Chapter 5
New Ideas about Space and Missile Defense After the War, 1991-1997

ARSPACE After The Gulf War

As the president unveiled a new SDI and the Soviet Union began to wither and disappear, American forces were engaged in conflicts in Southwest Asia that underscored the utility of space-based systems. ARSPACE and ASI both passed the tests presented by the Gulf War and Somalia, although this success may have sealed the fate of the latter organization. ARSPACE thrived because

> Desert Storm provided a real test for the command….ARSPACE didn't fight the war in the traditional Army sense of fighting and we sure didn't win the war. However, we believe we exposed the Army to the potential of space applications early on, prior to the war, and that exposure assisted the fighters to do their jobs better and easier.[1]

The challenge ARSPACE then faced was using space-related systems and products in later operations and weaving space into the Army's consciousness. Otherwise, old difficulties would re-emerge and the Army would again "have a problem getting back into space [because] not many of our people understand space assets and what we can do."[2] The need to meet this challenge and fix the shortcomings exposed by the test of combat in the Gulf War led to creating two new organizations: the Army Space Support Team (ARSST) and the Joint Tactical Ground Station (JTAGS).

As with the end of every major conflict, the end of the Gulf War saw a renewal of the roles and missions debate. It was preceded by an internal Army discussion of the future administrative location of ARSPACE. The Vanguard Study considered whether it made more administrative sense to continue to keep ARSPACE as a FOA reporting directly to the Department of the Army or to make ARSPACE a subordinate entity to a major command.[3] The Army chose to bring its "strategic and space assets together in a single MACOM." A single organization would be responsible for managing "strategic defense, development and use of strategic space assets to support the AirLand Battle Future concept." In addition, it would be "streamlined, cost-effective management."[4]

In a memo to the Vice Chief of Staff of the Army, a writer dissented from the study's conclusion. He observed that the study investigated two approaches: to integrate space responsibilities throughout the Army's structure, or to consolidate space operations into a focused command. If the Army followed the former path, it would embed space expertise in the places where the problems and requirements would be first identified. However, such an approach would need a careful long-term management and budget strategy in light of the "budget and force structure cuts." Following the latter path would guarantee the Army would have a critical mass of expertise, interest and responsibility in a single location but such a command could become isolated from the Army's over-all needs and responsibilities. Thus, the "VANGUARD recommendations would significantly weaken Army space capabilities over the long-term."[5]

Despite this dissenting opinion, the Army chose to follow the study's recommendation to "Reduce the size of ARSPACE Headquarters by 10 percent and consolidate [it] with the Strategic Defense Command." The rationale was direct, noting that consolidating the two entities "establishes a single Army organization for strategic and space assets. The SDC commander would be dual-hatted as CG ARSPACE, thereby ensuring senior Army representation at the U.S. Space Command." In addition, the consolidation would realize 10 percent cost savings as "the result of streamlining minimum essential functions." At the same time, "Retaining ASPO as a FOA recognizes two important features" of that organization. First was "the importance of its current mission and functions" and second, a recognition of the fact that ASPO was "predominantly involved in tactical as opposed to strategic missions that SDC and ARSPACE perform."[6] According to General Order 12, ARSPACE was "discontinued as a field operating agency of the Office of the Deputy Chief of Staff for Operations and Plans, Headquarters, Department of the Army" and "was established as a subordinate command of the United States Army Space and Strategic Defense Command."[7]

New Discussions of Roles and Missions Regarding Space

At about the same time, a roles and missions struggle began over which service would have primary responsibility for space assets. The calls for consolidation came from several quarters, beginning in February 1993 with the recommendations of the Chairman of the Joint Chiefs of Staff, General Colin Powell. He recommended eliminating USSPACECOM and creating a combined element of USSTRATCOM. The Army and Navy functions of the new command would be scaled back. The commander of the Army Space and Strategic Defense Command, Lieutenant General Donald Lionetti, responded that since the Army is the largest consumer of space products it should have a role in developing them. In May 1993, a new edition of *Joint Doctrine: Tactics, Techniques and Procedures for Space Doctrine* noted the lessons learned from the Gulf War and urged the services to make greater use of space assets. The Air Force also made repeated attempts to consolidate or transfer the Army's space mission to itself. The Air Force Chief of Staff, General Merrill McPeak, advocated transferring all military space operations to the Air Force "to avoid overlapping functions in this time of shrinking budgets." However, in September the DoD decided to leave the commands as they were because of the limited cost savings and "the need to stimulate space operations."[8]

The Air Force continued to advocate consolidation to save money. The Army contended that losing control of its space assets would have a two-fold effect: it would hamper efforts to use digital information on the battlefield and silence Army participation in joint space operations. As the Army grew smaller, space became increasingly critical for power projection. In addition, without direct links to field commanders, use of space-based capabilities would be jeopardized.[9] Defending the Army role in USSPACECOM, retired General Frederick Kroeson wrote that the only alternatives to a joint command are either "a defense space agency or assigning space activities to a single service." He pointed out that agencies only add bureaucratic layers but do not improve service to forces in the field and that while "single service assignments worked in the short term," over the long term the "other services find that their needs are not precisely met." However, joint commands have proven their worth through experience.[10]

Although an Air Force Association report called for creating a Joint Space Management Board to recommend the ways in which resources would be divided according to joint or single service requirements, the venue of the dispute moved to a congressionally mandated Commission on Roles and Missions.[11] The Air Force continued to insist that the real standard of decision-making "is whether a different organization offers opportunities for increased efficiencies, reduced costs and expanded combat capability." The USASSDC Commander, Lieutenant General Jay Garner, and the Secretary of the Army, Togo West disputed this assertion. General Garner pointed out, "Because the Army is the biggest user of space, it needs to ensure continued and significant involvement in space matters." Secretary West argued, "Space is a place, not a role, function or mission. All forces must be able to leverage the tremendous potential that free access to space offers. To ensure continued success in what is still a new frontier, we should look for efficiencies in what we have, rather than centralizing responsibilities."[12] Senior Army leaders were joined by senior Navy and Marine Corps leaders in opposing the move to give the Air Force central control over space. The main issues were defined as who will manage military space assets, how will future space requirements be addressed and to what extent the service's space commands will be organized?[13] This dispute over roles and missions continued over the next year with the Army and Navy holding onto their own space commands. As the Roles and Missions Commission of the Armed Forces began its deliberations, the Air Force continued to advocate centralizing space activities under its purview. This purview was expanded when the Air Force staked a claim to be the lead service in Theater Missile Defense, previously an Army mission. In response, the Army's Deputy Chief of Operations and Plans, Lieutenant General Paul Blackwell replied, "Simply stated, Theater Missile Defense should be directed by the man in charge (the joint task force commander). It can't be a sequential transition from ship-to-shore. It has to be seamless."[14]

The argument soon shifted to a discussion over creating a Space Architect in the Department of Defense. The crux of the argument was the role of an oversight board. The original Air Force proposal contained no provision for an oversight board. The Army urged that a Defense Space Management Board serve as a Board of Directors. The Army Chief of Staff, General Gordon Sullivan, expressed concern about "the lack of a space board of directors." He believed this board would serve as a multi-service forum for "senior level leadership involvement" in approving space 'blueprints,' policy, acquisition matters, management process and organization. "A distinct space board of directors will provide service leadership with the requisite insight into the architectural and budgetary trades while assessing the impact of final guidance on programs at all levels."[15] *Inside the Army* reported that "Army officials would be more comfortable with the Air Force proposal if it included…a joint service oversight body… that could serve as an 'appeals court' for issues" that needed to be resolved. The fears of the other services concerned the Space Architect's ability "to circumvent the service staffs and the effective elimination of an element of the coordination process."[16] The Army repeatedly expressed its reservations about the plan and worked to change it. The chief fear was losing "responsibility and authority for ground equipment that leverages space products." The Army also feared the consequences of a single service being "the executive agent for space."[17] The Army had come a long way since it returned to space in earnest during the 1980s.[18] Consolidating Army space assets and functions also continued. In 1994, ASTRO's space technology functions were transferred to the USASSDC. In 1996, ASPO (responsible for the Army's TENCAP) was also transferred to USASSDC.

This debate took place against the background of a Congress increasingly critical of the way the DoD managed its space efforts. In 1992, a Joint House-Senate conference committee asserted that the Secretary of Defense should develop a comprehensive and centralized space acquisition strategy to improve efficiency and decrease costs. In 1993, the House Appropriations Committee noted that the existing space management structures were inadequate and that a coherent management structure for space programs should be created.[19] In 1994, the Defense Department broadly reviewed its space management practices and began restructuring several of the offices and directorates in order to improve integration and coordination of Defense Department space activities.[20]

Three organizational changes took place in 1994-1995.[21] The first was the Secretary of Defense's creation of the office of the Deputy Undersecretary of Defense for Space (DUSD/Space). The office would serve as the principal contact point within the Office of the Secretary of Defense for space matters and develop, coordinate, and oversee implementing the department's space policy and oversee all space architectures and the acquisition of space programs. The DUSD Space worked under the direct supervision of the Under Secretary of Defense for Acquisition and Technology.

Second, was the establishment of a Space Architect in the Department of Defense in March 1995. The office consolidated the responsibility for space missions and system architecture in the Defense Department to eliminate overlapping and redundant programs and make acquisition and future military operations more efficient. The Space Architect worked with the DUSD Space to develop and maintain an overall space system master plan specifying how mission support would be provided by space systems to combatant commanders and deployed operational forces. The Space Architect was a major general who reported through the Air Force Acquisition Executive to the Defense Acquisition Executive and who received policy guidance from the DUSD Space.

Third, the Secretary of Defense and the Director of Central Intelligence formed the Joint Space Management Board (JSMB) in December 1995. The board would act to consolidate defense and intelligence space architecture functions into a single national space architecture that would be designed to ensure they were integrated to the greatest extent possible.

These reforms were short lived as the Clinton Administration began to streamline the DoD's organization by introducing business practices into this bureaucracy. Two Defense Reform Initiative Directives (DRID) reorganized the department's space management responsibilities. In December 1997, DRID 11 abolished DUSD Space and transferred its policy functions to the Office of the Under Secretary of Defense for Acquisition and Technology and the Office of the Under Secretary of Defense for Policy. A later amendment transferred the DUSD Space's policy systems architectures, acquisition, management and integration functions to the Office of the Assistant Secretary of Defense (ASD) for Command, Control, Communications and Intelligence (C3I). In May 1998, DRID 42 ordered the ASD C3I to work with the Under Secretary of Defense for Policy to ensure that former's decisions were integrated into overall national policy decisions.

In July 1998, an amendment to DRID 11 abolished the Space Architect's office and replaced it with an office of the National Security Space Architect, who would be responsible for maintaining, disseminating and developing the National Space Security Master Plan, developing transition strategies for future space strategies, integrating requirements into future space system architectures and advising the ASD C3I and the Deputy Director of Central Intelligence for Community Management and their staffs of appropriate budget documents. The office was created to address the needs of the warfighter directly. DRID 11 also abolished the JSMB and replaced it with the National Security Space Senior Steering Group. It addresses broad national security space management and integration issues in the Defense Department and the intelligence community.

The End of the Cold War and a New Security Environment

There had been many changes to world politics since President Reagan's 1983 SDI announcement. The most revolutionary was the end of the Cold War, signaled by the end of the Soviet bloc in Eastern Europe. The Berlin Wall fell in 1989, which ended the division of the city and led to German reunification. As Russian troops were withdrawn from Eastern European countries, their communist governments fell and were replaced by freely elected noncommunist leaders. Even President Reagan's "Evil Empire," the Soviet Union, disintegrated into its component parts in 1991, leaving the United States as the sole superpower.[22]

Despite the disappearance of the traditional Cold War enemies, it was soon evident that threats still existed. In 1990 and 1991, the world focused its attention on the activities of Saddam Hussein, President of Iraq. During the subsequent Persian Gulf War, the Scud missile, although not a new weapon, was recognized as a new threat in the ballistic missile arsenal. Analysts observed that ballistic missiles "[appealed] to leaders of developing countries."[23] They were and still are valued for their long range, short flight time, payload flexibility, and relatively low cost. A 1992 study on BMD proliferation, for example, located the 300-km Soviet Scud in the arsenals of 16 countries. The same study found that "thirteen countries have produced or [are] in the process of producing" long range ballistic missiles. As Lieutenant General Donald

Lionetti observed, "The tactical ballistic missile genie is out of the bottle and can never be put back. There won't ever again be a mid to high intensity armed conflict without tactical missiles."[24]

A New Approach – President Bush and Star Wars

In 1989 there was a new president in the White House, but there were no anticipated changes to the Strategic Defense System. In fact, on 9 February 1989, President George H.W. Bush announced in an address to a Joint Session of Congress, that he would "vigorously pursue" the Strategic Defense Initiative. Following a review of the national defense strategy, Bush "concluded that the goals of the SDI program were generally sound." In addition, the program had the potential for a deployment decision in the next few years. Bush decided that "emphasis in this effort was to be directed toward perfecting boost-phase kill technologies such as Brilliant Pebbles."[25]

In December 1989, President Bush commissioned an independent review to examine the strategic requirements for a "new world order." Conducted by Ambassador Henry Cooper, the study concurred with this assessment of Brilliant Pebbles and its potential in the Strategic Defense Architecture.[26] It would ultimately define the concept for a new missile defense system known as Global Protection Against Limited Strikes (GPALS).

