Seize the High Ground

The Army in Space and Missile Defense

NIKE - ZEUS
1957-1964

SAFEGUARD Systems Command
1969-1974

Space and Missile Defense Command
2001-Present

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The Commander's Introduction

Part of the U.S. Army's strength lies in its traditions. These traditions are epitomized in the framework of lineage and honors that link soldiers and their units. As the Army's newest major command, one might assume that the U.S. Army Space and Missile Defense Command (USASMDC) would not have a significant historical record. However, USASMDC and its predecessor organizations have spent many decades (since 1957) focusing on issues and experiments with missile defense, space-based communications, and sensor technologies. This focus can be seen as a natural outgrowth of the Army's continuing strategic defense mission: defending the U.S. homeland.

It is my pleasure to introduce this history of the U.S. Army's activities in space and missile defense. A glance through the pages of this survey will illustrate the importance of space and missile defense to America's military focus. As the command evolved from its beginnings in 1957 into its present shape, it retained a functional organizational structure that oversaw the development of various systems from the earliest developmental stages to operational use. The USASMDC was, and remains, an adaptable, technology-based organization, open to new ideas, innovations and forms of collaboration. But, at the same time, we have never lost sight of our primary goal, giving the individual soldier the best possible tools for finding and destroying the enemy. We support the warfighting combatant commanders, play an important role in the acquisition process, work to integrate space and missile defense solutions within the Army, and act as the service's advocate in Joint Warfighting forums.

In the continuing evolution of the USASMDC's missions, I thank the soldiers and civilians who have served and continue to serve with loyalty, courage, intelligence, initiative, ingenuity, and creativity. I have the honor to serve as the command's public face not only for the dedicated men and women who serve in the USASMDC today but for all those who have contributed to our accomplishments over the last 46 years. May all those who read this book learn from the achievements captured in its pages.

SECURE THE HIGH GROUND

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Commanding

Preface and Acknowledgements

Seize the High Ground: The Army in Space and Missile Defense provides an overview of the Army's involvement in the development and use of space-based systems and missile defense to serve the nation. The Space and Missile Defense Command traces its origins to the founding of the nation, when strategic defense meant coastal fortifications. Through the 19th and 20th centuries, this concept expanded as new construction techniques were devised and coast artillery fire became more accurate. Since 1945 the concept of strategic defense has expanded beyond coastal fortifications and artillery to encompass outer space and missile defense. In order to meet these new challenges, the Army was specifically assigned to develop a system to detect, intercept and destroy enemy missiles. At the same time, the Army was intimately involved in the early days of space flight, building the missiles that launched the first American satellites and astronauts into orbit.

The Army's record of achievement in space and missile defense matters is a success story. Despite political controversies surrounding missile defense and conflicts over the Army's role in space, soldiers, scientists and technologists have been generally successful in devising ways to defend the nation from missile attack and in using space-based systems to increase the Army's combat power. Army operations since 1989 provide the historical evidence on which this judgment rests. Additionally, the functional task groupings the Army's space and missile defense units adopted to bring order to their activities may offer a template for future Army organization.

Although expanded and bearing a new title, *Seize the High Ground* builds upon the material presented in *Strategic Defense: Four Decades of Progress*, an earlier volume published by the USASMDC Historical Office in 1995. Sharon Lang and Lewis Bernstein, the authors of the present volume, are particularly indebted to Frances Martin, a coauthor of this 1995 volume. The authors also wish to thank Ms. Susan Gahagan of Sigma Services of America who designed the layout and Mr. Roy L. McCullough of Science Applications International Corporation (SAIC) for his comments and suggestions on a draft version of the manuscript.

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Introduction
A Historical Perspective of Missile Defense and Space

In 1997, the Army established its newest major command, the U.S. Army Space and Missile Defense Command, to serve as its proponent for space and national missile defense and overall integrator for theater missile defense. The Army's interest in space and missile defense stems from its traditional mission of strategic defense that began in the 1790s, when it built and manned coastal forts to defend the nation against assault from the sea. In the early 20th century, soldiers continued to man coastal forts and by World War II, they operated anti-aircraft sites across the nation to defend against the threat of long-range bombers. By 1945, the Army had a secure grasp of sensor technology fundamentals that enabled it to take, process, and analyze millions of photographs for intelligence purposes; it had created and operated a large, secure, unified global communications system, and created the best code-breaking capability in the world. Additionally, along with its air arm, the Army was working on developing guided missiles.

