces, Congress did not include space-based interceptors in the initial plan for a Limited Defense System. The sizes of the puzzle pieces reflect the relative investment currently projected; *i.e.*, the segment for homeland defense will likely cost about 2.5 times that of either Brilliant Pebbles or the Theater Ballistic Missile Defense Segment.

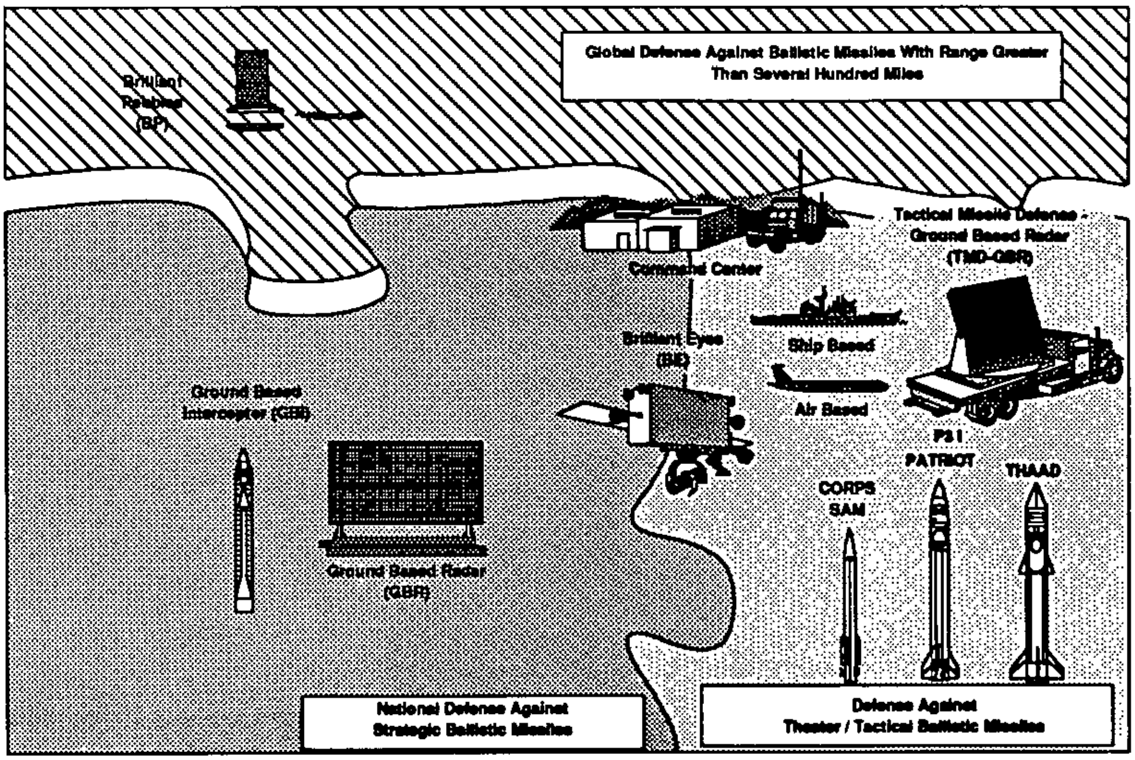

Figure 2-1 Global Protection Against Limited Strikes (GPALS)

As the technology is tested and proven, defensive elements could be deployed sequentially to provide incremental additions to defensive capability, and need not await the deployment of the entire system. Nor would the deployment of a defense system be contingent on the technical maturity of follow-on systems. GPALS would consist of the following:

- Space- and surface-based <u>sensors</u> capable of providing global, continuous surveillance and track, from launch to intercept or impact, of ballistic missiles of all ranges. The use of space-based sensors would allow for a reduction in the size, cost, and number of the surface-based weapons and sensors, while increasing their performance. In combination, the sensors would provide information to U.S. forces, and, potentially, to those of our allies.

- Interceptors, based in space, on the surface, and airborne, capable of providing high-confidence protection to areas under attack. Space-based interceptors could provide continuous, global interdiction capability against missiles with ranges in excess of approximately 500 km (about 300 miles). The surface-based interceptors, located in the United States, deployed with U.S. forces and, potentially, deployed by U.S. allies, would provide local point and wide area defenses.

- The Command Center infrastructure supports the centralized command and decentralized execution of the ballistic missile defense system while maintaining human control of the system at all times. These distributed facilities will be at the Cheyenne Mountain Air Force Base and collocated with the various ground-based sensor and interceptor sites. The command centers will link the GPALS elements through its command and control structure, communications networks and battle management software, ensuring that proper execution of a single coordinated defense exists. Additionally, the GPALS command and control will include an integrated system with theater forces to ensure coordination and information flow between theater ballistic missile defense assets.

A layered defense, including the combination of surface- and space-based interceptors and sensors, would provide the highest level of confidence in the effectiveness of the defenses, and, over the full range of GPALS missions. This is because a ground-only system does not have as many shot opportunities against a missile as does a combined space and ground system. For example, while a ground-based interceptor would only shoot at an incoming missile after it reaches its apogee, the space-based interceptor can intercept a missile in its early to mid stages of flight. The two systems combine to give the highest probability of engagement and kill.

2.3 Ballistic Missile Defense Architectures

The trajectory of a ballistic missile can be divided into several phases: boost, post-boost, midcourse, and terminal. The boost phase refers to the early portion of missile flight when the engines are burning and thrusting the vehicle out of the atmosphere. The post-boost phase refers to the period immediately after booster engine burnout, usually after the missile has left the atmosphere and initiates release of its warheads. The midcourse phase refers to the relatively long period when the warheads coast in space along their trajectories. The terminal phase refers to the last portion of flight when the warheads reenter the atmosphere. For long-range missiles, the time period of the boost and post-boost phases combined is a few minutes, the midcourse phase lasts about twenty minutes, and the terminal phase is a minute or so.

The opportunities to intercept a ballistic missile vary for each phase of the missile's trajectory. The architecture concept under development calls for a layered defense so that the technological capabilities we have developed can be employed in discrete fashion in each phase of the threat trajectory. This approach will result in the highest probability of engaging and destroying the threat.

A key feature of a multilayered defense is the use of both space-based and ground-based systems. For example, the most practical way with the widest coverage to detect the launch and flight of a strategic missile in its boost phase is to use an orbiting platform that can observe the launch from space. Destroying strategic missiles in their boost or post-boost phases, especially before the missiles have released their loads of multiple warheads, is another function that can only be performed practically from space. And in a battle that will only last about thirty minutes from launch to warhead impact, this capability increases the time and opportunities available to conduct intercepts throughout the battle space.

The discussion that follows addresses the layered Ballistic Missile Defense system--active Theater Missile Defense, Limited Defense System, and Space-Based Interceptors--to defend against limited ballistic missile attacks regardless of their source. The strategy for fielding an effective ballistic missile defense follows an orderly progression of testing the most promising technologies as they come from the laboratory and deploying defensive systems as their capabilities are proven. A more detailed plan for the deployment of theater and national defenses was recently provided to Congress.

2.3.1 Theater Missile Defense

The theater/tactical missile threat facing U.S. forces and those of our allies and friends is complex in terms of the types of threats (tactical ballistic missiles, cruise missiles, and air-to-surface missiles), the technical sophistication, destructive potential and concept of operations. These threats are addressed broadly in the JCS Mission Need Statement for Theater Missile Defense. The required general capabilities are grouped into four areas: Attack operations (counterforce); passive defense; active defense; and BM/C^3I. In combination with active defenses, counterforce, passive defense and BM/C^3I, the United States is provided with a capability to respond to the full range of theater missile threats using space- and surface-based interceptors. The focus of the discussion in this report is on the active defense portion of the general theater missile defense mission.

The active defense portion of the Theater Missile Defense program has been expanded in the past year to emphasize the transition from research and development to acquisition of a theater ballistic missile defense system. As stated in the Report to Congress on the SDI Program last year, we are aggressively pursuing the development of advanced, rapidly relocatable, ground-based wide area theater missile defenses for deployment in the mid-1990s. In parallel, we are researching and developing space, maritime, and ground-based sensors, and space, maritime, and air-launched interceptors, for deployment at a later time, which together with the theater ballistic missile defense systems developed in the mid-1990s will provide a mutually supporting system.

In the near term (1995-98), our strategy is to upgrade the PATRIOT system; add an upper-tier, area defense called THAAD (Theater High Altitude Area Defense); upgrade the Homing-All-The-Way-Killer (HAWK) air defense system; improve the Navy SPY-1 radar to give Aegis ATBM capability to defend the fleet, ports, and landing sites; and improve the battle management and command, control, and communications that support these elements.

PATRIOT is a mobile system consisting of a single radar, normally eight launchers with four interceptor missiles each, and a command and control unit. This system was originally designed to protect point or small area military targets (*e.g.*, an airbase or artillery battery) against attack from air-breathing threats such as cruise missiles or manned aircraft. PATRIOT was later upgraded to protect a limited area against faster moving short range ballistic missiles with a range up to about 370 miles. This is the capability that was demonstrated against Scuds in the Gulf War. Although this system is not designed to defend against very fast-moving threats such as long range ballistic missiles, additional enhancements are planned that would enlarge the area PATRIOT can defend. The planned PATRIOT Anti-Tactical Missile Capability Three (PAC-3) will be a major system upgrade that will increase PATRIOT's range, firepower, and lethality against short-range ballistic missile threats with ranges of 1,000 km. The ERINT program provides a hit-to-kill alternative interceptor technology that would be deployed with the PATRIOT system, enhancing further its firepower and lethality.

Recognizing the inherent limitations of a small-area defense system such as PATRIOT, the Department is developing THAAD as a key element for active theater missile defense. THAAD will provide wide area coverage and will engage tactical/theater ballistic missiles at high altitudes and at greater distance from the intended target, thereby minimizing debris and chemical/nuclear damage. THAAD is intended to counter ballistic missiles with ranges from about 50 miles to 1,800 miles. The THAAD element includes missiles, launchers, BM/C^3 units and ground support equipment, and is designed to be C-141 transportable (with an objective to make it C-130 transportable). The long-range Theater Missile Defense-Ground Based Radar (TMD-GBR) will provide fire control and surveillance for THAAD as well as for other active TMD systems. This radar is planned to be mobile and compatible with existing command, control and communications systems. The theater radar is a member of a family of radars under development.

The THAAD interceptor will be evaluated as a Navy system. Consequently, industry is being directed to provide the necessary data to evaluate the cost and operational effectiveness of making the THAAD interceptor compatible with the Vertical Launch System (VLS) carried on Navy cruisers and destroyers.

An important element of the THAAD program is the building of a prototype "battery" during the demonstration and validation stage of development for ballistic missile defenses. This "User Operational Evaluation (UOE) System" includes interceptors and TMD-GBR, will be used for early operational assessment, and has the potential to be deployed during a national emergency. This approach is designed to meet the Congressional mandate by providing an improved near-term active TMD capability by 1996 while lowering risk in subsequent phases of the acquisition cycle. The full operational system will be fielded in the 2000 time frame.

THAAD and PATRIOT will be supported by a sea-based area active TMD system, the CORPS SAM limited area defense system, and the capability to augment sensor elements for earlier detection and tracking of theater threats by utilizing Brilliant Eyes data for cueing theater interceptors. Ultimately, space-based interceptors could contribute to the active TMD mission by intercepting missiles with ranges greater than about 500 kilometers.

Corps SAM will be a highly mobile air defense system intended to replace the HAWK air defense system early in the next decade, and provide defense against aircraft, cruise missiles, and tactical ballistic missiles. The specific capabilities of CORPS SAM will be defined at the end of its concept definition phase as technical alternatives are evaluated and selected. It is the first system that will be designed as a dual use defense against manned aircraft and tactical ballistic missiles.

Maritime TMD applications are being investigated for both limited and wide-area protection, utilizing the U.S. Navy Aegis weapons system. The Secretary of the Navy and Chief of Naval Operations have indicated that their Service is committed to accomplishing the Navy role in the theater missile defense mission, and a flag-level office has been established within the Department of the Navy to integrate Navy TMD efforts. As noted earlier, SDIO is examining THAAD compatibility with the AEGIS system to permit eventual evaluation of a common missile utilizing the vertical launch system.

Figure 2-2 illustrates the near term theater ballistic missile defense architecture, and Figure 2-3 depicts the far term theater ballistic missile defense capability.

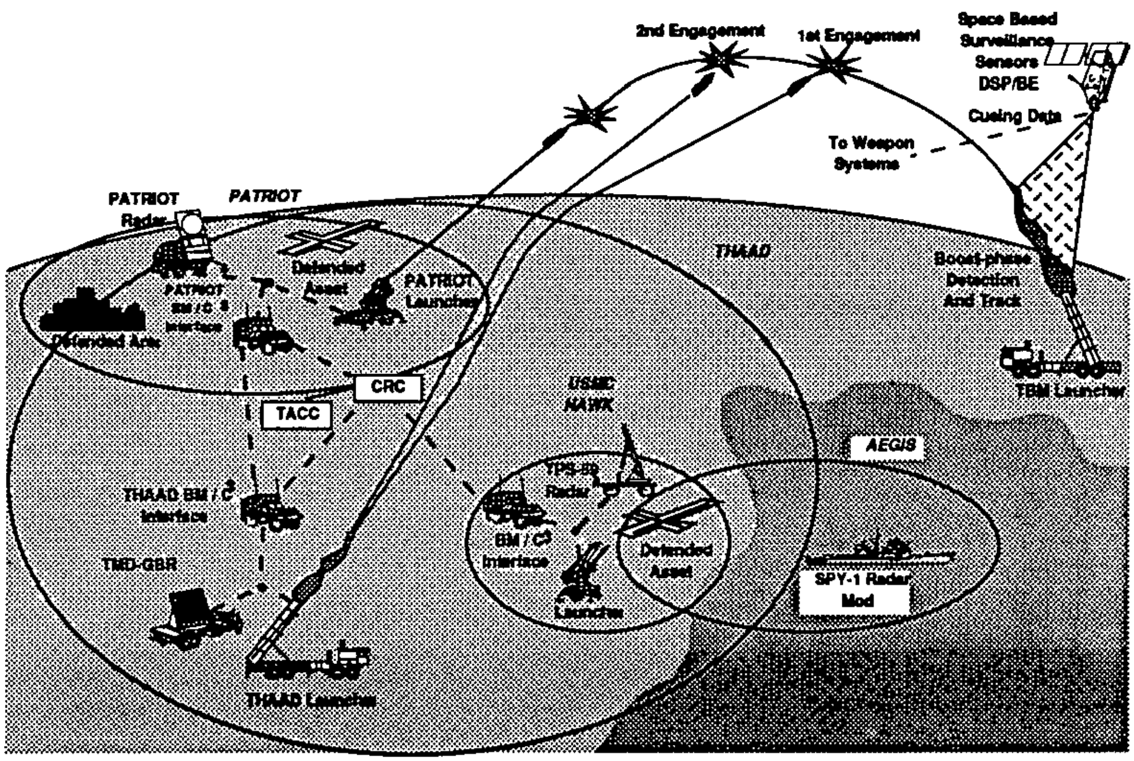

Figure 2-2 Notional Near Term Theater Ballistic Missile Defense Architecture

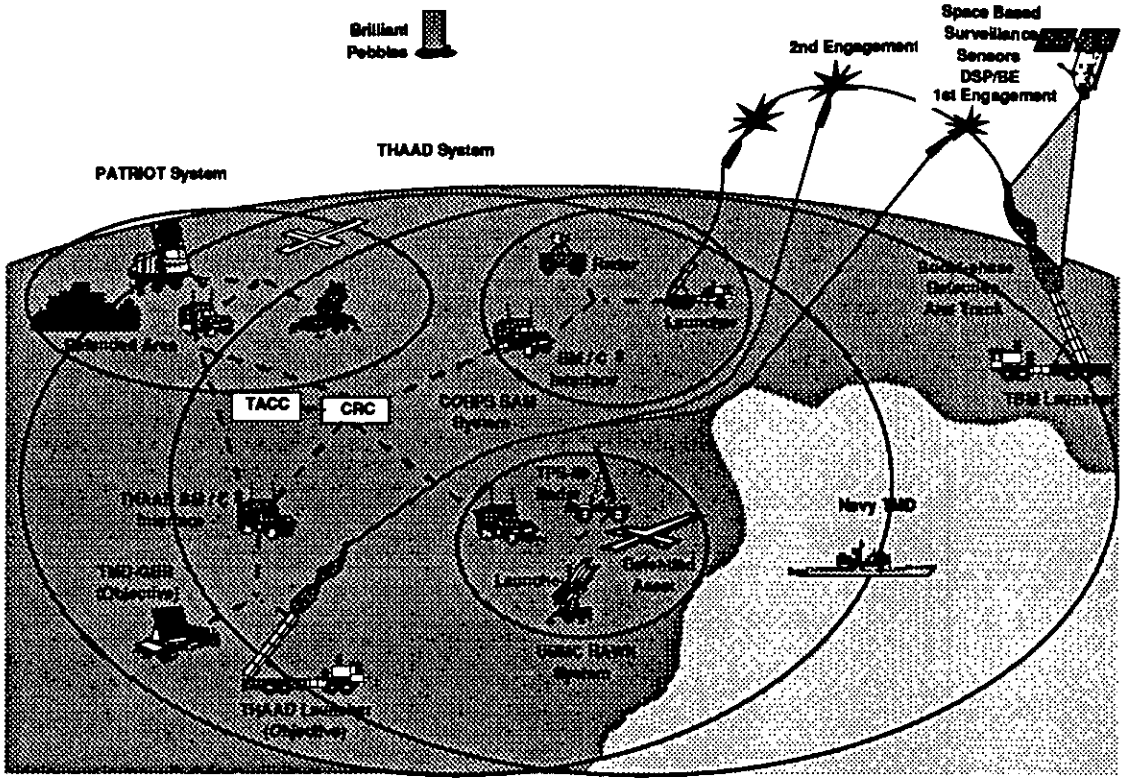

Figure 2-3 Notional Far Term Theater Ballistic Missile Defense Architecture

Other research efforts underway include Extended Range Interceptor (ERINT) technology, and the Arrow/Arrow Continuation Experiments (ACES), a cooperative U.S./Israeli interceptor technology program. Boost phase intercept technology for an airborne platform also is undergoing research. Airborne interceptors in the vicinity of a missile launch could place an enemy's theater ballistic missiles, regardless of their range, at risk.

The theater ballistic missile defense program involves all four Military Services and U.S. friends and allies in the development of technology and the selection of systems to provide an anti-missile defense. Additional information on the theater ballistic missile defense architecture and programmatic specifics was provided to Congress in the 180-day report mandated by the Missile Defense Act of 1991.

As noted in Chapter 6, although the objective of the ABM Treaty is to limit defenses against strategic ballistic missiles, there may be conflicts between the Treaty and the development and deployment of some of the theater/tactical missile defense systems under consideration. We are currently studying this issue.

2.3.2 Limited Defense System/National Missile Defense (NMD)

The Limited Defense System (LDS) architecture for the defense of the United States as set forth in the MDA includes multiple sites with ground-based interceptors supported by both ground-based radars and space-based sensors. In programmatic terms, SDIO refers to the LDS as the National Missile Defense (NMD) segment. This architecture is illustrated in Figure 2-4.

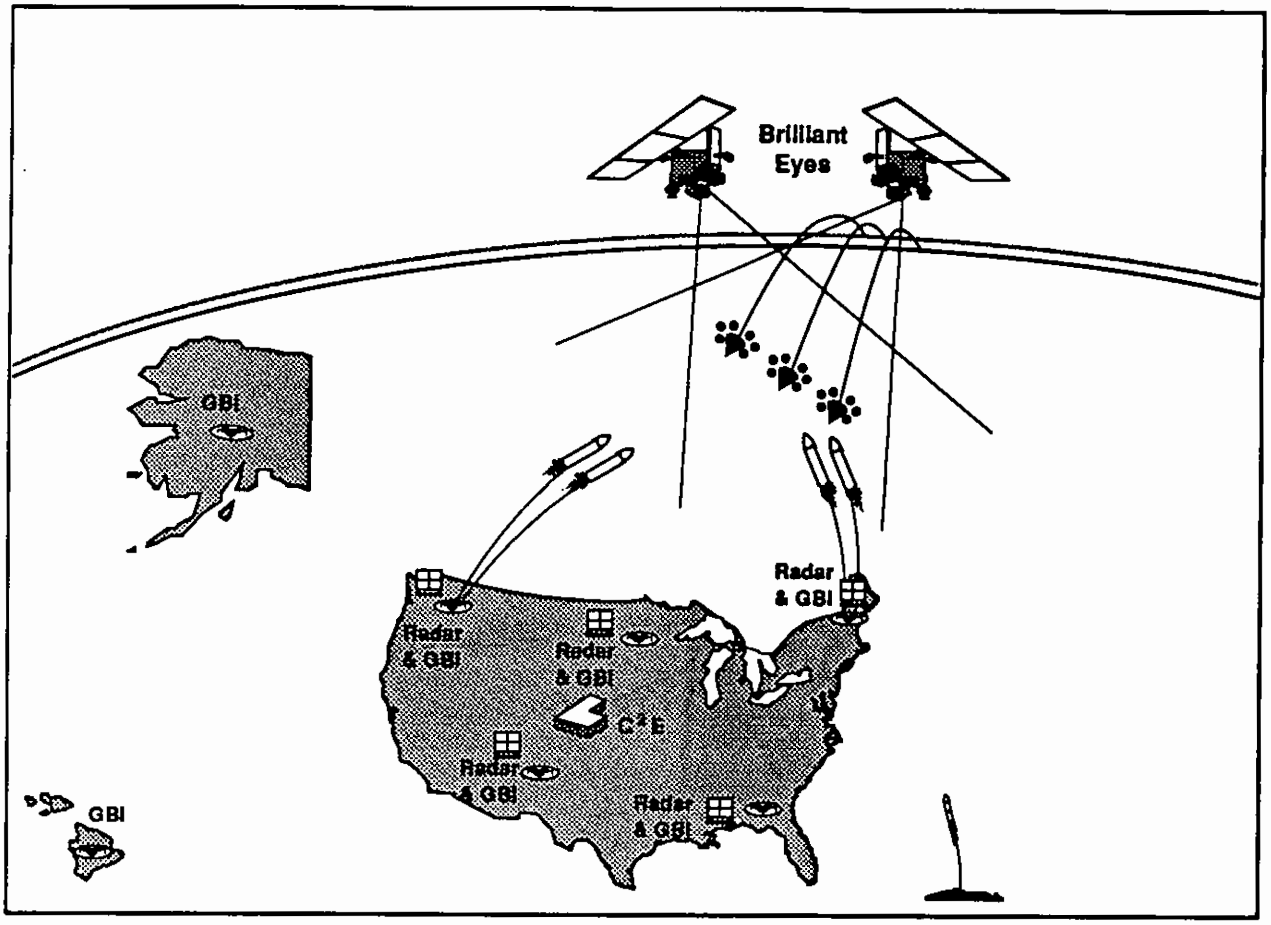

Figure 2-4 Limited Defense System/National Missile Defense Architecture

The required number of sites ranges from three to five in the continental United States plus one each in Alaska and Hawaii to provide defense coverage against the full range of GPALS threats. Depending upon progress in seeking relief from the ABM Treaty, we may be able to avoid a site at Grand Forks, which is not needed in a multiple site deployment. In the final deployment configuration, interceptors are committed toward their incoming targets based on early detection by the Brilliant Eyes (BE) space sensor system. BE develops high quality tracks and provides early discrimination shortly after the reentry vehicles drop off the post-boost vehicle. Later intercepts and trajectory and discrimination updates can be supported by both the BE and by the ground-based radar. The combination of both radar and optical data to support intercepts by the ground-based interceptors provides the most robust defense performance against the widest range of possible threat and penetration aid variations.

The baseline program will focus on the initial site and the sensor systems to support it in the context of an incremental deployment toward the 5-7 sites required to meet military requirements versus the full range of threats. This context is most important in designing the architecture for the battle management /command, control and communications (BMC^3) portion of the system. We intend to design an "open architecture" BMC^3 system which will allow for the future incremental addition of sensors, sites, and interceptors without redesign or rebuilding of the basic BMC^3 system. The initial site components of the system will be brought to operational status to support the initial site capability. The initial site will consist of the local components of the BMC^3 system plus the initial deployment of ground-based interceptors (GBI) and the first operational ground-based radar (GBR).

BE is being developed on a schedule that would permit deployment soon after the initial site is operational. The BE space-based sensor system will be the primary midcourse optical sensor, allowing tracking of post-boost vehicles and RVs as soon as they are dropped off. This provides the maximum time for the GBI to fly, generating the maximum possible defended footprint from each GBI site. During the deployment of the ground-based sites and before BE is available, cueing of the GBI into the battle to provide maximum defended footprint could be provided by either software upgrades to the early warning radars, construction on new radars, or by GSTS. Use of any of these interim cueing approaches may require treaty relief. BE also provides critical support to theater defense, cueing the radars and/or directly committing THAAD interceptors. Against longer range theater ballistic missile threats, this increases the defended footprint area by up to a factor of 10 from that provided by local radar support alone, greatly decreasing the ground assets required in-theater for a given level of defense. BE also is capable of peacetime monitoring of missile flights worldwide, providing the optical signature data base to allow all defense systems to operate at peak performance when called on in wartime.

The primary role of the Ground-Based Surveillance and Tracking System (GSTS) is to provide an option for interim cueing of GBIs at the initial site, prior to deployment of Brilliant Eyes. The current NMD architecture optical sensor requirements are met by the Brilliant Eyes (BE) program.

2.3.2.1 Initial Defense Site

While planning for the Limited Defense System architecture as described in the Missile Defense Act, our first priority will be to deploy by the earliest date allowed by the availability of appropriate technology, an ABM Treaty-compliant system at a single site.

The composition of the initial defense site is shown in Figure 2-5 with the Ground Based Radar (GBR), Ground Based Interceptor (GBI), and associated BMC^3.

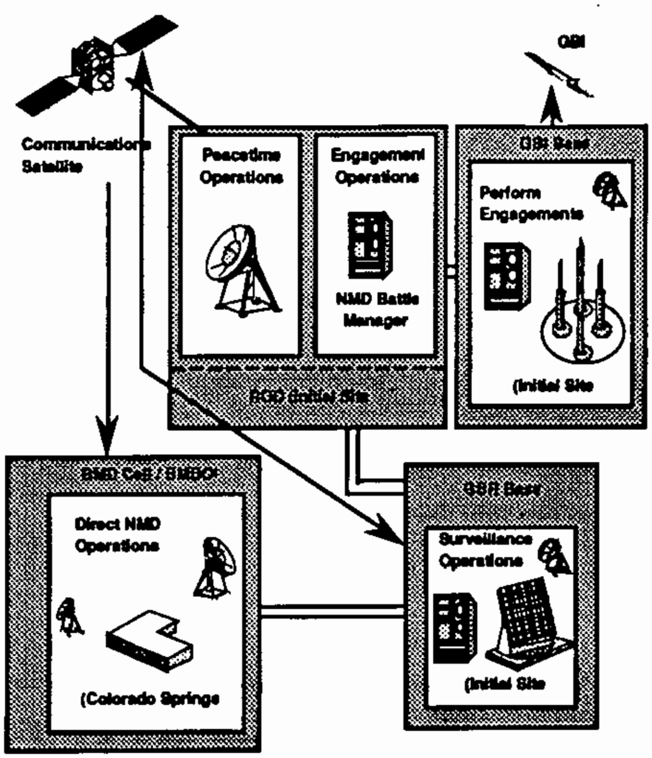

Figure 2-5 Initial Defense Site

The BMD cell located at Colorado Springs has a battle manager node that will allow CINCSPACE to enable the system and direct the battle. The BMD cell will be connected to the Regional Operating Center (ROC) located at the initial site by both land line and communications satellite to provide highly reliable and survivable control. The ROC also has a Battle Manager Node and is capable of directing the battle locally if communications are disrupted. The GBR will acquire and track the incoming ballistic missile targets. GBIs are committed and start their flyout based on initial tracks from the radar. After the GBR performs fine tracking and discrimination of the RVs from debris and penaids, inflight updates and target object maps may be issued to the interceptors inflight. Based on the initial commit data and any subsequent updates, the GBIs will acquire their targets with their onboard sensors, perform any detailed discrimination necessary, and intercept their designated RVs.

The initial site, if located at Grand Forks, would have coverage of central North America (Figure 2-6), against long range northern threats from the CIS, China, and the Middle East, when supported with a single co-located GBR. This area of coverage may be expanded if more accurate launch point determination and state vectors of inbound threat missiles are provided to the defenses. In this event, GBIs could be committed much earlier, thus greatly expanding their intercept range.