Global Protection Against Limited Strikes (GPALS)

Responding to these events, President George Bush presented a revised version of the SDI concept in his 1991 State of the Union address. Rather than the massive threat posed by the Soviet nuclear arsenal, the program was redirected to "emphasize defense against limited attacks of up to two hundred warheads."[27] Specifically, President Bush announced

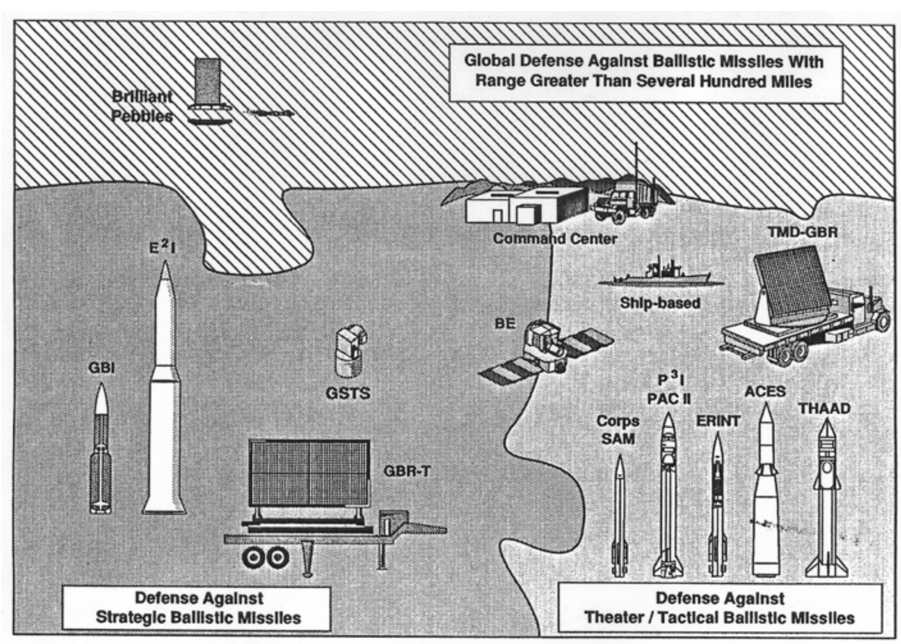

Fig. 5-1. The three pieces of the Global Protection Against Limited Strikes puzzle provide a global defense against strategic and tactical ballistic missiles.

> I have directed that the Strategic Defense Initiative program be refocused on providing protection from limited ballistic 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.[28]

A smaller version of Reagan's SDI, the GPALS would provide a defense against "purposeful strikes by the various Third World powers developing ballistic missiles, or accidental or unauthorized launches from the U.S.S.R."[29] The GPALS architecture focused on three elements. The first facet was a ground-based National Missile Defense (NMD) system. The second was a ground and sea-based Theater Missile Defense (TMD) system that would protect friendly nations, allies, and deployed American forces. The third and final element was a space-based global defense system "that could stop a small attack against virtually any point on the globe."[30] These goals would be accomplished with a tiered deployment of 1,000 space-based Brilliant Pebbles interceptors, 750-1,000 long-range ground-based interceptors located at six sites, space-based and mobile sensors, and transportable theater ballistic missile defenses.

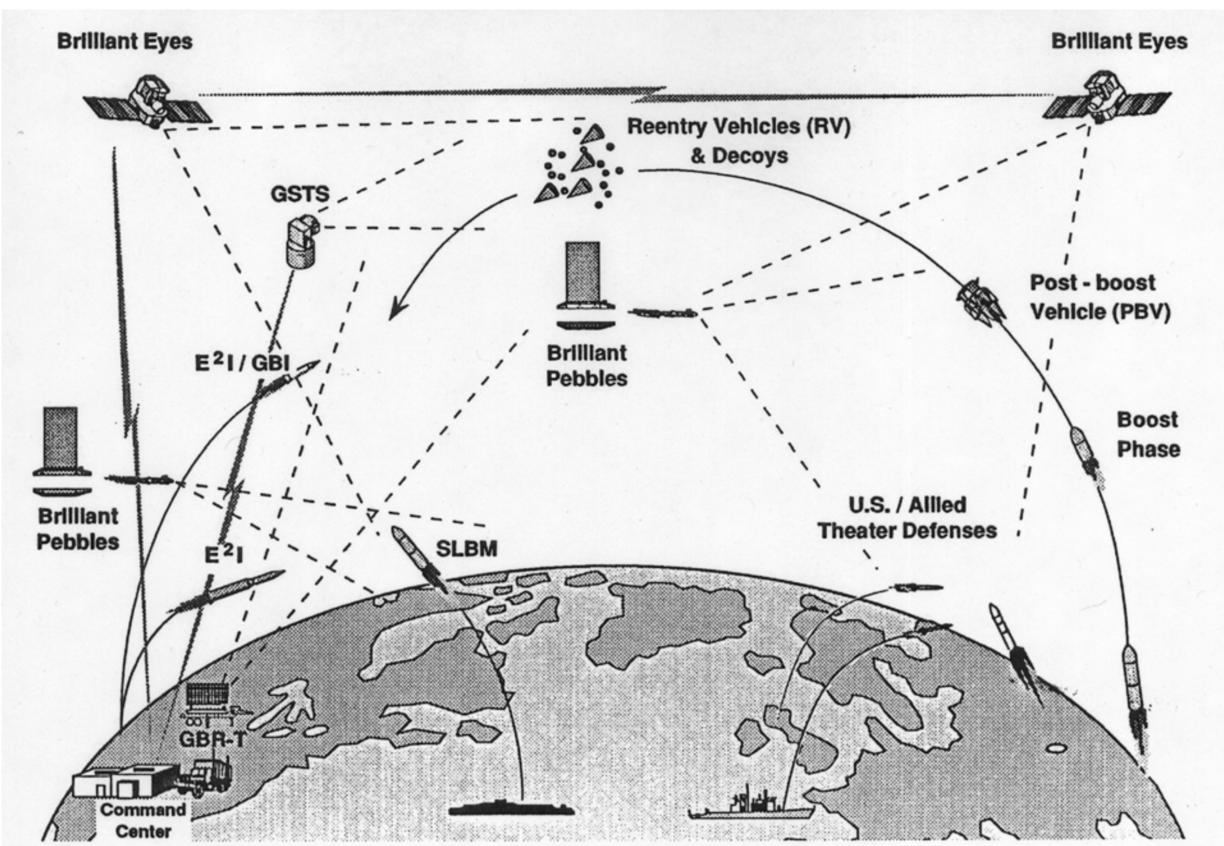

Fig. 5-2. The Global Protection Against Limited Strikes incorporated a new element - Brilliant Pebbles - in the global strategic defense scenario.

The events of Desert Storm which vividly illustrated the need for theater missile defenses had a strong impact on the American people. The Brilliant Pebbles space-based element of the GPALS System however renewed concerns about the militarization of space. The Missile Defense Act of 1991, signed into law on 5 December 1991, further defined the new initiative.[31] The legislation directed the Department of Defense to "aggressively pursue the development of advanced theater missile defense systems, with the objective of down selecting and deploying such systems by the mid-1990s."[32] With regard to National Missile Defense, DoD was to "develop for deployment by the earliest date allowed by … technology [development] or by fiscal year 1996 a cost effective, operationally effective, and ABM Treaty-compliant antiballistic missile system at a single site as the initial step toward deployment of an antiballistic missile system." Congress also supplied funding for Brilliant Pebbles and other innovative technologies, but these were not to be a part of any initial deployment. At the same time, Congress directed the President to pursue negotiations with the Soviet Union to allow the expansion of a deployed NMD system beyond the one location permitted by the ABM Treaty.

New Organization: Program Executive Office-GPALS

Fig. 5-3. Emblem of the GPALS Program Executive Office

As the roles and missions discussions over space continued, a newly revised strategic defense system was emerging. Freed from deterring a defunct Soviet Union, planners slowly began to create a new structure. The SDIO retained primary responsibility for this revised strategic defense system. With this new guidance and directives, however, on 29 July 1992 a newly created Program Executive Office (PEO) for GPALS replaced the PEO for Strategic Defense, established under the leadership of the U.S. Army Strategic Defense Command (USASDC) Commander in 1988.[33] Established by Memoranda of Agreement with the military services, the PEO provided a centralized organizational structure for the acquisition and deployment of missile defenses. Initially headed by a Major General, the U.S. Army GPALS PEO reported to the Army Acquisition Executive.

The PEO GPALS, subsequently renamed PEO for Missile Defense in 1993, was composed of elements of the USASDC and the U.S. Army Missile Command's PEO – Air Defense. The resulting organization was divided into two Program Offices – Army National Missile Defense and Army Theater Missile Defense. The NMD Program Office included the GBI, GBR, GSTS, Site Development and Regional Operations Center/Communications Project Offices, formerly of the USASDC. The TMD Office was composed of the Theater High Altitude Area Defense and Extended Range Interceptor Project Offices and the Adjunct Sensors, Arrow and Testbed Product Officers from the USASDC and the Corps SAM and Patriot Project Offices from the former Missile Command.

On 18 July 1996, the PEO Missile Defense officially became the PEO Air and Missile Defense (PEO-AMD).[34] As Colonel (P) Daniel Montgomery, PEO-AMD explained "air defense has historically included all threat platforms in the air or space – whether they are air breathing or not." The PEO's TMD systems, with the exception of THAAD, are also aircraft, cruise missile and helicopter killers.

New Organization: U. S. Army Space and Strategic Defense Command (USASSDC)

Fig. 5-4. The U.S. Army Space and Strategic Defense Command adopted this command logo in 1995

As part of the reorganization that created the PEO-GPALS, the USASDC became the U.S. Army Space and Strategic Defense Command, a field-operating agency of the Chief of Staff.[35] The new organization retained an affiliation with the SDIO, but would also provide an Army focal point for space and missile defense matters. The USASSDC continued to perform research and development for strategic and theater missile defense technologies and anti-satellite efforts, providing research and technological support to SDIO missions and matrix support to the PEO-GPALS. The command also retained operational responsibility for the Kwajalein Missile Range and the High Energy Laser Systems Test Facility.[36]

At the same time, General Orders 13 designated USASSDC as the Army's focal point for space. The creation of the USASSDC began the process, initiated by the Chief of Staff of the Army, to centralize research and development of space and strategic assets for the benefit of the soldier in the field. In the first step the U.S. Army Space Command, formerly a field operating agency of the office of the Deputy Chief of Staff, Operations and Plans, became a subordinate command of the USASSDC in August 1992.[37] Just two months earlier, the Chief of Staff of the Army had approved a realignment proposal which made the ARSPACE the "user" for deployed ground-based elements of the NMD program.

The next step in the creation of a united Army space program came in March 1993. On 3 March, Lieutenant General William H. Forster, Military Deputy to the Assistant Secretary of the Army (Research, Development, and Acquisition) ordered the transfer of the Army Space Technology Research Office (ASTRO) from the Communications-Electronics Command to the USASSDC. Created in 1988 by the Army Materiel Command, the ASTRO managed near and possible far-term space R&D programs and provided a developer focus both within the Army and with outside agencies. As part of the USASSDC, ASTRO became the Space Applications Technology Program.

The final step in consolidating the Army Space program came on 1 July 1994. On that date, the Army Space Program Office (ASPO), a field agency of the Office of the Deputy Chief of Staff for Operations and Plans transferred to the USASSDC.[38] The ASPO, which was established in 1973, has responsibility for the Tactical Exploitation of National Capabilities Program (TENCAP).

A New Priority – Theater Missile Defense

Although the emphasis upon Theater Missile Defense (TMD) began with the GPALS initiative, the command began exploring theater concepts in the mid-1980s. In December 1985, the SDIO assigned to the USASDC the task of developing TMD architectures.[39] Six months later Secretary of Defense Caspar Weinberger relayed the increasing concern in Europe of the "growing threat posed in the chemical, nuclear and especially conventional areas by increasingly accurate Soviet shorter-range missiles."[40] Secretary Weinberger directed SDIO to explore "specific ways in which the U.S.-led SDI research program [could] assist the NATO extended air defense effort in which the Europeans are taking a leading role." At a NATO Defense Ministers conference in Brussels in December 1986, Weinberger announced the first seven contracts devoted to TMD. Contractor teams from Germany, France, Italy, Great Britain, Israel and the United States participated in the first phase of the TMD Architecture Study.

Two years later, the Joint Chiefs of Staff approved the Army Tactical Missile Defense Operational Concept, which outlined the capabilities required to counter the tactical missile threat of the future. By 1990, the programs had progressed to the extent that the SDIO received a new program element, entitled Theater Missile Defense, in the appropriations legislation. The Appropriations Conference Committee also recommended that the Defense Department accelerate research on theater and tactical ballistic missile defense systems. Two Army programs, the Extended Range Interceptor (ERINT) and the Arrow, were specifically mentioned at this time. The SDIO was subsequently assigned responsibility, on 9 November, for the centrally managed DoD Theater and Tactical Ballistic Missile Defense program.[41] In January 1991, all Army TMD functions would be assigned to the USASDC in the Theater Missile Defense Applications Project Office.[42]

The events of Operation Desert Storm would prove the significance of Theater Missile Defenses. Although later studies would question its effectiveness, as Scud missiles[43] rained upon coalition forces and allied nations, the only defense was the modified Patriot anti-aircraft missile system.[44] The worst event of the war for American forces was not in battle, but rather the 25 February 1991 Scud attack on an Army barracks near Dhahran, Saudi Arabia, which killed 28 soldiers and wounded 100 others. As a *Los Angeles Times* reporter observed: "The age of Star Wars had arrived."