At the end of World War II, the United States and the rest of the world were introduced to two new threats—ballistic missiles and nuclear weapons. Postwar assessments pointed the way toward new weapons systems and using rockets in space exploration. In the mid-1950s, Soviet intercontinental ballistic missiles threatened to destroy American cities with nuclear warheads. In 1955, the technological challenge posed by this new threat led the Army to begin studying the feasibility of creating a defense against ballistic missiles. In October 1957, the Army created the Redstone Anti-Missile Missile Systems Office in Huntsville, Alabama, initiating research that led to the NIKE-ZEUS anti-missile system. These efforts provided the foundation for the Army's space and missile defense program.

Through the late 1950s, the Army's efforts in rocketry, missile defense, and sensor technology were complementary—each capability worked to enhance the other. Although not seen at the time, they were inter-locking efforts. In fact, the Army built and launched the nation's first ballistic missile and earth orbiting satellite. The Mercury astronauts were placed in orbit by modified Army Redstone rockets, the Jupiter Cs. These feats, which challenged the U.S.S.R.'s first ventures into space, were the work of Dr. Wernher von Braun and his rocket team at the Army Ballistic Missile Agency at Redstone Arsenal, Alabama. The first communications and reconnaissance satellites were developed and launched through a partnership between private industry and government in which the Army played a prominent part. This link was temporarily broken by the Eisenhower Administration's decision to create the National Aeronautics and Space Administration (NASA) and redistribute space and missile roles and missions among the services. NASA received the Redstone program, the Explorer satellite program, and all the rocket and missile contracts the Army had with the California Institute of Technology's Jet Propulsion Lab, as well as responsibility for developing the 1.5-million-pound thrust Saturn rocket. The Army also transferred technical expertise from the Army Ballistic Missile Agency Development Operations Division to NASA.

The Army lost most because it had the most to lose, but it did retain responsibility for maintaining and improving worldwide communications and for missile defense. The former derived from its communications functions while the latter from its charge to defend American territory, in terms of coastal defense, then antiaircraft defense, and finally air defense. The Army's work served as a catalyst for a telecommunications revolution because satellites stitched the world together in a way very different from either wires or cables. As it temporarily lost part of its space functions, it concentrated on the air defense mission.

In 1962, the NIKE-ZEUS program made the first successful intercept of an intercontinental ballistic missile. In 1963, Project MUDFLAP achieved a satellite intercept. These successes generated controversy when Secretary of Defense Robert S. McNamara determined that the missile defense system was neither technologically feasible nor cost effective. He assumed the Soviets would overwhelm it by launching more missiles than could be intercepted. His own preferred solution was peace through terror or mutually assured destruction. In 1965, after China developed and tested nuclear weapons and missiles, strategists began to refer to an "Nth country" threat to stability. McNamara eventually agreed with the premise and announced a decision to deploy a system to protect against a possible Chinese attack, and development work proceeded. As arms control negotiations began with the Soviet Union, diplomats on both sides used their anti-missile systems as bargaining chips to obtain concessions from each other. By the 1970s, the Army activated the only missile defense system in the West, the Stanley R. Mickelsen SAFEGUARD Complex in North Dakota. The ratification of the SALT I agreement in 1972 limited deployment of ballistic missile defense systems. In 1975, as a cost-cutting measure, the United States deactivated its system.

Despite this setback, the Army's scientists and engineers continued to develop and test a missile defense system through the Ballistic Missile Defense Organization (BMDO). The period between 1974 and 1983 began with declining interest in Ballistic Missile Defense (BMD) initiatives, followed later by guidance to accelerate development of a defense for American ICBMs. The Systems Technology Radar, designed to provide data in terminal, low-altitude, and midcourse operations, was a major improvement over the SAFEGUARD Missile Site Radar. This unmanned system was capable of transmitting thousands of beams per second and used a versatile transmitted waveform combined with more advanced signal processors that permitted better target discrimination. With these advances over the SAFEGUARD radar, the Systems Technology Radar alone could serve as a radar system for defending Minuteman missiles. This radar system was also an important element in the underlay of the proposed layered defense concept.