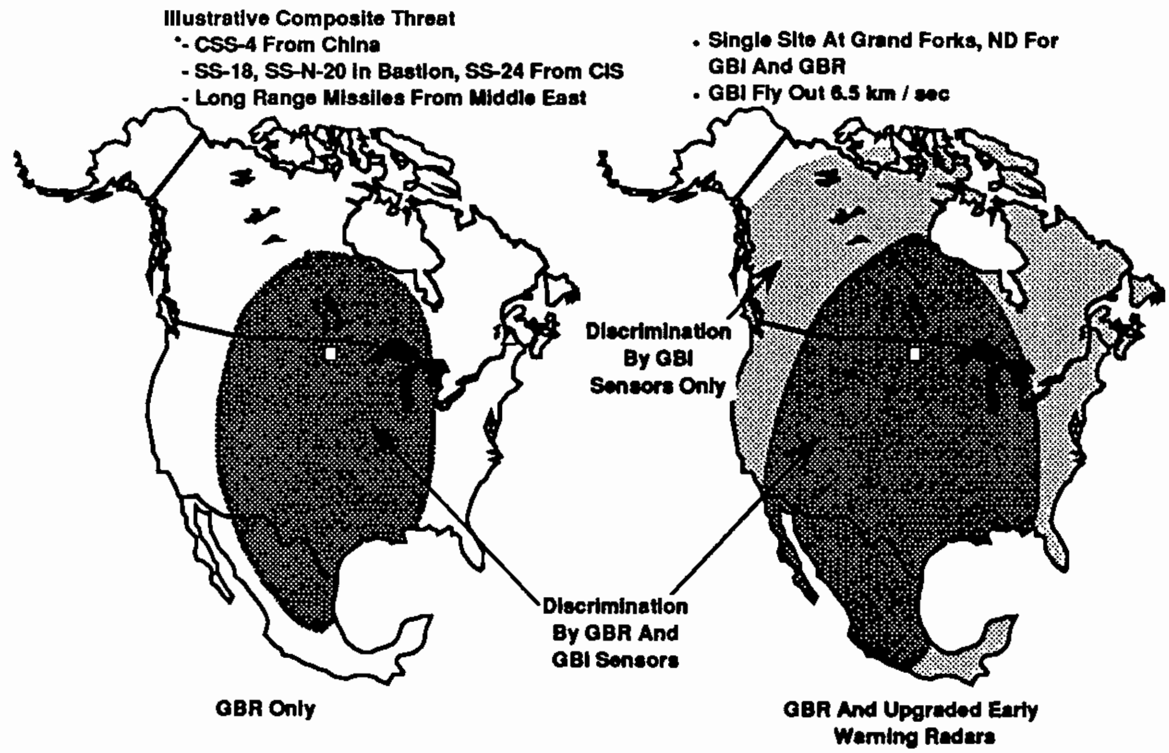

Figure 2-6 Composite Multi-Threat Defense Coverage Single Site at Grand Forks, ND

The right portion of the figure shows the coverage obtained by upgrading the existing early warning radar network (BMEWS/PAVE PAWS). In the dark shaded region (which does not include the east and west coasts). The interceptors are committed by the early warning radars but are supported for target discrimination during the intercept by the GBR at Grand Forks as well as by their own on-board sensors. In the lighter shaded region the interceptors are committed to a point in space by the early warning radars but must rely solely on their own on-board sensors for proper target selection after acquiring the target complex. This mode of operation should provide good capability against the current expected threat, but not future threats. Greater confidence in target discrimination against more responsive threats will result when additional sensor support, such as from additional Ground-based Radars and/or Brilliant Eyes, is provided.

Deployment at Grand Forks, ND, would be compliant with the ABM Treaty. However, against the possibility of short range out of bastion SLBMs, even when committed with BE, CONUS and North America cannot be completely protected. Due to the SLBM's short time of flight, there is insufficient time to fly a GBI from Grand Forks to intercept the SLBMs on the coasts. To provide coverage for the possibility of out of bastion SLBM, multiple sites in CONUS are required.

Initial analyses indicate that a multi-site defense system, which is our ultimate objective, would require sites in the Northeast, Northwest, Southeast, Southwest, plus Alaska and Hawaii. In this eventuality, the site at Grand Forks would be redundant, since the four CONUS sites would be sufficient to offer complete coverage of the United States. Thus, a preferred strategy--the ABM Treaty aside--would begin with the first site in the Northeast (or Northwest), in which case cueing would still provide total CONUS coverage for the long range Northern threats (see Figure 2-7). However, in this instance, we could save $1-2 billion because we would ultimately require one less site.

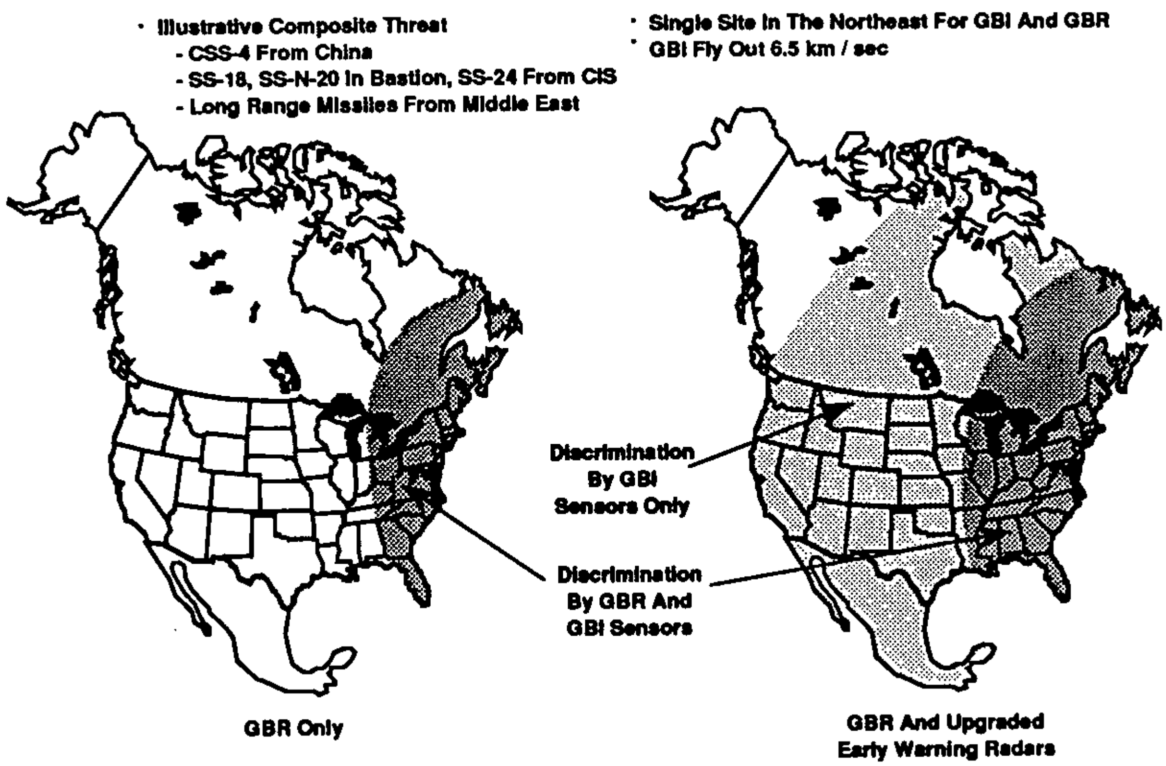

Figure 2-7 Composite Multi-Threat Defense Coverage Single Site in Northeast

Architectural analysis of these options is in process to determine the most cost-effective method of complying with the MDA. These details as well as the implementation plan will be presented in the 180-day report to Congress due in June.

2.3.3 Space-Based Interceptors (SBI)

Although Congress mandated that space-based interceptors, including Brilliant Pebbles (BP), not be included in the initial plan for deploying a Limited Defense System, the 1991 Missile Defense Act states that:

> "To effectively develop technologies relating to achieving the goal specified in (the Act) and to provide future options for protecting the security of the United States and the allies and friends of the United States, robust funding for research and development for promising follow-on anti-ballistic missile technologies, including Brilliant Pebbles, is required."

Brilliant Pebbles is a space-based, highly autonomous, proliferated, surveillance and kinetic hit-to-kill interceptor system. The BP concept consists of single interceptors and their associated "life jacket" carrier vehicles. The interceptor incorporates sensors, guidance control, battle management, and an axial propulsion stage. The interceptor will possess high-rate attitude control, on-board data processing, navigation, and divert propulsion capabilities. Each life jacket provides on-orbit power, low-rate attitude control, surveillance, communication, thermal control, and protection from the space environment and hostile countermeasures. Ground control systems will provide man-in-the-loop, positive control of the BP constellation.

The BP constellation planned for GPALS would constitute the initial intercept layer of a multilayered defense against both strategic and theater ballistic missiles in excess of 500 kilometers. It would offer a defensive tier with warning, command and control, sensing, and intercept technologies that are independent of those dedicated to the surface-based layers.

BP would be continuously in position to provide global detection of an attack and a means to destroy both strategic and theater ballistic missiles. It could act autonomously to provide highly effective protection against a limited number of missiles, regardless of their source, that exceed 80 km altitude for more than about three minutes, as would be the case for missiles following minimum energy trajectories with ranges greater than approximately 500 km. Additionally, BP has shot opportunities against realistically depressed trajectory ballistic missiles with ranges greater than approximately 700-800 km.

BP would be deployed in low earth orbit and operate in conjunction with the surface-based defensive tier. The combination of BPs and ground-based interceptors deployed in the United States, such as GBI, would provide the highest confidence protection of the United States against limited strategic missile threats. In some theaters, where the threat involves shorter range, mostly endoatmospheric missile threats that BP cannot engage, including short-range depressed trajectory systems, surface-based active TMD such as THAAD, ERINT, and improved PATRIOT could complement BP to provide the highest confidence theater defense.

The surface-based defenses, both those located in the United States and those in the theater, would benefit from an independent assessment of threat characteristics, early cuing, and from the thinning of the threat by BP. The requirements for surface-based elements to detect threats at long-range and ensure highly effective coverage over broad areas can be significantly reduced by the presence of space-based defenses.

BP's capability for multiple shots per target would greatly increase the probability of intercept and ease the burden on surface-based interceptors, minimizing the number required to help perform national and theater defense.

BP could be available for deployment as early as the end of this decade, depending on the level at which the program is funded.

Figure 2-8 depicts SBI operation.

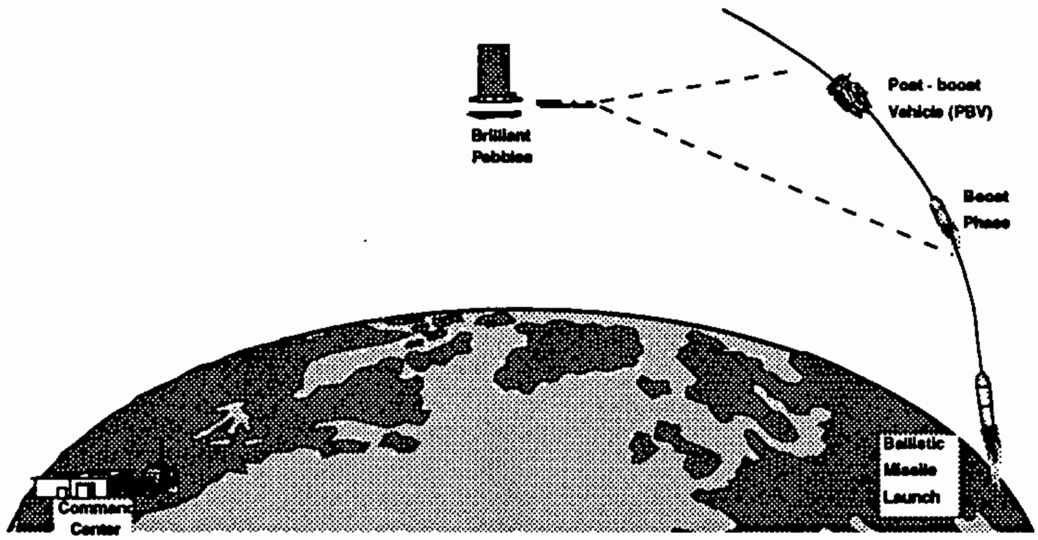

Figure 2-8 BP Operation

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Chapter 3

Description of Each SDI Project

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Chapter 3
Description of Each SDI Project

This chapter responds to subparagraph (b) (2) of Section 224 of the National Defense Authorization Act for Fiscal Years 1990 and 1991 (Public Law 101-189), which requests "a detailed description of each program or project which is included in the Strategic Defense Initiative or which otherwise relates to defense against strategic ballistic missiles, including a technical evaluation of each such program or project and an assessment as to when each can be brought to the stage of full-scale engineering development (assuming funding as requested or programmed)."

3.1 Introduction

Section 3.3 of this chapter contains a description of each project within the SDI program. For those projects which are developing systems to meet U.S. ballistic missile defense requirements, the project descriptions include an estimate for when each system could be ready for full scale engineering development (now called engineering and manufacturing development). The acquisition strategy and test and evaluation program for all such systems are in accordance with requirements specified in the DoD 5000 series documents.

Five major program elements are used to integrate all SDI projects. These program elements were established by Congress during the FY 92 budget process, and partition the SDI program into discrete mission areas. A description of these program elements is provided in Section 3.2, and each project description identifies the associated program element(s).

In addition to establishing the five SDI program elements, Congress also passed the Missile Defense Act (MDA) of 1991. This Act placed certain requirements on DoD which impact the pace and focus of the projects described in this chapter.

Last year, the President's FY 92 budget request for SDI was based on a plan calling for a deployment decision in the late 1990s, with the first ground-based site becoming operational by the year 2000. The Missile Defense Act of 1991 accelerated this schedule by several years, requiring deployment of the initial site by 1996, or as soon as the appropriate technology is available. However, while accelerating the schedule, Congress also reduced the overall FY 92 budget request for SDI by $1 billion, and that portion supporting the ground-based system by over $300 million.

These conflicting actions by Congress necessitated some modifications to the SDIO plan for providing the U.S. with ballistic missile defenses under the GPALS concept, but did not essentially change the long term program strategy. We are proposing program modifications primarily involving reprogramming near- and mid-term resources from technology base, advanced concepts, and space-based weapons research to support the accelerated schedule for near-term U.S. ground-based systems. Additionally, several parallel development approaches had to be surrendered to establish baseline technologies for initial site systems.

Figure 3-1 illustrates SDI's historical investment in near term space- and ground-based systems and technologies, and highlights FY 92 and FY 93 investment strategies both before and after passage of the Missile Defense Act of 1991. Despite the $1 billion reduction in FY 92, planned investments in ground-based programs are maintained. In the proposed FY 93 budget, investments in ground based programs, particularly U.S. defenses, have been increased substantially to support the accelerated initial U.S. site deployment. Meanwhile, that portion supporting space-based interceptors was reduced from last year's proposal for FY 93.

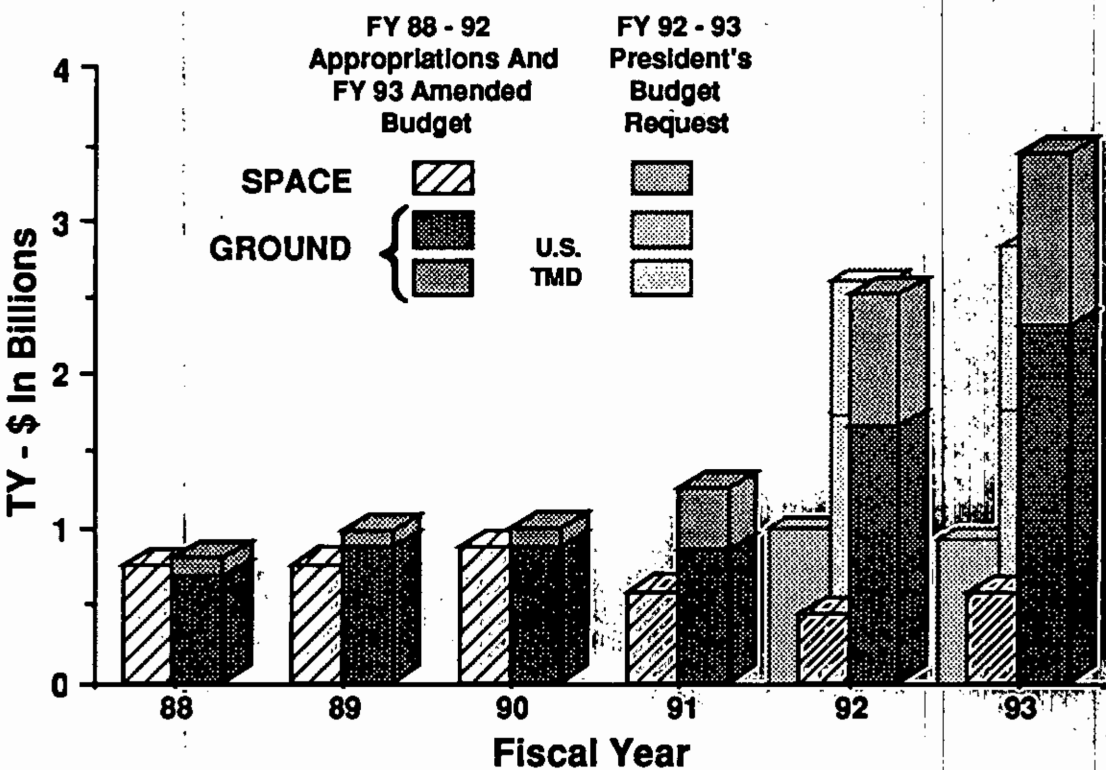

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Figure 3-1 GPALS-Related Space-Ground R&D Investment

Investment in space-based interceptors has been substantially reduced. This program, which consists primarily of the Brilliant Pebbles (BP) sensor/interceptor/battle management suite, now constitutes only 11 percent of total SDI funding for both fiscal years 1992 and 1993. This was the percentage appropriated for space-based interceptors in FY 1992 by Congress, while the Missile Defense Act of 1991 called for "robust funding" for follow-on technologies, including Brilliant Pebbles. In terms of both percentage of total SDI funding and actual dollars allocated, fiscal years 1992 and 1993 show the lowest investment levels for space-based interceptor systems since the Joint Chiefs of Staff first established mission requirements for a ballistic missile defense system (1987). These reductions will slip BP deployment options into the next century. Fully three quarters of the total SDI budget in FY 1992 and FY 1993 is now in support of TMD and Limited Defense System development.

In light of the Missile Defense Act of 1991, the following adjustments, among others, have been made to the program.

- <u>GBI/E2I</u>

Last year, we planned to carry two interceptor concepts, the GBI and the exo-endoatmospheric interceptor (E^2I), through the demonstration and validation phase and then decide, in the mid-1990s, which to carry into the Engineering Manufacturing Development (EMD) phase for deployment around the year 2000. We budgeted for developing and deploying E^2I, then judged to be the more expensive interceptor. We did not budget to deploy both at the end of the decade--although a mix was possible if the DEMVAL program succeeded in significantly reducing costs.

However that competition might have turned out, the GBI is more mature, and prudence demands we select the most mature technology now if we are to begin deployment in the mid-1990s as called for in the MDA.

At the same time, we continue to believe an endo-atmospheric interceptor option will be desired in the future. Accordingly, our acquisition strategy has been modified to develop the E^2I technology as a technology insertion program which would lead to deployment options at subsequent sites or as a retrofit pre-planned product improvement (P^3I) option for improving the interceptors at the initial site. Thus, rather than a competition between alternate concepts, we are now pursuing both concepts in a leader-follower context, with the leader being that interceptor exploiting the currently more mature technology, i.e., GBI.

This realignment will permit us to support earlier GBI deployment, as called for by the MDA, without cost growth in our interceptor deployment program over the next five years--and to preserve an option to deploy an E^2I capability by the end of the decade. However, there may be some growth in long-term total acquisition costs for GBI--something like $1 billion more for 5-7 sites.

We are moving ahead to implement this strategy. The formal request for proposals (RFPs) for the first phase of the GBI program was released to industry by the Army in early March, and contract awards are expected by the end of April. Pending approval of the Defense Acquisition Executive, competition to select a single GBI contractor will follow in the fall, with contractor selection early in 1993. This contractor may develop both the GBI for the initial site and manage a parallel effort to infuse technology from the SDIO technology programs into the development activities for subsequent sites in response to the evolving threat--e.g., by providing the technology base for an E^2I capability.

- <u>GBR</u>

As discussed in our Report to Congress last year, we are developing x-band ground-based radars under a "family-of-radars" acquisition strategy to address the requirements for both theater and strategic missile defense systems. Such an integrated acquisition strategy, with a single contractor, should reduce the total acquisition costs to meet TMD and LDS requirements by 25% as compared to two distinct GBR programs for theater and strategic defenses.

Since we were already seeking to provide advanced active TMD system capability by the mid-1990s as reported to Congress last year, there was no need to accelerate our development activities for the GBR. However, to be responsive to the MDA directions to accelerate our previous plans for deploying the initial LDS site, we have added the initial LDS-GBR to the RFP that has now been in the contractors' hands for 2 months. Contract award is expected by the end of the summer--again pending review by the Defense Acquisition Executive.

Regrettably, the GBR program cost estimates have grown significantly--by about $1.5 billion over the next 5 years. In part, this cost growth reflects the fact that the GBR now being pursued for deployment at the initial site is about four times the size and has almost three times the power of the GBR proposed last year--and its deployment is called for several years sooner. Some of this increase is also due to conservatism introduced during the exhausting Pentagon reviews of our GBR acquisition plan over the past 9 months; and, we believe that there will be substantial reductions when industry begins to provide real data for our consideration.

- <u>Sensor Cueing for LDS</u>

A single LDS site at Grand Forks, North Dakota, consisting of GBI and GBR elements (and the necessary command and control elements, of course), can protect only the central third of the continental United States (CONUS). However, the coverage from this single site could be expanded to include the entire continental United States if additional sensor information were used to "cue" (i.e., provide target vectors) GBIs into the battlespace before the collocated GBR could acquire the attacking ballistic missiles. In any case, a single site at Grand Forks could not defend against out-of-bastion submarine launched ballistic missile threats, or other potential threats emanating from the south.

In particular, full coverage for the continental United States (and most of Canada) would be provided by Brilliant Eyes (beginning at the end of the decade, according to the plan we presented to Congress last year). In addition, we are considering whether affordable measures might be taken as an interim step along with deployment of the initial site called for in the MDA to achieve earlier full coverage of the continental United States. Three alternatives are available:

-- GBRs in the Northeastern and Northwestern United States at an additional investment of about $800 million over the next five years--this would require relief from ABM Treaty restraints.

-- Software improvements to existing early warning radars at an additional investment of less than $400 million over the next five years--this may require relief from ABM Treaty restraints and the agreement of the host nations for the early warning radars. We are currently studying this issue.

-- Development and deployment of the ground launched surveillance and tracking system (GSTS) at an investment of about $1.6 billion during the next five years--whether this would require negotiated relief from the ABM Treaty would have to be formally determined within the U.S. government.

The first two of the above alternatives would be desirable parts of the ultimate LDS in any case.

After obtaining relief from ABM Treaty restrictions, further GBI/GBR sites would be needed in addition to the initial site to provide confident complete coverage of the continental United States against all limited ballistic missile threats, including ballistic missiles launched from out-of-bastion submarines. If relief from the Treaty could be obtained in time, deployment of the initial site in the Northeast followed by a Northwestern site would eliminate the need for a site at Grand Forks--and $1-2 billion could be saved. Hopefully, our ongoing discussions with the former Soviet Union will provide a basis for moving in this direction.

If GBRs were deployed in the Northeastern and Northwestern United States, improvements to the early warning radars would not be necessary to achieve complete coverage of the continental United States from Grand Forks. However, upgrading the early warning radars would enable full coverage from either Grand Forks or a Northeastern (or Northwestern) GBI site; would require a smaller investment in the near-term; and would leave an important residual capability for any subsequent deployment beyond the initial site. Of course, no decision would be taken to upgrade the early warning radars without appropriate clarification regarding ABM Treaty restrictions and consultation with our allies who are involved with maintaining these systems.

Developing and deploying GSTS would be the most expensive option; would not produce an integral part of the ultimate architecture; would have no value until used (unlike the radar options which could produce useful peacetime capability); and would have the undesirable attribute of being lost if launched due to spoofing, either intentional or accidental. Furthermore, in some scenarios, its use could exacerbate instabilities if it were mistaken for an ICBM launch. Nevertheless, we intend to complete assembly and ground testing of the GSTS sensor package as a technical hedge.

Whatever we decide regarding an interim cueing measure, Brilliant Eyes will essentially be our primary optical surveillance sensor to work in concert with the ground-based radars to improve the effectiveness of both LDS and active TMD systems. It provides the maximum time for interceptors to fly out from a given site and thus provides the maximum defended area possible from a given deployment of ground-based LDS or active TMD interceptors. Also, because Brilliant Eyes could be cued to continuously observe specific areas, it could serve to monitor missile tests worldwide, providing important intelligence and signature data to allow our defenses to maintain their peak effectiveness as new threats appear.

Our Brilliant Eyes acquisition strategy has been approved by the Defense Acquisition Executive, the RFPs for the competition to downselect from four DEMVAL contractors to two were recently released by the Air Force, and contractor selection is expected by the end of the summer. With the necessary funding support, we anticipate the first DEMVAL space tests in the 1996 time period, deployment of the first 12 operational satellites around the end of the decade, and a full operational capability early in the next decade. Although the cost estimate for the total acquisition of Brilliant Eyes has actually been reduced during the past year by almost $3 billion (in FY91 dollars), the estimate for the DEMVAL Program over the next five years has increased by about $600 million to assure an early evaluation of operational issues.

- SE&I, BM/C3, and ST&E

Acceleration of activities to support deployment of the initial LDS site, as called for by the MDA, leads to major realignment of several essential integrating activities--and substantially increased funding requirements over the next five years. The most important of these critical activities are: (a) systems engineering and integration; (b) battle management, command, control and communications (including the command center element (CCE)); and (c) system test and evaluation (ST&E). Our program planning to date suggests that these three critical activities will require about $3 billion more over the next five years than we planned for last year when contemplating only DEMVAL activities during most of that period and the deployment of the initial site at the end of the decade.

Systems engineering and integration is, in effect, the glue that holds the development activities together. Our development efforts cannot be viable without excellence here. Furthermore, ultimate system operational effectiveness depends upon the early effective execution of all three of these critical activities.

For example, we must fully define an open BM/C^3 architecture up front so that the components deployed to support the operation of the initial site can be exchanged for advanced components via P^{3}I programs or added to later (including with additional sites and even including possible allied active TMD systems) without requiring a major system redesign. And, to have confidence that the system will operate effectively when we activate the first site, we must have already been operating and gaining experience with the BM/C^3 system, including with essential hardware and software in conjunction with a comprehensive simulation and testing program. Indeed, our approach to building confidence will be to complete and fully test, via simulations and operational exercises, several "builds" of key hardware and software before initial site activation.

Our test and evaluation plans and programs are being developed in close cooperation with key members of the ST&E community, including all three services, to be consistent with OSD guidance in all key areas of interest. Testing has already begun in the earliest stages of our development activities. As we proceed, continued testing will help build confidence in an evolving and improving system capability that integrates the activities of the three services across theater and strategic lines.

SDIO constitutes a pilot program that is pushing realignment of T&E infrastructure to support the Department's new interest in developing fieldable prototypes. In many regards, the MDA is a key driver for innovation in this area--and the development activities for the initial site and subsequent improvements will serve as a proving ground for new concepts.

3.2 SDI Program Elements (PE)

Program Element: 0603216C - Theater Missile Defense (TMD)

The Theater Missile Defense (TMD) Program Element (PE) includes all programs, projects, and activities that have as a primary objective the development of deployable and rapidly relocatable advanced theater missile defenses. These defenses will defend forward-deployed and expeditionary elements of the Armed Forces of the United States. The near-term goal of the TMD program is to improve existing theater anti-missile capability by upgrading the Army's PATRIOT and the Navy's Aegis systems. Longer range plans include development of the Corps SAM and deployment of other advanced TMD systems in the 1990s. For instance, the Theater High Altitude Area Defense (THAAD) system will be available for deployment in a national emergency as a Deployable Demonstration System by the mid-1990s. A fully developed THAAD system could be ready near the turn of the century.

The TMD program involves all three services in the development of technology and the selection of systems to provide an anti-missile defense. For example, we intend to evaluate the utility of the THAAD interceptor in a Navy role, while the Air Force is considering an active TMD role for aircraft.

The active defense role of theater systems like THAAD and PATRIOT will be enhanced when combined with other elements of U.S. defenses such as Brilliant Eyes, and potentially, Brilliant Pebbles. Also, theater active defenses will complement and be integrated with theater passive defense and counterforce operations.

Program Element: 0603215C - Limited Defense System (LDS)

The Limited Defense System (LDS) PE includes programs, projects, and activities (and supporting programs, projects, and activities) which have as a primary objective the development of systems, components, and architectures for a deployable anti-ballistic missile system that is capable of providing a highly effective defense of the United States against limited ballistic missile threats, including accidental or unauthorized launches or Third World attacks. For purposes of planning, evaluation, design, and effectiveness studies, such programs, projects, and activities take into consideration both the current limitations of the anti-ballistic missile (ABM) Treaty and modest changes to the Treaty's numerical limitations and its limitations on the use of space-based sensors.

Activities within the LDS PE are focused on developing highly effective defenses including possibly several ground-based interceptor sites and space-based sensors to protect the entire United States, including Alaska and Hawaii, against ballistic missile attacks consisting of several tens to up to two hundred reentry vehicles (RV). Within this LDS framework, an ABM Treaty-compliant ballistic missile defense system located at a single site within the U.S. will be developed "by the earliest date allowed by the availability of appropriate technology or by 1996," in accordance with the Missile Defense Act of 1991. Development for follow-on sites and Brilliant Eyes is also included.

It is instructive to consider three categories of activities conducted within the LDS Program Element.

The System Development category is made up of those activities that directly constitute the formal development of the LDS system, including system engineering, command and control, system testing, and site preparation and construction. These are the principal activities that compose the Major Defense Acquisition Programs subject to oversight by the Defense Acquisition Executive. They compose approximately 40% of the LDS budget in FY92, are expected to grow to 54% in FY93, and ultimately, as the design is firmed up for final development and deployment, will compose an increasing percentage of the entire LDS budget.