TMD and the End of SDI

With the arrival of the new administration of President William Clinton primary emphasis remained on TMD efforts. On 13 May 1993, Secretary of Defense Les Aspin announced that with the end of the Cold War, the United States was no longer threatened by a massive attack from the Soviet Union. Instead, the new threat was theater ballistic missiles controlled by Third World dictators, or "hostile or irrational states that have both nuclear warheads and ballistic missile technology that could reach the United States."[45]

Thus the first priority became the deployment of a TMD system with space-based sensors.[46] The second priority was the NMD program with deployment timed to meet the threat posed by rogue nations. Further research and development, follow-on technologies such as directed energy efforts, received the lowest priority rating. To reflect the new priority structure and its wider mission, Secretary Aspin reorganized and renamed the SDIO to create the Ballistic Missile Defense Organization (BMDO).[47] With this shift from research to development and acquisition of systems, the BMDO now reported to the Under Secretary of Defense for Acquisition, rather than directly to the Secretary.

Released in September 1993, the Bottom-Up Review of the Military, initiated by the Clinton Administration, outlined the national security plans for the five-year period between 1995 and 1999. The goal was to field effective TMD systems in the shortest time possible, while also "providing a basis for a speedy decision to deploy national missile defenses should a serious threat … suddenly materialize."[48] Thus in the field of BMD, the review laid out a three-tiered program with primary emphasis given to TMD, in particular the follow-on to the Patriot system, modifications to the Navy's Aegis air defense system, and the Army's Theater High Altitude Area Defense system. The TMD program would receive a budget of $12 billion over that five-year period.[49] In contrast the NMD would only be allocated $3 billion and Follow-On Technology and Research and Strategy would share an allotment of $3 billion for the same time-frame.

The ABM Treaty and TMD Demarcation

In September 1994, President Clinton and Russian President Boris Yeltsin agreed that "[b]oth sides have an interest in developing and fielding effective theater missile defense systems on a cooperative basis."[50] The issue became the definition of a TMD system, in particular with reference to the Theater High Altitude Area Defense.[51] The Clinton administration proposed that the boundary between tactical and strategic ballistic missiles be "the ability to intercept a missile traveling at 5 kilometers per second."[52] They added that this determination should be based on demonstrated capability and not theoretical ability. Following two years of negotiations, officials agreed to the Russian proposal that TMD systems with a demonstrated interceptor velocity of 3 kilometers/second would comply with the ABM Treaty. The proviso was that these systems were not to be tested against target missiles with a range in excess of 3,500 kilometers and a maximum flight velocity of no more than 5 kilometers/second.[53] The governments of the United States, Russia, Belarus, Kazakhstan, and Ukraine signed the final agreement on 26 September 1997.

Reconfiguring the Post-Cold War Army

The evolution of missile defense systems and organizations was only one series of events that made up the task of reconfiguring the Army after the Cold War. The Chief of Staff of the Army, General Gordon Sullivan, established a new vehicle to investigate and support necessary change, the Louisiana Maneuvers (LAM) process. General Sullivan consciously modeled his LAM on the series of maneuvers the Army conducted in Louisiana and the Carolinas in 1940-1941. These maneuvers were a culmination of a series of corps- and field army-level exercises to train troops, test new doctrinal and organizational concepts, identify equipment requirements and evaluate future senior Army leaders that began in 1938. In using this term General Sullivan hoped to signal that this would not be business as usual but that the results would not be foreign to the Army. His idea was "to conduct experiments that would be the basis for designing new units." He also made it plain "that I – not merely my staff – was going to be personally involved."[54] The process General Sullivan set in motion gave ARSPACE greater impetus and outside support at the highest levels to make the changes indicated by the lessons of the Gulf War.[55]

In 1993 as part of the LAM process, the Army investigated the organization and equipment necessary to establish a deployable space support team and the following year established the Contingency Operations-Space (COPS) at ARSPACE. As the Army's senior leadership was deciding on the merits of the case for permanent space support teams, the Army Audit Agency released a report confirming a need for an organization that would provide space support to warfighting commanders and their staffs. After noting ARSPACE's successful support of field units in Bosnia and Somalia as well as relief efforts in the wake of Hurricanes Iniki and Andrew, it pointed out that providing operational support to commanders and their staffs was not part of ARSPACE's mission. It did not have the resources to provide sustained, operational support to units in the field. As a result, the commanders of these units had to go to many sources to obtain the support they needed. This was probably the final push needed to bring the required level of support for this mission. Later in 1994, the COPS became the ARSST.[56]

Given the lessons learned in TMD from the Gulf War, the need for early warning capabilities was unquestioned.[57] The result was fielding a unit, the Joint Tactical Ground Station, the JTAGS, in a relatively short period of time. This unit has demonstrated its ability to fulfill Army, Joint and coalition requirements for TMD. The process of establishing and training the unit and acquiring the appropriate equipment shows how rapid the process can be when an urgent need is presented. The same may be said for the organization and deployment of the ARSST. The JTAGS supports all aspects of TMD: passive defense, attack operations, active defense and command, control, communications, computers and intelligence (C4I) and is flexible enough to be placed in any theater of operations. The JTAGS is not merely an example of the Army's versatility; it is a multi-service system and drew on multi-service research and development, acquisition, training and unit operations. As the American military slowly evolves toward joint capabilities and joint operations, the lessons learned from the JTAGS could provide important insights for all the Services.[58]

ARSPACE and Contingency and Training Operations in the 1990s

While roles and missions were being debated in Washington, ARSPACE continued to support Army contingency operations and exercises. The areas to which American troops were deployed had minimal or nonexistent national communications infrastructures and space-based systems proved their worth again.

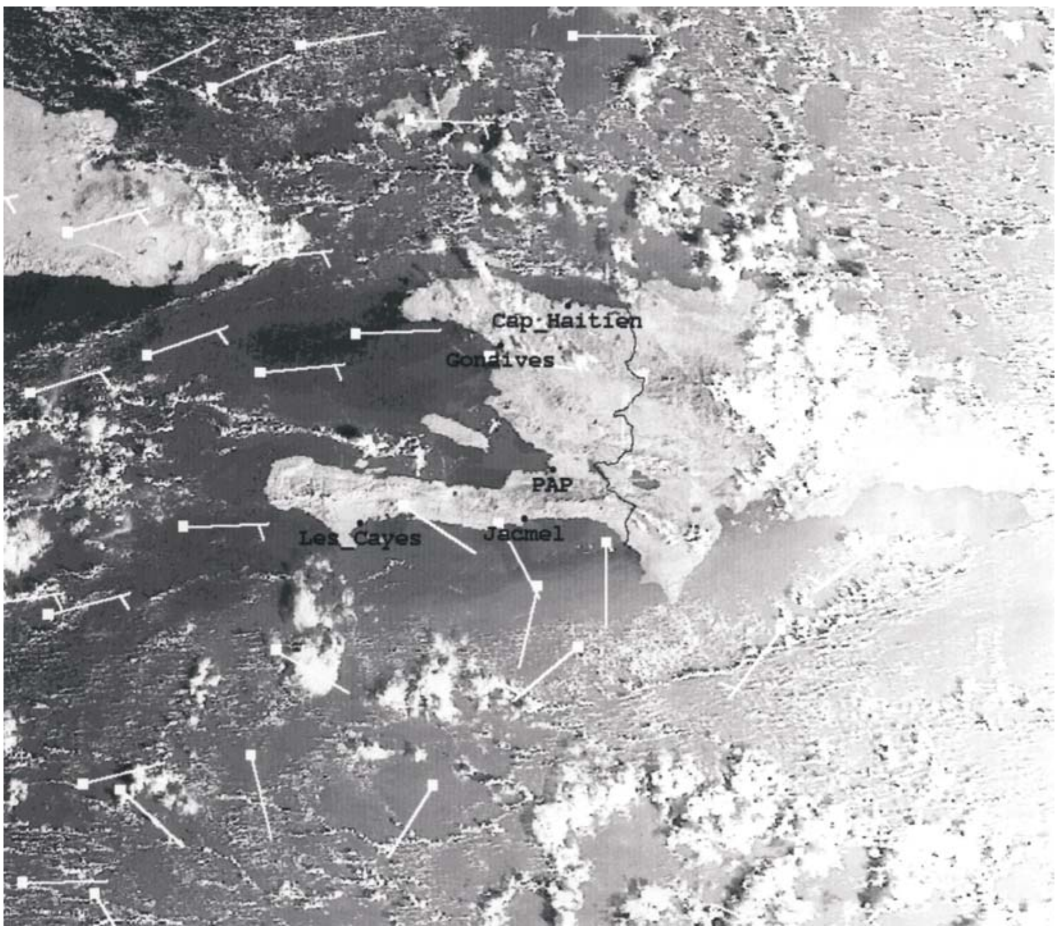

Fig. 5-5. Weather map of Haiti.

In the mid-1990s, the Army Space Command provided space products to troops involved in operations in Haiti and the Balkans, supplied material for planning an operation to evacuate noncombatants in Liberia and participated in major exercises.[59] In Operation Uphold Democracy (Haiti), ARSPACE supported Joint Task Force (JTF) 190, primarily the 10th Mountain Division and the XVIII Airborne Corps. At first the satellite communications systems were used to connect the forces ashore and afloat with decision-makers in Washington.[60] The systems employed included the Mission Planning Rehearsal System (MPRS), multispectral imagery (MSI), the Terrain Reconnaissance Tool (TRT), the Advanced Communication Satellite (ACTS) and INMARSAT. In addition, the Continental United States Regional Space Support Center supported the Atlantic Command, the XVIII Airborne Corps and the 10th Mountain Division with Defense Satellite Communications System planning support from Fort Bragg.

Fig. 5-6. Communicating in the aftermath of Hurricane Iniki in Hawaii.

As the situation in Haiti stabilized, the ACTS system was used for "morale video teleconferencing between soldiers in Haiti and their families" at their home stations.[61] In November 1995, ARSPACE personnel briefed NASA on the ways the ACTS satellite was used "in Haiti and impressed NASA with their use of the satellite and ground terminals."[62]

Space-based systems proved their worth. In fact, ARSPACE used three ACTS terminals in Haiti, two in Port au Prince and one in Cap Haitien. For the first thirty days of the deployment, "the ACTS VTC was the primary command and control system used by the JTF commander and staff." It was not until other "secure systems were brought on line" that ACTS was placed in a "secondary role of providing 'morale conferences' between soldiers in Haiti and their families." In mid-November, "a High Resolution Weather Receiver was sent to Haiti" along with trainers to instruct Air Force Staff Weather Officers in its use.[63] The joint task force continued to use this equipment until April 1995, when an ARSST brought it back, leaving the multinational force with a single INMARSAT terminal and pictel equipment for VTCs.[64]

Fig. 5-7. An Army Space Support Team in Albania supporting operations in Kosovo.

Army peacekeeping operations in the Balkans were supported in a similar fashion. The command supported the 1st Armored Division's planned entry into Macedonia with various MSI products, including three dimensional perspectives and "fly throughs" of Macedonia. It also supplied LANDSAT and SPOT maps to the division.[65] Later that year, through its 1st Satellite Control Battalion (SATCON BN) and ARSSTs, the command supported operations in Bosnia.[66]

The ARSPACE supported Allied Command Europe Rapid Reaction Corps, Task Force Eagle's and the 10th Special Forces Group's planning and preparation for Bosnia operations by providing them with a Multispectral Imagery Processor (MSIP). In addition, a single soldier from the Regional Satellite Support Center (RSSC)-Europe "was deployed to Zagreb, Croatia, as a member of the International Force Combined Joint Communications Coordination Center" and soldiers from the other two RSSCs were sent to Europe so that RSSC could operate 24 hours a day.[67] Later that month, two of the 1st SATCON BN's companies provided super high frequency (SHF) satellite communications (SATCOM) support for Operation Joint Endeavor using both DCSC satellites and the NATO IV series of SHF MILCOMSAT satellites.[68] Later reports detailed the support ARSPACE provided to this operation.[69] In this same time period, "USARSPACE RSSC-EUR provided Ground Mobile Forces (GMF) TACSAT planning" to support "EUCOM for Operation Assured Access," a noncombatant evacuation operation for Liberia. For the potential mission, the RSSC reconfigured the West Atlantic DSCS III Satellite. "The GMF terminals were operated by the 112th Signal Battalion and the 1st Combat Communications Squadron."[70]

The types of support provided for various contingency operations are summarized in the following table.