There were also experiments with an airborne telescope. The Ballistic Missile Defense Organization's engineers recognized the limitations of ground-based radars and explored using airborne/spaceborne sensors to discriminate between targets in the Designating Optical Tracker Program. These experiments with a rocket launched infrared telescope demonstrated that a long-wave infrared sensor could discriminate between, designate, and track a reentry vehicle. Encouraged by these successes, the experimenting continued with an Airborne Optical Adjunct to investigate the technical feasibility of using airborne optical sensors to detect, track, and discriminate between ballistic missile reentry vehicles along with the ability to pass trajectory

data to ground-based radars. Renamed the Airborne Surveillance Testbed, this optical sensor was the first Ballistic Missile Defense project incorporated in the next generation anti-ballistic missile initiative and played an important role in missile test programs and exercises.

During the 1970s, the Ballistic Missile Defense Advanced Technology Center explored military applications of neutral particle beams and high-energy lasers, two different directed energy technologies. The Advanced Research Projects Agency began initial research in the late 1950s and while Congressional parsimony and restrictions handicapped research, progress was made. The two primary efforts were the exoatmospheric neutral particle beam accelerator program and the collective ion accelerator experiment. By the late 1970s, Army researchers demonstrated that lasers could work with pointing and tracking devices to form an effective weapons system. After Congress began pressing Army officials to begin developing space-based laser weapons, the White Sands Missile Range, New Mexico, was designated as a suitable location for high-energy laser range testing. In 1980, following policy established by President Carter, Secretary of Defense Harold Brown directed the services to emphasize the use of lasers in space. BMDO focused on using lasers to destroy ballistic missiles in the boost or midcourse phase of their flights, before their reentry vehicles deployed.

To protect the Air Force's newest ICBM, the MX or Peacekeeper missile, the Army developed a low-altitude defense system composed of a series of radars, distributed data processors, and nuclear-tipped interceptors. Its size and design would complement any of the proposed MX ICBM deployments. In 1981, Secretary of Defense Casper Weinberger issued a Ballistic Missile Defense Program Directive to support all MX basing options. The directive also called for the development of a non-nuclear endoatmospheric weapon. With this guidance, the Ballistic Missile Defense Organization planned to convert the low-altitude defense system to a non-nuclear interceptor and renamed the program SENTRY. The next year, the Ballistic Missile Defense System Command terminated the SENTRY program.

The advances made in infrared sensor and computer technology encouraged scientists to experiment with hit-to-kill technology, that is, kinetic energy intercepts, leading to the first kinetic kill interception of a missile in space with the Homing Overlay Experiment. Launched by two Minuteman stages, the kill vehicle consisted of a computer, a long wavelength infrared optical sensor package for guidance, and a kill device. When the missile reached a point above the atmosphere, a sensor and computer on the launch rocket would locate and track the reentry vehicle and relay tracking data to the intercept vehicle. As the target neared, the kill vehicle would be launched and using its own infrared sensors and computer home in on the target. Right before intercept, the kill vehicle would unfurl the spokes of a 13-foot radial net that would capture the reentry vehicle.

In June 1984, the Homing Overlay Experiment successfully completed the first kinetic kill intercept. The kill vehicle intercepted a mock ICBM reentry vehicle more than 100 miles above the Pacific Ocean. In this test, the kill vehicle and the warhead closed at more than 15,000 feet per second and smashed into each other. The Homing Overlay Experiment was the first true revolution in ballistic missile defense since research began in the 1940s.

The Army's space and missile defense interests were revived by the internal debates over professionalism, equipment, and doctrine that occurred after the Vietnam War and President Reagan's 1983 Strategic Defense Initiative. However, this was foreshadowed by Army participation in the Tactical Exploitation of National Space Based Capabilities Program (TENCAP) beginning in 1973. By 1983, by virtue of its participation in TENCAP and its aggressive research program in missile defense, the Army found itself as the service with the most experience in dealing with technical missile defense problems as well as the biggest consumer of space products.

The Strategic Defense Initiative was buttressed by the Fletcher and Hoffman reports. The Hoffman group concluded that a missile defense could enhance deterrence and believed that an anti-tactical ballistic missile system could serve as a first step toward a national missile defense system. The Fletcher commission recommended a research blueprint for the Strategic Defense Initiative in the areas of Systems Concepts; Surveillance, Acquisition, and Tracking; Directed Energy Weapons; Conventional Weapons; Battle Management and Command, Control, and Communications; Survivability; Lethality and Threat Vulnerability; and Selected Support Systems. A somewhat constrained program based on this model became the guide for the Strategic Defense Initiative.