The second category of activities (Risk Mitigation, Hedges, and P3I) constitutes the technology program, in direct support of the LDS development activity, which will provide technological alternatives at the component and subcomponent level to mitigate risks in the main development program and to provide a basis for later technology insertion/P^3I programs. These activities will compose about 28% of the LDS Program Element budget in FY92 and about 20% in

FY93. Note that several activities were transferred from the Other Follow-On and Research and Support program elements.

The remaining one-third of the FY92 budget for the LDS element (Threat Evaluation, Phenomenology, and Other Support) is to help evaluate the threat; to improve our understanding of key phenomenology; particularly with respect to the discrimination problem; and to provide other critical support activities. In FY93, we anticipate these efforts will compose about one-fourth of the LDS budget.

Program Element: 0603214C - Space-Based Interceptors (SBI)

The Space-Based Interceptors PE includes programs, projects, and activities that have as a primary objective the conduct of research on space-based, kinetic-kill interceptors, such as Brilliant Pebbles (BP) and associated sensors that could provide an overlay to ground-based ABM interceptors.

Although Congress mandated that space-based interceptors, including Brilliant Pebbles, not be included in the initial plan for deploying a Limited Defense System, the 1991 Missile Defense Act states that:

> "To effectively develop technologies relating to achieving the goal specified in (the Act) and to provide future options for protecting the security of the United States and the allies and friends of the United States, robust funding for research and development for promising follow-on anti-ballistic missile technologies, including Brilliant Pebbles, is required."

Space-based interceptors offer a cost- and operationally effective means of providing highly effective protection, on a global basis, against limited ballistic missile attacks. Accordingly, this PE will include research and development to provide options to integrate a future deployment of Brilliant Pebbles with other strategic and active theater missile defense systems.

Program Element: 0603217C - Other Follow-On Systems

The Other Follow-On Systems PE includes programs, projects, and activities that have as a primary objective the development of technologies capable of supporting systems, components, and architectures that could produce highly effective defenses in the future. SDI is pursuing these promising technologies in order to support a possible future decision to increase ballistic missile defense capabilities. Such a decision would be based on how the ballistic missile threat evolves.

Most notable among the areas being investigated are advanced sensor and interceptor, directed energy, and hypervelocity gun technology. Advanced sensor technology efforts are focusing on improving the speed and quality of acquisition, tracking, and discrimination capabilities of sensor platforms. Advanced interceptor projects such as the Lightweight Exoatmospheric Projectile (LEAP) program are developing lighter, lower cost interceptors with improved guidance, tracking, and propulsion features. SDI's directed energy program is pursuing high energy laser and particle beam technologies which will support the development of systems capable of near speed-of-light intercept, interactive discrimination, and continuous worldwide coverage. Finally, research in the field of hypervelocity technology is focusing on developing a gun which will utilize electricity and magnetism to accelerate projectiles to very high speeds sufficient to destroy an attacking missile or warhead on impact. The hypervelocity gun's primary advantages include multiple shot capability, a reusable launcher, and low-cost projectiles.

By pursuing a balanced approach that addresses the current threat while concurrently investigating more advanced technologies, SDI's vigorous follow-on research and development efforts ensure that the nation's ballistic missile defense program will retain enough flexibility to respond to threats which may evolve rapidly in the future.

Program Element: 0603218C - Research and Support Activities

The Research and Support Program Element contains three categories of activities: "Research", "General Test and Evaluation", and "Support" for activities in one or more of the other program elements. For example, some 80% of activities within this Program Element directly support the LDS and TMD Program Elements.

The research category was markedly reduced in response to the major Congressional cuts last year. In those cases where the technology work was appropriately aligned to activities in other program elements, funding was transferred to those program elements. Our Test and Evaluation efforts are absolutely essential to executing a viable, accelerated program to deploy the initial LDS site. About 50% of the support for our Test and Evaluation efforts is provided in this program element because the work is "common" to all of the elements of a complete global defense system. Under our General Support activities, we supply the basic management support to SDIO and our agents to accomplish the SDI program. Here we pay for salaries, buildings, and basic management support within executing services and agencies.

3.3 Project Descriptions

PROJECT TITLE:
1101 - Passive Sensors

PROGRAM ELEMENTS:
0603215C - Limited Defense System
0603214C - Space-Based Interceptors

PROJECT DESCRIPTION:

Limited Defense System

This project develops and demonstrates the infrared sensor component technology required for the performance, reliability, survivability, producibility, and affordability of the Global Protection Against Limited Strikes (GPALS) surveillance systems. The specific infrared technology areas include: improving the producibility of high quality radiation hardened beryllium mirrors, optical contamination, infrared detectors, readout devices, on-array signal processing techniques, optical test facilities for characterizing and calibrating sensors, nuclear test capability, active cryocooler development and life testing, pilot line production, "learning curve" manufacturing techniques out of lab and into industry, demonstrations of focal plane components, cost-performance-yield models for accurate system cost estimates, and integrated advanced sensor demonstrations.

Space-Based Interceptors

FY92-93 SBI program element funding will fund advancements to those projects listed above that have applicability to Space-Based Interceptors element needs.

PROJECT TITLE:
1102 - Microwave Radar Technology

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

This project addresses radar system design and component technology needed to build long-range radar capable of multiple target detection, tracking and discrimination functions. Targets are ballistic threats at both endo and exoatmospheric ranges. The project provides the critical Ground-Based Radar (GBR) technology for all strategic defense systems.

Large Radar Technology

This task develops ground-based radar technologies for phased array systems having large bandwidth and precision tracking for midcourse, early reentry, and near exoatmospheric discrimination and fire control missions.

Innovative Radar Technology

This task is developing high risk radar technologies which have direct benefit for ground-based radar operation in electronic countermeasures and nuclear environments. Innovative concepts which exploit neural network aperture controllers, resonant target phenomenology features, and advanced beam-forming will be developed.

PROJECT TITLE:
1103 - Laser Radar Technology

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

This project develops and demonstrates the laser radar technologies capable of supporting SDS components and architectures. Laser radar technology includes development of components, systems, data bases of target measurements, and supporting analysis. Laser transmitters, receivers, mechanisms for steering and directing beams, and signal processing are included in component development. Data base development includes both laboratory and field measurements, and developing simulations for calculating laser radar cross sections and evaluating system performance.

For many missions, laser radars are preferred over microwave radars due to smaller size and tighter beam divergence. Laser radars also provide the spatial and velocity resolution for midcourse discrimination of RVs from other objects. This technology will also be used in boost phase for active tracking of threat boosters and precision pointing of boost-phase weapons, and in midcourse for designation. Specific technologies include lasers with high temporal and frequency stability and wide bandwidth waveforms, wide bandwidth detectors, optical beam steering and receiving systems for rapid retargeting, and signal processing and analytical tools required for implementation. The Army Missile Optical Range is utilized to make calibrated laboratory target measurements, and the Firepond laser radar is used to make field measurements of deployment events for targets launched from Wallops Island, VA.

PROJECT TITLE:
1104 - Signal Processing

PROGRAM ELEMENTS:
0603215C - Limited Defense System
0603214C - Space-Based Interceptors

PROJECT DESCRIPTION:

Limited Defense System

This project develops and demonstrates the techniques and components associated with onboard high speed sensor signal and data processing for multiple interceptor and surveillance sensor systems and provides a radiation hardened digital and analog circuit component technology base supporting LDS technologies. To accomplish mission objectives, key elements must perform large numbers of computations to perform surveillance, acquisition, tracking, and kill assessment of missiles and reentry vehicles. These elements must survive and continue to perform in high levels of natural and nuclear radiation. Selected elements must continue to operate through very high flash levels of nuclear burst. High speed and low power Very Large Scale Integrated (VLSI) electronic circuits and memories with performance comparable to DoD Very High Speed Integrated Circuit (VHSIC) technology must be developed to achieve very high levels of performance and radiation hardening. Further development of this technology is absolutely critical to lowering the risk and system costs involved with a deployment/full-scale development decision.

Space-Based Interceptors

SBI will co-fund with LDS a project that will produce two radiation hardened state-of-the-art 32 bit Reduced Instruction Set Computers (RISC) for space applications. The two RH32 processors have special features that are required for space applications that are not found in commercial processors. The level of testability, fault tolerance, and radiation immunity built into the RH32 processors distinguish them from processors available or planned. The built-in fault tolerance features will enable the RH32 to operate through the harsh space radiation environment with a very high delivery of processor service. A companion effort, the RISC Ada Environment (RISCAE), will develop the software environment for both processor designs.

PROJECT TITLE:
1105 - Discrimination

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

Theater Missile Defenses

Funding under this Program Element provides for analyses and simulation in support of active TMD discrimination. FY 1993 efforts will be accomplished under project 1109.

Limited Defense System

This task area is responsible for characterizing the optical and radar signatures of threat objects (e.g. penaids and RVs) and backgrounds for development of effective target acquisition and discrimination techniques for GPALS efforts related to systems funded under the LPS Program Element. Activities encompass all phases of ballistic missile flight. Collection and analysis is done on celestial and atmospheric backgrounds, development of phenomenology models, discrimination algorithms (Lexington Discrimination System (LDS)), and integrated tools for a realistic assessment of surveillance, acquisition, tracking, and discrimination techniques.

PROJECT TITLE:
1106 - Sensor Studies and Experiments

PROGRAM ELEMENTS:
0603216C - Theater Missile Defenses
0603215C - Limited Defense System
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

This project includes a variety of experiments, studies, and support elements designed to examine the interrelationships between sensors, discriminants, and other information fusion considerations. Data collected within this project is critical to the design of all surveillance and weapon sensors and sensor processing algorithms in the Strategic Defense System. The Midcourse Space Experiment (MSX) also supports GPALS elements funded under Limited Defense System (PE No. 0603215C) and Advanced Electro-optics under Theater Missile Defenses (PE No. 0603216C).

Theater Missile Defense

Advanced electro-optical sensor technologies being developed include visible, ultraviolet, and infrared radiation hardened charge-coupled device (CCD) imagers, step-stare sensor signal processing algorithms, and processor architectures to support evolving SDI midcourse surveillance concepts. Methodologies and techniques for performing track correlation and multisensor discrimination are also included. Progress will be verified by designing, building, and field testing sensors and by performing end-to-end simulations. Sensors will be demonstrated on the MSX experiment.

Limited Defense System

The Infrared Background Signature Survey (IBSS) will provide multi-spectral (ultraviolet, visible, and infrared) and radiometric measurements of orbiter plumes, earth backgrounds, chemical releases, orbiter environment, gas releases, and calibration sources. These data are critical to determining the requirements for the major SDIO systems. Measurements were made both with the Shuttle Pallet Satellite Platform (SPAS) II in the shuttle bay and with the SPAS deployed from the shuttle that has maneuvered from the immediate vicinity. The IBSS instrumentation package was developed jointly by the U.S. and the Federal Republic of Germany. A follow-on SPAS mission, SPAS III, is planned for FY94.

The Midcourse Space Experiment (MSX) will provide the system functional demonstration, target and background data, and the technology demonstrations necessary for the midcourse sensor platforms to meet Milestone II. MSX is planned for CY93. The principal sensor is a cryogenic MWIR/LWIR radiometer and spectrometer system with high off axis rejection optics. MSX will provide data on real midcourse targets against real backgrounds at realistic system ranges for use in system ground demonstrations; provide high quality target and background phenomenology data for further development of robust models of representative scenes; demonstrate key functions such as acquisition, tracking, handoff and bulk filtering; provide multi-wavelength target phenomenology data for assessing optical discrimination algorithms; and demonstrate the capability to integrate key technologies into a working platform similar to proposed operational midcourse sensor designs.

Unconventional Passive Discrimination is an evaluation and development task for optical discrimination techniques that make use of target signature time history; information to perform target classification/discrimination. The feasibility of these techniques was demonstrated with previous optical target measurements (e.g., Malabar, Have Jeep, Starmate). UPD techniques are potentially applicable to both surveillance system elements and interceptor system elements.

Other Follow-On Systems

The Vehicles Interaction Program (VIP) is investigating the interactions of a space vehicle with the space environment. The work to be done consists of ground research and flight experiments to investigate observed phenomena attributed to such interactions. Ground research will include analysis and interpretation of previous experiments and existing data, laboratory studies and experiments, and basic research and model development. Flight experiments include ballistic and orbital flights designed to obtain data that will be used to validate and refine models developed in ground research and to better characterize the phenomena.

Advanced discrimination techniques will be developed to counter new/innovative penetration aid developments, including the use of directed energy assets (lasers and neutral particle beams), dust and debris, and infrared and ultraviolet emissions from space objects.

PROJECT TITLE:
1109 - TMD Discrimination

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses

PROJECT DESCRIPTION:

This program consists of a sequence of flight tests planned to address critical system level discrimination issues for active theater missile defense. The objective of the program is to collect critical sensor data on potential countermeasures such that the active TMD system discrimination performance against these threats can be assessed. The threats considered for these flights are tank fragmentation, jamming, chaff, reduced cross-section, RV modifications, and decoys.

PROJECT TITLE:
1201 - Interceptor Component Technology

PROGRAM ELEMENT:
0603215C-Limited Defense System

PROJECT DESCRIPTION:

This project is developing advanced components for lightweight, low-cost interceptors for the Limited Defense System. The technologies provide a basis for highly effective ground-based interceptor systems that are deployable as early as 1996, with the GPALS LOC, and through the year 2000 and beyond, with follow-on efforts. Technology development efforts focus on addressing the more stringent, follow-on requirements, such as onboard discrimination, greater kinematic capability, enhanced autonomy, and increased threat complexity. Component performance will be demonstrated through ground testing of hardware and software at contractor's facilities, the KKV Hardware-in-the-Loop Simulation (KHILS) facility, the National Hover Test Facility (NHTF), and through flight testing. Propulsion components will be demonstrated through static test firings and flight tests.

Seeker components that are being developed range from the UV through the VLWIR. Early emphasis was placed on hardened focal plane array (FPA) and readout development (128x128 Pixels) and fabrication at low cost (1000 FPA/Year Production Rate) while maintaining required performance (11-14 um Cutoff Wavelength). Recently initiated efforts aim toward multicolor operation and neural network or optical processing techniques to aid in discrimination. A solid state ladar with an agile beam director is also being designed to improve discrimination capability.

The interceptor avionics technology development effort has produced a lightweight (75 g), high throughput (400 MOPS) signal and data processor that is programmable and very adaptable to a variety of interceptor applications. Current emphasis is on hardening of this processor, development of neural networks for on-FPA signal processing, and creation of advanced algorithms for multi-seeker data fusion, image processing, discrimination, and autopilots.

Inertial Measurement Unit (IMU) development to date has focused on a lightweight (30 g), low-cost ($500/Unit) micromechanical inertial guidance system providing a 3-axis gyro and accelerometer on a single chip with performance parameters typical of those associated with space-based systems (10°/Hour Drift Rate). Programs were initiated in 1991 to address the more stringent performance requirements associated with the longer flyout time of ground-based endoatmospheric interceptors (0.01-1.0°/Hour Drift Rate). Development of a stellar navigation system has also been initiated to enhance interceptor performance.

Propulsion system technology development has been ongoing since 1988. Advanced liquid axial stage technology has been developed and tested that provides 8X weight reduction in stage weight over older interceptor propulsion systems while reducing cost. This particular component, known as ALAS, will be flight tested in the coming year onboard one of the LEAP experiments. Solid axial stage components have also been developed and will be tested in the near-term. These systems are primarily for space-based applications.

PROJECT TITLE:
1202 - Interceptor Integration Technology

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems
0603215C-Limited Defense System

PROJECT DESCRIPTION:

LDS funding provides for the development, integration, and evaluation of advanced, high performance, lightweight interceptor technologies for use in both theater and strategic defense. These technologies will be used to support Ground Based Interceptors (GBI) and Theater High Altitude Area Defense (THAAD).

Follow-on funding provides for the development, independent government testing, and experimental integration of state-of-the-art component technology to provide risk reduction for systems that could be deployed prior to the beginning of the twenty-first century.

Develop miniaturized, advanced interceptor components to integrate into Lightweight Exoatmospheric Projectiles (LEAP) with a hit to kill kinetic energy mission, required for improved system cost-effectiveness. Develop and test a sensor package which will fly along on and observe interceptor demonstration flights. Develop and test lightweight seeker technologies and interceptor components. This project has the capability of determining proper technology integration techniques; validating seekers and inertial measurement units in hardware-in-the-loop facilities; performing free flight hover tests; performing technology validation flights in suborbital, reduced mission scenarios; and performing orbital technology validation flights in support of Engineering Manufacturing Development decisions.

PROJECT TITLE:
1203 - Hypervelocity Technology

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

This project will demonstrate the launch of a guided projectile (D-2) from a hypervelocity gun (HVG) with associated fire control to demonstrate the potential of a HVG system as a candidate weapon system for active Theater Missile Defense (TMD) in the near-term and other longer-range applications in the far-term. This involves the development of the Gee-hardened D-2 projectile which is a command guided to terminal homing interceptor. To launch the D-2 at required velocities greater than 3 km/sec, the High Energy Railgun Integrated Demonstration (HERID) electromagnetic launcher and Eglin battery upgrade supply (BUS) system is being developed as a test bed for pre-DEM/VAL demonstrations. A fire control effort is underway to determine what technology is necessary to command guide the ground-launched D-2 to a hit-to-kill intercept at ranges up to 25 km.

HVGs feature very high acceleration and minimum dead zone intercepts, potential for low marginal costs per round for large required inventories, practicality of quickly switching loads, reduced weight and volume of ammunition, and potential for very high velocities with very high acceleration.

Cooperative HVL experimental and applied research efforts will be conducted with approved foreign organizations in accordance with SDIO memorandum of understandings.

PROJECT TITLE:
1204 - Interceptor Studies and Analysis

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

This project satisfies the mission requirement for interceptor studies and analyses through systems engineering and technical assistance, special projects for advanced technologies, program planning and analysis, and aerodynamic studies and analysis. Additionally, trade studies are conducted to determine the best possible technologies in which to invest, in order to give the highest payoff to GPALS element interceptors that could be deployed after the beginning of the twenty-first century.

PROJECT TITLE:
1206 - Advanced TMD Weapons

PROGRAM ELEMENT:
0603216 - Theater Missile Defenses

PROJECT DESCRIPTION:

The purpose of this project is to perform research on advanced active theater missile defense (TMD) weapons components and subcomponents and associated technologies in concert with active TMD architecture study results, other SDIO technology efforts (e.g., ground sensors for cueing weapons), and overall Strategic Defense Initiative GPALS objectives. The project is structured with a near-term goal of supporting development of an active TMD system to counter the current theater threats and a long-term goal of technology advancement to support future theater defense as well as overall SDIO system development under the GPALS program. The project objectives are being accomplished through a number of technology demonstration programs and studies including Enhanced Kinetic Energy (EKE) Warhead, Directed Energy Weapons (DEW) and Electrothermal Gun (ETG).

Enhanced Kinetic Energy Warhead

The EKE Warhead Program, a follow-on to a joint USA/USAF technology program (1986-89) that demonstrated the EKE concept, is developing and testing EKE warheads to neutralize conventional, chemical, and biological threats. Full-scale fragment and hit-to-kill (HTK) EKE warheads will be developed, and warhead performance will be demonstrated through rocket sled tests. Testing against simulated chemical and biological threats will be emphasized. Warhead designs, including level 2 drawings, and test evaluation reports will be delivered. The EKE Fragment Warhead Program is jointly conducted by the Joint Tactical Missile Defense Program Office and the Army Chemical Research, Development, and Engineering Center. Explosive ejection of fragments without initial fragment destruction will be demonstrated. Perforation of the threat target with the surviving fragments and breakup/ injection of the EKE reactant material into the target will also be demonstrated. Both are scheduled in early FY92. The EKE HTK Warhead will provide the advantages of EKE when the HTK interceptor hits exactly where intended. It also allows graceful degradation of the HTK interceptor when it achieves a near miss of the target "sweet spot."

Directed Energy Weapons

Included in this project is a concept developmental effort that will evaluate the feasibility of developing directed energy weapons for active TMD application. The effort is especially designed to develop weapons capable of achieving boost-phase intercept of theater tactical ballistic missiles. However, the effort will evaluate ground-based, space-based, and airplane-based laser system effectiveness in booster-, midcourse-, and terminal-phase intercept of tactical ballistic missiles. Various candidate laser systems such as the chemical oxygen codene laser and free electron laser will be evaluated. Evaluation of candidate laser systems will provide the basis for funding the high-leverage development of laser subsystems. Development of either a ground-based or airplane-based laser system would provide one critical component of a readily transportable active TMD System.

Electrothermal Gun

The Electrothermal Chemical (ETC) Gun Program is a technology effort to develop and demonstrate the means to gun-launch and control hit-to-kill, hypervelocity projectiles. This program is a direct result of a combined SDIO/Ballistic Research Laboratory (BRL) effort to develop, understand, and document the performance of internal ballistic physics and associated scaling factors of ETC Gun performance using theoretical analysis and supporting experiments. The program has three parts. The first part is a technology project exploring the feasibility of combining electrical and chemical energy sources to produce hypervelocities. Two projectile acceleration schemes, hybrid gun and traveling charge (TC), were developed simultaneously. The hybrid acceleration scheme uses electrothermal injectors to provide an electrically enhanced coventional chemical charge to propel a projectile. The TC scheme provides initial acceleration via the hybrid scheme and then further accelerates the projectile, by igniting a second charge integrated with the projectile, with electrothermal injectors located midway down the gun barrel. A series of experiments using a 60-mm gun were conducted to demonstrate each process in FY 90 and FY 91. The hybrid concept showed more promise and is being aggressively pursued. Additional experiments using the hybrid concept with a 60-mm and a 105-mm gun during FY 92 through FY 95. The goal of this effort is to produce muzzle velocities 35% greater than could be obtained using comparable conventional propellants. The second part of the ETC Gun Program involves two studies of missile defense threat and mission analysis. The first study completed in FY 90 investigated strategic missile defense, and the second, currently underway, is investigating theater missile defense. The results of both studies will be used to define requirements, guide development, and create a road map for critical issue resolution. The third part of the ETC gun program is a two-phased study of fire control. Three contractors are separately pursuing solutions to the fire control of gun-launched hypervelocity projectile. The program is divided into two phases. Phase I is the identification of critical issues through the preliminary design of a fire control and battle management system. During Phase II, the contractors will conduct experiments and tests to resolve the critical issues identified during Phase I.

PROJECT TITLE:
1208 - Discriminating Interceptor

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

To achieve a high probability of kill of midcourse targets, interceptors must be capable of discriminating between real targets, decoys, and debris during the exoatmospheric portion of flight. The interceptor must be lightweight, low cost, and must be able to kinematically engage a full range of threats. To acquire midcourse targets and perform discrimination at sufficient range to implement guidance commands requires broad utilization of the electromagnetic spectrum and use of ladar to capitalize on available discriminants. Processors able to support the large computational demand, while staying within cost and weight constraints were once beyond the limit of technology, but recent advances in interceptor signal and data processor development (PE No. 0603217C, Project 1201) have made a discriminating seeker and interceptor feasible.

Discriminating interceptors with increased autonomy will reduce communication bandwidths and simplify the overall architecture. Discriminating seekers are now available with higher resolution and signal-to-noise ratios at close range than current state-of-the-art technology can provide. Discrimination technology will allow interceptors to take advantage of not only temperature and emissivity, but of other discriminants as well. These include static features, such as length, width, and shape; surface features such as, texture, hot spots, polarization, and sub-features; and dynamic characteristics such as spinning, coning, precession, and microdynamics.

This program will design, integrate, and test an Advanced Discriminating Interceptor. The effort will provide a Block Upgrade for the Ground-Based Interceptors deployed at the initial NMD site. Seeker components will be developed that utilize the latest in active and passive technology to do discrimination on-board the interceptor. Critical components will be fabricated and tested. Flight test vehicles will be designed, built, and tested to demonstrate the technology.

PROJECT TITLE:
1209 - Endoatmospheric Interceptor Technologies

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

This project will develop and demonstrate advanced components for miniaturized endoatmospheric interceptors as part of a comprehensive program to coordinate the development of endoatmospheric interceptor technology components. These technologies provide the basis for intercept of strategic and tactical ballistic missiles within the atmosphere.

The project consists of development and test of innovative seeker and aperture (optical windows and RF radomes) concepts. These seeker and aperture concepts will be tested in the Aero Optic Evaluation Center (AOEC) being developed by SDIO for this purpose.

This project will develop and demonstrate miniaturized endoatmospheric interceptors for strategic and tactical missile defense under the ENDO LEAP program. The program will evaluate the seeker and aperture concepts developed under Follow-On Systems, build and test atmospheric seekers, and build and flight test miniaturized experimental kill vehicles. The ENDO LEAP seekers and experimental vehicles will be tested in the AOEC facility under development. The miniaturized experimental vehicle will have self-contained autonomous guidance, jet reaction or aerodynamic control, optical or radar seeker and will be capable of hit-to-kill accuracy, not requiring a warhead.

This project will provide the technologies to block upgrade current ERINT and THAAD performance capabilities for active TMD. Aimpoint selection and minimum seeker response time will provide assured endoatmospheric Hit-to-Kill, making the interceptor more responsive to advanced threats. RF technologies will eliminate current TWT technologies replacing them with higher power solid state devices, which significantly reduces interceptor size and weight.

This project will provide endoatmospheric technologies to block upgrade the Ground-Based Interceptors which are to be deployed at the initial NMD site. The aero-thermal and aero-optical issues associated with hypervelocity flight in the atmosphere will be resolved. Advanced window materials and cooling techniques will be developed and tested. This will provide interceptor velocities and performances that incorporate and exceed the current low velocity HEDI flight tests, and make the concept of E^2I feasible.

PROJECT TITLE:
1210 - Navy LEAP Technology Demonstration Program

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

Funding under this program provides for the planning and testing which could provide a low-cost, low-risk, demonstrated technology insertion option, based on LEAP interceptor technologies. This could provide a near-term, comprehensive demonstration of the applicability of LEAP technology to a system more closely representative of a deployable system than the current launch vehicles. The program will include a series of suborbital flight tests of the Navy STANDARD missile, which will include LEAP program-developed technology as part of the payloads. The flights will be increasingly challenging, as is the current LEAP flight test program. A step-by-step approach will be used to demonstrate the use of LEAP projectiles and technology with existing boosters, sustainers, and shipboard launch and fire control systems. The program will culminate in a series of realistic, fully-integrated high speed intercepts at sea. In order to minimize cost, reduce risk, and enable early demonstration, maximum use will be made of existing hardware, test facilities, test infrastructures, and procedures. Early tests will be performed using deployed extended range missile systems (Terrier).

PROJECT TITLE:
1211 - Interceptor Facilities

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

Funding for this program provides for the development, independent government testing, and experimental integration of state-of-the-art component technology to provide risk reduction for Limited Defense systems that will be deployed prior to the beginning of the twenty-first century. Prior to FY 1992, efforts in this project were funded in project 1202, and in FY 1993, funding will be provided within project 3310.

This task centers around developing independent government validation technology to verify contractor material performance and exercise baseline interceptor models in support of an Engineering and Management Development (EMD) decision. This project has the capability of determining proper technology integration techniques, conducting digital simulation of interceptor kill vehicles in real time, validating seekers and inertial measurement units in hardware-in-the-loop facilities, performing free flight hover tests, and, as required, performing technology validation flights in suborbital, reduced mission scenarios.

The National Hover Test Facility has been developed to support the validation of integrated KEW performance. Inexpensive, repeatable, and observable system level demonstrations of advanced technology suites is the key technical issue of the program. The facility has already demonstrated the ability to flight test, validate performance, and identify and resolve flight anomalies in vehicle propulsion and guidance hardware and software. The facility testing is an integral component of the overall SDIO ground and space test effort and directly supports flight testing of the Space Based Interceptor (SBI) vehicle and the LEAP vehicles. In addition, the facility is a unique national asset for the validation of Ground Based Interceptor (GBI). Lastly, integration issues associated with the current Brilliant Pebbles (BP) vehicle concept will also be addressed at the facility prior to system deployment. Onboard vehicle system measurements are acquired using facility telemetry equipment. Targets at the facility include static rocket motor firings of scaled ICBMs, orbiting space objects which are viewed through a satellite tracking system, and heated target test stands to simulate tracking of IR targets.

The Aero-Optic Evaluation Center (AOEC) is being developed for evaluating endoatmospheric interceptor concepts and testing endoatmospheric interceptor hardware under near-flight conditions. The center piece of the AOEC is the Large Energy National Shock (LENS) Tunnel. The tunnel will produce flow conditions that lead to dissociation of the atmosphere and the formation of plasma. In the near-term, the AOEC will provide fundamental scientific insight into hyper-velocity, high enthalpy flow dynamics; aero-optic performance data on ENDO-LEAP fore-body and seeker window design concepts; and validation data for current Computational Fluid Dynamics (CFD) models.

The Kinetic Kill Vehicle Hardware-in-the-Loop Simulator (KHILS) provides test support to the LEAP, ENDO LEAP, GBI, Discriminating Interceptor, and Brilliant Pebbles programs. These tests validate critical hardware components required for the systems in a HWIL fashion. Seeker breadboards/brassboards, signal processors, IMUs and guidance processors are tested as well as the integrated KKVs. The tests will use real-time simulation techniques to validate the hardware components/subsystems against realistic operational backgrounds. The most advanced HWIL capabilities available anywhere will be on line in KHILS to provide the performance capability required to adequately test KEW systems. In the interim, a baseline simulator has been established to test the various KKV technology brassboards (e.g. ULTRASEEK, SPPD). Research continues into highly versatile test technologies to extend scene projection capabilities into the ultraviolet and the full infrared spectrum.