Table 5.1: Equipment Support for Contingency Operations, 1990-1994

Equipment/ Contingency	MSI	MPRS	INMARSAT	Weather
Desert Storm	X		X	X
Provide Comfort	X			
Zaire NEO Non-combatant Evacuation Operation	X			
Hurricane Relief Iniki Andrew			X	
Somalia	X	X		X
Bosnia	X	X	X	
Macedonia	X	X	X	
Rwanda	X			X
Haiti	X	X	X	X

Source: USASMDC Archives

The command also participated in major training exercises. In 1995, for example, these included Atlantic Resolve, Roving Sands, Ulchi Focus Lens and Cobra Gold. It frequently used the exercises as part of the ASEDP process. In Atlantic Resolve that year, ARSPACE deployed twenty personnel to use all the ARSST equipment (for mapping, weather, intelligence and command and control capabilities as well as selected intelligence assets).[71] Command and control capabilities included the Space Enhanced Command and Control System.[72]

In Roving Sands that year an Army Tactical Missile Defense Element (ATMDE) Force Projection Tactical Operations Center (TOC) was airlifted to Fort Bliss. The Vehicular Data Communications and Positional Awareness Demonstration was brought to Forts Hood and Bliss for the exercise.[73] At Roving Sands, the ATMDE "generated significant interest." It was deemed a success, "demonstrating its capabilities in a dynamic environment." It was hoped it would provide "initial baseline data for the Army's War Fighting Experiment."[74] The ARSST-PAC and the JTAGS at Osan AFB, Republic of Korea participated in Ulchi Focus Lens with weather (the 607th Squadron) and intelligence support (2nd Infantry Division).[75] For Cobra Gold, the Pacific Command supplied an ARSST and its associated equipment[76] to support Army units from I Corps, 25th Infantry Division and the 1st Special Forces Group that participated.[77]

Fig. 5-8. In Albania supporting Task Force Hawk.

On 20 June 1994, Vice Chief of Staff of the Army General J.H. Binford Peay III signed the Charter for the Theater Missile Defense Advocate. This charter made the Commanding General of USASSDC the Army's Theater Missile Defense Advocate. As such, the Commander was tasked to serve as the Department's focal point and coordinator for systems requirements and operational aspects of TMD. He would also conduct department level studies of all four elements of TMD – Active Defense, Attack Operations, BM/C^{4}I and Passive Defense. Some of these key TMD missile programs developed by the command are outlined below.

Extended Range Interceptor (ERINT)/ Patriot Advanced Capability-3 (PAC-3)

The Extended Range Interceptor (ERINT) was a follow-on to the 1980s FLAGE experiment.[78] To create the ERINT engineers upgraded the design of the FLAGE adding, for example, aerodynamic maneuvering fins and attitude control motors, thereby extending the range of the system.[79] Despite funding cuts, ERINT passed its final design review in December 1989. Under the new guidance, this high velocity, hit-to-kill missile was to be used primarily against maneuvering tactical missiles and secondly, against air-breathing aircraft and cruise missiles.[80]

In 1992, LTV Aerospace & Defense Company demonstrated the ERINT's flight capabilities. Later in that same year, the policy redirection towards theater/tactical defense resulted in the upgrading of the ERINT to the status of Project Office. During the third flight test, in June 1993, the ERINT tracked its target but failed to intercept the Lance missile.[81] The problems were soon rectified and the ERINT had several successful intercept tests in fiscal year 1994. These tests pitted the ERINT against two target theater ballistic missiles with simulated bulk chemical warheads and an air-breathing drone.[82]

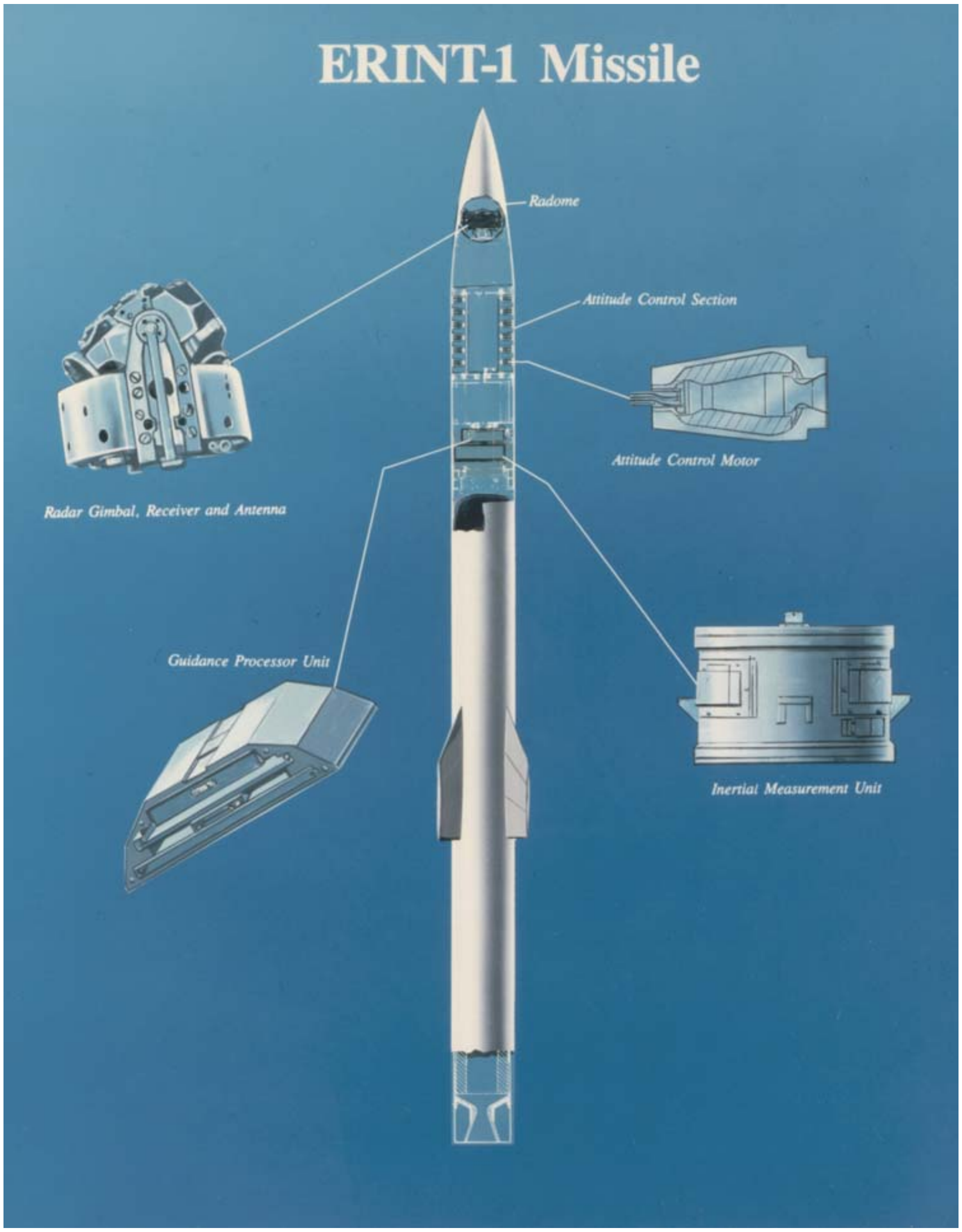

Fig. 5-9. The Extended Range Interceptor incorporated several technological advances creating a smaller, more effective interceptor.

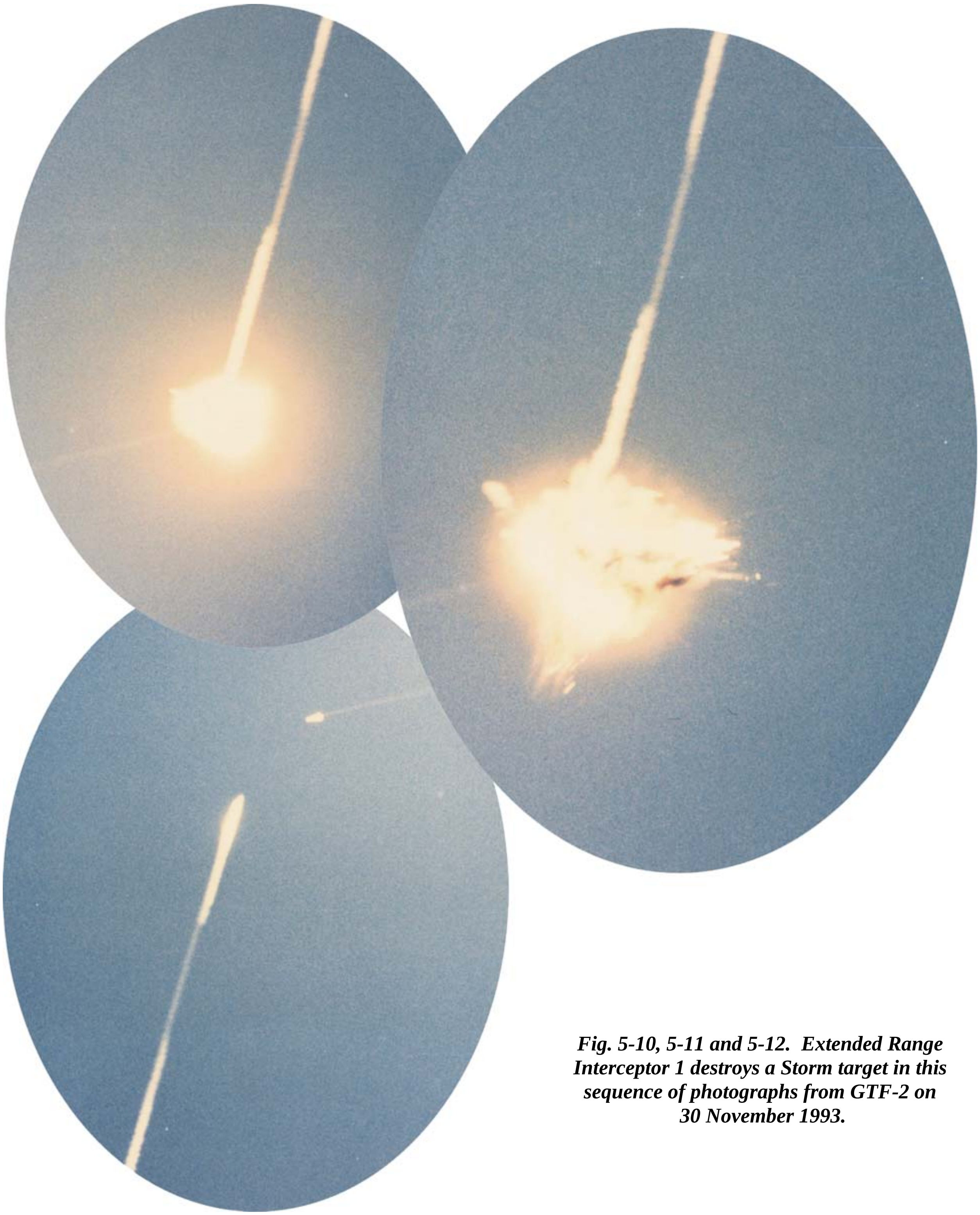

Fig. 5-10, 5-11 and 5-12. Extended Range Interceptor 1 destroys a Storm target in this sequence of photographs from GTF-2 on 30 November 1993.

Fig. 5-13. The PAC-3 uses an attitude control system made of a ring of small solid rocket thrusters which provide "the extremely rapid air frame response accuracy to achieve hit-to-kill performance." Compared to its predecessor, the PAC-2, the PAC-3 can protect an area seven times greater and is effective against chemical and biological warheads. Photograph taken on 5 February 2000.

Budget constraints put the ERINT in direct competition with another short-range theater missile defense system, the Patriot missile developed by Raytheon Corporation for the U.S. Army Missile Command.[83] The Army evaluated the ERINT and a revised Patriot as part of the pre-planned upgrades to the Patriot system, the Patriot Advanced Capability – 3 (PAC-3). The Army System Acquisition Review Council determined the ERINT, which is half the size of a Patriot missile, "[offered] increased range, accuracy and lethality."[84] The official decision came on 19 May 1994, when the Defense Acquisition Board endorsed the Army's decision to select the ERINT missile. In July, Principal Deputy Under Secretary of Defense R. Noel Longuemare authorized the ERINT project to enter the engineering and manufacturing development phase. Following these decisions, the ERINT Project Office merged with the Patriot Project Office, within the PEO for Missile Defense, and the ERINT missile became known as the new interceptor for PAC-3. In this capacity, the PAC-3 will be the lower tier of a two-tier active theater missile defense.[85]

The Army conducted the PAC-3 deployment in a three phased configuration. The first units received the PAC-3 Configuration 1 in December 1995. This system incorporated the guidance enhanced missile or Patriot GEM, and improvements to the BMC^3I. The PAC-3 Configuration 2 system, fielded in fiscal year 1998, used both the PAC-2 and GEM missiles and made upgrades to the radar, communications and other systems. The PAC-3 Configuration 3 meanwhile introduced the new PAC-3 hit-to-kill interceptor and made additional improvements to the communications, radar and ground support systems. Plans originally called for the PAC-3 Configuration 3 to be fielded in the year 2000. However, the situation in the tense Persian Gulf region in early 1998, led to a Pentagon decision to deploy the relatively untested prototype PAC-3 missiles.[86]

Testing resumed in 1999 with a seeker characterization flight in March and the first official intercept test of a PAC-3 in September. Both tests achieved successful intercepts and led to a government decision to enter low-rate initial production phase. At the same time, however, the program experienced budget overruns and set-backs that put the program more than a year behind schedule.[87] Despite these financial controversies, the test program proved successful. Integrated tests conducted in 2000 demonstrated the system's capabilities against several types of targets – tactical ballistic missiles, cruise missiles and an aircraft.[88] The developmental test phase ended in March 2001 with the first tactical ripple mode test. The first missile destroyed the target and the second self-destructed as expected. After completing seven intercepts in as many attempts, however, operational tests conducted in 2002 proved less successful. Although targets were intercepted, one or more of the missiles failed to perform as expected in four successive ripple tests. The anomalies were identified and addressed and, as Colonel Tom Newberry observed, "Nothing that we've encountered so far would indicate that we've got some sort of systemic problem."[89]

The PAC-3 system consists of the launcher with up to 16 missiles, a radar, fire control station, power supply and communication relays. Configuration 3 deployment began in March 2000, when batteries in the 108th Air Defense Artillery Brigade received the first PAC-3 radars. The first new missiles were delivered in September 2001. In spite of the operational test issues, by August 2002, the Pentagon declared the PAC-3 combat ready.[90]

Arrow

Another element in the lower tier for the theater architecture is the Arrow missile system, developed jointly by the governments of Israel and the United States.[91] Initiated in July 1988 with a Memorandum of Understanding, the Arrow is an anti-tactical ballistic missile for specific use in Israel but capable of operating with American TMD systems. A successful first launch in August 1990 was followed by several failed tests, which resulted in a redesign of the Arrow System.[92] Nevertheless the two governments signed a Memorandum of Agreement on 7 June 1991 for the Arrow Continuation Experiments (ACES) to develop an Arrow-2 missile and launcher. Also with the new emphasis on TMD, on 29 July 1992, the Arrow Office transferred to the PEO-GPALS and became the Arrow Project Office.[93]

Fig. 5-14. Unlike other theater missile defense systems, the Arrow, which travels at Mach 9, employs a warhead to intercept its targets.