The Strategic Defense Initiative Organization was a multi-service group. However, the Army's anti-ballistic missile experience was its foundation, and the Army repeatedly took the lead in project development. This experience allowed the Strategic Defense Initiative Organization to protect the technology base, increase the emphasis on proof-of-feasibility experiments with greater investment in high risk-high payoff approaches, and continue examining multi-layered defense.

Researchers from the Strategic Defense Initiative Organization (SDIO), the Army, and the Air Force created a concept for tiered, or layered, defense against enemy missile systems to ease interception of an incoming missile during its three flight phases: boost, midcourse, and terminal. Each of the services was assigned elements designed to track or intercept during specific phases of the missile flight. The Strategic Defense Command and the Army assumed the lead in the effort.

The Strategic Defense Initiative concept for the boost phase incorporated the Boost Surveillance and Tracking System, the Space-Based Laser, and the Ground-Based Laser. The Strategic Defense Command shared responsibility for the Space-Based Laser with the Air Force, while it was assigned sole control over the Ground-Based Laser. In the midcourse phase, the system architecture envisioned a Space-Based Surveillance and Tracking System, a Space-Based Interceptor, a Neutral Particle Beam, and the Exoatmospheric Reentry-vehicle Interceptor Subsystem. The Air Force directed development of the Space-Based Surveillance and Tracking System and the Space-Based Interceptor while it shared responsibility with the Army and the Strategic Defense Command for the Neutral Particle Beam. The Army then directed the evolution of the Exoatmospheric Reentry-vehicle Interceptor Subsystem. The final defense layer, the terminal phase, employed the Airborne Optical Adjunct, the Ground-Based Radar, the Ground-Based Surveillance and Tracking System, and the High Endoatmospheric Defense

Interceptor. The Strategic Defense Command had the lead on all of these programs. All three primary elements, the Air Force, the Army, and SDIO, shared in the development of the Battle Management/Command, Control, and Communications systems. As these programs evolved to the demonstration stage, the command explored new areas in interceptor, sensor, and related technology. Advances have been made in optics, sensors, and data processing, which have subsequently been applied to existing and planned systems.

Existing in parallel and drawing on some of the strategic defense initiative's research was the anti-satellite program. In January 1989, the Defense Acquisition Board authorized developing an anti-satellite program to deploy in the mid-1990s. In March, the Army received the lead in this joint service effort, based on its record with ground-based interceptors. The program would counteract an already deployed Soviet anti-satellite system. The Defense Acquisition Board requirements included using both kinetic energy and directed energy approaches.

As funded, the anti-satellite program was distinct from strategic defense, but drew on the Strategic Defense Command's kinetic and directed energy research. Thus, Strategic Defense Initiative funding directly affected anti-satellite development. Although there were delays in the directed energy program, the kinetic energy program proceeded with only a few setbacks. The proposal for two versions of a kinetic energy weapon, one ground-launched, the other sea-launched, was reduced to a single system. In August 1990, the Rockwell International Corporation was awarded a contract to develop a ground-launched kinetic energy anti-satellite weapon. The first tests for this visual light sensor system were planned for January 1992. Following budget reductions and program restructuring, the Army recommended canceling both programs. Funding was restored after several senators wrote to President Bush to support the effort. In 1992, Congress directed that the program reflect the end of the Soviet threat and the proliferation of militarily significant space capabilities of a growing number of countries.

By June 1993, continued budget cuts forced the termination of the Kinetic Energy Anti-Satellite Joint Program Office. The Defense Authorization Act for 1994 directed its conversion to a command-managed technology program and progress continued at a slower rate. The work culminated in a September 1995 hotfire strapdown test that demonstrated the kill vehicle's ability to fly a predetermined simulated flight path by firing its divert/attitude control system thrusters. The system also successfully acquired and tracked a target with its onboard computers. Two years later, the prototype concluded a successful hover test, in which the sensor acquired and locked onto a simulated moving target.