PROJECT TITLE:
1212 - D-2 Program

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

This project will develop and integrate components for a guided projectile (D-2) for a hypervelocity gun (HVG) with associated fire control to demonstrate the potential of a HVG system as a candidate weapon system for active Theater Missile Defense (TMD) and other longer range applications in the far term. This involves the development of the Gee-hardened D-2 projectile which is a command guided to terminal homing interceptor.

PROJECT TITLE:
1301 - Radio Frequency Free Electron Laser (RFFEL) Technology

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

The goal of the RFFEL program is to demonstrate the capability of a high power FEL to perform boost-phase and post-boost-phase intercept of ballistic missiles or theater missiles from earth orbiting platforms. Midcourse interactive discrimination can also be performed by destroying simple decoys and thermally tagging or imparting velocity change to sophisticated decoys. Additional Space-Based (SB) FEL missions include self defense, defense of other platforms in the strategic defense constellation, and the suppression of strategic aircraft.

The primary thrust of the current program is the design and fabrication of a proof-of-principle FEL device to validate FEL technology and demonstrate operation of a moderate power FEL. This effort is called the Average Power Laser Experiment (APLE). The device being fabricated under APLE is a 10.6 micron, 100kW average power FEL utilizing a Single Accelerator Master Oscillator-Power Amplifier (SAMOPA) design. The APLE Prototype Experiment (APEX) at Los Alamos will occur in parallel with APLE. The APEX project involves operation of a SAMOPA FEL that validates, at subscale, all physics issues related to the APLE.

SBFEL technology development is planned in parallel with the APLE device fabrication, concentrating on advancing and tailoring FEL technology required for operation in a space environment. This technology includes improved system efficiency and the development of superconducting and cryogenic accelerators. The technology development strategy leverages a large amount of beam control, optics and acquisition, tracking and pointing technologies from other directed energy weapon projects.

PROJECT TITLE:	**PROGRAM ELEMENT:**
1302 - Chemical Laser Technology	0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

Space-based chemical lasers (SBLs) will enhance an SDS consisting of kinetic energy weapons by adding global (to the cloud tops), 24 hour, zero time-to-intercept hard kill of strategic and tactical targets. This capability adds early boost-phase kill of strategic and tactical ballistic missiles, increased capability for hard kill in the bus phase, additional robust passive and active midcourse discrimination against simple decoys, interactive discrimination against more sophisticated decoys, and intercept of long-range strategic bombers and cruise missiles. Early boost-phase kill of strategic or tactical ballistic missiles provides very high leverage to the defense by negating missiles before they can deploy multiple warheads, decoys, chemicals, or submunitions. In all cases, debris will fall far from protected territory and, in many cases, on the territory of the aggressor. Early boost-phase kill also provides effective defense against threats which are most difficult for conventional architectures, namely low apogee trajectory and high traffic threats.

Critical technical issues for the SBL element can be grouped into five areas: the laser device; beam control; optics; acquisition, tracking, pointing, and fire control (ATP/FC); and high power integration. The laser or beam generating device is a hydrogen fluoride chemical laser which produces the high power laser beam by photon extraction from excited HF molecules, generated by the energetic reaction of hydrogen and fluorine. In 1990 and 1991, the Alpha program demonstrated near-weapon-level continuous-wave operation. The Alpha design is space compatible and directly scalable to weapon-level power requirements. Required beam control technology was demonstrated by the LODE program in 1987. Required optical technology can be subdivided into two classes: small high-incident-power optics for handling the high power beam within the SBL and large moderate-incident-power optics for directing the expanded high power beam toward the target. Required small high-power optics have been demonstrated in a number of SBL programs, including Alpha. The LAMP program, completed in 1989, demonstrated a 4-meter diameter beam director primary mirror whose design is space compatible and directly scalable to weapon size. ATP/FC technology to meet SBL ATP/FC requirements is being developed in project number 1305. High power integration is being demonstrated in a stepwise fashion through the Alpha and LAMP Integration (ALI) and Star LITE programs. In ALI, the Alpha, LODE, and LAMP hardware and technologies are being integrated for an end-to-end (save ATP/FC) ground demonstration of an SBL in the early FY95 time frame. In Star LITE, ALI hardware and designs will be integrated with an ATP suite and a spacecraft, and launched for an end-to-end space demonstration of a weapon-scalable SBL against thrusting targets in late FY97. In parallel, a number of laboratory efforts are developing additional promising technologies for defense against robust far-term threats. These efforts include low absorptance optical coatings that may permit the use of uncooled optics throughout the optical train, shorter wavelength lasers that may achieve equivalent range performance with a smaller diameter beam director mirror, molecular (rather than mechanical) methods for compensation of beam aberrations to produce the required beam quality, optical train designs that would permit retargeting over larger angles by tilting a lightweight, small-diameter mirror rather than pointing the entire telescope, and manufacturing techniques for improving the producibility and decreasing the cost of large optics.

The Star LITE experiment will demonstrate the readiness of the SBL to enter into EMD. An initial operational capability for the SBL could be achieved early in the next decade.

PROJECT TITLE:
1303 - Neutral Particle Beam Technology

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

The Neutral Particle Beam (NPB) project exploits the capability of a stream of atomic particles to penetrate into a target 1) to provide lethal energies and/or 2) to induce signatures that permit discrimination. Such a beam is capable of effecting kill of ballistic missiles in the boost, post-boost, and midcourse phases. The NPB project has a technology development segment, a ground-based technology integration segment, and a space experiments segment. Together, these segments address the key technical and system issues associated with the feasibility of deploying an NPB system capable of lethal intercept as well as midcourse discrimination. The technology development segment concentrates on developing enabling technologies for the ground and space experiments and initially deployable NPB systems. In the ground-based integration experiments, the Accelerator Test Stand (ATS) was used to integrate and test low energy components; the Ground Test Accelerator (GTA) is the primary test bed for initial NPB system development and also for advanced technologies such as high brightness ion sources, advanced neutralizer development, and Acquisition, Tracking, Pointing and Fire Control (ATP/FC); and the Continuous Wave Deuterium Demonstrator (CWDD) examines high duty factor and deuterium operation at low energies. The NPB space experiments include Beam Experiments Aboard Rocket (BEAR) flown in July 1989, which addressed basic space operability issues, and Far-field Optics eXperiment (FOX), an orbital experiment which will address key NPB issues that cannot be tested on the ground.

PROJECT TITLE:
1304 - Nuclear Directed Energy Technology

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

Nuclear Directed Energy Weapon (NDEW) concepts offer the promise of fundamental improvements in defense technology, including high brightness, large lethal volume, multiple simultaneous target engagement, and alternative lethality mechanisms. Development of NDEWs is being pursued to provide a base of knowledge concerning such weaponry that would permit the U.S. to better judge potential Soviet capabilities, and to provide the basis for a ground-based or pop-up U.S. NDEW capability should it be needed at some point for Strategic Defense System (SDS) follow-on phases. The NDEW research path is focused on a program of theoretical and computational development in concert with underground nuclear tests and related laboratory experiments. A DoD and DoE cooperative program is conducting mission analyses as well as exploring systems engineering concerns.

Technical capabilities are being developed within this project to enable extremely precise measurements of high performance coatings on mirrors employed in high-energy laser weapon systems. This work supports development and validation of hardened coatings for space laser systems.

PROJECT TITLE:
1305 - Acquisition, Tracking, Pointing and Fire Control Technology

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

Acquisition, tracking, pointing, and fire control (ATP/FC) efforts will advance the technologies required to perform critical functions for all candidate DEW concepts to be used in GPALS follow-on architectures. These functions include acquiring, identifying, and prioritizing the targets to be engaged, precision tracking of each target, selecting and establishing the line-of-sight to the target aimpoint, holding the beam on the aimpoint, assessing the results, and reinitiating the sequence to engage a new target. ATP/FC technologies are required for both boost-phase destruction and midcourse interactive discrimination missions. Efforts within the ATP/FC technology base address major tracking/pointing component performance issues, and the development of technologies for advanced ATP/FC experiments through the Advanced DEW Active Precision Tracker (ADAPT) program. Studies are in progress to define experiments that integrate ATP/FC with weapon concept experiments in both the space based laser and NPB projects. A series of field experiments with payloads on high altitude balloon platforms will build upon the RME pointing and stabilization achievements to demonstrate all the tracking and functional integration needed to control single target engagements. The pace of ATP-FC development is planned to support an advanced technology demonstration of a directed energy weapon concept in the late 1990s, which could lead to an initial operational capability early in the next decade.

PROJECT TITLE:
1307 - DE Demonstrations

PROGRAM ELEMENT:
0603217C - Other Follow-on Systems

PROJECT DESCRIPTION:

Directed energy weapons will provide revolutionary capabilities for the next decade's military systems. These "speed-of-light" weapons project lethal beams near-instantaneously to distant targets, disabling and/or destroying them in seconds or less. Examples of DE possibilities follow: (1) Worldwide full-time negation of strategic and theater missiles early in boost phase with a constellation of space-based high-energy lasers. This provides a hedge against the depressed trajectory; a solution for short timeline threats; and, hard kill of chemical and biological threats -- even if delivered as clustered munitions -- far from defended territory. Further, debris from the encounter does not attain orbit, simplifying the acquisition and intercept problem for other layers of the defense.
(2) Robust interactive discrimination of warheads from decoys in midcourse using lasers or neutral beams. The neutral beam offers the unique advantage of disrupting or disabling electronics, resulting in mission failure and possibly devaluing salvage fusing.
(3) Worldwide full-time negation of strategic bombers and cruise missiles to the cloud tops, and potentially complete air superiority, with space-based lasers. (4) Worldwide full-time high resolution surveillance using the large telescopes and sophisticated sensors aboard the DE weapon platforms. (5) Theater defense with surface-, air- and space-basing of high-energy lasers. Proliferated mobile ground-based lasers can provide point or area defense, and aircraft and space-based systems can negate missiles in the boost phase.

Within this project, directed energy weapon components are assembled to demonstrate and assess their system performance in operational environments. The objectives are to field near-term (3-4 year) experimental platforms at scales which can be extrapolated with confidence to systems with operational capabilities.

PROJECT TITLE:
1403 - Computer Engineering

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

This effort provides technologies required to develop a highly reliable space borne multiprocessor computer architecture. This project consists of two technology tasks: An Advanced Information Processing System (AIPS) able to meet reliability requirements; and a Very High Speed Integrated Circuit (VHSIC) multiprocessor development effort. This project results in a technology base for a radiation-hardened 32-bit computer, efficient configuration of generic VHSIC Spaceborne Computer (GVSC), and other multiprocessor computers.

PROJECT TITLE:
1405 - Communications Engineering

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

Develop communications technology to support operational requirements for defensive systems. Develop communications components, both radio frequency (RF) and laser communications, for space-to-space, space-to-ground, and ground-to-space links. Efforts to define requirements for space qualification and radiation hardness of extremely high frequency (EHF) components needed for robust communications are included.

PROJECT TITLE:
1501 - Survivability Technology

PROGRAM ELEMENTS:
0603216C - Theater Missile Defenses
0603215C - Limited Defense System
0603214C - Space-Based Interceptors

PROJECT DESCRIPTION:

Theater Missile Defenses

Develops and demonstrates survivability technologies to ensure that active TMD elements can perform their mission in all expected environments. Approaches include: studies/analyses, appropriate tests and demonstrations, and SEO development. Technologies will be available for incorporation into active TMD elements at EMD.

Limited Defense System

Develops and demonstrates survivability technologies to ensure that National Missile Defense (NMD) elements can perform their mission in all expected environments. Approaches include: studies/analyses, Above-Ground and Under-Ground Testing (AGT/UGT), Survivability Enhancement Option (SEO) Development, and operability demonstrations. Technologies will be available for incorporation into NMD elements at EMD.

Space-Based Interceptors

Develops and demonstrates survivability technologies to ensure that SBI elements can perform their mission in all expected environments. The approach is AGT/UGT demonstrations.

PROJECT TITLE:
1502 - Lethality and Target Hardening

PROGRAM ELEMENTS:
0603216C - Theater Missile Defenses
0603214C - Space-Based Interceptors
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

The Lethality of SDI and active TMD weapons is part of the measure of effectiveness of how well SDI and active TMD systems fulfill defense mission requirements. The Lethality and Target Hardening program is developing a necessary and sufficient understanding of physical principles involved in weapon/target interaction, target response and kill modes, and resulting signatures needed for interactive discrimination and kill assessment.

Each of the following tasks are interdependent because of the common physical principles involved in the lethality technology, but have been programmed separately to align the major program tasks with the SDI and active TMD elements.

Theater Missile Defenses

The TMD lethality task has similar requirements to the other tasks but specifically addresses active TMD interceptors and theater threats. Theater threats include conventional, chemical, biological, and nuclear warheads. A common, validated lethality criteria for a high confidence kill against any/all threat warheads is required. This lethality criteria is developed in coordination with active TMD interceptor development, and the lethality of the interceptors will be validated in cooperation with interceptor demonstration/validation flight tests. Successful accomplishment of this task depends on lethality technology development under the Other Follow-On Program Element.

Space-Based Interceptors

Objective of the SBI lethality task is to develop validated lethality criteria for space interceptors against all boost, post-boost, and midcourse threats. Primary lethality technology emphasis is on target hit and damage assessment in demonstration/validation flight tests and on lethality issues for space interceptor engagement of large multiple warhead targets. This task was separated from the SDI Research and Support Program element for FY 1992.

Other Follow-On Systems

This task provides supporting lethality technology for developmental SDI ground-based interceptors (including theater defenses) and directed energy weapons. This supporting lethality technology includes lethality phenomenology analyses and tests to evaluate defense warhead and/or hit-to-kill effectiveness against simulated threat warheads. Priority technology support is for active theater missile defense lethality issues against potential chemical and biological threats.

PROJECT TITLE:
1503 - Power and Power Conditioning

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

Other Follow-On Systems

This program was established to develop generation and conditioning technologies capable of producing required quantities of electrical power needed by advanced ground- and space-based kinetic/directed energy weapons and surveillance and BM/C³ systems that might be deployed after the beginning of the twenty-first century. Power requirements for the various SDIO payloads are divided into two broad categories: (1) baseload power for surveillance, communication, and housekeeping applications; (2) burst power for weapons and discrimination operations, and periodic testing. The nuclear power technologies developed under this PE support the follow-on systems of SDIO and are characterized by high power density requirements and the need for higher levels of passive survivability. The major projects in this PE to satisfy these follow-on requirements are the Thermionic Fuel Element (TFE) program, the Thermionic System Evaluation Test, and the Thermionic Space Reactor System Design. Due to budget cuts, these nuclear power technology programs have been modified and extended.

Research and Support Activities

This program was established to develop generation and conditioning technologies capable of producing required quantities of electrical power needed by advanced ground- and space-based kinetic/directed energy weapons and surveillance and BM/C³ systems. Power requirements for the various SDIO payloads are divided into two broad categories: (1) baseload power for surveillance, communication, and housekeeping applications; (2) burst power for weapons and discrimination operations, and periodic testing. General categories in the program and major projects to satisfy program requirements include: baseload power (Survivable Solar Power Subsystem Demonstrator-SUPER; advanced solar technology; multi-megawatt technology generators, fuel cells, power conditioning), and assessments and analyses. Due to budget cuts, the burst power and power conditioning technology development programs have been stretched or terminated.

PROJECT TITLE:
1504 - Materials and Structures

PROGRAM ELEMENTS:
0603214C - Space-Based Interceptors
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

The Materials and Structures (M&S) Project conducts research, development and flight and ground test demonstrations in lightweight structural materials, adaptive structures technology, propulsion/ thermal/optical materials, tribomaterials, superconductor devices, and space environmental effects.

Other Follow-On Systems

Follow-On M&S projects focus on providing advance materials and structures technologies to meet the extreme pointing and tracking, secure communications, and enhanced discrimination requirements of near- and far-term GPALS systems as they mature in development. To gain confidence in the ability of these systems to operate in the natural and threat environments, requires system selected materials evaluations and adaptive structure technologies. Superconducting devices will provide orders of magnitude increased capabilities in secure communications and target discrimination.

Space Based Interceptors

M&S supports Space-Based Interceptor activities through the application of advanced materials technologies to BP designs and orbital flight tests of advanced materials. These efforts will provide for low earth orbit exposure of potential BP material samples to the natural space environment. M&S technology will also be used to reduce vibration through the application of improved active and passive damping materials for BP.

PROJECT TITLE:
1505 - Launch Planning, Development and Demonstration

PROGRAM ELEMENTS:
0603214C - Space-Based Interceptors
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

Other Follow-On Systems

Past launch failures, an outdated space transportation technology base, diminished launch capacity, and high space transportation costs have seriously undermined America's ability to access space. To economically meet the growing space launch requirements of the 1990s and beyond, a system is needed which will provide low cost, reliable, high capacity, and operationally flexible access to space. The objective of the Advanced Launch Development Program is to provide a technology basis for a launch vehicle program to begin in the late 1990s. Previous cost goals established for the Advanced Launch System (ALS) program are still valid: A ten-fold reduction in the cost to deliver cargo to low earth orbit as compared to the present cost of the Titan IV. In 1991, the ALS program was restructured to the National Launch System (NLS) program. Activities focus on defining appropriate vehicle concepts and propulsion and nonpropulsion technology demonstrations. Funding responsibility for this project has been transferred to the USAF and NASA.

Phase I

The 1988 Strategic Defense System (SDS) Defense Acquisition Board Annual Review directed that the OSD perform a study to determine the most cost-effective approach to meeting SDS launch requirements in concert with other national security launch requirements. The study included all aspects of SDS deployment, maintenance, and replenishment, as well as consideration of existing ranges and launch vehicles currently available, and explored the possibility of using alternative launch sites or boosters. An assessment of the capability of both production and launch facilities to support the required deployments was made. Emphasis was placed on achieving minimum cost for deployment of a Phase I SDS. A product of the launch study was a methodology which allows for rapid cost estimation of launch costs for various SDS launch architectures. FY92 and beyond funding is zero due to Congressional action and transfer of funds to other projects.

PROJECT TITLE:
1601 - Innovative Science and Technology (IS&T)

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

Explore innovative science and technology for several technologies of interest to SDIO.

PROJECT TITLE:
1602 - New Concepts Development

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

Explore innovative concepts pursuant to PL97-219 which mandates a two-phase R&S competition for small businesses with innovative technologies.

PROJECT TITLE:
1701 - Launch Services

PROGRAM ELEMENT:
0603217C - Other Follow-on Systems

PROJECT DESCRIPTION:

Special Projects

Develop and deploy flight hardware to support accelerated test programs for emerging specialized application technologies associated with GPALS. Plan and execute test programs; collect and analyze data; and issue final reports as appropriate. Plan for and conduct orbital insertion missions in support of other special test activities.

Launch Services - Low Cost Flight Test Services (LCFTS)

Define, develop, and conduct fast-response, ground-based, pre-flight verification and ballistic or space flight testing of unique concepts and high yield approaches for SDI weapons, seekers, and targeting applications that might be deployed beyond the turn of the century. Provide experienced launch and flight test teams including: launch services, payload processing, payload integration, mission operations/planning, range operations/integration, mission analysis, and test operations.

PROJECT TITLE:
1702 - Special Test Activities

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

Develop accelerated test programs for emerging special application technologies. Determine acquisition strategy. Acquire test systems and test equipment. Plan and execute test programs including on-orbit command, control, and validation of demonstration payloads and resulting data collection.

Programs being accomplished under this effort include ZEST and the Single Stage Rocket Technology Program (SSRTP), previously known as the Single Stage to Orbit (SSTO). The SSRTP will focus on the development of technology for a reusable, suborbital launch vehicle. The SSRTP program will design, develop, and validate a reusable launch vehicle (either manned or unmanned) capable of airline-like operations to augment existing space launch capability.

PROJECT TITLE:
2102 - Space-Based Sensor (Brilliant Eyes)

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

The Brilliant Eyes (BE) system is a distributed constellation of space-based surveillance sensor satellites which support the battle management/C^3 and weapons of the GPALS architecture. BE satellites carry a suite of passive sensors including short, medium, and long wavelength infrared (SWIR, MWIR, and LWIR) and visible sensors. These sensors can acquire against small "hot spot" surface areas, track, and discriminate strategic and longer-range tactical ballistic missiles. BE supports National Missile Defense (NMD) and active Theater Missile Defense (TMD).

BE target track and discrimination data support battle planning and execution for midcourse intercepts. This data includes weapon target assignments, target updates, discrimination target maps to the interceptors shortly before intercept, and kill assessments of midcourse intercepts. In support of active TMD, BE provides launch point determination for counterforce, impact point prediction for passive defense, and accurate target track for active defense.

This constellation of satellites provides global access, both below-the-horizon (BTH) and above-the-horizon (ATH), of tactical and strategic ballistic missiles in their boost, post-boost, and midcourse phases.

The concept of operations for BE consists of two primary modes. The first is a "hot spot" surveillance mode. The BE sensors constantly survey a predesigned, limited area of the Earth's surface, such as a theater of operations or a missile field. In this mode, BE sensors acquire the boosters and continue tracking through the midcourse phase with internal handover among the different sensors. The second mode of operation is used in the case of a ballistic missile launch that occurs outside the limited number of predesignated surveillance areas. The BE sensors receive a track handover from Brilliant Pebbles or other boost surveillance sensors, such as DSP or FEWS. BE sensors then acquire the boosters and continue tracking through the midcourse phase.

The major technical issues being addressed by this program include: (1) software validation and performance utilizing SDIO test beds (Surveillance Test bed and National Testbed); (2) distributed surveillance, sensor fusion, and sensor taskings utilizing computer simulations and flight demonstrations; (3) sensor acquisition, tracking, and discrimination performance with simulated and actual backgrounds utilizing ground and flight demonstrations; (4) technology maturity and performance through analyses, hardware in the loop ground tests, and flight demonstrations; 5) weapon support capacity and loading utilizing analyses and hardware-in-the-loop ground tests; and 7) producibility demonstrations utilizing analogy to current systems and engineering models and simulation of critical components.

The test program for BE includes computer simulations, ground demonstrations, and flight demonstrations to collect data and demonstrate the technical maturity of the BE program for a Milestone II decision in mid 1990s. Technology maturity could support a BE deployment early in the first decade of the next century.

The BE project is expected to begin the Engineering, Manufacturing, Development phase (formerly Full Scale Development) by 1998.

PROJECT TITLE:
2103 - Ground-Based Surveillance and Tracking System

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

The primary role of the Ground-Based Surveillance and Tracking System (GSTS) is to provide an option for interim cueing of GBIs at the initial site, prior to deployment of Brilliant Eyes. The current NMD architecture optical sensor requirements are met by the Brilliant Eyes (BE) program.

The GSTS concept is composed of ground equipment and a launchable, long wavelength infrared (LWIR) sensor system. The sensor system is boosted into suborbital flight by a ground-based, fast response rocket to provide above the horizon surveillance to detect and track attacking ballistic missiles in the midcourse. Once in space, the GSTS sensor will provide object data to the ground segment where engagement planning operations will provide weapon tasking and inflight targeting support. GSTS will provide surveillance data to the Command and Control Element (C^2E) for situation and kill assessment.

GSTS funding includes work being performed to develop SDIO sensor test capabilities at Arnold Engineering Development Center (AEDC). Two existing sensor test chambers at AEDC are being upgraded, the 7V chamber and the 10V chamber. The 7V chamber will be used principally for seeker testing (such as GBI and BP seekers), and for calibration of surveillance sensors (such as GSTS and BE). The 10V chamber will be used to perform end-to-end functional and performance characterization and testing of surveillance sensors. These ground test capabilities are required for GSTS and BE, as well as providing support for other SDIO programs.

PROJECT TITLE:
2104 - Ground-Based Radar

PROGRAM ELEMENTS:
0603216C - Theater Missile Defenses
0603215C - Limited Defense System

PROJECT DESCRIPTION:

NMD-GBR is the strategic member of the SDIO "Family of Radars" and consists of deployed radars (NMD-GBR) and a single DEM/VAL radar (GBR-T). The other member of the "Family" is the theater radar (TMD-GBR) described below.

Theater Missile Defenses - Ground-Based Radar (TMD-GBR)

The TMD-GBR meets an immediate requirement for a more capable active theater missile defense radar. The TMD-GBR utilizes current GBR technology. Required functions include attack early warning, threat type classification, launch/ impact point estimation, threat classification against theater/tactical ballistic missiles. The TMD-GBR will have fire control support capabilities against tactical ballistic missiles and residual capability against cruise missiles and other air breathing threats.

The TMD-GBR project is expected to begin the Engineering Manufacturing Development phase (formerly Full Scale Development) in 1996.

Limited Defense System - National Missile Defense Ground-Based Radar (NMD-GBR)

NMD-GBR is required to detect, acquire, and track RVs from accidental or unauthorized limited strikes from ICBMS, SLBMs, or MRBMs. The NMD-GBR supports the Ground-Based Interceptor (GBI) in exoatmospheric engagements. The NMD-GBR can operate autonomously or can use range extending cueing support from other space and/or ground based Early Warning Systems (EWS) sensors. The NMD-GBR will also provide precision tracking, launch point prediction and signal/ data processing for exoatmospheric/endoatmospheric discrimination and classification in support of the Ground Based Interceptor (GBI). The GBR-T DEM/VAL radar will provide the Functional Test Validation (FTV) of the NMD-GBR at the USAKA national range.

The NMD-GBR project is expected to begin the Engineering, Manufacturing, Development phase (formerly Full Scale Development) by CY 1996.

Family of Radars Design Concept

The design and fabrication of the TMD-GBR and the NMD-GBR will be based upon the family of modular X-Band radars concept derived from the GBR-X radar program conducted 1986-1991. A common antenna module serves as the radar aperture building block for the "family of radars". The radar transmitter, receiver, signal processor, data processor, and software have significant commonality. The transmitter (power) and aperture are sized to the radar range requirements.

PROJECT TITLE:
2106 - Advanced Contingency Theater Sensor

PROGRAM ELEMENTS:
0603216C - Theater Missile Defenses
0603214C - Space-Based Interceptors

PROJECT DESCRIPTION:

Theater Missile Defenses

The purpose of this project is to demonstrate near-term TMD sensor upgrades and technologies with potential application to Theater Missile Defense (TMD). These demonstrations provide near-term sensor alternatives that address critical TMD sensor needs. These improvements are accomplished through block upgrades to existing sensor systems and/or the introduction of new technologies.

This project includes the TMD Experiments Program (previously Project Number 1205) which consists of the Advanced Contingency Theater Sensor (ACTS), Patriot Remote Launch Demonstration; Tactical Surveillance Demonstration (TSD); Passive Sensor System II (PSS II); Multi-function Electronically Scanned Adaptive Radar (MESAR); and the Expert Missile Tracker (EMT). Additional sensor development will include processing of space sensor data; the RAPTOR high-altitude, long endurance airborne platform; and another round of invite, show, and test experiments.

Space-Based Interceptors

This project provides collateral spin-off technology from the RAPTOR program that is applicable to the Brilliant Pebbles program.

PROJECT TITLE:
2201 - Space-Based Interceptor

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

The earlier Space-Based Interceptor program, under the old Phase I architecture, was directed at resolving the technical issues for various space-based interceptor concepts. Brilliant Pebbles has replaced SBI as the space-based tier of GPALS, and SBI will be terminated when Martin Marietta completes its hardware development and integration and hover testing. However, certain previously planned SBI tests have been continued because they have the potential to provide components for the Ground-Based Interceptor (GBI) reducing overall GBI risk.

PROJECT TITLE:
2202 - Ground-Based Exoatmospheric Interceptor Development

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

The objective of the Ground-Based Interceptor (GBI) development effort is to develop and deploy a ground-launched exoatmospheric interceptor designed for hit-to-kill (non-nuclear) intercepts of Intercontinental Ballistic Missile (ICBM) and Submarine Launched Ballistic Missile reentry vehicles (RVs) in the midcourse of their trajectories. Midcourse sensors will acquire, track, and pass threat cluster information to the Command and Control Element, which will cue the interceptors and provide updates if they are available. Using onboard sensors, the interceptors will acquire the threat cluster and select the RV. The deployment will be as directed in the 1991 Missile Defense Act.

GBI work is separated into four tasks: (1) ERIS Functional Technology Validation (FTV), (2) Exoatmospheric Test Bed Payload Launch Vehicle (XTB/PLV), (3) GBI DEM/VAL Activities, and (4) Initial NMD Interceptor.

Task 1. The ERIS FTV effort consists of a series of 2 exoatmospheric interceptor experiments to validate the concept of intercept of an RV in the presence of decoys. The first flight test mission was flown in FY91 and was highly successful. The second mission was attempted in May 1991 but was aborted due to anomalous target trajectory data. It has been rescheduled for FY92.

Task 2. The XTB/PLV effort will ensure that the $100M investment made at USAKA in support of the FTV program will not be lost, and that the experience gained by the launch support personnel is retained for subsequent testing at USAKA. Early GBI flight tests planned to support the initial National Missile Defense deployment will utilize the XTB/PLV launch facilities and services until the GBI booster is developed. Brilliant Pebbles will also use the launch services for suborbital tests.

Task 3. Selected GBI technologies from the program GBI DEM/VAL Activities will be transferred to SDIO/Technology to support the development of an advanced discriminating interceptor. The remaining efforts under the existing GBI DEM/VAL contracts will be downscoped to support an NMD interceptor development.Program

Task 4. A full and open competition is contemplated, with contracts to be awarded in FY92 or FY93 that will support a later deployment decision for the initial NMD interceptor.