Despite two partially successful launches, in September 1992 and February 1993, concerns about the feasibility of the Arrow continued. These doubts were raised again when a planned ship-based launch against a simulated chemical warhead, the first attempt by a "western-developed missile" to intercept a target with a non-conventional warhead, was canceled.[94] Given its test record, some members of Congress expressed a reluctance to continue funding the Israeli program. The Arrow test program continued to be plagued by mechanical problems until June 1994. In two previous intercept tests the warhead had failed to detonate, although the Arrow came close to the target. On 12 June 1994, however, the Arrow successfully intercepted a surrogate tactical ballistic missile. This was the seventh and final test before the initiation of the ACES and the Arrow-2 system.[95]

The ACES program began with the initial flight test of the two-staged Arrow-2 missile in July 1995.[96] This test was followed by a successful intercept of a simulated Scud missile on 20 August 1996. With the completion of two more successful intercepts, the ACES program ended in 1998 to be replaced by the Arrow Deployability Program. The goal of this initiative was to integrate the Arrow missile with its various system components and determine the Arrow's ability to operate with American TMD systems.

The Arrow program completed its first integration test on 14 September 1998. During this test, the Arrow 2 interceptor was controlled throughout its flight by the various components of the Arrow Weapon System, specifically the surveillance/fire control radar (Green Pine), the fire control center (Citron Tree) and the launcher control center (Hazel Nut Tree). A second full system test conducted in November 1999 again demonstrated the system's ability to acquire and intercept targets.

With the completion of these tests officials declared the Arrow Weapon System to be initially operational, as a limited contingency capability. The Israeli government deployed its first battery of 14 Arrow missiles on 14 March 2000. With the first delivery to the Israeli Air Force, Major General Eitan Ben-Eliahu declared, "As of today we complete the acceptance of the only weapon system of its kind in the entire world. We are the first to succeed in developing, building and operating, a defense system against ballistic missiles."[97] In a 14 September 2000 test, the Arrow Weapon System successfully intercepted an air-launched Black Sparrow target in an in-bound trajectory. As a result of this test, Israel declared the first battery, located near Tel Aviv, operational on 17 October 2000. A second battery has since been added at Hadera, with plans for a third battery.

Since this time, officials have expanded the tests of production missiles to include new challenges. In August 2001, the Arrow-2 achieved an intercept at approximately 100 kilometers from the coastline at a distance "higher and farther than in any previous tests." In January 2003, four Arrow interceptors were launched almost simultaneously against a simulated barrage of target missiles. Israeli officials stated that "the Arrow should be able to intercept an incoming missile in less than three minutes at altitudes of more than 30 miles." Israel developed the system in preparation for a possible war against Iraq.

Theater High Altitude Area Defense (THAAD)

For longer-range protection, the USASDC and SDIO introduced the THAAD missile system in 1988, the first weapon system developed specifically to defend U.S. and allied soldiers, military assets and population centers from the threat of theater ballistic missile attack.[98] Designed to counter tactical ballistic missiles, such as the Scud, the THAAD system uses truck mounted launchers and a ground-based radar. According to plans THAAD missiles, "smaller, faster and smarter" than existing systems, would be able to defend an area "dozens of times wider" than a Patriot battery.[99]

Fig. 5-15. The curly-cue in the Theater High Altitude Area Defense (THAAD) contrail is part of a purposeful maneuver to burn off excess fuel before the missile proceeds down range. The first THAAD intercept occurred during the tenth flight on 10 June 1999.

Fig. 5-16. The Theater High Altitude Area Defense, launched from a palletized truck.

Fig. 5-17. During the fifth THAAD test in March 1996, the metric accuracy of the THAAD DEM/VAL radar achieved a mark 4.6 times greater than was required, by the ninth test, the accuracy rate exceeded the baseline by 12.0 times. Essentially, if the radar was in Huntsville, Alabama, it could see an object smaller than a basketball sitting above the Washington Monument.

Fig. 5-18. Activation Ceremony of the Bravo Battery of the Theater High Altitude Area Defense Battalion.

The THAAD request for proposals was delayed several months as the SDIO and the Army debated the appropriate acquisition strategy.[100] The demonstration/validation contract, however, was awarded to Lockheed Missiles and Space Company in September 1992. In March 1993, the design underwent a revision, producing a "larger kinetic-kill interceptor and a more powerful rocket booster," to accommodate the flight termination system and ensure the system's ability to intercept tactical missiles "above and just within the Earth's atmosphere."[101]

In addition to the treaty woes, cost growths, budget cuts, management problems, and technical concerns combined to delay THAAD testing.[102] Nevertheless, with three flight tests beginning in April 1995, the THAAD project achieved its objectives and made preparations for the next phase of the demonstration/validation program. The first intercept attempt occurred on 13 December 1995. The THAAD demonstration/validation radar performed as planned, tracking and detecting all objects. The overall test, however, did not achieve an intercept due to software problems.

Despite this setback, the Army continued to move forward with plans to establish a THAAD battalion and deploy a prototype system. The Total Army Analysis 2001 validated the requirement for the battalion in 1993.[103] The Air Defense Command would be composed of a brigade, three Patriot battalions, a THAAD battalion and two Avenger battalions for each of the three major regional contingencies. Bravo battery, with 81 soldiers, was established after the first successful flight test. The Army activated the second battery, Alpha, on 23 February 1996 at Fort Bliss, Texas. Together they comprise the core of the THAAD User Operational Evaluation System battalion - 1st Battalion, 6th Air Defense Artillery. A THAAD battery consists of a THAAD Radar, a BM/C4I element, and nine launchers with a basic load of eight missiles on each launcher.

Between December 1995 and May 1998, the THAAD test program made five intercept attempts. Although the tests illustrated the exceptional qualities of the radar, proved the communications links, and demonstrated the palletized launcher system, no intercept was achieved. With this test record and cost increases, the program repeatedly faced opposition from OSD. The Army, supported by the Navy and the Ballistic Missile Defense Organization, remained dedicated to the THAAD program. The resulting investigation attributed the test failures to quality control issues in the manufacturing process and prompted program revisions.[104] In a cost-sharing agreement between Lockheed Martin and the Army, the contractor would pay up to $75 million if they failed to achieve three hit-to-kill intercepts over the remainder of the Program Definition and Risk Reduction phase.[105] Five tests remained in this phase of the test program. In many respects, however, as one Democratic Senate aide remarked, "In reality, if there's one more failure there is no more THAAD."[106]

The year 1999, then, was crucial in the evolution of the THAAD program. The first intercept test of the year though ended in yet another failure. An attitude control thruster failed and the interceptor missed the target by 12 meters. Per the cost-sharing agreement, Lockheed was penalized $15 million. Two subsequent tests demonstrated the THAAD's capabilities.[107] On 10 June 1999, in its seventh intercept attempt, the THAAD weapon system successfully intercepted a Hera target missile in the upper atmosphere over WSMR.[108] The THAAD scored its second consecutive hit on 2 August 1999. In contrast to the June test, this intercept occurred outside the Earth's atmosphere. As Ed Squires, Lockheed Martin's THAAD Vice President, explained "By achieving a target intercept under a more stressing flight test scenario, we have been able to obtain the final missile design information required to move this program forward."[109]

Following the second successful THAAD intercept, Pentagon officials instructed the Army to cancel the remaining Program Definition and Risk Reduction flight tests and begin preparations for Engineering and Manufacturing Development. A 98-month EMD contract was signed with Lockheed Martin on 28 June 2000. Designed in two phases, the primary focus of the first phase of the contract is the demonstration of the redesigned system's capabilities in a series of ground and flight tests.[110] During this phase of low rate initial production, the team will also validate the production process. The second phase calls for a battle management and other software enhancements to provide full operational requirements compliance.

The redesigned THAAD will incorporate recommendations of the soldiers of the THAAD battalion, which address everything from ergonomic changes, improvements to software operation and doctrinal issues.[111] In addition, the redesign will create a more testable missile, according to Hans Mark, Pentagon Director of Research and Engineering.[112] Officials removed the requirement to intercept targets at altitudes ranging from 15-20 kilometers to the vacuum of space, determining that design complications did out weigh the benefits of these low altitude maneuvers. The new requirement of 40 kms and up will reduce the stress on the system's seeker and guidance system. In 2002, Colonel Patrick O'Reilly, THAAD Project Manager reported that the project is "going great" – slightly ahead of schedule and under cost.[113] In fact, the THAAD Project Office received the David Packard Excellence in Acquisition Award in 2002 for developing innovative logistics concepts, based on "pit-stop technology," that potentially reduce operation and support costs throughout the life of the system.[114]

Deployment has been an issue throughout the THAAD test program. In 1996, the Pentagon explored the possibility of deploying a prototype system to South Korea due to the North Korean missile test program and the rising tensions in the region.[115] Congress even mandated, in the 1996 defense bill that a system be in place by 1998. A GAO study conducted at the same time recommended not fielding a prototype until late 2000, until the THAAD was fully tested. The current goal is to field the system to operational units in 2007, and an entire battery by 2008. Full deployment should be attained by 2013.

National Missile Defense Redefined

The national missile defense system initially defined in the GPALS concept incorporated the various elements of the Strategic Defense Initiative. Budget constraints, due in part to the redirection toward theater programs, resulted in the termination of the HEDI program at the end of fiscal year 1992. The Bush Administration's interest in the Air Force's Brilliant Pebbles program led to the cancellation of the GSTS project, as the Brilliant Pebbles could serve both as boost and midcourse sensors.

In October 1992, Congress passed the National Defense Authorization Act for Fiscal Year 1993, which amended the Missile Defense Act of 1991. It placed greater emphasis on treaty compliance for any NMD system that the United States might deploy and eliminated the 1996 target date for deployment of an NMD site.[116] Five months later, the Total Army Analysis 2001 validated the requirement for a National Missile Defense for the continental United States.[117] Meanwhile, the Bottom-Up Review released in September 1993, recommended that the NMD program be reduced to a System Technology Demonstration. Funding for the program was reduced accordingly. The BMDO leadership negotiated to create a restructured NMD "Technology Readiness Program."[118]

The Ground-Based Interceptor remained a viable element of the NMD system and plans called for one hundred interceptors to be deployed the former SAFEGUARD site near Grand Forks, North Dakota. Despite continued progress, by the end of 1993, the future for the ERIS/GBI project did not look positive. Officials deferred acquisition efforts to await future directions following a DoD review of the Strategic Defense Initiative and the release of the National Missile Defense Acquisition strategy.

The program, renamed the Exoatmospheric Kill Vehicle (EKV) program, seemed to rally in 1994. On 26 May, the USASSDC announced a downselect in the EKV contractors, from three to two.[119] Although funding was significantly reduced, the SDIO Director, Lieutenant General Malcolm O'Neill (USAF) wrote in his response to Congress that he "[envisioned] this program as a series of epochs designed to incrementally mature the technology necessary to provide defense of the United States."[120] He added that the final EKV contractor would design, fabricate and test the system, with tests scheduled for FY97. Nevertheless, funding was again cut in subsequent years, as the Congress, the administration of President William Clinton and the military continued to argue the merits of a national missile defense system.