The program experienced funding problems throughout its history, resulting in rescheduling and other setbacks. In 1998, the U.S. Space Command's Mission Needs Statement for Space Control included a requirement for an anti-satellite capability. In that same year, however, President Clinton used a line item veto to eliminate funding for the anti-satellite program as well as 42 other programs. This action was declared unconstitutional by the U.S. Supreme Court and the funding restored. Surviving on Congressional plus-ups, the program was transferred to the Army Aviation and Missile Command in October 2001.

The command also proceeded with laser experiments and created a dedicated test facility for them. In 1974, the Congress directed the Defense Department to create a military high-energy laser test facility to halt redundant development work at various government and contractor sites. In 1981, the Defense Department awarded a contract to construct a site at White Sands Missile Range, which was nearly complete by 1984. The High Energy Laser Systems Test Facility (HELSTF) would support Army and Department of Defense laser research and development, test, and evaluation, as well as integrate and operate lasers and related instruments, facilities, and support systems. HELSTF would also conduct and evaluate laser effects tests on materials, components, subsystems, weapons and systems. The facility became operational in September 1985 with an Air Force Lethality and Target Hardening program experiment for the Strategic Defense Initiatives Organization. In this test, a Mid-Infrared Advanced Chemical Laser destroyed a Titan booster rigged to simulate the conditions of a thrusting rocket booster.

In October 1989, the Secretary of the Army had the facility transferred from the Army Materiel Command to the Strategic Defense Command to centralize high-energy laser research. The actual transfer occurred in October 1990. HELSTF's mission expanded to include a full range of research, development, test, and engineering functions. These included test and evaluation, laser damage and vulnerability support, intelligence evaluation resources, advanced system integration center, range instrumentation, space surveillance, and anti-satellite contingency capability. The site has been active in the command's directed energy programs.

As the Army made progress in missile defense, experimented with anti-satellite weapons systems as well as laser and particle beam weapons, its long dormant interest in space began to revive. It was assisted by its own internal reformation and the announcement of President Reagan's National Space Policy in July 1982. The policy included commitments to explore and use space for peaceful purposes by all nations, pursue activities in space supporting the United States' right of self-defense, make space-based systems available to commercial and government users, and continue to study space arms control options that would limit testing and deploying specific weapons. In 1988, the policy was updated, reaffirming the national commitment to space exploration and addressing civil, military, and commercial space use. It called for American space policy to obtain scientific, technological, and economic benefits for the general population and to improve the quality of life on earth through space related activities, promote international cooperative activities while protecting American interests.

Because there was not a pre-existing critical mass of interest for space as there was for missile defense despite the Army's use of the medium, the way forward was more difficult. First, the Army had to reinvigorate its interest and begin to see space-based systems as force multipliers. While the National Space Policy indicated a broad interest, there was still no direct reason for the Army to become aware of its reliance on space-based systems. The event that drove this dependence home was Operation Urgent Fury, the invasion of Grenada in 1983.

In 1983, the Army Science Board's study *Army Utilization of Space Assets* concluded the Army was not using space systems to their full potential; to achieve better exploitation there must be a high-level commitment backed by sufficient resources. Operation Urgent Fury highlighted the services' scramble for access to limited space assets. Because it had used other

services' systems too long, the Army was assigned the leftovers in a crisis. The subsequent Combined Arms Grenada Work Group recommended the Army develop, own, and control its own satellites to ensure critical communications in such operations. Later in 1983, an Army Space General Officer Working Group was founded to provide direction for Army space efforts. In 1984, the Army Science Board studied the Army's use of space to support its missions, concluding the Army made limited use of space assets and was neither active nor influential in designing and operating most of the space systems then in use. In August 1984, an Army Space Council was created to approve proposals and provide direction for the Army's involvement in and use of space.

In September 1984, the Vice Chief of Staff of the Army, General Maxwell Thurman, activated an Army Staff Field Element, the nascent form of the Army Space Command, at Air Force Space Command headquarters. By the end of 1984, the Army had four organizations to manage its space commitments. First, there was an Army Space Council chaired by the Vice Chief of Staff then the Army Space Working Group. The third organization was the Army Space Office, a focal point for space-related matters that served as a liaison to the Joint Staff and the Office of the Secretary of Defense, and finally the Army Staff Field Element of Air Force Space Command. The Space Office identified five high-priority space tasks: developing Army space policy; creating an Army space-related requirements and programs inventory; near-term enhancements to Army space involvement; developing Army space-related requirements based on an operational concept for space support to warfighting; and developing Army options to support a unified space command.