The GBI project is expected to begin the Engineering Manufacturing Development phase (formerly Full Scale Development) by 1998.

PROJECT TITLE:
2203 - HEDI (Endo/Exoatmospheric Interceptor (E^2I))

PROGRAM ELEMENTS:
0603216C - Theater Missile Defenses
0603215C - Limited Defense System

PROJECT DESCRIPTION:

Theater Missile Defenses

The Theater Missile Defenses program element is funding a portion of the KITE-2a flight test, as the data collected in this test will be beneficial to active TMD interceptor efforts, particularly to Arrow, THAAD and Navy far-term interceptor designs.

Limited Defense System

The concept for performing the High Endoatmospheric Defense Interceptor (HEDI) mission is the Endo-Exoatmospheric Interceptor (E^2I) which operates primarily during the reentry phase of attacking ballistic missile trajectories. It is designed to engage Intercontinental Ballistic Missile (ICBM) and depressed Submarine-Launched Ballistic Missile (SLBM) attacks.

While previously a separate program, in the future the E^2I effort will be developed as a potential Block upgrade to the Ground Based Interceptor (GBI) for inclusion in the ground based tier for GPALS. It was in competition with the GBI (midcourse option); the decision was made to select GBI for the initial NMD interceptor. Therefore the E^2I DEM/Val contract awards will not be made. The endoatmospheric interceptor research efforts will continue under SDIO technology.

The primary E^2I activity is a technology demonstration effort called the Kinetic Energy Kill Vehicle Integrated Technology Experiment (KITE) with the objective of resolving key technical issues through intensive ground and flight testing of a 300kg kill vehicle. KITE-1 was an extremely successful flight in January 1990 at White Sands Missile Range (WSMR). The second KITE flight in August 1991 at WSMR ended 0.2 seconds into flight when the self-destruct system engaged prematurely. In May 1992, KITE-2a will provide critical aero-optic measurements of blur induced by the forebody and window coolant flow and measurement of the refraction caused by the hypersonic shock wave. These cannot be measured in ground testing. This data is critical to both ATBM as well as ABM interceptors and has shared funding between the TMD and LDS line elements.

This effort is unfunded in FY93. However, depending on funding and the results of KITE-2a, a KITE-3 test flight may be conducted in FY93. The KITE-3 integrated mission would intercept an RV with Patriot conducting an underlay intercept of a replica.

PROJECT TITLE:
2204 - DEW Concept Definition

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

DEWs are being developed as advanced weapons systems for possible integration into a follow-on to the GPALS. DEW Concept Definition efforts will establish and maintain concept performance requirements and technical characteristics that are traceable to the requirements of the evolving GPALS architecture. This work will include development and analysis of alternate system designs, definition of weapon platform subsystem performance requirements, critical technology issues identification, technology program plan development, and theoretical analyses. A data base will also be developed to allow timely preparation and revision of System Concept Papers (SCPs)/Decision Coordinating Papers (DCPs) and Test and Evaluation Master Plans (TEMPs). The data base will provide the basis for technology development and demonstration plans. If executed, these would furnish the technology base and requisite demonstrations to resolve critical DEW issues on a scale sufficient to establish confident extrapolation to weapons level performance.

PROJECT TITLE:
2205 - Brilliant Pebbles (BP)

PROGRAM ELEMENT:
0603214C - Space-Based Interceptors

PROJECT DESCRIPTION:

The Space-Based Interceptor (SBI) Program Element (PE) is a research effort to develop promising follow-on anti-ballistic missile technologies. Project 2205 within this PE funds the Brilliant Pebbles (BP) program. BP is an element of the Global Missile Defense (GMD) program, which in turn, is one segment of the Global Protection Against Limited Strikes (GPALS) ballistic missile defense system. The BP program is directed toward demonstrating and validating a system concept that defeats both theater and strategic ballistic missiles with ranges greater than approximately 500 kilometers in normal flight trajectory--or about 800 km for depressed trajectories, whatever their source or destination on the globe, in their boost, postboost, and midcourse phases of flight. The product of the BP program will be a system that consists of space, ground, and launch components. The space component is comprised of singlet interceptors and their associated "life jacket" carrier vehicles.

The interceptor is a light-weight, kinetic, hit-to-kill vehicle that incorporates sensors, guidance control, battle management, and an axial propulsion stage. It possesses high-rate attitude control, onboard data processing, navigation, and divert propulsion capabilities. Each life jacket provides on-orbit power, low-rate attitude control, surveillance, communication, thermal control, navigation, and survivability. The ground component provides "man-in-the-loop" positive control of the BP constellation. The launch component is used to place the deployment package of BP singlets into space and operational orbits.

The objectives of the current BP Pre-EMD phase include: finalizing the BP System Concept, demonstrating and validating the system design concept; developing and implementing a comprehensive risk management/mitigation program; and conducting the necessary trade-offs to balance performance, producibility, operability, supportability, affordability, and schedule requirements. Specific technical issues to be resolved during Pre-EMD include demonstrating: target acquisition, discrimination, and tracking; BP end-game intercept performance and flyout guidance performance; station-keeping adequacy; singlet and life jacket performance; communication systems; computers and software; survivability; launch system/payload integration; and linkages with the element command center. These demonstrations will be performed through a combination of: Treaty-compliant orbital and suborbital flight testing, ground and underground testing, hover tests, "hardware-in-the-loop" testing, detailed simulations, and technical analyses. Overall risk assessment for Pre-EMD is low to moderate.

The BP concept evolved from key component technology efforts conducted by Lawrence Livermore National Laboratory (LLNL). These results were passed to industry for technical advancement and testing. LLNL will continue to provide advice to both the industry contractors and the government task force.

The BP project is expected to begin the Engineering, Maufacturing, Development phase (formerly Full Scale Development) by 1996.

PROJECT TITLE:
2207 - Patriot Multimode Missile

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses
0604225C - Engineering Manufacturing Development

PROJECT DESCRIPTION:

Patriot is a long-range, mobile, field Army and Corps air-defense system, which uses guided missiles to simultaneously engage and destroy multiple targets at varying ranges. Current threat theater ballistic missiles (TBMs) with significantly improved range and accuracy have increased the threat against Patriot air-defense sites and defended assets. This could result in the destruction of air-defense sites and provide the enemy air superiority once an attack is initiated. The current Patriot missile requires improved performance and increased accuracy to counter the evolving threat and to increase its contribution to the lower tier of the theater segment of a Global Protection Against Limited Strikes (GPALS) system. The Multimode Missile Program will incorporate a multimode seeker into the Patriot missile which will enable fuze/guidance integration and create the potential for using directed or focused blast warheads. Repackaging the Patriot guidance section with an active seeker will provide smaller miss distances at extended ranges and eliminate a potential rate saturation problem. The multimode guidance capability will provide the accuracy needed to counter the advanced, high-speed TBM threats as well as the low RCS, long-range targets in all operational environments.

The cornerstone of US and allied air defense, the Patriot was fielded in 1983 as a theater defense weapon system to counter the air-breathing threat. In 1988, this all-altitude, all-weather interceptor was improved to acquire, identify, track, engage, and destroy incoming TBMs. The Patriot anti-tactical missile capability (PAC) consisted of modifications to the system software (PAC-1) and to the missile warhead and fuse assembly (PAC-2). These improvements provided Patriot with a self-defense capability during Operation Desert Storm. The PAC-2 capability, deployed in January, 1991, extended the fire unit corollary asset defense capability.

PROJECT TITLE:
2208 - Extended Range Interceptor (ERINT)

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses
0604225C - Engineering Manufacturing Development

PROJECT DESCRIPTION:

The purpose of this project is to fund both the Demonstration/Validation (DEM/VAL) and Engineering Manufacturing Development (EMD) of the Extended Range Interceptor (ERINT-1) Technology Program. This technology program is being considered as a potential adjunct to several systems in the theater segment of the Global Protection Against Limited Strikes (GPALS) system.

The ERINT-1 will demonstrate a small, agile, hit-to-kill missile that will provide an asset defense against incoming maneuvering and non-maneuvering TBMs. A secondary objective of the Program is to provide defense against the air-breathing threat. The missile combines several state-of-the-art technologies, including an onboard active millimeter wave seeker that provides endgame guidance, advanced flight control technologies for agility in terminal maneuvers, lethality enhancement technologies, and a lightweight composite case solid rocket motor. The ERINT has been designed to integrate easily with existing air defense capabilities such as Patriot, and is a technology capable of integration into the Navy AEGIS weapon system.

The ERINT Program will undergo a series of eight flight tests during FY1992-93. Results from these tests, from accompanying simulation and other analyses, and from ongoing acquisition planning, analysis, and trade studies being performed by US Army organizations will be used to establish the ERINT acquisition strategy. On the basis of ERINT test results, high fidelity simulations, and cost and operational effectiveness, the U.S. Army and SDIO will determine the future acquisition strategy.

PROJECT TITLE:
2209 - Arrow Continuation Experiments (ACES)

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses

PROJECT DESCRIPTION:

The ACES Program is a US-Israeli initiative designed to provide Israel with a basis for an informed EMD decision for an area tactical ballistic missile defense capability. This Program is a follow-on demonstration phase for Arrow interceptor development. Critical lethality tests will be conducted in the initial phase of this program using the Arrow-1 missile developed during the Arrow program. An Arrow-2 missile will be designed and tested for an increased engagement envelope. If successful, the Arrow-2 will satisfy the Israeli requirement for an interceptor for population defense and will support US technology base requirements for new advanced anti-tactical ballistic missile technologies that could be incorporated into the GPALS layered defense system.

PROJECT TITLE:
2210 - THAAD

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses

PROJECT DESCRIPTION:

The THAAD system is a key element of the GPALS architecture and will provide large area coverage in both mature and contingency theaters. THAAD will engage tactical/theater ballistic missiles at high altitudes which minimizes debris and chemical/nuclear damage. THAAD will be interoperable with US Air Defense Systems, space-based sensors and NATO systems. THAAD will complement lower tier defenses such as Patriot and Corps SAM.

The THAAD element includes missiles, launchers, BM/C^3 units, and support equipment. The THAAD BM/C^3 units will be compatible with the battalion air defense Tactical Operations Centers (TOCs) to enable communication to higher and lower echelons. The Theater Missile Defense Ground-Based Radar (TMD-GBR) element will provide fire control and surveillance for THAAD as well as for other active TMD systems. The THAAD element, combined with the TMD-GBR element forms the THAAD System. The THAAD system will be C-141 transportable and will utilize existing standard government power systems. Furthermore, the potential for adapting the THAAD system in a cost and operationally effective manner for a sea-based defense is being considered.

The THAAD Dem/Val program will include building a prototype "battery" called the User Operational Evaluation System (UOES). It will consist of 40 missiles with launchers, 2 BM/C^3 units, 2 GFE TMD-GBRs, and support equipment. The UOES will be used for early operational assessment but also has the potential to be deployed during a national emergency. This approach provides near-term improved active TMD capability and lowers the risk of subsequent phases of the acquisition cycle. The objective system will be fielded in the 2000 time frame.

The THAAD project is expected to begin the Engineering, Manufacturing, Development phase (formerly Full Scale Development) by 1996.

PROJECT TITLE:
2212 - Corps Surface-to-Air Missile

PROGRAM ELEMENT:
0603216C -Theater Missile Defenses

PROJECT DESCRIPTION:

Corps SAM is a GPALS MDAP program. The program will lead to the development of a strategically deployable, tactically mobile, low- to medium-altitude air and ballistic missile defense system that will support deployed Corps, contingency operations, and rapid reinforcing missions. The near-term effort is focused on Concept Definition activities directed towards establishment of a range of requirements for a Corps SAM system and identification/evaluation of concepts that will most likely satisfy these requirements. Corps SAM will be optimized for operation in the context of the Army's AirLand Operations doctrine as it applies in both mature and contingency theaters. Its distributed/netted architecture and module components will allow the unit to be task-organized and the equipment configured according to the array of expected air and missile threats, available strategies, and acceptable level of risk and cost. The system will provide area and point defense capabilities against both TBM and air-breathing threats compatible with strategic deployability and tactical mobility. Corps SAM will be an integrated part of the overall Air Defense/active Theater Missile Defense architecture. As such, it will be compatible/interoperable with other Army air defense systems (i.e, THAAD, Patriot, FAAD) and will interface with joint and allied sensors and BM/C^3I networks. Concept studies will include both Government and contractor efforts to perform cost, schedule, and performance trade-offs and evaluation of system level concepts. Operational analyses will be conducted to evaluate the impact of various concepts/requirements on missions, force structure, and system effectiveness. A program baseline will be established for Milestone I approval that defines cost, schedule, and performance objectives as well as an acquisition strategy designed to meet these objectives.

The Program is also investigating possible international interest in the cooperative development of Corps SAM.

The Corps SAM project is expected to begin the Engineering, Manufacturing, Development phase (formerly Full Scale Development) by 1997.

PROJECT TITLE:
2300 - Command Center

PROGRAM ELEMENT:
0603215 - Limited Defense System

PROJECT DESCRIPTION:

Global Protection Against Limited Strike (GPALS) system surveillance and engagement activities are coordinated and controlled by the Command and Control Element (C^2E). C^2E is a distributed system of facilities, equipment, software/algorithms, communications, personnel, and procedures that support centralized command and control and decentralized execution of Ballistic Missile Defense thus maintaining human control of the system at all times. The C^2E is comprised of five sub-elements: Ballistic Missile Defense Operations Center and Cell (BMDOC and BMDC), Regional/Element Operations Centers (ROC/EOC), the Command and Control Network (C^2N), the Communications Network Management (CNM), and Battle Management (BM). Management of three functional areas, Command and Control, Communications and Battle Management, will implement the responsibilities of the C^2E through an evolutionary acquisition approach.

Command and Control includes the specification, design, fabrication, and test of a Command and Control capability to demonstrate GPALS system ballistic missile defense requirements for human-in-control. This will be accomplished through a series of hardware and software development blocks that incrementally increase system functionality and performance. The development of decision aid hardware and software in conjunction with command and control gaming to validate and refine the command and control processes, procedures, and responsiveness is the initial focus.

Communications involves the development and integration of the C^2N which consists of the Terrestrial Communications Network (TCN) and the Space Communications Network (SCN). This also involves evaluation of existing capabilities and off-the-shelf components. The Communications Network Management (CNM) capability will also be developed using a similar approach. Common Communications Components (COM^3) is a development action that will implement an inter-operable communications network for GPALS.

Battle Management addresses the area of automated control. It includes the automated functions that support inter-element interaction for control of weapons and sensors and is resident on (and tailored to) every system element. The objective is to establish battle management functional definitions to ensure that the multiple GPALS elements execute a single, coordinated defense.

The technologies required for EMD are sufficiently mature to support the implementation of Evolutionary Acquisition. Focusing on off-the-shelf capabilities reduces schedule and technical risk, and allows hardware/software testing to begin earlier than would normally be expected. This also accommodates deployment responsibilities of the C2E as required by the MDA 1991.

The Command Center project is expected to begin the Engineering, Manufacturing, Development phase (formerly Full Scale Development) by 1998.

PROJECT TITLE:
2304 - System Software Engineering

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

GPALS will require adaptive, fault-tolerant, reliable, trusted software that must be developed, integrated, and tested across multiple systems and developers. This project will provide the capability to specify, develop, acquire, integrate, test, and maintain software for SDIO. Research and development efforts underway to achieve these capabilities include proof-of-concept demonstrations; tools and methods analysis; software code prototyping; laboratory experiments; software contractor evaluations; and various analyses, investigations, and reports. Proof-of-concept demonstrations of formal methods for software development, demonstrating the production of code to Trust Level five, are expected during FY96. Build One of the SDI Software Engineering Support Environment (SESE) is scheduled for completion in FY93 with subsequent builds completed in FY94 and FY95. Efforts continue in the research and development of parallel processing technologies. Standards, products, tools, and methodologies developed under this activity apply to all SDI Element software development efforts and will provide the basis for coordinated and successful SDI software development, integration, and testing efforts.

PROJECT TITLE:
3102 - System Engineering

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

The Systems Engineering and Integration Contractor (SEIC) addresses architecture definition requirements analysis and system definition of the GPALS system and elements that are within the system. The SEIC provides risk assessment and trade studies to optimize and balance the system. Trade studies will be performed for mission analysis, discrimination, technical performance, cost analyses, and technology insertion. The systems engineering and integration task requires planning and participation in integrated testing and identification and resolution of key Demonstration/Validation (DEM/VAL) issues. An important task of the SEIC is to ensure a rationale growth path exists for incremental deployment of the GPALS capability.

The SEIC is responsible for examination and analysis of the Threat, as derived from the Systems Threat Assessment Report (STAR), as a basis for system definition and analysis. The SEIC identifies, defines, and decomposes the functions and inter-relationships of GPALS. The definition and decomposition process is developed to a level of detail permitting unique element function/performance requirements allocations and the definition of the interfaces between individual elements. Key DEM/VAL issues identified in the requirements definition process are allocated to data, demonstrations, and simulations and are generated for areas identified as low confidence to facilitate an informed Milestone II decision. As part of the demonstrations during DEM/VAL, this project will support the design and development of the Command Center Element. This includes designing the related functions including selection of algorithms, communication network concepts, processors, and software.

The SEIC performs support task requirements for active Theater Missile Defense (TMD) by providing the resources necessary to accomplish the integration and balancing tasks to: (1) integrate the TMD segment into GPALS, (2) integrate Strategic Sensors and space-based GPALS elements with active TMD, (3) integrate and balance SDIO and Service active TMD activities, and (4) define interfaces to the theater C^3 structure.

The SEIC will support the requirements definition and integration of Global Missile Defense overlay and early deployment of a National Missile Defense that will protect the United States from limited attack by FY96.

PROJECT TITLE:
3103 - SDIO Metrology

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

The Metrology effort was previously started in Projects 3104 and 3105 and is presently in progress at National Institute of Science and Technology facilities in Gaithersburg, MD, and Boulder, CO. This project addresses the identification and development of critical measurement standards, unique to SDIO requirements, which are inadequate or non-existent at the U.S. National level. These standards will provide the legal and scientific basis for measurement of performance of SDIO system parameters.

PROJECT TITLE:
3104 - Integrated Logistics Support

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

The Integrated Logistics Support (ILS) project addresses the identification and quantification of the essential elements of a Global Protection Against Limited Strikes (GPALS) support system. It identifies the basic supportability costs, schedule, performance, and support technology drivers in each SDI project to ensure the minimum cost of ownership and maximum effectiveness of the GPALS system.

PROJECT TITLE:
3105 - Producibility and Manufacturing

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

This project will identify producibility and manufacturing risks associated with the new technologies and designs being proposed for Global Protection Against Limited Strikes (GPALS) and will coordinate and implement a structured, unified approach to risk reduction and mitigation of common producibility and manufacturing issues.

The approach involves the following four efforts:

1. Manufacturing Strategy Development. This effort develops and implements a capstone Strategic Defense System Manufacturing Strategy (based on the revised DoDD 5000.1, DoDI 5000.2) providing leadership and direction as the Elements

and Systems Engineer develop their manufacturing strategies. This strategy development will flow down to the Element Contractors and subcontractor levels.
2. Industrial Resource Analyses. Analyses and Risks of the shortfalls of industry's capability to manufacture key element design technologies.
3. Initiating critical producibility programs with industry in a number of high-priority areas to complement ongoing technology or Element producibility and manufacturing efforts.
4. Manufacturing Operations Development and Integration Laboratories (MODILs). MODILs serve to address and ultimately mitigate high producibility risks. This involves accelerating the development, integration, and introduction of modern, cost-effective manufacturing technologies into the design and the industrial base using existing national resources (government labs, industry, academia).

These efforts combine to assure that commitment and emphasis will be placed on risk reduction and design-for-manufacturability during the appropriate design or development phase.

PROJECT TITLE:
3107 - Environment, Siting, and Facilities

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

Provide environmental impact analysis documentation and facility acquisition support for the SDIO systems and technical development projects. Plan, program, budget and monitor facility acquisition of Military Construction projects. Provide guidance and prepare Environmental Assessments and Environmental Impact Statements, as applicable, for SDIO technology demonstrations and test and evaluation activities. Develop guidance for Executing Agents on facility acquisition and environmental matters.

PROJECT TITLE:
3108 - Operational Environments

PROGRAM ELEMENT:
603215C - Limited Defense System

PROJECT DESCRIPTION:

The purpose of this project is to identify, integrate, coordinate, and resolve natural and nuclear environmental issues. The program will focus on characterizing natural, debris, and nuclear environments from a systems perspective. DoD and DoE programs will be reviewed to identify specific areas where additional effort is needed to support deployment/operation of a GPALS system, thus providing an adequate understanding of natural, debris, and potential nuclear environments within which a missile defense system must operate.

There are two main efforts ongoing within this project: (1) the KEW Space Debris Modeling effort, in which the Debris Radiance (DEBRA) model and a long-term DoD model of the space debris environment (Debris Analysis Workstation, or DAW) are being developed; and (2) the Nuclear Effects Physics Modeling effort, in which first-principle physics satellite nuclear radiation codes are being upgraded to provide higher-fidelity, faster-running, trapped, radiation transport codes. Both DEBRA and the nuclear effects codes, with associated documentation, will be delivered to SDIO's National Test Bed (NTB) for use in assessing system survivability of GPALS space assets.

PROJECT TITLE:
3109 - System Security Engineering

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

The objective of the project is to ensure that Electronic Information Systems Security (ELINFOSEC) is integrated into the Global Protection Against Limited Strikes (GPALS) system, including the National Missile Defense (NMD) and Theater Missile Defense (TMD) programs. This objective will counter the existing and rapidly growing threat arrayed against an electronic information system like the GPALS system. Communications Security (COMSEC) and Computer Security (COMPUSEC) equipment, technology, methodologies, and designs will be integrated with the development of GPALS elements.

PROJECT TITLE:
3110 - Survivability Engineering

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

The system Survivability Program is responsible for oversight and management of the GPALS Survivability Program. This oversight activity includes coordination of the SDIO's survivability-related activities to support the GPALS acquisition process, ensuring that the proper interfaces are established and maintained within the system, element, and component levels of the Program.

The Program provides for the generation of system and top-level element survivability requirements that are directly traceable to SDIO-approved mission requirements and threat scenario(s). Analyses are performed to support TMD, GMD, and NMD. This analysis includes performance of system-level trade studies to assess the ability of the system and elements to survive and operate in natural (e.g., debris) and manmade hostile (e.g., nuclear, laser, ASATs) environments. Additionally, the System Survivability Program supports the element programs by ensuring that the elements' survivability design concepts are consistent with their survivability requirements and that the segments/elements are prepared for DAB and other critical reviews. The Program is also responsible for defining requirements for and performing system-level survivability-related tests, namely through SDIO's test beds within the National Test Bed (NTB). This includes identifying environment/response modeling requirements within the test beds and defining system survivability test requirements as inputs to the SDI test and evaluation planning process. Finally, the Program is responsible for defining and assessing critical survivability-related operational concepts that are consistent with system and element survivability requirements, that enhance the system/elements' survivability, and that provide maximum flexibility to the User.

PROJECT TITLE:
3111 - Surveillance Engineering

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

In all mission areas and phases of the Global Protection Against Limited Strikes (GPALS) System, some level of target surveillance/discrimination capability will be needed in order to meet mission requirements. However, surveillance/discrimination, to include bulk filtering, track initiation, tracking, track correlation, discrimination, and sensor management, is one of the most difficult and fundamental problems facing GPALS. This problem will also become more complex in the future as target decoy technology improves and is acquired by potential threats. This program addresses a wide range of surveillance/discrimination issues from a systems perspective and develops and evaluates algorithms and systems schema to meet mission requirements by efficient use of available sensing resources. To accomplish this, this program is developing a simulated test environment known as the Surveillance Test Bed (STB). The STB is one of several test beds that will be resident on the National Test Bed (NTB). The STB provides the capability to evaluate element algorithms or Test Articles (bulk filtering, tracking, discrimination, etc.) and system schema (the framework that integrates elements and algorithms into a coordinated system) on a high fidelity simulation of element sensors. In addition to the STB, other lower fidelity software tools will be utilized to conduct analysis and identify scenarios to be evaluated with the STB. This program will also develop and implement a methodology for validation of system level discrimination performance, including performance of system discrimination schema and algorithms in wartime environments. Close coordination is maintained with the Discrimination Technology project (#1105). Discrimination algorithms developed under that project will be evaluated and validated.

PROJECT TITLE:	**PROGRAM ELEMENT:**
3112 - Systems Engineering Support	0603215C - Limited Defense System

PROJECT DESCRIPTION:

The systems engineering support will provide critically needed capability to develop and use test beds and other models/simulations in support of the design and validation of Limited Defense System (LDS) concepts. State-of-the-art test beds, models/simulations, and analysis tools are being developed in support of studies and analyses conducted prior to the Milestone II engineering and manufacturing development decision. These tools will support the SDIO community in evaluation/ comparison of alternative architectures and support element model development/integration. In general, system engineering support will include: design, development, integration, test, and maintenance of Level One and Level Two System Simulators (L1SS/L2SS); design, development of Command and Control simulators (C^2 Sims) and component commands Concept of Operations; and development of the Software Engineering, Test, and Integration Center (SWETIC).

PROJECT TITLE:	**PROGRAM ELEMENT:**
3113 - Ground Communications	0603215C - Limited Defense System

PROJECT DESCRIPTION:

Provide environmental impact analysis documentation and facility acquisition support of the SDIO National Missile Defense (NMD) systems and technical development projects. Plan, program, and budget Environmental Assessments and Environmental Impact Statements, as applicable, for SDIO NMD facility design and construction activities. Develop guidance for Executing Agents on facility acquisition and environmental matters.

PROJECT TITLE:
3114 - Launch Communications

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

This is a new project activity. Provide environmental impact analysis, documentation, and facility acquisition support for the launch and deployment of SDIO space elements systems and technical development projects. Plan, program, budget and conduct Environmental Assessments and Environmental Impact Statements, as applicable, for SDIO space elements ground-based facility design and construction activities. Develop guidance for Executing Agents on facility acquisition and environmental matters.

PROJECT TITLE:
3201 - Architectures and Analysis

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

This project develops, evaluates, and compares alternative architecture concepts for all phases of the Strategic Defense System (SDS), including Limited Protection Systems (LPS), Global Protection Against Limited Strikes (GPALS), Phase I, and Follow-on Architectures. Emphasis is on the insertion of newly emerging technologies into the system elements to reduce system cost and increase effectiveness. Includes upgrading and maintaining simulation tools which are necessary to conduct architectural level analyses, such as the Mission Effectiveness Model (MEM) and the exoatmospheric discrimination simulation (XoDis). Element task areas are: Follow-on Architecture Analysis, Alternative Architectures, Analysis Tools, and Direct Support.

PROJECT TITLE:
3202 - Operations Interface

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

The mission of the SDI Organization is twofold: (a) to support national security policy and strategy and (b) to manage the development and deployment of a ballistic missile defense (BMD) system that meets the operational mission requirements of the designated users of that system. For the first part, analyses and simulations focus on definition of the GPALS concept, coordinating and refining the concept definition with other parts of DoD, external agencies, and (indirectly) with Allies and friends who may cooperate in mutual deployments of a BMD system. The Mission Analysis function provides direct support to the Director, SDIO, and senior OSD policy officials on a variety of sensitive policy and strategy issues, including implications of events in Russia and other members of the Commonwealth of Independent States (CIS) for the SDIO/GPALS program; the status of formerly-Soviet offensive ballistic missile capabilities; arms control; strategic stability and deterrence; and proliferation of nuclear weapon and ballistic missile technology in the rest of the world. For the second part, analyses and simulations address strategic and tactical effectiveness, including offense-defense interaction of proposed GPALS system architectures against offensive ballistic missile threats to the U.S., our allies and friends, and deployed forces. Analytical results are then used to support activities required for the Defense acquisition process, including preparation of Cost and Operational Effectiveness Analyses required by the Defense Acquisition Board. Funds are also provided from this Project to operational users (USSPACECOM, ARSPACE, AFSPACE, NAVSPACE, Marines, SAC/STRATCOM) to enable them to develop their concepts of operations for employing BMD and ensuring that these concepts are integrated into the overall BMD system deployment strategy and planning.

PROJECT TITLE:
3203 - Intelligence Threat Development

PROGRAM ELEMENTS:
0603216C -Theater Missile Defenses
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

The purpose of the SDI Intelligence Threat Development project is to provide an up-to-date threat description against which system-specific "design-to" threat specifications, lethality designs, and target objects are developed. The primary vehicle for providing this threat description is the System Threat Assessment Report (STAR), which is updated by SDIO, reviewed by the services, and validated by the Defense Intelligence Agency annually under this project. The Intelligence Threat Development Program divides the threat into two major categories--Delivery Vehicles and Payloads--and three levels of detail within each category. The delivery vehicle category includes ballistic missile boosters and aerodynamic missiles residing within the Commonwealth of Independent States (CIS), CIS post-boost vehicles (buses), and Rest-of-World (ROW) missiles (ballistic and aerodynamic) with ranges greater than 30 kilometers. The payload category includes CIS re-entry vehicles (warheads), penetration aids, and ROW missile warheads (both nuclear and non-nuclear). The STAR addresses the threat faced by a Global Protection Against Limited Strikes (GPALS) system from two points of view. First, the descriptions of CIS threat vehicles, warheads, and penetration aids are equally applicable whether the U.S. is under limited or all-out nuclear attack. Second, the ROW threat descriptions address the threat both from the perspective of attack against CONUS (strategic) and overseas theater (tactical) elements. The threats are described at the highest level in terms of country-of-origin (Level 0); form, fit, and function (Level 1) necessary to produce the SDI "design-to" threat specifications; and the very detailed Level 2, where actual materials and structures are described for use in lethality studies and actual target designs. The analyses will evaluate emission signatures, reflection signatures, trajectories, and vulnerabilities for strategic and theater elements of GPALS. These analyses will provide detailed data for developing both theater defense systems and other GPALS systems.