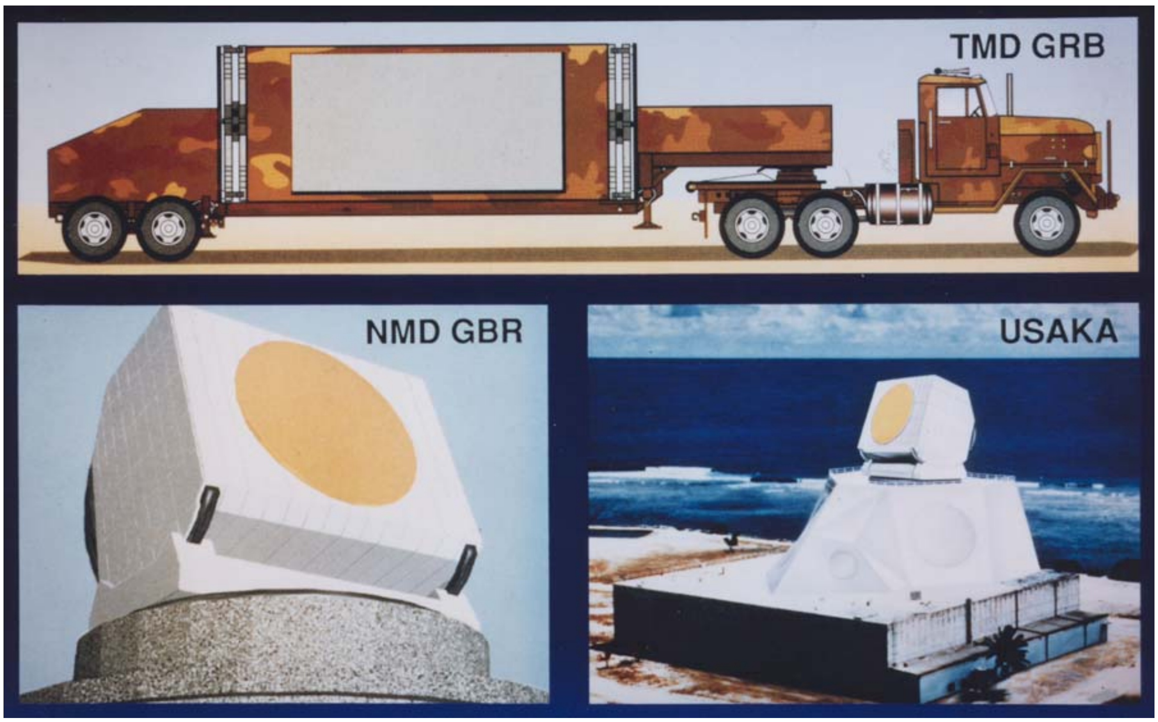

Fig. 5-19. The Ground-Based Radar Family of Radars included the truck mobile Theater Missile Defense system, the planned National Missile Defense radar and the experimental complex to be constructed at Kwajalein.

The Ground-Based Radar Experimental program faced similar obstacles.[121] Approved for the DEM/VAL phase in 1990, SDIO ordered the cancellation of the GBR-X program in 1991 following the Midcourse and Terminal Tier Review Architecture Study. Primary attention would instead be placed upon creation of a "Family of Radars" which employed a modular antenna component concept.[122] These radars would be used in support of TMD and GPALS, or Strategic Missile Defense. The TMD radar should be integrated with a variety of theater systems, such as the Patriot and ERINT. The GPALS facility would be able to operate in both the endo and exoatmosphere modes. The family of radars included four functional systems, three for theater defense and one for strategic operations. Raytheon Corporation was selected to perform the demonstration/validation for the radars in 1992.

In the next year, the family of radars became the TMD GBR, in support of the Upper Tier Theater Missile Defense System and the NMD GBR for strategic defense. Although both radars share many qualities, the NMD radar was designed to have a larger antenna, thereby requiring a larger power supply. With dramatically reduced funding in November 1993, the NMD-GBR was "restructured to leverage off of TMD and… concentrate on critical technology issues."[123] Thus at the end fiscal year 1993, only the mobile TMD GBR had received approval to proceed. This approval was based upon the radar's ability to "meet an immediate requirement for a more capable wide-area-defense radar to provide surveillance and fire control support" to the THAAD missile system.[124] The TMD GBR was to provide threat attack early warning, threat type classification interceptor fire control, sensor/cueing, launch/impact point estimation, threat classification against theater/tactical ballistic missiles and kill assessment. Two years later, in 1995, the NMD Program Office established the NMD-GBR Product office and the GBR Project Office became a product office and was absorbed into the THAAD Project Office.[125]

Other Initiatives – Targets

The command and its predecessors have been actively involved in developing targets for test programs.[126] Traditionally, Minuteman I missiles served as targets for ICBM intercept tests. The surplus stock of these ICBMs, however, is nearly depleted.[127] Therefore, boosters designed and tested by the command are to fill this void and provide cost-effective payloads (targets) for both strategic and theater systems. In addition to serving as a target, the systems will assist in the development of detection procedures and technologies.

The Strategic Targets Product Office initiated the SDIO funded Strategic Target System (STARS), in 1985. Its goal was "to launch missiles with experimental payloads into near-space to simulate the reentry of ballistic missile warheads."[128] Lacking the range of a Minuteman, the STARS IRBM had to be launched from the Pacific Missile Range in Kauai, Hawaii. This move provoked considerable public opposition from environmentalists. An extensive review and subsequent court decision, however, allowed the project to proceed. Following this controversial beginning, the STARS initiated its test phase in 1993. In 1994, the USASSDC introduced the STARS II, a new configuration of the target which included the addition of the Operation and Deployment Experiments Simulator post-boost vehicle.[129] With this adaptation, the STARS II provided the ability to maneuver payloads and deploy them after the third-stage missile motor drops off, increasing the target's viability in interceptor and sensor test programs.

With several successful flight tests, plans called for the target to be incorporated into the BMDO's midcourse space experiment. On 24 April 1996, the BMDO launched the MSX satellite into near-synchronous orbit to collect data on missile signatures in the midcourse phase.[130] In this test, conducted on 3 September 1996, the STARS deployed 26 objects to be observed by the MSX with its infrared, ultraviolet, and visible-light sensors. This launch brought the STARS record to four successes out of four launches.

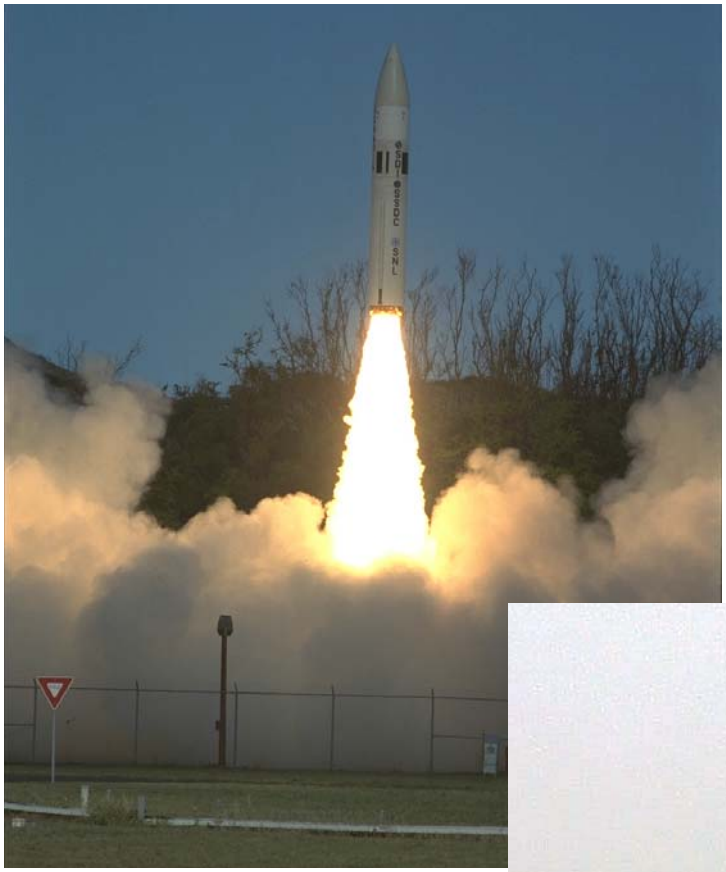

Fig. 5-20 and 5-21. The STARS (left) and Minuteman II MSLS (below) are among the Strategic Target Systems.

Following the shift away from NMD in 1993, the GAO initiated a study to determine the future of the STARS project – termination or temporary hold pending future NMD tests and possible TMD testing.[131] The STARS Project Office presented six arguments for the continuation of the program. The STARS is exempt from both START treaties. It can deliver payloads at a variety of speeds and trajectories. It is the only target system operating in the 1,500-3,000 km range. Finally, the STARS had a demonstrated ability to provide support for various experiments. The STARS remains on the inventory of available Strategic Targets.

A second system was later added to the arsenal of the Strategic Targets Product Office - the Minuteman II-based Multi-Service Launch System (MSLS), a joint Army-Air Force program. Introduced in 1996, the MSLS target system consists of an MSLS front section with a three-stage Minuteman II booster. Within a year, the system enjoyed a three-for-three success rate. A follow-on system, the Orbital/Suborbital Target Launch Vehicle completed its first demonstration flight on 28 May 2000.[132] The Orbital/Suborbital Program Target Launch vehicle is scheduled to replace the MSLS in future integrated flight tests for the ground-based midcourse defense system.

Fig. 5-22 and 5-23. Both the STORM (right) and HERA (above) have served as targets for the THAAD and the PAC-3 projects.

The theater target program, a product of the BMD Space Payloads Office, began in 1993 and progressed rapidly.[133] These target systems are used in tests of the THAAD, Patriot, Corps SAM and the GBR. The Storm was first developed in 1988, completed its fifth successful flight in December 1993.[134] During this flight, the Storm launched the new maneuvering target test vehicle in its first test.[135] The target missile with a range of 400km is designed to simulate the predicted maneuvers of future short and medium-range ballistic missiles. By 1995, with ten straight successes, the Storm had developed a reputation for reliability supporting ERINT and THAAD tests. A modified single-stage Storm, the Storm II Maneuvering Tactical Target Vehicle, became operational in 1997. The new version of the Storm was developed "for use in evaluating current and future theater missile defense weapon systems," such as the Patriot.[136]

A second theater target, the Hera achieved its first flight test in April 1995.[137] Developed to support THAAD interceptor and radar tests, the Hera has a longer range than the Storm and is capable of delivering a variety of payloads to include chemical weapons. The Hera is launched from the specially developed Launch Complex 94 at Mountainair, New Mexico, which provides appropriate distances to simulate realistic scenarios.[138] Following three successful flight tests, the Hera served as the target in the first THAAD intercept test in February 1996. In that next year, the Hera flew in support of the PAC-3 test program. A new version of target, the Hera modified ballistic reentry vehicle (MBRV-3), was tested in March 1998. Although the targets program experienced problems with the Hera target, its successes far outnumbered its failures and the Hera remains a viable tool in the BMD test program.

In order to simulate a target with a mobile launch capability, the Targets Office developed the Short Range Air Launched Target (SRALT). The SRALT is dropped from a C-130 cargo plane and descends by parachute before igniting its motors at the appropriate altitude. The system completed its first risk reduction flight at the Pacific Missile Range, in April 1999. With a range of up to 600km, the SRALT was developed for the Navy Area Defense and the THAAD test programs.

Responsibility for the targets project originally rested with the Test and Evaluation Directorate, later known as the Targets, Test and Evaluation Directorate, of the USASSDC. Its significance was elevated in March 1998 when the Army Acquisition Executive chartered the Ballistic Missile Targets Joint Project Office (BMTJPO) which sought to centralize the requirement held by all branches of the service to develop and launch ballistic missile targets. At the recommendation of the BMDO, the BMTJPO transferred to BMDO in October 2001.[139] The move "[was] expected to improve the effectiveness of countermeasures available to the military." The Targets Office remained with BMDO for less than a year. On 19 September 2002, Lieutenant General Ronald Kadish, Director of the Missile Defense Agency, transferred the targets management and execution to the U.S. Air Force Space and Missile Defense Center. Specifically, responsibility for managing targets development was to be put under the Rocket Systems Launch Programs at Kirtland AFB, New Mexico, "to streamline activities associated with development of the Ballistic Missile Defense System (BMDS)." The MDA/Targets and Countermeasures Directorate in Washington at MDA, however, "[would] remain the primary interface for overall program management and program integration within the BMDS."[140]