Space-related activity in the Army reached critical mass in 1985. That year, the Combined Army Combat Developments Activity created a Space Directorate, a Space Initiatives Study Group was formed to analyze the ways the Army should use space, and the Staff Element at the Air Force Space Command became the Army Space Planning Group—the Army element of the new U. S. Space Command. The following year, the Army Space Planning Group became the Army Space Agency. The Army Space Initiatives Study was published in December 1985. The study advocated making the Office of the Deputy Chief of Staff for Operations and Plans the senior Army staff proponent for space, and recommended that the Combined Arms Center at Fort Leavenworth become the Army proponent for space and that the Command and General Staff College become the lead Army school for space education. The study also urged forming an Army Space Command as the Army component of Space Command and advocated the Army integrate the use of space and space products into its doctrine. The report further called for establishing an Army Space Institute, the Army Space Technology Research Office, and the Army Space Agency. The Space Initiatives Study counseled that the Army train soldiers about space systems and create an additional specialty indicator to trace personnel with experience, education, and training in space systems.

The Army Space Institute (ASI) was founded in 1986 to serve as a clearinghouse for matters relating to the Army's use of space. Functioning as the Training and Doctrine Command (TRADOC) proponent for space and space systems, it was responsible for developing Army space concepts, doctrine, training, force structure, materiel requirements, techniques, and procedures that would apply space systems and technology to improve the execution of AirLand

Battle Doctrine and support the Strategic Defense Initiative. The ASI maintained a tactical focus throughout its existence, approaching its mission aggressively, and predicted that space systems would be available at the battalion and company levels. It also prepared for the Army Space Demonstration Program to show the ways current space-related products could support battlefield commanders and their units, down to the squad level. In 1986, shortly after the space activities skill code was established, ASI proposed to redefine it while realizing this did not address the basic need to build expertise. In 1987, a new Space Activities skill code definition was sent to the Vice Chief of Staff of the Army with specific qualifications in duty assignment, military training, and civilian schooling.

The Army had long had an interest in manned space flight. In January 1959, NASA dealt a blow to the Army's hopes for continued involvement in space exploration when it published the selection criteria for astronauts from the military services. One of the requirements—that an astronaut had to be an experienced jet aircraft pilot—eliminated Army personnel from consideration as astronaut candidates. In 1964, NASA dropped the requirement for pilot experience for crew members, but only in an effort to recruit "scientist-astronauts" to conduct research on space flights. Most of these candidates had doctoral degrees in the natural sciences, medicine, or engineering, or equivalent experience. Because few of its officers had advanced training in these fields, the Army was once again excluded from the manned space program. In January 1978, NASA announced the selection of 35 new astronaut candidates for the Space Shuttle Program, the first chosen since 1969. This group included the first women and racial minorities chosen; additionally, two new astronaut job titles were created, pilot and mission specialist. Both civilians and military officers were among the candidates; one of the latter was Major Robert L. Stewart, who became the Army's first astronaut.

In 1986, the Pentagon established the Military Man in Space program as part of Shuttle operations. The Air Force was the overall Executive Agent and the Office of the Deputy Chief of Operations and Plans, Department of the Army, became the Executive Agent for the Army program. The program was to evaluate, through experiments proposed by each uniformed service and approved by DoD, ways in which military operations on earth could be improved using space-related facilities and technologies. In 1987, the Army proposed three experiments it thought would improve its war-fighting capabilities, Terra View, Terra Scout, and Terra Geode. These three experiments played significant roles in the future of manned space flight. In 1987, as its participation in NASA burgeoned, the Army established an Army Astronaut Detachment at the Johnson Space Center. Between 1983 and 1989, interest in space was revived as the Army formed a space command and mounted an educational effort to show how space-based systems were invaluable to the warfighter.

Two events in the 1990s changed the way the Army looked at space and missile defense. First, the Cold War ended with the collapse of the Soviet Union and its Eastern European empire. While this ended the threat of nuclear confrontation, it ushered in an era of geopolitical instability. The proliferation of missile technology and weapons of mass destruction signaled a change in strategic defense. The emphasis shifted away from protecting the United States from wide-scale nuclear attack to protecting against limited attacks from hostile nations. The new emphasis was exemplified in President Bush's new approach to the problem of missile defense.