PROJECT TITLE:
3204 - Countermeasures Integration

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

The purpose of the SDI countermeasures integration project is to identify likely countermeasures to strategic defense system concepts such as GPALS (and/or individual system components) to assist defense systems designers to make their systems robust against potential countermeasures. The countermeasure may be technical--directed specifically against the hardware of the defense system, or tactical--designed to avoid or suppress the defense. The countermeasures project uses a Red-Blue Team methodology and includes concept verification through analysis and experimentation. On a continuing basis, a Defense Science Board Task Force will make recommendations on the existing DoD-SDIO countermeasures program and suggest necessary improvements.

Major technical issues include denying or delaying target acquisition, discrimination, and aimpoint for GPALS elements. R&D approaches used include Red Teams, countermeasure studies and analysis, ground tests, and flight tests.

PROJECT TITLE:
3205 - Theater Missile Defense (TMD) Special Studies

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses

PROJECT DESCRIPTION:

The purpose of this project is to produce workable solutions to the critical issues within Theater Missile Defense. The priorities are based upon input from theater Commanders-in-Chief (CINCs), allies, and the US Services. The research and development tasks contained in this program are centrally managed and directed by SDIO, in close cooperation with the Executing Agents.

The objective is to define technical and other systematic approaches to operational requirements critical to an integrated active TMD complex of systems. The project spans both Allied and the four Uniformed Services interests and concerns. Within the program are: European and Northeast Asian Theater architecture studies; two Artificial Intelligence software projects for Command and Control and Discrimination; an analysis to determine the best interface between GPALS and TMD roles and systems; support of Israeli TMD studies and analysis; U.S. Air Force studies, analysis, and experiments to examine sensor and Command and Control support and improvement for active TMD; U.S. Marine Corps studies and research into HAWK and supporting sensor system improvements to provide point defense against ballistic missiles; U.S. Navy studies and analysis into local and regional defense using existing and augmented Fleet assets to counter Ballistic Missiles; and U.S. Air Force studies for other TMD pillars beside active defense (e.g, TPS-75 modifications, command and control integration, etc.)

PROJECT TITLE:
3206 - System Threat

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

With the changing world situation and the proliferation of ballistic missiles, it is imperative that an accurate characterization of theater, national, and global threats be developed. The accurate specification and characterization of ballistic missiles and the appropriate development and integration of scenarios using these characterizations is critical to: (1) the analysis of alternative ballistic missile defense architectures; (2) the performance assessments of potential technology applications; and (3) the operational performance evaluations of candidate designs. The threat specifications and characterizations must be based on accepted intelligence community threat projections or realistic estimates of technological/operational innovations; be traceable back to objective and quantifiable analyses; and be supported by the using organizations. These threat projections, described in engineering terms and parameters, must be used by all SDIO agencies to ensure that results can be compared and contrasted.

The System Threat development project is an integral part of SDIO's three-part Threat Program. The System Threat project uses as a baseline the System Threat Assessment Report (STAR) developed under the Intelligence Threat Development project (#3203) and incorporates likely adversary countermeasures identified in the Countermeasures Integration project (#3204). The System Threat project adds system-specific engineering characterization details described in the form of scenarios characterizing particular timing, targets, and tactics.

The System Threat Project achieves its objectives through the auspices of the Threat Working Group (TWG), and the TWG subgroups (the Scenario Working Group (SWG) and the Penetration Aids Panel). The TWG and the TWG subgroups include representatives from: the intelligence community (DIA, CIA, Service Science and Technology centers, etc.); the SDIO and Service element development offices; the using commands (USSPACECOM, USASDC, etc.); the Service engineering support agencies; and contractors associated with the government functions. Using the expertise available through the TWG, the System Threat Project:

(1) Identifies user needs for threat scenario descriptions.
(2) Identifies analyses needed to fully specify and characterize the threat missile systems.
(3) Exposes the analysis results to all interested agencies.
(4) Addresses critical threat issues which arise during the analysis process.
(5) Ensures all supporting agencies' views on threat issues are fully aired.
(6) Reviews and approves all System Threat Scenario Descriptions.
(7) Produces threat computer tapes and supporting documentation for use by the development community.

The System Threat Scenario Description Documents are presented to the SDIO System Design Board (SDB) for endorsement and configuration control.

PROJECT TITLE:
3207 - System Architecture

PROGRAM ELEMENT:
0603215 - Limited Defense System

PROJECT DESCRIPTION:

The objective of this project is to define an evolving architecture for the phased deployment of the GPALS defense system. The emphasis will be on the Limited Defense System including initial deployments. This project will also define how Theater Missile Defense (TMD), Space-Based Interceptors (SBI), and Other Follow-On Systems will be integrated into GPALS. This project will provide recommendations on System Elements, command and control, battle management, acquisition strategies, program management, and site activation. This project will also provide inputs to reports to Congress, Cost and Operational Effectiveness Analysis (COEA), and other required acquisition documents.

PROJECT TITLE:
3208 - Integration and Balancing

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses

PROJECT DESCRIPTION:

System Engineering Management/Documentation

Develop, coordinate, and staff interagency MOUs. Develop system engineering management concepts and planning and acquisition strategies. Documentations: System level ILSP, TMD Master Plan, System level Test and System Engineering Plans, System level BCE, Active Defense Architecture Specifications, Configuration Management Plan, Risk Management, System Engineering Notebook.

Integration and Balancing Studies

Threat, vulnerability, survivability of assets, force on force modeling, to define conflict outcomes as a function of A/P/CF. Interpillar BM/C^3 requirements and operations for each TMD mission and region of interest.

Asset Survivability

Characterize defense requirements for all asset types to be protected by theater defense systems.

Regional Characterizations Assets

Detailed spatial data of countries most likely to be involved with conflicts involving theater/regional ballistic missiles.

Risk

Support trade studies with cost models and estimates of risk assessments for alternative TMD architectures and concepts.

Techbase System Engineering

Inputs to Army Technology Base Master Plan.

ILS, Prod. Cost Support

Provide support cost requirements for all asset types to be protected by theater defense systems.

Facility Support for Special Access Program Integration and Balancing Studies

Maintain, modify, and/or develop simulation facilities and technical data repository for special access programs (SAPs) and infusion into active TMD. Develop multi-level technical data repository of TMD-related SAP data. Develop/modify, install, and enhance simulation tools. Conduct I & B studies considering SAPs. Develop SAP interfaces to EADTB.

Threat/Scenarios

Continued characterization and refinement of emerging TMD threats: RCS, trajectories, accuracies, and inventories. Develop Penaid characteristics and IR signatures. Collect and catalog design to and excursion threat data. Support validation activities. Collect and catalog scenarios used by the TMD community. Compare for consistency and compatibility. Maintain design to and excursion threats for the US Army TMD studies.

PROJECT TITLE:
3209 - Special Studies

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

This project contains classified programs relating to technological advancements.

PROJECT TITLE:
3210 - Tactical Missile Defense Attack

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses

PROJECT DESCRIPTION:

The purpose of this project is to undertake studies to develop and demonstrate the means to counter tactical missiles (TMs) through a centrally managed, anti-TM research program concentrating on operations to destroy TM launchers and supporting equipment. This includes: command, control, communications, and intelligence (C^3I) functions; sensors and sensor fusion; and weapon systems. This effort will lead to materiel requirements definitions and needs to counter TMs. The study and development program will be a multi-service effort. The service executing agency will centrally manage its service's efforts and report to the SDIO.

The project currently has three major areas of research. Research into promising sensor technologies, with concentration on overhead assets, will yield technical design requirements for both theater fire control and warning functions. Information and intelligence fusing research to identify and strike critical mobile targets will be funded. Research into weapon systems capabilities will determine design requirements for near term product improvement programs and technical requirements for long-term acquisition items.

PROJECT TITLE:
3211 - C^4I and Operational Analysis

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses

PROJECT DESCRIPTION:

This effort is a partial follow-on to FY 1991 Project 3208. C^4I, in the context of this project, is defined as all those Command, Control, and Intelligence functions, serviced by computers and communications systems, beyond Weapon Control functions , which will be integrated into the existing air defense function and structure. In 1992, this project funding is apportioned 90% for US Army C^4I concerns and 10% for Joint concerns. In future, this project will contain those USMC, USAF, and USN specific tasks (now contained within Project 3205) which contribute to the enhancement of C^4I systems for active TMD. A significant change in future funding profiles based on the task reorganization is anticipated.

The portion of the project for Joint work is being geared to support the JCS's JROC TMD Special Study Group on C^3I. It is anticipated that studies and analysis of Desert Storm, Just Cause, and Urgent Fury C^4I will be consulted, as well as original work initiated. The US Army effort includes developing and analyzing known and planned Unified Theater Army Air Defense CONOPS and C^3I Architectures to examine warfighting stratagems plus weapons and sensor use; identifying information types and information flows based on strategems and use; determining the optimum architecture via trade studies; initiating work on SAMOC; demonstrating of current Intelligence networks to move National Sensor information rapidly into and around Unified Theaters; initiating work on ADTOC; initiating program to IV&V Air Defense software.

PROJECT TITLE:
3212 - Passive Defense

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses

PROJECT DESCRIPTION:

The purpose of this project is to undertake studies to develop and demonstrate the means to minimize the effectiveness of Tactical Missiles (TMs) against high priority assets within the theater. The program will apply technology developments to defeat, confuse, or minimize the effectiveness of threat acquisition sensors and the technology related to surviving TM attacks. The study and development program will be centrally managed and directed by the U.S. Army Strategic Defense Command which will report to the SDIO.

The project is currently conducting research into sensor negation, asset hardening, and other survivability measures for the following critical theater targets; GUARDRAIL ground station, corps command posts, US Army aviation forward area rearm refuel points (FARRPs), and the POMCUS sites. Future year work will address additional theater assets and TM systemic issues.

PROJECT TITLE:
3213 - Active Defense Engineering

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses

PROJECT DESCRIPTION:

This project provides system engineering and mission analysis support to evaluate alternative concepts and architectures for the active defense pillar of TMD. This project consists of two objectives.

One project objective is to support the operational user with engineering analysis to evaluate the system implications of various scenarios, threats, and operational requirements. Balancing of threat allocation and time line/battle space between the upper and lower tiers will be conducted. The analysis will also define the key active defense sensor trades and requirements. Data from trade studies will be used as analytical support for Cost and Operational Effectiveness Analyses and operational requirements development. Products will support THAAD, Patriot, and Corps SAM.

Another objective of this project is to define the architecture and external interfaces required to satisfy TMD mission needs. New active theater missile defense systems will be integrated into the existing U.S. and allied battlefield C^3I architectures. Timeliness and quality of information have a direct effect on the required effectiveness of the overall TMD system. This effort will recommend preferred alternatives to optimize TMD performance. Focus will be on TMD internal and external information exchange and data distribution requirements.

PROJECT TITLE:
3301 - SDIO Test Data Centers

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

These Centers archive, catalog, maintain, process, distribute, and provide controlled access to SDIO experiment data. Their mission is to serve as the principal repository for SDIO experiment data and to assist the analysis and science community with their requirements for information to evaluate GPALS feasibility, development, and implementation. Additionally, the Data Centers provide specialized data products and analysis support for SDIO System Elements. Presently, there are five Data Centers located at DoD centers of expertise in specific areas of science and technology. They are the Backgrounds Data Center (BDC), Kinetic Energy Weapon Data Center (KDC), Midcourse Data Center (MDC), National Test Facility Data Center (NDC), and the Plume Data Center (PDC).

PROJECT TITLE:
3302 - System Test Environment

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROGRAM DESCRIPTION:

The mission of the Strategic Defense Initiative (SDI) National Test Bed (NTB) Program is to provide a comprehensive capability to experiment and evaluate alternative SDI system concepts, architectures, including battle management/command, control and communications (BM/C^3), and key defensive technologies and integrate the ultimate SDS. The NTB consists of a network of integrated, geographically distributed, simulation and support facilities. The National Test Facility at Falcon AFB, CO, is the hub and central experiment and simulation facility. The mission of this project has changed to identify only the infrastructure support for tasks and projects previously identified as part of Project 3302. Those projects/tasks now are identified separately under their respective projects. This project consists of the acquisition, operation, and maintenance of computing and communications networks, secure facilities, and technology required to support the NTB mission. The network nodes include SDIO, Army Strategic Defense Command, Air Force Space Systems Division, Air Force Electronic Systems Division, Strategic Air Command, Los Alamos National Laboratory, Naval Research Laboratory, General Electric Corporation - Blue Bell, PA., Army Space Command, and Riverside Research Institute - Arlington, VA.

PROJECT TITLE:
3303 - Independent Test and Evaluation

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

Provide independent T&E oversight and assessment of all (GPALS) element tests to ensure that comprehensive T&E programs are implemented to support GPALS design, development, construction, operational capability, and deployment. This effort provides GPALS wide T&E programmatic and technical management, verification and validation (V&V), certification, status monitoring, and targets to support SDI test programs.

PROJECT TITLE:
3304 - Targets

PROGRAM ELEMENTS:
0603216C - Theater Missile Defenses
0603215C - Limited Defense System
0603214C - Space-Based Interceptors
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

This task provides for overall coordination of the targets development and acquisition program to support Test and Evaluation target requirements throughout the SDI Program and, as such, is funded across several Program Elements. Currently, three tasks are included in this project: the SDIO Targets Program, Space Test Range, and Studies and Analyses.

The objective of the Targets Program is to provide engineering and threat representative test targets for experiments and for Developmental Test (DT) for the GPALS/Phase I Program. These targets must meet SDS performance, engineering, and threat characteristics requirements to provide test articles that will adequately emulate the expected threat and support engineering and development tests. Test and Evaluation is the staff function designated to provide for the design, development, characterization, validation, production, acquisition, and support system tests. The targets of concern are Boosters, Re-entry vehicles (RV), Post-Boost Vehicle (PBV), Decoys, and Penetration aids (Penaids).

Targets will be designated and developed based on element and system level development test/experiment requirements. Initial target design and development will include an engineering and threat representative target set approved by the Test and Evaluation Working Group (TEWG) and validated by the intelligence community. Testing will be conducted on the test targets to ensure that they meet the characterization and validation requirements of the standard/threat target set. This characterization will ensure the proper data is available, post test, for accurate and timely test evaluation.

Products resulting from this effort will include:
- Pre-production prototypes (target booster, PBVs, RVs, Decoy/Penaids)
- Flight-qualified hardware
- Pre-production, validated test articles (PBV/RVs, Penaids/Decoys)
- ERIS, KITE-3, GBI, MSX, AST targets, ARE-2H payload, GSTS, BP, Patriot, ERINT
- Launcher Boosters
- Range Telemetry and Communication Equipment

PROJECT TITLE:
3305 - Theater Test Bed

PROGRAM ELEMENT:
0603216C - Theater Missile Defenses

PROJECT DESCRIPTION:

The Theater Test Bed effort will develop computer-based analysis centers to evaluate the component and overall system designs postulated for Theater Missile Defense. The Theater Test Bed Program will provide the capability for operational, doctrine, and materiel developers and systems engineers and analysts to address the issues associated with Theater Missile Defense. This effort will develop a common base for simulation software and the means to augment it with location-unique software for the specific, local analysis and provide the capability for man-in-the-loop/hardware-in-the-loop experiments and the networking of test bed centers. In addition, the effort will identify, design, and evaluate appropriate joint and unilateral experiments. Major test bed characteristics include real time operations, a friendly, highly interactive user environment, direct user control, Ada and maximum software portability, and security requirements compatible with multinational participation.

PROJECT TITLE:
3306 - Computer Resources and Engineering

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

This project provides funding for the Advanced Research Center and Simulation Center (ARC/SC) for ongoing operations and maintenance in support of Ground-Based Elements (GBE). The ARC/SC is an advanced computation technology system providing the operational test bed for resolving weapons, sensors, and battle management and command, control and communications (BM/C^3) issues for strategic and theater defense. It also serves as a development and test capability for other USASDC programs, to include the Surveillance Test Bed, Extended Air Defense Test Bed, and Ground-Based Radar Test Facility. The ARC/SC is a major node in the National Test Bed (NTB).

Facilities at Huntsville (US Army Strategic Defense Command) support evolving architecture analysis and represent the only operational, high-fidelity simulation capable of providing end-to-end GBE issue resolution.

PROJECT TITLE:
3307 - Airborne Surveillance Test bed (AST)

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

Limited Defense System

The Airborne Optical Adjunct (AOA) program was expanded to use the AOA as an Airborne Surveillance Test bed (AST) to conduct experiments that will help GPALS elements resolve critical system and optical sensor functional issues throughout all phases of a ballistic missile trajectory. The AST program provides for the design, fabrication, integration, and operation of a BMD type infrared (IR) sensor. This IR sensor, together with the appropriate data processing, display control, communications, and ancillary equipment was installed on a modified Boeing 767 commercial aircraft. It collects multi-target data, verifies sensor technical requirements, and validates signal and data processing techniques and algorithms. The major issues to be addressed by the AST are bulk filtering, sensor-to-sensor correlation, resolution of closely-spaced objects, discrimination, hand over to other sensors, and signal and data processing requirements for IR sensor performance. The AST provides a design and performance data base for ongoing as well as future programs in the areas of design, system performance, and operation of IR sensors, real time onboard signal and data processing, performance of an integrated IR sensor system, and target signatures. The need to perform these functions accurately and reliably places great demands on the airborne optical system, the most complex of its kind ever built. The operation of the AST sensor system provides data essential for risk reduction and effective design of future optical surveillance systems. Initially, the AST subsystems were tested at ground facilities. After integration on the aircraft, the integrated system was tested in flight tests over the Continental United States (CONUS) and is being used in functional demonstrations and to support collection of key optical data from a series of SDI experiments conducted at United States Army Kwajalein Atoll (USAKA), WSMR, ETR, and other national test ranges.

Theater Missile Defenses

The sensor functions for anti-tactical ballistic missile (ATBM) missions, part of the GPALS concept, are the same as those sensor functions for BMD missions. AST was tested as an optical sensor adjunct with the U.S. Army's Patriot Air Defense System for an experiment at WSMR to validate the applicability of IR sensors in an ATBM role. In addition to the basic sensor functions, AST's integration with radar sensors, ATBM C^2 element, and interceptor missiles provides useful experience translatable into the BMD integration mission.

PROJECT TITLE:
3308 - System Simulations (Level I and Level II)

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

The System Simulators are being developed to provide end-to-end analysis capabilities which are based on current Global Protection Against Limited Strikes (GPALS) architectural concepts and are traceable to the top-level system requirements. Level I is fundamentally a stochastically driven model which captures the performance requirements allocations of the system and its elements and will be the primary tool for the iteration and validation of the requirements allocation process. Level II will be a more detailed, higher fidelity, design specific representation of the system and, while retaining some architectural configuration flexibility, will be parameterized to a much lesser extent than Level I. Level II is, in addition, a critical exercise in the engineering and integration of the system and its interfaces, in that the Level II development spans multiple development agencies and will precede the availability of hardware components and subsystems by years. The cognizant services and Element Program Offices are directly responsible for the development of their models which will then be integrated into a common simulation framework at the National Test Facility. Level II as an analysis tool is expected to play a crucial role in the formal testing of the system.

PROJECT TITLE:
3309 - System Test Planning and Execution

PROGRAM ELEMENT:
0603215C - Limited Defense System

PROJECT DESCRIPTION:

The objective of this project is to provide "system-level" test planning and execution for developmental test (DT) and operational test (OT) for the GPALS system and its system-level segments. Element developmental, test, and evaluation (DT&E), however, remains the responsibility of the element program manager as does element-to-element interface testing. This project supports both the SDIO and service system-level planning for DT and OT. This project will support system-level DT tests and will provide the funding for OT tests conducted by the Operational Test Agencies within each Service.

System-level testing will consist of three related efforts in DEMVAL: 1) Extraction and augmentation of system data from element DT contractor and government tests to meet system test objectives as defined in the System Test Plan; 2) augmentation of inter-element live field integration tests to complete a series of System Integration Tests (SIT); and 3) completion of system-wide GPALS emulations in a real time Integrated System Test Capability (ISTC). DEMVAL system test planning also includes planning for the tests in the GPALS Engineering and Manufacturing Development (EMD) phase in sufficient detail to define the resources and provide those top-level test plans to support the Milestone reviews and to scope the EMD Statements of Work.

When SDIO-sponsored system-level tests piggyback on element and inter-element tests to collect system data or satisfy "system" test objectives, this project will fund the system-level incremental delta test costs, i.e., additional planning, instrumentation, test time, data analysis and evaluation over and above the basic element test costs. Certain tasks are related but not included; i.e., Service element DT. The NTB is separately funded through its own project. Further, Allied tests are not included.

PROJECT TITLE:
3310 - Test and Evaluation Facilities and Launch Support

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

This objective of this project is to provide adequate, common-user test and evaluation (T&E) facilities to enable SDIO test and experiment programs to meet their objectives. This is the first year these projects are consolidated for management purposes; the plan is to further consolidate management for other multi-user facilities in future years. Prudent consolidation can enhance efficiency and economy while satisfying user requirements. Facilities requirements will be satisfied using existing resources whenever possible. New and upgraded facilities will only be pursued when no existing capability will meet basic requirements. This project includes the following facilities: the Center for Research Support (CERES), Millstone Hill Radars Support, and range support for SDIO programs at WSMR, USAKA, and ESMC LC20.

PROJECT TITLE:
3311 - Mobile Test Assets

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

This project allocates resources to develop, operate, maintain, and upgrade SDIO mobile test assets. SDIO test and technology experiment programs require adequate test resources, ranges, monitoring, and data collection to accomplish their test objectives. When existing ranges/launch locations and fixed facilities do not have sufficient capability to support SDIO test and experiment requirements, mobile assets will be programmed consistent with overall T&E requirements. In FY 1992, this project specifically addresses the range support ship, USNS *Redstone*. In subsequent years, the plan is to consolidate other common user mobile test assets under this project. The USNS *Redstone* and her electronic system, the M247 Flight Test Support System, were specifically designed and developed by the Navy Strategic Systems Program for supporting TRIDENT flight test activity. Prior to FY 1992, it has not been available nor used for support of SDIO missions. During FY 1992 and in subsequent years, it will be used to perform the range support mission for SDIO experiments for the Lightweight Exoatmospheric Projectile (LEAP) project, Brilliant Pebbles (BP) tests, and Theater Missile Defense (TMD) tests where Wake Island serves as the target launch location. Wake Island has not traditionally been used as a range asset and is not equipped for this mission. Relocating the *Redstone* to the Western Pacific will satisfy this requirement in a cost-effective manner.

PROJECT TITLE:
3312 - System Test Environment Support

PROGRAM ELEMENTS:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

The System Test Environment Support project provides a critically needed capability to the SDI community in special studies and analyses, dealing with Strategic Defense System (SDS) architectures, elements, technologies, interfaces, strategies, testing, and simulation/modeling to include time sensitive studies and analyses. Particular programs supported include: Architecture Development--GPALS/NMD Requirements; Element Support--Brilliant Eyes and Brilliant Pebbles; Technology Investigation--Communication/Neural Workshop; Interface Compatibility--United States/United Kingdom, Theater Missile Defense (TMD), and Extended Air Defense Test Bed (EADTB); Strategic Algorithms; Demonstration and Validation Testing--GPALS/NMD Experiment Design. Provides the SDI community with an Institutionalized Model Set. This will be a "tool box" of models that the NTB has performed confidence assessment and/or validation and verification on and that SDIO has accredited. Provides advanced hardware and software environment initiatives to meet near-term requirements in Visualization, Software Environment, Technology Insertion, Networking, Simulation Techniques, and Security.

PROJECT TITLE:
4000 - Operational Support Costs

PROGRAM ELEMENTS:
0603215C - Limited Defense System
0603214C - Space-Based Interceptors
0603217C - Other Follow-On Systems
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

This project provides system engineering and program control support common to all other projects within these PEs. Typical system engineering tasks include review and analysis of technical project design, development and testing, test planning, assessment of technology maturity, and technology integration across SDIO projects and support of design reviews and technology interface meetings. Program control tasks include assessment of schedule, cost, and performance, with attendant documentation of the many related programmatic issues. This project supports funding for civilian personnel and expenses for travel (TDY), training, rents, communications, information management, utilities, printing, reproduction, supplies, and equipment.

PROJECT TITLE:
4302 - Technology Transfer

PROGRAM ELEMENT:
0603218C - Research and Support Activities

PROJECT DESCRIPTION:

The Technology Applications Program was established in 1986 to make SDI technology available to federal agencies, state and local governments, and U.S. business and research interests.The objective of this program is to develop and support the transfer of SDI-derived technology to Department of Defense applications as well as to other federal, state, and local government agencies; federal laboratories; universities; and the domestic private sector.

PROJECT TITLE:
4305 - Miniaturized Accelerators for PET

PROGRAM ELEMENT:
0603217C - Other Follow-On Systems

PROJECT DESCRIPTION:

The Medical Free Electron Laser (MFEL) program seeks to develop and enhance free electron laser technology and to assess how the unique characteristics of FELs may be exploited for applications in medical, biophysical, and materials science research. After FY90, SDIO transferred total responsibility for the MFEL program to DDR&E/Environmental and Life Sciences.

The Positron Emission Tomography (PET) accelerator program, initiated in FY88 by Congressional direction, is a research project that will reduce the size, weight, and cost of current particle accelerators used to develop radio-pharmaceuticals for Positron Emission Tomography medical diagnoses.

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Chapter 4

Relationship of SDI Projects and Activities to Possible Deployment Phases

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Chapter 4
Relationship of SDI Projects and Activities to Possible Deployment Phases

This chapter responds to subparagraph (b)(4) of Section 224 of the National Defense Authorization Act for Fiscal Years 1990 and 1991 (Public Law 101-189), which requests "an explanation of the relationship between each such [deployment] phase and each program and project associated with the proposed architecture for that phase."

The following charts display the relationships between the various SDI Projects, the mission functional areas, the Program Element which funds each Project, and the phase of the deployment that is planned for the project. For a more complete description of each project, refer to Chapter 3.

Correlation of GPALS Functional Areas and SDI Program Support Activities with Projects, Program Elements, and Possible Deployment Phases

GPALS Functional Areas & Program Support Activities	Projects	Program Elements					Deployment Phase	
		TMD	LDS	SBI	Follow-On	Research & Support	GPALS	Potential Follow-On
Sense an Attack	1101 Passive Sensors		•	•			•	
	1102 Radar		•				•	
	1103 Laser Radar		•				•	
	1104 Signal Process		•	•			•	
	1105 Discrimination	•	•				•	
	1106 Sensor Studies	•	•				•	
	1601 IST					•	•	•
	2102 Brilliant Eyes		•				•	
	2103 GSTS		•				•	
	2104 GBR	•	•				•	
	3109 System Security		•				•	
	3110 Surv Engineering		•				•	
	3111 Surveillance Eng	•	•				•	
	3307 AOA/AST		•				•	
Control, Operate, & Integrate	1403 Computer Eng		•				•	
	1405 Comm Eng		•				•	
	1601 IST					•	•	•
	2300 Command Center		•				•	
	2304 S/W Eng		•				•	
Engage & Destroy-Strategic	1208 Discrimination Tech		•				•	
	1209 Endo Tech		•		•		•	•
	2201 SBI		•				•	
	2202 GBI		•				•	
	2203 E^2I	•	•				•	
	2205 Brilliant Pebbles			•			•	

NOTE: The single site, initial limited defense system is captured under the GPALS portion of these charts.