End Notes

[1]"Memorandum from Colonel Michael Keaveney on Assuming Command, 1 April 1991."
[2]From a speech made by Brigadier General Robert Stewart, Deputy Commander, U.S. Army Strategic Defense Command at the U.S. Space Foundation's Fifth National Space Symposium. General Stewart became the Army's first astronaut in 1979 and logged 289 hours in space. Although he was referring to the Army's situation after Vietnam, his comment illustrates the difficulties of introducing new methods into any institution. See Martin Berkey, "General: Satellite Secrecy No Longer Needed," *Huntsville Times* 9 April 1989.
[3]VANGUARD Study 1990.
[4]"Enclosure 3: Alternative 3, SDC Consolidation and Information Paper ARSPACE Resubordination to SDC, 28 March 1991."
[5]"Memorandum Through the DCSOPS to the VCSA regarding the VANGUARD Proposals, 16 October 1990." The counterpoint to this criticism appeared in the ARSPACE journal, *STAR*NET*, "The faulty assumption…is that the traditional proponents… will recognize the need for space applications and support such a need across proponent lines…. Only in Desert Storm did we see real space applications but their use and interest base quickly eroded in the post-conflict period." See "Commander's Corner, Regarding the Army and Space," STAR*NET 1.4 (15 January 1992):2.
[6]"VANGUARD Final Report, Conclusions and Recommendations, V-23-V-24."
[7]General Order 12, 1 July 1993.
[8]Donald G. Dupont, "Final Roles and Missions Report Says Space Lead Should Go To STRATCOM," *Inside the Army* (15 February 1993); Donna Haisiley, "Draft Joint Staff Pub Pushes for Greater Battlefield Use of Space Assets," *Inside the Army* (17 May 1993); Genevieve Anton, "Air Force Chief Urges Consolidation of All Military Space Operations," *Colorado Springs Gazette-Telegraph* (16 April 1993);" Neil Munro and Barbara Opall, "DoD Nixes Merger of U.S. Nuclear, Space Commands," *Defense News* (27 September - 3 October1993)" respectively.
[9]Jason Glastow and Steve Weber, "Air Force Moves to Push Army, Navy Out of Space," *Army Times* 24 October 1994. At the same time, a retired Air Force Colonel Kenneth A. Myers argued that while consolidation sounds persuasive the Air Force "has not always been a positive force in achieving formidable space capabilities," pointing out that the service had opposed geostationary satellites for communications, delayed and fought GPS, opposed MILSTAR and did not support LANDSAT. He called for creating a new space service "to organize, train, equip and sustain space forces to support military operations and national security requirements." See Kenneth A. Myers, "Military Space Control Reality Check," *Space News Supplement* 1-13 November 1994:15-16.
[10]General (ret.) Frederick J. Kroeson, "The Army's Role in Space," *Army* November 1994:28.
[11]"Air Force Association Calls for Reorganization of Space," *BMD Monitor* 18 November 1994:40. This same article noted that the report stated, "The U.S. military advantage in space could be lost if organizational, launch and budget problems "are not addressed."
[12]"DoD Debate Over Management of Military Space Assets Finds New Venue," *Inside the Army* 28 November 1994:27. The Army, Navy and Marine Corps implicitly defined space as another place to control to win the terrestrial battle. Space is those regions from, through or in which systems operate.
[13]"Space Control Debate Takes Center Stage," *Space News Supplement*, 12-18 December 1994:10. The Army was prepared to resist consolidation if it would minimize its assured space access and prevent it from voicing its requirements. The Navy asserted it needed an independent space command because of the "unique nature of its reliance upon space systems."
[14]"Army Remains Involved in Space," *AUSA News* 17.3 (January 1995).
[15]"Army Seeks Assurances on Space Architect 'Board of Directors'," *Inside the Army* 12 June 1995: 11-12; "Army Pushing for Space Oversight Management Plan," *Inside the Army* 1.12, (24 March 1994): 26-27
[16]"With Input from Services, Joint Staff…Air Force Secretary Submits Proposal for New Space Architect Position," *Inside the Army* 7.11 (20 March 1995):23-25.
[17]"Pentagon Acquisitions Chief Clears Space Architect's Office for Lift-off," *Inside the Army* 9 October 1995.
[18]As originally formed, the Office of the Space Architect had three divisions, one for requirements, concepts and operations (CONOPS), a second for analysis and a third for capabilities. The first would work with military space assets to understand and assess requirements and concepts of operations. The second division would serve as the

"in-house analytical capability." The third would check requirements from the perspective of existing and planned space capabilities and would have major responsibility for integrating and synthesizing architectural capabilities. While the Space Architect would direct planning and analysis, and promulgate standards and architectures. On the other hand, the Space Architect would not execute acquisition programs, validate requirements or direct resource allocation. See "With Input from Services, Joint Staff…Air Force Secretary Submits Proposal for New Space Architect Position," *Inside the Army* 7.11 (20 March 1995):23-25.

[19]United States General Accounting Office, *National Space Issues: Observations of Defense Space Program and Activities*, 16 August 1994, GAO/NSIAD-94-253, 10.

[20]United States, Department of Defense, *Annual Report to the President and Congress 1996* (Washington, D.C.: Government Printing Office, 1996), p. 79.

[21] Unless otherwise noted the following is based on Joshua Boehm with Craig Baker, Stanley Chan and Mel Sakazaki, *A History of United States National Security Space Management and Organization*, www.fas.org/spp/eprint/article03.html accessed on 3 July 2002.

[22]In 1990, Lithuania initially declared its independence. In the next year the other republics made their own declarations - Georgia (4 June), Estonia (20 August), Latvia and Lithuania (21 August), Ukraine (24 August), Byelorussia (25 August), Moldavia (27 August), Azerbaijan (30 August), Uzbekistan (31 August), Kirgizia (31 August) and Tadzhikistan (9 September). On 8 December 1991, the leaders of Russia, Ukraine and Byelorussia proclaimed the Soviet Union had ceased to exist and declared the creation of a Commonwealth of Independent States. President Gorbachev subsequently announced, on 17 December, that all Soviet central government structures would cease to exist effective at the end of the year. Gorbachev resigned as president on 25 December, effectively marking the demise of the Soviet Union and the end of the Cold War.

[23]System Planning Corporation at the direction of the Strategic Defense Initiative Organization, *Ballistic Missile Proliferation: An Emerging Threat 1992* (Arlington: System Planning Corporation, 1992).

[24]Lieutenant General Donald M. Lionetti, Commander USASSDC, 1992.

[25]Missile Defense Agency, "Missile Defense Milestones, 1944-2000," http://www.acq.osd.mil/bmdo/mdolink/html/milstone.html.

[26]Ambassador Cooper served as the chief American negotiator at the Defense and Space Talks in Geneva since 1987 and was appointed SDIO Director in July 1990.

[27]Baucom, *Origins*, p. 199.

[28]State of the Union Address by President George H.W. Bush, 29 January 1991, located at http://www.c-span.org/executive/transcript.asp?cat=current_event&code=bush_admin&year=1991.

[29]McMahon, p. 94-95.

[30]Baucom, *Origins*, p. 199.

[31]This act is part of H.R. 2100, the "National Defense Authorization Act for Fiscal Years 1992 and 1993."

[32]"Missile Defense Milestones, 1944-2000," http://www.acq.osd.mil/bmdo/bmdolink/html/milstone.html.

[33]Lieutenant General Robert Hammond, the USASDC Commander, was appointed the PEO Strategic Defense on 5 October 1988.

[34]The PEO-AMD was composed of the National Missile Defense Program Office, the THAAD, Patriot and Arrow Project Offices and the CORPS SAM/Medium Extended Air Defense System (MEADS) and Joint Tactical Ground Station (JTAGS) Product Offices. Memorandum for Assistant Secretary of the Army (Research, Development and Acquisition) from COL Daniel L. Montgomery, PEO-MD, Subject: Name Change of Program Executive Office (PEO), Missile Defense, 23 May 1996.

[35]General Orders 13, dated 1 July 1993.

[36]The HELSTF had transferred to the USASDC from the Army Materiel Command on 1 October 1990 as part of the Army initiative to centralize directed energy research. General Orders 12, dated 8 May 1991.

[37]General Orders 20, dated 4 April 1988.

[38]General Orders 17, dated 15 December 1995.

[39]The Multinational Programs Office oversaw this initiative.

[40]Memorandum from the Secretary of Defense to the Director, SDIO.

[41]The SDIO established on 15 March 1991 a new Deputy for TMD, equal in status to the Deputies for Technology and Strategic Defense.

[42]As a result of this decision, the U.S. Army Missile Command's Joint Tactical Missile Defense Management Office transferred to the USASDC.
[43]A direct descendant of the German V-2, the SS-1 Scud missile was first deployed by the Soviet Union in the 1960s. Designed to carry either a 100-kiloton nuclear warhead or a 2,000 pound conventional warhead over ranges from 100 to 180 miles, the weapon can also carry chemical or biological agents. During the Gulf War, the Iraqis used a modified Scud with a reduced warhead and larger fuel tank for greater range. It was, as a result, "structurally unstable and often broke up in the upper atmosphere," reducing its accuracy but also making it more difficult to intercept given the unpredictable flight path. Excerpted from Norman Friedman's *Desert Victory - The War for Kuwait* (Naval Institute Press, 1991) http://www.pbs.org/wgbh/pages/frontline/gulf/weapons/scud.html.
[44]The modified Patriot employed a proximity fuse to destroy the incoming missiles rather than a kinetic energy intercept.
[45]Announcement by Secretary of Defense Les Aspin, dated 13 May 1993; Memorandum for Correspondents, No. 159-M, 13 May 1993.
[46]K. Scott McMahon, *Pursuit of the Shield* (New York: University Press of America, 1997), pp. 246-247.
[47]Directive 5134.9 re: Ballistic Missile Defense Organization issued by Deputy Secretary of Defense John M. Deutch on 14 June 1994 specifically defined the new missions for the BMDO program.
[48]Office of the Secretary of Defense, *Report of the Bottom-Up Review*, October 1993, pp. 41-48 cited in Baucom, "The U.S. Missile Defense Program, 1944-1994," 27.
[49]DoD leaders would soon reduce this and other allocations with most of the cuts coming from TMD. Congress also indicated that it would not support the funding levels outlined in the review.
[50]The two presidents also agreed to conduct a joint TMD early warning exercise at this Washington Summit, see http://sun00781.dn.net/nuke/control/abmt/chron.htm.
[51]In addition to the missile's velocity and range, at issue was "the mobility of the THAAD batteries and the system's ability to process targeting information from ground, as well as space-based sensors." Barbara Opall, "Strategic Accord Inhibits Advances in TMD Programs," *Defense News*, 4-10 October 1993.
[52]Of particular interest for the American government was the protection of the THAAD system. "Plan may foment administration battle with Senate: Russia Considers U.S. Plan to Clear ABM Treaty for THAAD." *Inside the Pentagon*, 9 December 1993.
[53]See http://sun00871.dn.net/nuke/control/abmt/chron.htm.
[54]Gordon R. Sullivan and Michael V. Harper, *Hope Is Not A Method: What Business Leaders Can Learn From America's Army* (New York: Times Books/Random House, 1996), p. 169.
[55]General Sullivan had been considering the issues surrounding change since the end of the Cold War. His message concerning the Louisiana Maneuvers and his remarks at the TRADOC Desert Storm conference may be found in Gordon R. Sullivan, *The Collected Works of the Thirty-second Chief of Staff, United States Army: Gordon R. Sullivan, General, United States Army, Chief of Staff, June 1991-June 1995*, ed. by Jerry L. Bolzak (Washington, D.C.: U.S. Army Center of Military History, 1996), pp. 103-105 and 44-45, respectively. The standard work on General Sullivan's Louisiana Maneuvers is James L. Yarrison, *The Modern Louisiana Maneuvers* (Washington, D.C.: U.S. Army Center of Military History, 1999). A useful examination of previous large-scale Army exercises is Jean R. Moenk, *A History of Large-Scale Army Maneuvers in the United States, 1935-1964* (Fort Monroe: Historical Branch, Office of the Deputy Chief of Staff for Military Operations and Reserve Forces, 1969) while the standard work on the 1940-1941 maneuvers is Christopher R. Gabel, *The U.S. Army GHQ Maneuvers of 1941* (Washington, D.C.: U.S. Army Center of Military History, 1991).
[56]A complete treatment of the founding and early days of the ARSST may be found in U.S. Army Space and Missile Defense Command Historical Office and Science Applications International Corporation, Space Warriors: The Army Space Support Team (unpublished ms held at USASMDC Historical Office).
[57]The shortcomings of TERS are outlined in CALL Newsletter No. 91-3, Chapter 3, "Tactical Early Missile Warning" http://call.army.mil/products/newsltrs/91-3/chap3.htm accessed on 10 January 2003 as well as Space Warriors, 1-19-20. Nevertheless, it was better than no warning at all. Although postwar assessments of units in the Persian Gulf noted that the "early warning system was inadequate" or that "Divisions need improved air attack early warning capability and access to real-time early warning information," TERS did provide, within its limits some form of early warning. See U.S. Army Space and Missile Defense Command Historical Office and Science