He ordered the Strategic Defense Initiative program to emphasize defense against limited attacks; the new system was called Global Protection Against Limited Strikes. It was designed to counteract strikes by various Third World countries developing ballistic missiles, or accidental or unauthorized launches from the Soviet Union. This reorganization unified the Army's space and strategic defense efforts in the new Army Space and Strategic Defense Command. Completing this unification was the transfer of the Army Space Technology Research Office from the Communications-Electronics Command in 1993 and the transfer of the Army Space Program Office in 1994.

The second event was the Gulf War of 1990-1991. Desert Storm was the nation's first space war and marked a change in military technology and tactics. During this war, the Army relied on space-based systems to provide soldiers with position and navigation information, multi-spectral imagery, satellite weather and communications, and ballistic missile warning. The war demonstrated the growing importance of space as a military medium.

The Gulf War demonstrated that space-related systems and products could successfully support the Army's operations. Units used the Global Positioning System (GPS) to navigate, control convoys and resupply operations, mark and breach minefields, and conduct artillery surveying and fire direction. Tactical units used weather receivers to obtain crucial weather information quickly. When weather information was combined with multi-spectral satellite imagery, maps using the latest intelligence were created and distributed in a timely manner. Tactical missile detection used space-based systems to warn units of incoming rocket attacks.

Commercial space systems played a large role in the Gulf War and had a large impact on the military. Although the military Defense Satellite Communications System carried about half of the communications traffic in the war, the INTELSAT system carried another quarter—the commercial system supplemented the military system. The WRAASE weather receiver was a commercial product and the topographical units' services expanded because of the commercial equipment and software bought during the war. Even the much-heralded GPS could not be distributed to the majority of units until the Army bought and sent commercial receivers to the Persian Gulf. A final enduring lesson from the Gulf War was the relatively short shelf life of combat experience. If the Army would retain its interest in space and space-based systems and products, the Army's space community must make a greater effort to normalize and operationalize space through the capture and dissemination of the lessons it learned from observations and historical study of training, exercises and combat operations.

It was also obvious that few commanders fully grasped the potential of the space-based systems to which they had access. Few understood how military space-related systems and their products could help them improve their tactical practices and their grasp of the operational art.

The Army found itself increasingly dependent upon space-based systems to conduct operations. The typical soldier relied on them to determine his position, locate the enemy, communicate with friendly forces, and fire "smart weapons." For the Army, space was becoming the new high ground, an important part of firepower and information dominance on the battlefield of the future. It became crucial for the Army to improve its space technology.

The end of the Cold War led to the reconfiguration of the Army in the 1990s. The Chief of Staff of the Army, General Gordon Sullivan, established a new vehicle to investigate and support necessary change, the Louisiana Maneuvers process. In 1996, the Army initiated the Army After Next Project to fashion requirements for the Army of the near future, concentrating on the possible shape of warfare between 2010 and 2025. The project would explore the nature of warfare thirty years in the future and help develop a long-term vision for the Army. In 1997 and 1998, a series of war games demonstrated how crucial space assets had become and would remain to modern land warfare. The Army After Next Space Game Two showed how space support could be integrated into a cohesive theater campaign. Its results gave the Army a better understanding of the ways in which space-based resources might affect military operations on the ground. The game also pointed out ways commercial space-based systems could amplify the commander's knowledge of the battlespace with improved position and navigation capabilities and imagery systems. Many of the Army's senior leaders identified space as the battlefield's new "high ground."

As the world political situation changed, the emphasis in missile defense changed from the strategic to the theater level. Although planning for theater missile defense began in the mid-1980s, the events of Operation Desert Storm proved the significance of theater missile defenses. In 1993, the Clinton Administration reemphasized theater missile defense efforts because the new threat was theater ballistic missiles controlled by Third World dictators. The first priority became deploying a theater missile defense system with space-based sensors. The second priority was deploying a national missile defense program to meet the threat posed by rogue nations. When it came to further research and development, follow-on technologies like directed energy efforts received the lowest priority rating. The Strategic Defense Initiatives Organization was reorganized as the Ballistic Missile Defense Organization, which reflected the new priorities and wider mission. With this shift to development and acquisition of systems, the new organization reported to the Under Secretary of Defense for Acquisition.