Correlation of GPALS Functional Areas and SDI Program Support Activities with Projects, Program Elements, and Possible Deployment Phases

GPALS Functional Areas & Program Support Activities	Projects	Program Elements					Deployment Phase	
		TMD	LDS	SBI	Follow-On	Research & Support	GPALS	Potential Follow-On
Engage & Destroy - Theater	1206 Theater Intercept	•					•	
	2106 ATS	•		•			•	
	2203 E^2I	•					•	
	2208 ERINT	•					•	
	2209 ACES	•					•	
	2207 PATRIOT	•					•	
	2210 THAAD	•					•	
	2212 CORPS SAM	•					•	
Engage & Destroy - Follow-on	1201 Int Comp Tech		•					•
	1202 Exo LEAP		•		•			•
	1203 HV Technology				•			•
	1204 Int Study & Analy				•			•
	1210 Navy Exo				•			•
	1301 FEL				•			•
	1302 Chem Laser				•			•
	1303 NPB Tech				•			•
	1304 NDEW				•			•
	1305 ATP/FC				•			•
	1601 IST					•		•
	1602 SBIR					•		•
	2204 DEW Concept Def				•			•
Support with Key Technology	1501 Survivability	•	•	•			•	
	1502 Lethality	•		•	•		•	•
	1503 Power Cond				•	•	•	•
	1504 Mats & Structs			•	•		•	•
	1601 IST					•		•

GPALS Functional Areas & Program Support Activities	Projects	Program Elements					Deployment Phase	
		TMD	LDS	SBI	Follow-On	Research & Support	GPALS	Potential Follow-On
Perform System Analysis, Engineering & Testing	1501 Survivability	•	•	•			•	
	1502 Lethality	•		•	•		•	•
	1504 Materials & Structures			•	•		•	•
	1701 Launch Services				•			•
	1702 Spec Test Acts				•			•
	2304 S/W Engineering		•				•	
	3102 Sys Engineering		•				•	
	3104 ILS		•				•	
	3105 Prod & Manufacture		•				•	
	3107 Environmental Siting & Facilities					•	•	
	3108 Ops Environment		•				•	
	3109 Sys Sec Eng		•				•	
	3110 Surv Engineering		•				•	
	3111 Surveillance Eng		•				•	
	3112 Arch & Analysis		•				•	
	3202 Ops Interface					•	•	
	3203 Threat Dev	•				•	•	•
	3204 Countermeasures					•	•	•
	3205 TMD Studies	•					•	
	3206 System Threat					•	•	
	3207 Arch Engineering		•				•	
	3208 TMDI Integration	•					•	
	3209 Special Studies		•				•	
	3210 Counterforce	•					•	
	3211 C^4I	•					•	
	3212 Passive Defense	•					•	
	3213 Active Defense	•					•	
	3282 Ops Planning		•				•	
	3292 Off/Def Analysis		•				•	
	3301 Data Center					•	•	•
	3302 Sys Test Envir					•	•	
	3303 Ind T/E Oversight					•	•	
	3304 Targets	•	•	•		•	•	
	3305 Theater TB	•					•	
	3306 ARC					•	•	
	3307 AOA/AST		•				•	
	3308 Sys Simulator		•				•	
	3309 Sys Test Plan/Exec		•				•	
	3310 Test Facility					•	•	
	3311 Mob Test Assets					•	•	
	3312 NTB Support					•	•	
Manage	4000 Management Support		•		•	•	•	•

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Chapter 5

Other Nation Participation

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Chapter 5
Other Nation Participation

> This chapter responds to subparagraph (b)(5) of Section 224 of the National Defense Authorization Act for Fiscal Years 1990 and 1991 (Public Law 101-189), which requests "(a statement addressing) the status of consultations with other member nations of the North Atlantic Treaty Organization, Japan, and other appropriate allies concerning research being conducted in the Strategic Defense Initiative program."

5.1 GPALS and the Allies

With the refocusing of the SDI Program toward GPALS, the United States has significantly increased the priority assigned to theater missile defenses--improved theater missile defenses would be the first elements of GPALS to be deployed. Moreover, the U.S. Congress has appropriated funds to accelerate Theater Missile Defense (TMD).

With respect to theater defenses specifically, the United States could deploy such transportable defenses to a region during times of heightened tensions, or they could be permanently deployed by a government on its own territory. It is likely that U.S. forces forward deployed in peacetime will have active theater missile defenses as part of their equipment.

The United States believes a number of friends and allies will be interested in the TMD aspects of GPALS, particularly because third world ballistic missile proliferation is a growing concern to many of them. If friends and allies decide to deploy their own theater missile defenses, i.e., in parallel with those deployed by the United States, we would envision them as being autonomous systems potentially capable of being interoperable with elements of United States defenses, such as receiving space-based sensor data to increase their efficiency.

The deployment of a system to defend against limited ballistic missile strikes would contribute to the security of U.S. friends and allies. To that end, there are several general areas for cooperation with allies and friends:

- Participation in the Strategic Defense Initiative Organization's (SDIO's) basic research and development programs that have application to GPALS. This could mean participation in technology research and development or in GPALS-related experiments.

- Government-to-government cooperation specifically in TMD-related aspects of GPALS, which may be of particular interest to allies.

- Independent acquisition of a theater missile defense system, either purchased from another country such as the United States, or indigenously developed, which could be interoperable with elements of a U.S. system.

Such cooperation would not be a new activity. Allied participation in SDI research predates the refocus of the program toward GPALS. In fact, the United States has already developed a considerable level of allied participation in SDI-related research since early in the program.

5.2 Consultations with Allies on the SDI

The United States has long consulted with allies and friends regarding SDI research, development, testing, and deployment plans. In particular, the United States has sought to work within the NATO alliance to continue a mutual security framework, including cooperation regarding ballistic missile defenses, for confronting the instabilities of the post-Cold War multipolar world. In response to U.S. initiatives, the November 1991 Rome Summit document acknowledged the risks of the proliferation of ballistic missiles and weapons of mass destruction and noted that the "solution of this problem will require complementary approaches including, for example, export control and missile defenses."

Several in-depth presentations on the GPALS concept were provided to allied and friendly governments during 1991. These presentations provided detailed information on the conceptual framework for achieving global protection against limited ballistic missile strikes, and offered foreign participation in GPALS, with particular initial emphasis on the theater missile defense segment of GPALS.

U.S. officials briefed the GPALS concept in the Pentagon to representatives from fifteen nations on March 28, 1991. Following that introductory GPALS briefing, DoD officials visited the major capitals in Europe in April 1991, and the Far East in June 1991. In each capital, discussions were held with senior foreign officials on the GPALS concept, and their views were solicited on prospective participation in the development and acquisition of GPALS. During 1991, several nations, as well as NATO, identified concerns for anti-tactical ballistic missile (ATBM) defense and expressed a receptiveness to continuing the dialogue with the United States on the GPALS concept and its development to assess how they might actively participate.

In addition, U.S. officials consulted with allied leaders, both bilaterally and in NATO fora, on the results of high-level negotiations and meetings (outlined in Chapter 1) with the former Soviet Union on U.S. objectives for ballistic missile defense. Furthermore, senior government and industry personnel from several allied countries have visited the United States for detailed technical discussions and updates on the SDI program.

SDIO sponsors annual advanced planning briefings to acquaint government and industry representatives from selected allied nations, as well as U.S. industry, with SDI projects, initiatives, and future acquisition plans. The SDIO also co-sponsors an annual classified multinational conference on theater ballistic missile defense technologies and prospective employment architectures. The last such conference was held in Tel Aviv, Israel, in March 1992.

5.3 Allied Participation in SDI Research

Allied participation in SDI is of significant benefit to the United States as well as to the participating nations. The United States has signed Memoranda of Understanding (MOUs) on participation in SDI research with the governments of the United Kingdom (December 1985), Germany (March 1986), Israel (May 1986), Italy (September 1986), and Japan (July 1987). The MOUs are not related to specific projects -- they are designed to facilitate allied participation in SDI research and development as permitted under U.S. laws, regulations, and international obligations, including the anti-ballistic missile (ABM) Treaty. Companies in countries that have not signed an MOU have also successfully competed for contracts, and countries that have not signed an overarching SDI MOU have signed government-to-government agreements for cooperative research on specific SDI-related projects.

All SDI contracts are awarded strictly on the basis of technical merit and cost in accordance with the procurement practices mandated by Congress. Several such provisions apply to the awarding of SDI contracts to foreign firms. The Bayh Amendment to the FY 1973 Department of Defense Appropriations Act provides that no Department of Defense research and development (R&D) contracts may be awarded to foreign firms if a U.S. entity is equally competent to carry out the work and is willing to do so at lower cost. The Defense Appropriations Acts for Fiscal Years 1986 and 1987 prohibited setting aside funds for SDI research contracts awarded to foreign firms, and stated that U.S. firms should receive SDI contracts unless awards would be likely to degrade research results.

In 1987, Congress enacted additional legislation (Section 222, National Defense Authorization Act for Fiscal Years 1988 and 1989) regarding allied participation in the SDI Program. This legislation prohibits the award of new SDI contracts to allied entities unless certain conditions are satisfied. Such provisions shall not apply to the award of subcontracts. In FY 1991 three contracts were awarded to foreign entities under Public Law 100-180, Section 222, Subsection (b). Of these contracts, SDIO awarded one to the United Kingdom Ministry of Defence for the extension of research on the Advanced Sensor Hardening Concepts for Space Platforms. Additionally, SDIO awarded a contract to SOFRADIR of Chatenay Malabry, France, for the fabrication, testing, and delivery of two photovoltaic long wavelength infrared mercury cadmium telluride array detectors possessing high sensitivity, superior responsiveness, pixel uniformity, and low noise characteristics at nominal operating temperatures. The third contract awarded by the Department of the Air Force to Culham Laboratory of the United Kingdom Atomic Energy Authority to study the physics and optimization principles of high brightness negative ion volume sources required in SDI Neutral Particle Beam applications.

5.4 Cooperative SDI Programs with Friends and Allies

Long-standing laws and policies governing rights to research results developed under U.S. contracts ensure that the U.S. technology base receives the benefits of all SDI research, whether performed by a domestic or foreign contractor. In accordance with these laws and policies, the U.S. Government will receive rights to use the technology developed under SDI contracts. Contractor rights to use the results of their SDI research depend on security considerations and specific conditions of each contract. These ground rules for cooperation are fully reflected in each of the MOUs and Memoranda of Agreement (MOAs) the United States has signed on participation in SDI research. In order to fully exploit the technology development SDIO has funded abroad, entries are being added to SDIO's Technology Applications Information System (TAIS) database synopsizing the technology for potential spin-off applications to qualified United States industry and government agency users. The status of significant ongoing projects is also provided.

The following section addresses cooperative projects between the U.S. and our friends and allies throughout the history of the SDI Program.

- **France:** $17.37 million. Sensors, theater defense architecture, free-electron laser technology, klystrons, and propulsion components and casings.

  Status: In January 1990, SDIO signed a Memorandum of Agreement (MOA) with the French Ministry of Defense (MOD) regarding free-electron laser (FEL) research. Under this five-year agreement, information will be exchanged and cooperative research projects will be developed to reduce cost and schedule risks for both countries. Materials have been identified for exchange, and a visit to France is planned to share information and identify concepts for collaboration in FEL research.

- **Germany:** $88.55 million. Pointing and tracking, optics, lethality and target hardening, electron laser technology, theater defense architecture, infrared phenomenology, and SPAS assembly.

Status: The Infrared Background Signature Survey (IBSS), conducted aboard the U.S. Space Shuttle Discovery, received a reusable Shuttle Pallet Satellite from Messerschmitt-Boelkow-Blohm (MBB). Other German firms including Linde, Kaiser Threde and AEG Telefunken, along with the University of Berlin, contributed to the development of the sensor suite.

A five-year lethality program headed by Diehl GmbH, along with MBB and the Ernst Mach Institut (EMI), was funded by SDIO through the Defense Nuclear Agency. EMI developed an innovative warhead fragment with unusual penetrating capabilities, while MBB developed a technique for accelerating large masses at extremely high velocities. Results from this work have already been transferred to the U.S. Theater Missile Defense lethality program data base, the orbital debris breakup study, and the high explosive initiation and weapon safety programs.

* **Israel:** $412.08 million. Electrical and chemical propulsion, magnetohydrodynamics, short-wave chemical lasers, theater defense architecture, Arrow and ACES experiments, and the Israeli Test Bed.

Status: In June 1988, SDIO and the Israeli Ministry of Defense concluded an MOA for a cooperative SDI research project on the Arrow anti-tactical ballistic missile (ATBM) experiment. The experiment, to be conducted at an Israeli test range, is designed to demonstrate the capability to intercept a surrogate tactical ballistic missile. Three flight tests were held in 1990 and 1991; the next Arrow test launch date will be scheduled upon completion of analyses of previous flight test data.

In March 1989, SDIO and the IMOD concluded an MOA to develop an Israeli Theater Ballistic Missile Test Bed (ITB) on a cooperative, cost-share basis. The ITB was opened in March, 1992. It is a computer simulation facility capable of conducting simulations against postulated theater missile threats.

In May 1989, SDIO and an Israeli government research facility signed a cost-sharing agreement to develop a low-cost hypervelocity gun (HVG). The HVG is expected to be capable of accelerating projectiles to velocities in excess of 3.0 kilometers per second; perform barrel and armature material research; and resolve other technical issues associated with hypervelocity gun technology. Based on the results of a series of experiments, additional experiments are scheduled to produce muzzle velocities significantly greater than could be obtained using comparable conventional propellants.

In June 1991, SDIO and the Israeli MOD concluded a Memorandum of Agreement that implemented the Arrow Continuation Experiments (ACES), a cooperative, cost-share program designed as a follow-on demonstration phase of the Arrow interceptor experiment. ACES will provide for the development of a tactical ballistic missile interceptor that will be smaller, lighter, and have a greater engagement envelope than the original Arrow design. This interceptor will support Israel's requirement for tactical ballistic missile defense and it will benefit U.S. technology base requirements for advanced ATBM technologies.

* **Japan:** $6.00 million. Superconducting magnetic energy storage, superconducting materials, diamond coatings, signal processing, electric propulsion, and Western Pacific theater defense architecture.

Status: SDIO signed a contract with a Japanese firm in November 1988 to analyze and assess the unique requirements associated with the defense of U.S. and allied assets in the Western Pacific region against attack by medium- and short-range ballistic missiles. The second phase of this effort was completed in March 1991 and **an active** TMD architecture has been developed. Phase three will further define and evaluate architectures in light of contingency operations; further develop battle management, command, control, and communications (BM/C3); and address transportability and mobility architectural issues. Phase four, scheduled to begin in April 1992, will address architectural issues through interactive modeling and simulation.

* **Netherlands:** $14.34 million. Theater defense architecture and electromagnetic launcher technology.

  Status: The five-year cooperative research agreement on electromagnetic launcher technology was signed in July 1987 with the Netherlands Organization for Applied Scientific Research. An electromagnetic launcher, provided by SDIO, has been repeatedly tested at the Prins Maurits Laboratory. Scientists have redesigned the launcher to improve its performance; designed new types of solid armatures to improve launch efficiencies; and identified promising new concepts for pulse power investigations. Dutch research to date has increased gun efficiencies and operating capabilities of mechanical opening switches. Future plans include cooperative solid state switch research and continued technical exchanges to further U.S. and Dutch electromagnetic launcher research.

* **United Kingdom:** $129.09 million. Optical and electron computing, thyratrons, ion sources and power conditioning for particle beams, electromagnetic rail gun technology, optical logic arrays, countermeasures and penetration aids, UK Test Bed, and theater defense architecture analyses.

  Status: The United Kingdom (UK) MOD and SDIO signed a cooperative agreement in January 1989 to develop a prototype artificial intelligence framework. The framework is based on the principle of comparing *a priori* information about offensive missile objects to real time sensor data. The prototype is based on a blackboard architecture where signal processing, clustering, and raid assessment rules are partitioned. The framework control module manages tasking and data sharing to maximize the timeliness and accuracy of the discrimination process. Two of the three programs are near completion.

  In April 1989, SDIO and the UK MOD signed a cooperative agreement to develop a Knowledge-Based System (KBS) Data Fusion Demonstrator. The effort will develop battle management algorithms based on KBSs for fusing information gathered by disparate types of sensors. Efforts will be undertaken to run the UK KBS benchmarks on U.S. computers in mid-1991.

  In September 1988, under a cost-sharing arrangement with the UK MOD, SDIO undertook a joint cooperative project known as the Extended Air Defense Test Bed (EADTB). The EADTB will support extended air defense planning, concept analysis, doctrine development, and battle plan development. The simulation framework for the EADTB has been developed and is undergoing testing. Requirements for a terminal tier experiment were defined as of March 1991.

  Work is continuing with the UK to develop neutral particle beam (NPB) technology under SDIO's directed energy research program. Culham Laboratory in the UK is developing high brightness, continuous wave, ion-source technology, as well as the ion source, instrumentation and control, and beam stop for the Continuous Wave Deuterium Demonstrator (CWDD). Power technology for the CWDD is being developed by a British firm. Two British firms and Culham laboratory have also assisted in designing the NPB Power System Demonstrator. Additionally, Culham Laboratory and one British firm initiated the design of a space-engineered NPB ion ejector source for the Neutral Particle Beam Space Experiment (NPBSE). Because of the advanced quality of their efforts on the first ever space-engineered ion ejector continuous wave source, both Culham Laboratory and the British firm have been selected by the U.S. prime contractor to provide the ion source for the NPBSE.

Additional U.S.-foreign SDIO research efforts include:

* **Belgium:** $0.52 million. Theater defense architecture, laser algorithms, and mosaic array data compression and processing module.

* **Canada:** $8.00 million. Power system materials, particle accelerators, platforms, theater defense architecture, and sounding rockets.

* **Denmark:** $0.03 million. Metrology of magnetic optics.

* **Italy:** $15.79 million. Cryogenic induction, superconducting magnetic energy storage, millimeter-wave radar seeker, theater defense architecture, and smart electro-optical sensor.

The above descriptions indicate that SDIO is conducting an active program of cooperation with our friends and allies. The annual SDI funding dedicated to cooperative research activities with friends and allies, normally constitutes 2-3% of SDIO's fiscal appropriations. The SDIO is engaged in a number of exploratory discussions with friends and allies to determine other areas of mutual research interest in GPALS to be pursued via similar types of arrangements.

5.5 Summary of Allied Participation and Cooperation

Allied scientific excellence and technical capabilities have been and continue to be demonstrated through contractual efforts and cooperative research projects. They have made many technical contributions to both strategic ballistic missile and theater missile defenses. Currently, trends in allied involvement in the SDI Program are theater-missile-defense-related activities, test bed and technology experiments, and other cooperative activities of mutual interest. Continued allied participation and cooperation in the SDI Program promote greater scientific understanding and technological mastery of the ballistic missile defense problem. Through these multinational efforts, SDIO's theater and strategic missile defense technologies continue to advance.

Chapter 6

ABM Treaty Compliance

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Chapter 6
ABM Treaty Compliance

6.1 Introduction

The 1972 Anti-Ballistic Missile (ABM) Treaty addresses the development, testing, and deployment of ABM systems and components. It should be noted that nowhere does the ABM Treaty use the word "research." Neither the United States nor the Soviet delegation to the Strategic Arms Limitation Talks (SALT I) negotiations chose to place limitations on research, and the ABM Treaty makes no attempt to do so. The United States made it clear during the ABM Treaty negotiations that development commences with the initiation of field testing of a prototype ABM system or component. The United States had traditionally distinguished "research" from "development" as outlined by then-U.S. delegate Dr. Harold Brown in a 1971 statement to the Soviet SALT I delegation. Research includes, but is not limited to, conceptual design and laboratory testing. Development follows research and precedes full-scale testing of systems and components designed for actual deployment. Development of a weapon system is usually associated with the construction and field testing of one or more prototypes of the system or its major components. However, the construction of a prototype cannot necessarily be verified by national technical means of verification. Therefore, in large part because of these verification difficulties, the ABM Treaty prohibition on the development of sea-, air-, space-, or mobile land-based ABM systems, or components for such systems, applies when a prototype of such a system or its components enters the field-testing stage.

The ABM Treaty regulates the development, testing, and deployment of ABM systems whose components were defined in the 1972 Treaty as consisting of ABM interceptor missiles, ABM launchers, and ABM radars. ABM systems based on other physical principles and including components capable of substituting for ABM interceptor missiles, ABM launchers, or ABM radars are addressed only in Agreed Statement D. In order to fulfill the basic Treaty obligation not to deploy ABM systems or components except as provided in Article III, this agreed statement provides that in the event that ABM systems based on other physical principles and including components capable of substituting for ABM interceptor missiles, ABM launchers, or ABM radars are created in the future, specific limitations on such systems and their components would be subject to discussion in accordance with Article XIII and agreement in accordance with Article XIV of the Treaty. The Agreed Statement does not proscribe the development and testing of such systems, regardless of basing mode. The SDI Program will continue to be conducted in a manner that fully complies with all U.S. obligations under the ABM Treaty.

Research and certain development and testing of defensive systems are not only permitted by the ABM Treaty but were anticipated at the time the Treaty was negotiated and signed. Both the United States and the Union of Soviet Socialist Republics supported this position in testimony to their respective legislative bodies. When the Treaty was before the Senate for advice and consent to ratification, then-Secretary of Defense Melvin Laird advocated, in his testimony, that the United States "vigorously pursue a comprehensive ABM technology program." In a statement before the Presidium of the Supreme Soviet, Marshall Grechko said the ABM Treaty "places no limitations whatsoever on the conducting of research and experimental work directed toward solving the problem of defending the country from nuclear missile strikes."

6.2 Existing Compliance Process for SDI

The Department of Defense (DoD) has in place an effective compliance process (established with the SALT I agreements in 1972) under which key offices in DoD are responsible for overseeing SDI compliance with all United States arms control commitments. Under this process, the SDI organization (SDIO) and DoD components ensure that the implementing program offices adhere to DoD compliance directives and seek guidance from offices charged with oversight responsibility.

Specific responsibilities are assigned by DoD Directive 5100.70, 9 January 1973, "Implementation of SAL (Strategic Arms Limitation) Agreements." The Under Secretary of Defense (Acquisition), USD(A), ensures that all DoD programs are in compliance with United States strategic arms control obligations. The Service secretaries, the Chairman of the Joint Chiefs of Staff, and agency directors ensure the internal compliance of their respective organizations. The DoD General Counsel provides advice and assistance with respect to the implementation of the compliance process and interpretation of arms control agreements.

DoD Instruction S-5100.72 establishes general instructions, guidelines, and procedures for ensuring the continued compliance of all DoD programs with existing arms control agreements. Under these procedures, questions of interpretation of specific agreements are to be referred to the USD(A) for resolution on a case-by-case basis. No project or program which reasonably raises a compliance issue can enter into the testing, prototype construction, or deployment phase without prior clearance from the USD(A). If such a compliance issue is in doubt, USD(A) approval shall be sought. In consultation with the office of the DoD General Counsel, Office of the Assistant Secretary of Defense for International Security Policy, and the Joint Staff, USD(A) applies the provisions of the agreements, as appropriate. DoD components, including SDIO, certify internal compliance periodically and establish internal procedures and offices to monitor and ensure internal compliance.

In 1985, the United States began discussions with allied governments regarding technical cooperation on SDI research. To date, the United States has concluded bilateral SDI research Memoranda of Understanding (MOUs) with the United Kingdom, Germany, Israel, Italy, and Japan. All such agreements will be implemented consistent with United States international obligations, including the ABM Treaty. The United States has established guidelines to ensure that all exchanges of data and research activities are conducted in full compliance with the ABM Treaty obligations not to transfer to other states ABM systems or components limited by the Treaty, nor to provide technical descriptions or blueprints specially worked out for the construction of such systems or components.

6.3 SDI Experiments

All SDI field tests must be approved for ABM Treaty compliance through the DoD compliance review process. The following major programs and experiments, all of which involve field testing, have been approved and are to be conducted during the remainder of FY 1992 and FY 1993: Laser Atmospheric Compensation Experiment (LACE), Relay Mirror Experiment (RME), and the Wideband Angular Vibration Experiment (WAVE); the Kinetic Energy Kill Vehicle Integrated Technology Experiment (KITE), flights in the High Endoatmospheric Defense Interceptor (HEDI) project; flights throughout FY 1992-1994 in the Airborne Surveillance Test Bed (AST) program, a revision of the Airborne Optical Adjunct project (including AST viewing Patriot intercepts); the Ground-Based Interceptor (GBI) (formerly the Exoatmospheric Reentry Vehicle Interceptor Subsystem (ERIS)) flight experiments; the Lightweight Exoatmospheric Projectile (LEAP) flight experiments I - III (the LEAP IV experiment is pending approval); Brilliant Pebbles Flight Experiments 1 - 5; Brilliant Pebbles Flight Experiment 1T (1M pending approval); Patriot Pre-Planned Product Improvements; Extended Range Interceptor (ERINT) program flight experiments; and the Israeli Arrow interceptor development known as the Arrow Continuation Experiments (ACES).

The following major projects and experiments have been approved for later years, subject, in some cases, to review of more completely defined experiments: Single-Stage-To-Orbit experiment; the Midcourse Space Experiment (MSX); the Ground-Based Radar Experiments

(TMD-GBR dem/val); Zodiac Beauchamp Sensor Integration Experiment (Project Clementine, pending approval); Neutral Particle Beam Space Experiment (NPBSE); and the Star LITE Space-Based Laser Experiment (formerly Zenith Star).

In addition, the following data collection activities continue to be approved: the Optical Airborne Measurement Program (OAMP) and High Altitude Observation aircraft (HALO and Argus); Red Gemini VI-IX; the Firebird experiments; Brilliant Eyes ground testing, including testing of a proof-of-principle device in conjunction with, and attached to ground-based telescopes Aerothermal Reentry Experiments (ARE-2H and ARE-3); Ultraviolet Plume Instrument (UVPI) and Army Background Experiment; Red Tigress; Bowshock III; the Polar Ozone Aerosol Measurement (POAM) experiment; Countermeasures Demonstration Experiment; and SPAS III (Shuttle Pallet Satellite). The following projects have been approved, but are not funded for FY 1992: Sounding Rocket Measurement Program (SRMP); Transportable LADAR System; Vehicle Interactions Program/Vehicle Interactions Characterization Experiment (VIP/VICE) flights; and Radiant Shield. The System Integration Tests (SITs) planned for FY 1992-1993 utilize data collected by a variety of sensor systems for simulation and integration planning purposes; follow-on SITs beginning in 1995 will be examined for Treaty compliance as their experiments are better defined.

The following projects have approved activities that are not considered to be in field testing; Average Power Laser Experiment (APLE); Alpha/LAMP Integration; Hypervelocity Gun (HVG); and the Space-Based Interceptor (SBI). Also, the National Test Bed has been determined to be compliant with the ABM Treaty.

The following target development projects have been approved: STARBIRD; Strategic Target System (STARS); Operational and Development Experiments Simulator (ODES); Project Redwood; ERINT Target System development project and the Target Development Tests. The Brilliant Pebbles Target Launch Vehicle Demonstration is pending approval. All SDI launches are reviewed for compliance with the research and development launch provisions of the 1987 Intermediate-Range Nuclear Forces Treaty. Such launches will be notified to the Nuclear Risk Reduction Center of the former Soviet Union as required.

The following programs, some of which have not been sufficiently defined for compliance review, are not yet approved: Brilliant Pebbles flight tests 2M, 3M, 4M, 2T, and 3T; LEAP flight tests 5, 6, 7, X, FTV-2, FTV-3, FTV-4, and FTV-5; Advanced Contingency Sensor (ACTS); Theater High Altitude Area Defense (THAAD); the Ground-based family of radars (TMD-GBR and GBR-T); Corps SAM; Aegis SPY-1 radar and Standard II (Block 4) upgrades; HAWK and AN/TPS-59 radar upgrades; Brilliant Eyes flight tests; Miniature Seeker Technology Integration (MSTI) experiments (MSTI-Scout 1 is pending approval.); RAPTOR/TALON; High Altitude Balloon Experiments (HABE); and Brilliant Pebbles Tether Tests.

We are planning to develop and deploy theater/tactical missile defense systems to counter the projected threat to our forces abroad and to our allies. Although the objective of the ABM Treaty is to limit defenses against strategic ballistic missiles there may be conflicts between the Treaty and the development and deployment of some of the theater/tactical missile defense systems under consideration. We are currently studying this issue.

Currently, no experiment has been approved that would not fall within the categories used in Appendix D to the 1987 Report to Congress on the Strategic Defense Initiative. Changes to previously approved experiments require compliance review.

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Chapter 7

Countermeasures

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Chapter 7
Countermeasures

This chapter responds to part (b)(7) of Section 224 of the November 7, 1989 Conference Report authorizing appropriations for FY 1990. This part requests "a review of possible countermeasures of the Soviet Union to specific SDI programs, an estimate of the time and cost required for the Soviet Union to develop each such countermeasure, and an evaluation of the adequacy of the SDI programs described in the report to respond to such countermeasures."

7.1 Introduction

1991 has been a year of transition for the SDI Countermeasures effort. In recognition of the changing international security environment, the Countermeasures program has intensified its focus on the Third World while continuing to investigate potential Commonwealth of Independent States (CIS) responses to the U.S. ballistic missile defense (BMD) architecture. As part of this effort, the Countermeasures program has placed a greater emphasis on the evaluation and verification of simpler counters which are more likely to be employed by a resource-constrained CIS and technologically unsophisticated Third World nations.

7.2 The CIS

Potential CIS countermeasures examined in previous years include modifications to the offensive threat, such as decoys and replicas, that attempt to confuse and overwhelm the defense. Defense suppression/anti-satellite (ASAT) techniques, such as orbital and direct-ascent interceptors which attempt to destroy defense elements, were also considered. Advanced technologies, such as those employed in ground- and space-based directed energy and kinetic energy weapons, are also potentially available to the CIS as far-term countermeasures. Existing CIS ASAT capabilities, such as the co-orbital system, the Galosh, and a direct ascent ASAT weapon, have been judged to be basically ineffective in present numbers and design.

A study of potential CIS countermeasures concluded that the Russians may pursue an R&D hedge that emphasizes lightweight penetration aids that do not significantly erode missile payloads. Furthermore, CIS preoccupation with domestic crises and an economy undergoing reform clearly works against decisions to vigorously pursue costly sophisticated military countermeasures to the U.S. BMD system.

7.3 The Third World

A recently completed study of Third World reactions to the U.S. BMD system by the program's Strategic Red Team (SRT) concluded that such countries can be expected to react in a variety of ways depending on whether they see themselves as threatened by or protected by U.S. defenses. Major findings of the study include:

- A recognition that the traditional model of deterrence may no longer apply or may prove unreliable with regard to the behavior of ballistic missile-equipped Third World nations.

- Proliferation of ballistic missiles is becoming increasingly diffuse, with a variety of supplier networks for acquiring missile components and systems.

- Sophisticated counters to the U.S. BMD system are not likely to be employed before well into the first decade of the next century, if then.

- The most likely supplier of advanced ballistic missiles, and perhaps defense countermeasures, to the Third World will likely be the People's Republic of China.