Applications International Corporation, *The Joint Tactical Ground Station: Fielding and Operational Lessons Learned* (Huntsville: U.S. Army Space and Missile Defense Command, 2000; reprint ed., 2003), pp. 1-29-1-30.
[58]A complete account of the evolution of the JTAGS may be found in ibid.
[59]Unless otherwise noted, the material in this section on Haiti (Uphold Democracy) is based on Weekly Activities Report, 2 October 1995-8 April 1995 (hereafter referred to as ARSPACE Weekly Activities Report).
[60]For example, the ARSPACE Weekly Activities Report for 2-8 October 1995 states, "Using several USARSPACE Advanced Communications Technology (ACTS) terminals, President Clinton conducted a video teleconference (VTC) with members of the JTF staff in Haiti on 6 October. A VTC between the Army Chief of Staff and the JTF commanders and staff in Haiti was also conducted on 2 October."
[61]For example, see ARSPACE Weekly Activities Reports, 23-29 October 1995 and 30 October-5 November 1995.
[62]ARSPACE Weekly Activities Report, 13-19 November 1995.
[63]"ACTS Supports Forces in Haiti" and "Weather Satellite Supports Troops in Haiti," respectively. The High Resolution Weather Satellite Receiver received high resolution digital imagery from military and commercial polar orbiting satellites.
[64]ARSPACE Weekly Activities Report, 2-8 April 1995.
[65]ARSPACE Weekly Activities Reports, 7-14 January 1995 and 22-28 January 1995.
[66]The 1st SATCON BN was formed in 1995 and controls the DSCS, the super high frequency (SHF) communication network for American forces "anytime anywhere." The battalion provides technical support and troubleshooting for the system. It runs the Regional Space Support Centers (RSSC) and performs planning functions and authorizes warfighter use of the system. The battalion has a Headquarters Company (HHC) and five other companies spread around the world. The HHC resides at Falcon Air Force Base, Colorado. A Company is based at Fort Detrick, Maryland, Company B at Fort Meade, Maryland, C Company at Landstuhl, Germany, Company D at Camp Roberts, California, and Company E at Camp Buckner and Torii Station, Okinawa, Japan.
[67]ARSPACE Weekly Activities Report, 3-9 December 1995.
[68]ARSPACE Weekly Activities Report, 17-30 December 1995.
[69]Lieutenant Colonel Bill Bugert, "ASPO's TENCAP Supports Commanders in Bosnia," *The Eagle* January-February 1996:10; ARSPACE Weekly Activities Reports, 12-18 February, 23-29 September, 14-20 October, 11-17 November 1996.
[70]ARSPACE Weekly Activities Report 8-14 April 1996.
[71]ARSPACE Weekly Activities Reports, 16-22 October and 30 October-5 November 1994.
[72]The SPECC was designed to be used in a Joint Task Force/Joint operations Center and Combined Land Component Command G-3 Operations Cell. It allowed allied commanders to track progress of their respective forces from a single source. It gave commanders a quick common picture of the battlefield.
[73]The VDCPAD would provide a commander with real-time visibility throughout the phases of a conflict.
[74]ARSPACE Weekly Activities Reports, 9-15 April and 7-13 May 1995.
[75]ARSPACE Weekly Activities Report, 30 July-5 August 1995.
[76]Including the Mission Planning Rehearsal System, the Multispectral Imagery Processor (to develop and Intelligence Picture of the Battlefield [IPB]), the High Resolution Satellite Weather Receiver and INMARSAT.
[77]ARSPACE Weekly Activities Report, 23-29 April 1995.
[78]Reprinted and updated from Chapter 17, Walker, Martin and Watkins, *Four Decades of Progress*. The ERINT/PAC-3 missiles are 17 feet in length and 9.8 inches in diameter and weigh 707.6 pounds. Given its small size four PAC-3 missiles fit into a single Patriot canister or 16 per launch station.
[79]Kinetic Energy Weapons Directorate Historical Report for Fiscal Year 1988, dated 30 July 1993; Theater Missile Defense Applications Program Office Historical Report for Fiscal Year 1990, dated 18 November 1990, and the Joint Theater Missile Defense Program Office Historical Report for Fiscal Year 1991, dated 29 May 1992.
[80]Briefing, "ERINT-1 Program," [1991].
[81]"Data 'Drop-Out,' Mapping Errors are Possible Causes of ERINT Failure," Inside *the Army*, 28 June 1993. Note all ERINT tests were conducted at White Sands Missile Range, New Mexico.
[82]The Storm target contained a cluster of 38 pressurized, water-filled containers designed to simulate toxic chemical submunitions. "ERINT Scores successful intercept of simulated TBM," *Inside the Pentagon,* 2 December 1993; Martin Burkey, "ERINT missile test rates a success," *The Huntsville Times* 16 February 1994: B2; and "ERINT Hits Air-Breathing Target Drone," *Aviation Week and Space Technology*, 13 June 1994: 26.

[83]"Budget Constraints put ERINT and PATRIOT Interceptors on Collision Course," Inside *the Pentagon,* 26 November 1992.
[84]Unlike the ERINT, which used hit-to-kill technology, the PATRIOT multi-mode missile was equipped with a warhead. The kinetic energy intercept "releases 100 times more energy than is released by steel bomb fragments," increasing lethality explained Sid Wells, Vice President of Loral Vought Systems. Robert Langreth, "Sons of the Patriot," *Popular Science* June 1993: 1005; "Extended range interceptor wins approval for Patriot," *Redstone Rocket* 23 February 1994: 3; "Army recommends ERINT to DAB for Patriot Improvement," *BMD Monitor* 25 February 1994.
[85]Memorandum, Principal Deputy Under Secretary of Defense R. Noel Longuemare to Secretary of the Army and Director, Ballistic Missile Defense Organization, Subject: PAC-3 Acquisition Decision Memorandum, dated 7 July 1994; and "Army Weaponry and Equipment," *Army* 44 (October 1984): 296-297. The Patriot Project Office later merged with the Medium Extended Air Defense System Product Office, in October 2001, forming the Lower Tier Project Office, to "take maximum advantage from lessons learned from our legacy systems to ensure that interim and objective lower tier systems meet operational requirements at reduced cost."
[86]Daniel Dupont, "Pentagon Decides to Deploy Patriot PAC-3 Missiles to Persian Gulf Area," *Inside the Arm,* 16 February 1998: 1. Although deployed, industry and Pentagon officials did not expect to use the PAC-3 interceptors at this time.
[87]Requirements changes in January 1999 caused some delays and dry weather conditions at the test range postponed the first intercept test by six months.
[88]"The PAC-3 missile employs a lethality enhancer consisting of two rings of large fragments which slowly expand about the missile centerline to increase the effective radius of the PAC-3 missile against softer targets, such as cruise missiles, aircraft or helicopters." Lockheed Martin pamphlet entitled "PAC-3 missiles."
[89]Colonel Newberry, PAC-3 Program Manager, quoted in Bradley Graham 'Missile Defense Program Changes Course," *The Washington Post* 5 August 2002: A-6.
[90]Tony Capaccio, "Lockheed Defensive Missile Said Ready As U.S. Eyes Iraq Options," *Bloomberg.com*, 14 August 2002.
[91]Reprinted and updated from Chapter 17, Walker, Martin and Watkins, *Four Decades of Progress.*
[92]The MOU with Israel included an Israeli Testbed. Arrow Project Office Historical Report for Fiscal Year 1994, undated.
[93]Oversight of the Arrow Project Office transferred again on 1 October 2001 to the Ballistic Missile Defense Organization.
[94]Barbara Opall, "Arrow to Face Chemical Target Test," *Defense News* 31 May – 6 June 1993: 30 and Opall and Sharone Parnes, "Test Halts Cast Shadow on Arrow," *Defense News* 19-25 July 1993: 4, 50.
[95]Steven Pearlstein, "The Missile Makers' Next Big Target," *Washington Post* 5 August 1992: 81.
[96]Known as the Hetz-2 in Israel, the interceptor measures 23-feet in length and is designed to intercept missiles at altitudes between 10-40 kilometers. Unlike American missile defense systems, the Arrow is equipped with a warhead.
[97]See http://www.mod.gov.il/modh1/homa/.
[98] Reprinted and updated from Chapter 17, Walker, Martin and Watkins, *Four Decades of Progress*. The THAAD system is designed to defend an area about 200 km in radius and up to 150 km in altitude, an area approximately 10 times greater than the Patriot's. Project oversight transferred to the PEO-GPALS in 1992, the THAAD Project Office moved again on 1 October 2001 to the BMDO.
[99]Barbara Opall, "New THAAD Puts on Weight – Redesign of Larger Missile May Add Cost, Limit Availability," *Defense News*, 22-28 March 1993: 3, 28.
[100]Caleb Baker, "SDIO, Army Ends Dispute Over Theater Defense," *Defense News*, 25 November 1991: 4, 29.
[101]"Scuds blow up missile design," *Army Times* 5 April 1993.
[102]Daniel G. Dupont and Jeffrey Moag, "Lockheed Exceeds Its THAAD Cost Estimates by $83 Million," *Inside the Army* 15 August 1994; "Appropriations Slice $30 Million Intended for FY-95 THAAD Testing," *Inside the Army,* 8 August 1994; and "Independent Study Uncovers Management Problems With THAAD Program," *Inside the Army,* 26 December 1994.
[103]"TAA validates requirement for NMD – Total Army Analysis 2001 Adds THAAD Battalion to Corps Force," *Inside the Army* 5 July 1993.

[104]Among the identified problems were a malfunctioning lanyard which reset the avionics computers, a focal plane array overload preventing target identification, and the DACS motors did not operate properly. Colonel Louis Deeter, THAAD Project Manager, described the problems as "a failure of robustness" rather than a failure of design. Brett Davis and Martin Burkey, "THAAD thud may be $15M penalty," *The Huntsville Times*, 10 July 1998: A-11.
[105]Davis and Burkey, "THAAD thud".
[106]Quoted in Richard Parker, "Lockheed told to overhaul THAAD*,*" *The Huntsville Times* 9 July 1998: A-1, A-9.
[107]LuAnne Fantasia, "Take THAAD!!," *The Eagle*, Special Edition 1999, Joe Guy Collier, "THAAD 'smokes split-off warhead," *The Huntsville Times* 2 August 1999: A-1.
[108]This was the tenth of 13 planned tests. In this test, the Hera target simulated a Scud missile.
[109]Lockheed Martin Fact Sheet – "THAAD Second Intercept, August 2, 1999."
[110]Ground tests, to include cold motor static firings are on-going and flight tests are scheduled to begin in 2004.
[111]Ann Roosevelt, "Soldiers Help Save Money on THAAD Program," *Defense Week* (26 June 2000): 3.
[112]The objective characteristics for the THAAD are weight 600 kilograms, length – 6.2 meters, with an infrared terminal guidance seeker. BMDO Fact Sheet 204-00-11. "Army, OSD Confident THAAD EMD Design will Fix Missile's Problems," *Inside Missile Defense* 20 October 1999.
[113]Sandy Riebeling, "THAAD System," *Redstone Rocket* 5 May 2002.
[114]"Race car technology puts THAAD team in winner's circle," *The Redstone Rocket* 17 July 2002: 7. The team studied the automotive racing industry's maintenance diagnostics to improve the system design and reduce repair times.
[115]Brett Davis, "Missile System needs more tests, report says," *The Huntsville Times* 10 July 1996: B-2.
[116]In addition, Congress eliminated the requirement to deploy a TMD system by the mid-1990s and replaced it with a requirement to develop advanced theater missile defense systems for deployment.
[117]The deployed system would be manned by reserve forces. "TAA validates requirement for NMD – Total Army Analysis 2001 Adds THAAD Battalion to Corps Force," *Inside the Army* 5 July 1993.
[118]The NMD program was funded at $3 billion over a five-year period. "National Missile Defense: An Overview (1993-2000)," http://www.acq.osd.mil/bmdolink/html/nmdhist.html.
[119]"Rockwell, Hughes get SSDC contract go-ahead," *Redstone Rocket* 1 June 1994: 8.
[120]Jason Glashow, "Hughes, Martin, Rockwell now in race: Contractors are Concerned GBI Downselect Could Yield Two Loses," *Inside the Army* 3 January 1994.
[121]Reprinted and updated from Chapter 15 of Walker, Martin and Watkins, *Four Decades of Progress*.
[122]Media Briefing presented by Colonel Arthur C. Meier II, GBR Project Manager, dated 20 May 1991.
[123]Ground-Based Radar Project Office Historical Report for Fiscal year 1994, undated; Barbara Opall, "Missile funds shift to small, mobile systems," *Army Times* 6 December 1993.
[124]Ground-Based Radar Project Office Historical Report for Fiscal Year 1994, undated, Ground-Based Radar Project Office Historical Report for Fiscal Year 1993, dated 23 March 1994
[125]Skip Vaughn, "National missile defense establishes radar project," Redstone *Rocket*, 12 July 1999: 16 and Vaughn, "Radar product office joins THAAD missile team," *Redstone Rocket*, 5 July 1995: 1.
[126]Reprinted and updated from Chapter 16 of Walker, Martin and Watkins, *Four Decades of Progress*.
[127]Melinda Larson, "Kauai to Kwajalein fight support by KMR: STARS mission a stellar success," *Kwajalein Hourglass*, 28 August 1993: 1, 3.
[128]Rick Lehner, "Strategic Target System and the National Environmental Policy Act: STARS Lessons to be Learned," 1994, 3; "STARS missile has successful flight," Redstone *Rocket*, 27 July 1994: 2.
[129]In contrast, the STARS I consists of a refurbished Polaris first and second stages and a commercially purchased Orbus I third stage that can deploy single and multiple payloads.
[130]"Stars Booster Deploys Objects for MSX Test," *Aviation Week and Space Technology*, 16 September 1996. The MSX satellite collected data on realistic missile-type targets and penetration aids against terrestrial, Earth and celestial backgrounds for both TMD and NMD programs. The command was involved with the MSX effort since its inception in 1987.
[131]"Ballistic Missile Defense: Current Status of Strategic Target System" Letter Report – 3 March 1995, GAO/NSIAD-95-78.
[132]The system consists of a front section atop a three-stage Minuteman II booster. Jeff Compton, "NMD Target vehicle flies demonstration," *The Eagle* October 2000: 22.

[133]Targets, Test and Evaluation Directorate Historical Report for Fiscal Year 1992, dated 21 December 1993.
[134]The Storm target is composed of a Sergeant motor in the first stage, a Minuteman I third stage motor in the second stage and a specially designed ballistic reentry vehicle.
[135]Gerda Sherrill, "New theater missile defense target demonstrated," *Redstone Rocket*, 22 December 1993: 15.
[136]Lieutenant Colonel James D. Matthewson, Jr. Storm Product Manager, quoted in "Missile target vehicle has successful test at White Sands Missile Range, N.M.," *Redstone Rocket*, 12 November 1997: 20. The Storm II target is made from a Minuteman II second stage booster and a Pershing II reentry vehicle.
[137]The Hera consists of a modified second and third stage from Minuteman II missile, a modified Pershing II guidance and control section, various interstage hardware, and an instrumented ballistic reentry vehicle. USASSDC News Release, "First Hera Target Flyout Test," 24 April 1995.
[138]A second launch site was constructed at Fort Wingate, New Mexico.
[139]With the transfer the JPO was renamed the Missile Defense Targets Joint Program Office. Memorandum from the Office of the Secretary of the Army, Acquisition, Logistics and Technology, dated 6 September 2001, Subject: Program Realignments.
[140]In 2002 the BMDO became the Missile Defense Agency. Memorandum from the Secretary of Defense, dated 2 January 2002, Subject: Missile Defense Program Direction.