Another 1991 study analyzed the motivation driving Third World nations' desire to acquire ballistic missiles. The study concluded that missiles are becoming the long-range weapon of choice in regional conflicts; and that missiles are acquired for technological prestige, autonomy of action, and warfighting capability. However, ballistic missile use is hampered by effective long-range guidance and reconnaissance capability, which in turn limits missile targets to large static areas such as cities, industrial facilities, and military bases.

7.4 Countermeasures Costs

The potential costs to the CIS and the Third World of developing countermeasures and other responses to the U.S. BMD system are the subject of ongoing analyses. Economic conditions and pricing mechanisms in the CIS continue to be extremely volatile. As such, the reliability of costing data as well as the affordability of any large-scale response is highly questionable and subject to change. Cost and affordability analyses for third world nations will be addressed as potential countermeasures developed by those nations are identified.

7.5 Countermeasures Evaluation And Verification

The Countermeasures program's evaluation and verification effort begins with the identification of potential countermeasures by Red/Blue exercises. In Red/Blue efforts, the Red Team adopts an adversary mindset and develops countermeasure concepts; the Blue Team develops concepts to negate the potential countermeasure. Potential countermeasures are then subjected to laboratory and flight tests to determine technological feasibility and availability and the timing of appearance. Analyses are also conducted to evaluate the role that political factors play in development and deployment of countermeasures. Countermeasure concepts under investigation include RV replica and decoy discrimination, RV signature masking, and other techniques to confuse the defense.

After consultation with Congress, an agreement was reached on the establishment of a Defense Science Board (DSB) Task Force to review the SDI Countermeasures Program. As noted in the Report of the Committee on Appropriations (Report 102-95), the "DOD Independent Review of SDIO Countermeasures- Action Plan" was developed to address Committee concerns. The Action Plan directs the DSB Task Force to examine past and ongoing studies in the Countermeasures program, assess the conduct, results and adequacy of the program, and develop findings and recommendations regarding its future efforts. The Task Force will provide its report in the summer of 1992.

7.6 Summary And Conclusion

During 1991, the SDI Countermeasures program continued to reorganize and refocus its efforts in response to the evolving international security environment. With the collapse of the Soviet Union and the increasing proliferation of ballistic missiles and associated technology, countermeasures employed by adversaries are likely to become more varied and innovative. In response to this challenge, the Countermeasures program will continue to coordinate with element and system designers to ensure that U.S. deployed defenses can respond effectively to all potential countermeasures to SDI.

Chapter 8

Funding

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Chapter 8
Funding

This chapter responds to subparagraph (b)(8) of Section 224 of the National Defense Authorization Act for Fiscal Years 1990 and 1991 (Public Law 101-189), which requests "details regarding funding of programs and projects for the Strategic Defense Initiative (including the amounts authorized, appropriated, and made available for obligation after undistributed reductions or other offsetting reductions were carried out), as follows:

(A)"The level of requested and appropriated funding provided for the current fiscal year for each program and project in the Strategic Defense Initiative budgetary presentation materials provided to Congress.

(B) "The aggregate amount of funding provided for previous fiscal years (including the current fiscal year) for each such program and project.

(C) "The amount requested to be appropriated for each such program and project for the next fiscal year.

(D) "The amount programmed to be requested for each such program and project for the following fiscal year.

(E) "The amount required to reach the next significant milestone for each demonstration program and each major technology program."

Table 8-1
Project Funding Profile
(In Millions of Then-Year Dollars)

Project Number and Title	Funds Expended Through FY 1991	FY 1992 Appropriation	FY 1993 Request
1101 Passive Sensors	416	34	56
1102 Microwave Radar	103	12	18
1103 Laser Radar Technology	431	13	13
1104 Signal Processing	503	30	45
1105 Discrimination	1007	89	126
1106 Sensor Studies & Experiments	792	184	208
1109 Theater Defense Discrimination	0	10	11
1110 Sensors/Integration	0	21	54
1201 Interceptor Component Technology	494	31	63
1202 Interceptor Integration Technology	466	126	79
1203 Hypervelocity Technology	149	6	11
1204 Interceptor Studies & Analysis	651	15	18
1205 Foreign Technology Support	40	0	0
1206 Advanced TMD Weapons	285	18	14
1208 Discriminating Interceptor	0	7	50
1209 Endoatmospheric Interceptor Technology	0	57	63
1210 Navy LEAP Technology Demonstration	0	8	35
1211 Interceptor Facilities	0	17	0
1212 D-2 Program	0	6	19
1301 Free Electron Laser	1020	23	24
1302 Chemical Laser Technology	770	104	175
1303 Neutral Particle Beam Technology	650	80	76
1304 Nuclear Directed Energy Technology	127	5	0
1305 Acquisition, Tracking, Pointing & Fire Control Technology	1392	67	47
1307 Directed Energy Demonstration	0	0	24
1403 Computer Engineering	1	1	1
1405 Communications Engineering	12	11	24
1501 Survivability Technology	486	68	135
1502 Lethality and Target Hardening	431	51	50
1503 Power & Power Conditioning	462	6	47
1504 Materials & Structures	134	24	58
1505 Launch Planning, Development and Demonstration	284	0	0
1601 Innovative Science & Technology	583	70	83
1602 New Concepts Development	146	40	41
1701 Launch Services	25	71	68
1702 Special Test Activities	23	17	36
2102 Brilliant Eyes	362	116	278
2103 Ground-Based Surveillance & Tracking System	112	118	112
2104 Ground-Based Radar	284	82	212
2106 Advanced Contingency Theater Sensor	0	28	90

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Table 8-1 (continued)
Project Funding Profile
(In Millions of Then-Year Dollars)

Project Number and Title	Funds Expended Through FY 1991	FY 1992 Appropriation	FY 1993 Request
2201 Space-Based Interceptor	599	9	0
2202 Ground-Based Exoatmospheric Interceptor Development	669	173	160
2203 HEDI (E^2I)	558	66	0
2204 DEW Concept Definition	137	2	5
2205 Brilliant Pebbles	525	390	450
2207 PATRIOT Multi-mode Missile	45	160	171
2208 Extended Range Interceptor (ERINT)	103	160	129
2209 Arrow Continuation Experiments (ACES)	42	60	58
2210 THAAD	20	100	243
2212 CORPS SAM	0	25	25
2213 Sea-Based TMD Interceptor	0	30	26
2300 Command Center	655	74	1204
2304 System Software Engineering	5	8	8
3102 System Engineering	191	74	199
3103 SDIO Metrology	0	1	0
3104 Integrated Logistics Support	44	4	7
3105 Producibility & Manufacturing	29	9	20
3107 Environment, Siting & Facilities	51	11	16
3108 Operational Environments	2	1	1
3109 System Security Engineering	7	11	12
3110 Survivability Engineering	2	2	8
3111 Surveillance Engineering	7	10	11
3112 System Engineering Support	0	27	29
3113 Ground Communications	0	15	13
3114 Launch Communications	0	3	0
3201 Architecture and Analysis	191	3	5
3202 Operations Interface	29	7	6
3203 Intelligence Threat Development	65	10	10
3204 Countermeasures Integration	109	17	22
3205 Theater Missile Defense Special Studies	138	68	32
3206 System Threat	7	8	7
3207 System Architecture	14	24	0
3208 Integration and Balancing	28	7	11
3209 Special Studies	0	16	0
3210 Tactical Missile Defense Attack	0	4	3
3211 C^4I and Operational Analysis	0	16	19
3212 Passive Defense	0	1	3
3213 Active Defense Engineering	0	6	3
3282 Operational Planning	1	1	1
3292 Offense-Defense Analysis	1	1	1

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Table 8-1 (continued)
Project Funding Profile
(In Millions of Then-Year Dollars)

Project Number and Title	Funds Expended Through FY 1991	FY 1992 Appropriation	FY 1993 Request
3301 SDIO Test Data Centers	0	11	22
3302 System Test Environment	550	83	116
3303 Independent Test & Evaluation	15	6	6
3304 Targets	276	147	217
3305 Theater Test Bed	101	55	37
3306 Computer Resources and Engineering	39	29	29
3307 Airborne Surveillance Test Bed	625	38	45
3308 System Simulating (Level 1 and Level 2)	5	9	7
3309 System Test Planning and Execution	0	24	133
3310 Test and Evaluation Facilities and Launch Support	0	49	57
3311 Mobile Test Assets	0	12	14
3312 System Test Environment Support	0	15	15
4000 Operational Support Costs	1190	407	351
4302 Technology Transfer	8	2	3
4305 Miniaturized Accelerators for PET	59	1	1

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Table 8-2
Estimated Funding Required to Meet Next Milestone
(In Millions of Then-Year Dollars)

Program/Project	Required After FY 1993	Description of Next Milestone	Date
2104 Theater Missile Defense-Ground Based Radar	434	Milestone II	1996
2207 PATRIOT	722	Milestone III for Multi-mode Missile	1995
2210 THAAD	1188	Milestone II	1996
2212 CORPS SAM	547	Milestone II	1997
2102 Brilliant Eyes	1043	Milestone II	1998
2104 National Missile Defense-Ground Based Radar	1545	Milestone II	1998
2202 Ground Based Interceptor	915	Milestone II	1998
2205 Brilliant Pebbles	1715	Milestone II	1997
2300 Command Center	707	Milestone II	1997
1301 Free Electron Laser	288	Megawatt Class FEL Demonstration	1998
1302 Chemical Laser	1064	Capstone Technology Integration Experiment	1997
1303 Neutral Particle Beam	360	Far Field Optics Experiment	1997
1305 Acquisition, Tracking, Pointing/Fire Control	190	Integrated ATP Demonstration	1997

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Chapter 9

Relation of SDI Technologies to Military Missions

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Chapter 9
Relation of SDI Programs to Military Missions

This chapter responds to subparagraphs (b) (9) and (b) (10) of Section 224 of the National Defense Authorization Act for Fiscal Years 1990 and 1991 (Public Law 101-189), which requests "details on what Strategic Defense Initiative technologies can be developed or deployed within the next 5 to 10 years to defend against significant military threats and help accomplish critical military missions. The missions to be considered include the following:

(A) "Defending elements of the Armed Forces abroad and United States allies against tactical ballistic missiles, particularly new and highly accurate shorter-range ballistic missiles of the Soviet Union armed with conventional, chemical, or nuclear warheads.

(B) "Defending against an accidental launch of strategic ballistic missiles against the United States.

(C) "Defending against a limited but militarily effective attack by the Soviet Union aimed at disrupting the National Command Authority or other valuable military assets.

(D) "Providing sufficient warning and tracking information to defend or effectively evade possible attacks by the Soviet Union against military satellites, including those in high orbits.

(E) "Providing early warning and attack assessment information and the necessary survivable command, control, and communications to facilitate the use of United States military forces in defense against possible conventional or strategic attacks by the Soviet Union.

(F) "Providing protection of the United States population from a nuclear attack by the Soviet Union.

(G) "Any other significant near-term military mission that the application of SDI technologies might help to accomplish."

Subparagraph (b) (10) requests "for each of the near-term military missions listed in paragraph (9), the report shall include the following:

(A) "A list of specific program elements of the Strategic Defense Initiative that are pertinent to such missions.

(B) "The Secretary's estimate of the initial operating capability dates for the architectures or systems to accomplish such missions.

(C) "The Secretary's estimate of the level of funding necessary for each program to reach those initial operating capability dates.

(D) "The Secretary's estimate of the survivability and cost-effectiveness at the margin of such architectures or systems against current and projected threats from the Soviet Union."

9.1 Introduction

This chapter discusses the application of SDI technologies to critical and/or significant military missions. The chapter also addresses the issue of cost effectiveness at the margin within the context of the changing international security environment, and the survivability of proposed defensive systems.

9.2 SDI Technologies and Critical Military Missions

For SDI systems associated with missions (A) through (F) in subparagraph (b) (9), information on the schedule and cost to achieve initial operating capability (IOC) will be provided in the 180-day report on the deployment of Theater/Tactical missile defenses and a single-site, initial National Missile Defense system, as requested by Congress. IOC schedule and cost estimates related to the potential application of SDI technology to other significant military missions is not provided because such information would be speculative at this time.

Figure 9-1 lists the critical military missions (A) through (F) specified by Congress in subparagraph (b) (9), and identifies the SDI systems which incorporate the near term technologies which could accomplish these missions. The six missions are addressed wholly, or in part, by the GPALS concept of protection against limited ballistic missile attack. Details on these systems are found in Chapters 2 and 3 of this report.

Mission	Project	Program Element
A. Defending elements of the Armed Forces abroad and United States allies against tactical ballistic missiles (TBMs), particularly new and highly accurate shorter-range ballistic missiles of the Soviet Union armed with conventional, chemical, or nuclear weapons.	•1206/2209 - Arrow/ACES	0603216C
	•2102 - BE	0603215C
	•2104 - TMD-GBR	0603216C
	•2205 - BP	0603214C
	•2207 - PATRIOT	0603216C
	•2208 - ERINT	0603216C
	•2210 - THAAD	0603216C
	•2212 - CORPS SAM	0603216C
	•2300 - C^2E	0603215C
B. Defending against an accidental launch of strategic ballistic missiles against the United States.	•2102 - BE	0603215C
	•2104 - GBR	0603215C
	•2202 - GBI	0603215C
C. Defending against a limited but militarily effective attack by the Soviet Union aimed at disrupting the National Command Authority or other valuable military assets.	•2205 - BP	0603214C
	•2300 - C^2E	0603215C
D. Providing sufficient warning and tracking information to defend or effectively evade possible attacks by the Soviet Union against military satellites, including those in high orbits.	•2102 - BE	0603215C
	•2205 - BP	0603214C
	•2300 - C^2E	0603215C
E. Providing early warning and attack assessment information and the necessary survivable command, control, and communications to facilitate the use of United States military forces in defense against possible conventional or strategic attacks by the Soviet Union.	•2102 - BE	0603215C
	•2104 - GBR	0603215C
	•2205 - BP	0603214C
	•2300 - C^2E	0603215C
F. Providing protection of the United States population from a nuclear attack by the Soviet Union.	•2102 - BE	0603215C
	•2104 - GBR	0603215C
	•2202 - GBI	0603215C
	•2205 - BP	0603214C
	•2300 - C^2E	0603215C

Figure 9-1 SDI Technologies and Critical Military Missions

9.3 SDI Technologies and Significant Military Missions

This section addresses significant military missions that SDI technologies might help to accomplish. Significant military missions include air, maritime, ground, and space defense.

9.3.1 Air Defense

The North American air defense mission encompasses surveillance, warning, interception, and identification or negation of unknown aircraft that penetrate the air defense identification zone. Systems that contribute to the air defense mission in the North American continent include the Joint Surveillance System network of Air Force and Federal Aviation Administration radars, the Distant Early Warning Line/North Warning system radars across Alaska and Canada, Over-the-Horizon Backscatter radar, Airborne Warning and Control System (AWACS) aircraft, and fighter-interceptors on continuous alert. SDI technologies could significantly improve air defense mission efficiency and effectiveness, especially against future threats.

North American air defense assets operate as a system, with one type of surveillance asset compensating for the deficiencies of others. Interceptor aircraft assist fixed surveillance sensors in identifying all tracks of incoming aircraft. In some cases, AWACS aircraft and interceptors perform surveillance when transient gaps occur in radar coverage. If fixed or aircraft-based sensors had greater capability, interceptors could perform more critical missions. Improvements in sensor range, data processing, and operating efficiency would greatly facilitate the air defense mission.

Because aircraft can be diverted to many possible targets, discerning the objectives of an air-breathing attack is difficult. However, broad patterns of mass raids can be revealed if information from multiple sensors can be assimilated simultaneously. SDI's advances in survivable communications and distributed computation could significantly improve raid recognition, attack assessment, and efficient assignment of interceptors.

The North American air defense surveillance mission could obtain substantial benefit from a variety of SDI efforts. SDI electrical power projects could provide long-term energy sources for unattended ground-based radar systems. Battle management and communications systems within the SDI Program could facilitate sensor data fusion and attack assessment. Improvements in aircraft-based compact data processing and sensor operations could greatly enhance airborne surveillance of air-breathing threats. Survivable, high-data-rate communication systems could help maintain connectivity among the air defense regions and improve the allocation of interceptors and sensors within and among regions.

Tactical air defense in a theater of operations is closely integrated with Theater Missile Defense (TMD) and includes sensors such as the AWACS and other (non-TMD) mobile ground-based radars. These sensors provide early warning and engagement control of Air Force air defense and Army antiaircraft surface-to-air missile systems such as the PATRIOT (in its anti-aircraft role), HAWK, Stinger, and Chaparral, as well as Vulcan gun systems. The current air defense sensor/weapon configuration results in a highly decentralized command and control environment, which is further constrained by limitations in battle management/command, control and communications (BM/C^3) technology.

Theater air defense operations depend on limited sensor and BM/C^3 architectures, which are in turn affected by electronic countermeasures and raid size. Sensors incorporating sophisticated SDI technology would ensure sustained theater air defense operation and would preclude the operation's being hampered by countermeasures.

Theater air defense operations could also benefit from the development of SDI technologies. For example, the extension of air defense systems to a more robust role could be derived from hypervelocity gun (HVG), laser, and kinetic-kill vehicle experiments. Early-warning attack assessment functions could benefit from sensor developments. Missile lethality enhancements could be based on improved lethality and vulnerability analyses. Command, control, and data processing could be improved as a result of the software development and signal data processing work being accomplished for the SDI Program. Reductions in size and weight of the missile components and better rocket motors and gun launch components will result in both increased range and higher probability of kill.

At the global level, SDI computer technologies and simulation display advances could help integrate air-breathing and missile threat information necessary to respond to combined attacks. SDI kinetic energy interceptor technologies may allow more intercepts with fewer aircraft. Sensor, kinetic energy interceptor, and battle management technologies pursued by the SDI Program could all be applicable to the strategic air defense missions.

The utility of space lasers for worldwide air defense has been studied since the 1970s. Lethal beams can be projected to the cloudtops, destroying strategic bombers in seconds. Theater aircraft are similarly vulnerable. SDI progress in hydrogen fluoride chemical laser technology, and in the pointing and control of the high power beam makes a militarily useful system possible.

9.3.2 Maritime Operations

The global maritime operations of U.S. naval units and fleets in peacetime and wartime are critically dependent on surveillance, communications, and the ability to intercept hostile forces beyond the range at which the forces can actively threaten fleet units.

Advances in communications, multiprocessors, intelligence interfacing, and software, from projects now under development in the SDI Program, should greatly benefit U.S. fleet operations. For example, the SDI battle management software developed to track and intercept hundreds of ballistic missiles and reentry vehicles (RVs) should be readily adaptable to the Navy's requirements to perform similar operations involving seaborne and airborne friendly and hostile objects. Furthermore, SDI software development tools employing artificial intelligence and knowledge-based technology should markedly reduce the cost and time required to develop and manufacture secure and fault-tolerant software for tactical use in maritime operations.

The SDI advanced infrared sensor technology, if applied in naval aircraft and air defense missiles, could help fleet defenses keep pace with advances in the anti-ship missile (ASM) threat. Space-based radar, employing major advances in high-frequency and sophisticated signal processing techniques for extending sensor performance, will offer a valuable mix for confronting hostile forces with a multispectral surveillance, tracking, and targeting capability.

Spinoffs from HVG and laser technology could result in highly effective ship-based weapons for close-in defense. For example, a rapid-fire electromagnetic gun (rail gun) that propels a low-cost guided projectile could be very effective for defending against ASMs launched from bombers, ships, or submarines. Additionally, electromagnetic coil launchers, with the potential to launch much heavier aircraft from an aircraft carrier than currently is possible, offer a replacement for steam catapults.

Applications of SDI laser weapon technology could provide the quick-kill defense capability needed to counter even the most advanced ASMs. Advances in developing high-power microwave technologies for strategic defense may be applied to seaborne tactical weapons in defense against missiles and targeting satellites, and may be applied to suppression of enemy ship- and land-based defensive radars and command, control, and communication systems.

9.3.3 Ground Forces

For conventional ground force operations enemy forces most likely will deploy a vast array of weapons, including tanks, mobile artillery, armored personnel carriers, and attack helicopters. These weapons are designed to provide the mobility and firepower necessary to defeat allied forces. To counter this capability, U.S. forces require a continued infusion of new technologies to provide improved capabilities in the areas of firepower, fire control, and command control, and communications, as well as improved power supplies to enhance the mobile operations of advanced weapons.

The SDI Program is developing a range of advanced technologies that could be used to develop advanced weapons, support systems, and control systems for conventional forces. For example, HVG technologies could provide significant improvements in anti-armor operations. The HVG could be capable of long-range, rapid, lethal response to conventional attack. In addition, the ability to engage more than one target at a time is being developed through advances in computer-aided and controlled multitarget fire control systems. This ability would enhance the battle management functions of all forces and enhance their efficiency in the use of resources.

The development of high-power-density power supplies could provide a significant benefit to the modern ground force, especially command and control and support elements. Improvements in power technology have led to the development of systems that can provide sufficient power with low noise and/or thermal signatures. Lightweight, quiet power systems would reduce the signature of critical units, thus enhancing survivability while meeting power needs.

The SDI Program also is developing technologies to automate the collection, fusion, and processing of massive amounts of intelligence data on a near-real-time basis. These technologies can help ensure the timeliness and availability of reliable intelligence required to support mobile forces on a battlefield.

9.3.4 Space Defense

U.S. space defense requirements include space surveillance and tracking, space defense weapons, and space system survivability. Particularly relevant are SDI systems (Brilliant Eyes, Brilliant Pebbles technology, Ground-Based Interceptor) and technologies for maneuvering and hardening space platforms.

Additionally, multispectral focal plane arrays and on-board processing are being developed to provide global coverage and multiple track file maintenance. Short-wavelength lasers have direct potential for tracking and providing rapid images of satellites. In the long term, interceptors or other means of active self-defense are likely to be required (e.g., ground-launched interceptors could be used against the co-orbital ASAT).

Figure 9-2
Potential SDI Technology Benefits to Other Significant Military Missions

BENEFIT TO OTHER DEFENSE MISSIONS	SDI TECHNOLOGIES	CHAPTER 3/ PROJECT NUMBERS
Air Defense		
Long-term energy service	Electrical Power	1503
Sensor data fusion and attack assessment	Battle management and communications systems	1405, 2300, 3102 and 3306
Survivable high data rate communications		3102, 1405
Integration of threat information	Computational techniques and simulation deploy	2300, 3302, and 3306
More intercepts with fewer aircraft	Kinetic energy interceptor	1201 and 1202
More robust	Hypervelocity gun	1203
	Laser	1301 and 1302
	Kinetic-kill vehicle	1201 and 1202
	Survivability	1501
Missile lethality	Lethality and vulnerability analysis	1502
Command, control and data processing	Software development and signal data processing	1405, 2300, 3102, and 3306
Destroy strategic bombers and theater aircraft	Space-based chemical lasers	1302
Maritime Operations		
Long-range intercept	Theater endoatmospheric, and exoatmospheric interceptors	1201, 1202, 1206, 2202, and 2203
Secure, survivable communications network and advanced processing	Communication, multiprocessors, intelligence, interfacing, and software	1403, 1405, 2300, 2304, 3102, 3109, and 1501
Advanced infrared sensor technology in naval aircraft and air defense missiles	Advanced infrared sensor technology	1101, 1201, 2102, 2103, and 3307
Close-in defense	Hypervelocity gun and laser	1203, 1301, and 1302
Ground forces		
Anti-armor and antiaircraft	Hypervelocity gun	1203
High-power density power supplies	Power and power conditioning	1503
Computer-aided and -controlled multitarget fire control	Battle management	2300, 3102, and 3306
Space Defense		
Support satellite survivability	Space surveillance and engagement and satellite survivability	1301, 1302, 1303, 1501, 2102, 2103, 2205, and 3307
Multispectral focal plane arrays and on-board processing	Space sensors	1101, 2102, 2103, and 3307
Ground-based radar	Ground-based radar	1102 and 2104

9.4 Cost-Effectiveness at the Margin

In past years, the focus of the SDI Program has been deterrence of a massive intentional Soviet missile strike. In the former U.S.-Soviet relationship, U.S. planners evaluated prospective defenses using the Nitze Criteria of military effectiveness, survivability, and cost effectiveness at the margin (CEATM).

Public Law 99-145, Section 222 (dated November 8, 1985) stated that

> " (B) the system is cost effective at the margin to the extent that the system is able to maintain its effectiveness against the offense at less cost than it would take to develop offensive countermeasures and proliferate the ballistic missiles necessary to overcome it; . . . "

In the context of the previous U.S.-Soviet strategic balance, to prevent the Soviets from adding systems to overcome a deployed defense, the defense had to be less expensive to upgrade than the offensive weapons the Soviets deployed. In this context, the Soviets would have a reduced incentive to deploy extra systems, since the U.S. could counter these additions at less expense.

CEATM, while a key criterion for considering the possible deployment of a defense against a massive Soviet attack, is not relevant when applied to Global Protection Against Limited Strikes (GPALS). Additionally, the CEATM criterion was originally applied to avoid an unfavorable long-term, offense-defense, cost competition with the Soviet Union. Since a massive strike from the ex-Soviet, nuclear-capable republics is considered extremely unlikely, ensuring favorable CEATM is no longer an appropriate or relevant criteria.

Nor is CEATM a useful criteria in the context of accidental or unauthorized launches from former Soviet Union republics, or limited intentional strikes from other nations. The former Soviet Union has no incentive to modify its forces to ensure the success of accidental or unauthorized launches--this would be contradictory. And, with regard to intentional or other attacks by other nations, the defensive capabilities envisioned under the GPALS concept should be sufficient to handle the limited inventory of ballistic missiles these nations are likely to have in the near future.

A cost tradeoff more applicable to the mission of defending against limited strikes is the cost of the defense relative to value of the protected assets. For a strike against the continental United States (CONUS), this means weighing the cost of GPALS against the value destroyed by an attack in the absence of a defense--potentially tens of millions of lives and hundreds of billions or trillions of dollars.

In addition, in several important ways, GPALS may reduce the incentives of smaller nations to pursue ballistic missile capabilities. First, the presence of missile defense would increase potential attackers' cost of successfully delivering a weapon on target, thereby making it difficult for many economically constrained nations to pursue a ballistic missile development program capable of real strategic utility. Second, a space-based global defense could significantly reduce the effective range of a threat missile, thereby reducing the geographic scope of influence of the attacker and enhancing regional stability. Finally, the presence of a defense may require an attacker to alter his targeting, selecting less valuable but undefended targets, thereby reducing the strategic utility associated with ballistic missiles and providing a further disincentive for proliferation. The combination of these effects could do much to slow the spread of ballistic missiles, thereby aiding other nonproliferation efforts and reducing the possibility of an accidental, unauthorized or limited strike ever taking place. Criteria related to such anti-proliferation and regional-stability measures are much more germane to the GPALS mission than is the Nitze criterion of CEATM.

9.5 Survivability

A critical requirement of the Nitze criteria is to ensure the functional survivability of potential ballistic missile defense elements in a hostile environment. The U.S.'s former principal concern was the possibility of defense suppression attacks by the Soviet Union on elements of a U.S. ballistic missile defense system. To address this concern, the SDI program pursued vigorous development of both passive and active survivability technologies, methods and tactics. Passive measures include: hardening the defensive systems against nuclear, kinetic energy, laser, and RF/microwave threats; redundancy; and autonomy. Active measures include options such as attack warning, on board survivability management options, and evasion tactics.

The defense suppression threat was an acknowledged, critical factor in the design of defenses when the SDI program was focused on deterring and disrupting a massive Soviet attack. With the program focus changed to defense against a proliferating third country ballistic missile threat, and protection against limited (accidental or unauthorized) attacks by the former Soviet Union, it has been assumed that the concern over a defense suppression attack can be relaxed. This position presupposes that defense suppression capability is currently beyond the technical and economic capability of most (if not all) third world countries. Additionally, a defense suppression attack has been typically viewed as a precursor to a major Soviet attack.

However, an unauthorized, limited attack by a "rogue" commander or republic of the former Soviet Union could be accompanied by defense suppression measures if such an already existing capability was available to the commander or republic. Even without an accompanying defense suppression attack, the destruction by U.S. defenses of ballistic missiles and warheads in space may detonate the nuclear warhead(s) and produce a hostile (nuclear) space environment in which remaining defensive systems would have to operate. In addition, modest defense suppression attacks by third world countries are feasible, especially at the tactical level. Therefore, the design of SDI systems and architectures, even under the GPALS concept, continues to incorporate survivability measures.

The survivability of potential ballistic missile defense systems is ensured through a two-fold approach. First, broad-based SDI survivability programs are maintained to support the development of all potential BMD systems. These efforts include:

- A Balanced Hardening program, which develops survivability technologies such as: electronics that can operate within nuclear environments; hardened communications systems; and laser/radio frequency (RF)-jamming mitigation tactics. Once validated, these technologies are available for system developers to tailor them to satisfying system-unique requirements.

- An Environment/Analysis and Simulation program, wherein computer environment models are developed and made available to system developers. Operability demonstrations are conducted, and cost-effectiveness and functional assessments are performed.

- A special Theater Missile Defense survivability program which investigates theater-specific issues such as radar cross-section reduction techniques, protection from chemical threats, and countermeasures to anti-radiation missiles.

- A Test and Evaluation program, wherein proposed systems, subsystems, and components are subjected to simulated threat environments, to include ionizing radiation in underground nuclear testing.

Secondly, the formal DoD acquisition process demands that survivability requirements be developed and validated for each military system, and that adequate operational testing be conducted to ensure that systems satisfy those requirements before they are fielded. For SDI, survivability requirements are developed for both the individual defensive elements, and for the overall defensive system. Operational testing or appropriate simulation is likewise required and will be conducted at both levels.

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