The 1993 Bottom-Up Review of the Military initiated by the Clinton Administration outlined the national security plans for 1995-1999. The goal was to field effective theater missile defense systems in the shortest time possible, while providing a basis for a speedy decision to deploy national missile defenses if a serious threat appeared. The review offered a three-tiered program that emphasized theater missile defense, with the bulk of funding going to create this tier. In contrast, national missile defense and the research for follow-on technologies and strategies would be funded at much lower levels.

The mid-1990s also saw modifications to the Anti-Ballistic Missile Treaty referring to theater missile defense systems, specifically theater high-altitude area defense. In 1995, 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, adding this should be based on demonstrated capability and not theoretical ability. Following two years of negotiations, officials agreed to the Russian proposal that theater missile defense systems with a demonstrated interceptor velocity of 3 kilometers per second would comply with the treaty. The proviso was that the systems would not be tested against target missiles having a range greater than 3,500

kilometers and a maximum flight velocity of no more than 5 kilometers per second. The governments of the United States, Russia, Belarus, Kazakhstan, and Ukraine signed the final agreement on 26 September 1997.

These critical developments encouraged the Army to reevaluate its goals for space and missile defense and led to creating a new command specifically to meet these ends. Shortly before its creation, these objectives were outlined in a Memorandum of Agreement with the Training and Doctrine Command. The agreement made the command the Army's proponent for space and national missile defense and the overall Army integrator for Theater Missile Defense. The command would determine space requirements for TRADOC approval and lead the integration of doctrine, training, leader development, organization, matériel, and soldier solutions across the Army and within appropriate joint agencies. The agreement also chartered the command to establish a battle lab to plan and conduct space and missile-defense warfighting experiments, the first outside TRADOC.

The new command organized itself to meet its new responsibilities and lead the way for Army space and missile defense. The goals the Space and Missile Defense Command (SMDC) set included integrating space support in full spectrum land operations, creating a global multi-element missile defense, cultivating space partnerships, and extending advanced space and missile defense technology for combat forces. The SMDC would be tailored to suit the Army's needs in the new century for an organization combining combat and materiel developments, acquisitions, and operations in one place. Integrating these functions in a single entity would save time, effort, and money by reducing the competition for space and missile defense resources within the Army, enabling it to better explore the global reach of the command's assets.

The Space and Missile Defense Battle Lab was founded to interact with the other TRADOC battle labs on space and missile defense models and simulations, experiments, and technology infusions. It was formed by combining the former Battle Integration Center and the Army Space Exploitation Demonstration Program (founded in the mid-1980s to acquaint the Army with new space products and to be an element of the Army Space Command). A Force Development and Integration Center was established as the Army's manager and developer for space and missile defense. It would develop, manage, and prioritize missile defense and space future operational capabilities across the entire spectrum of TRADOC responsibilities from personnel to combat developments activities. It would also advocate the Army's positions on space and missile defense to the joint technical development and operational communities.

One of the Battle Lab's goals was to develop a Synthetic Battlefield Environment that would link technology to the warfighter by providing weapons developers, battle planners, and commanders with interactive realistic scenarios. The Synthetic Battlefield Environment rested with the Extended Air Defense Testbed. Initiated in 1989, the testbed models air, land, sea, and space-based forces and their contribution to theater-level extended air defense, enabling the user to develop tailored simulations from the fire-unit up to the theater level for theater missile defense and the global level for national missile defense. The Battle Lab also established a synthetic environment that permitted simulated elements to be replaced with actual hardware. The Synthetic Battlefield Environment has continued to grow with the evaluation of new

software and technologies that address aspects of space and missile defense. These include Project Stalker (which assists in locating, tracking, and destroying mobile transporter erector launchers) and the Battlefield Ordnance Awareness system (which collects and processes data on missile launches, artillery, and tank fire). These and other technological advances are brought to the soldier through traditional exercises, long-distance training, and the Space and Missile Defense War Game.

In addition, the Battle Lab brings products to the soldier through the Army Space Exploitation Demonstration Program. Many products could be used to illustrate the Battle Lab's successes with this program, including the Global Broadcast System–Joint In-Theater Injection, Joint Tactical Ground Station, and Force Protection Tactical Operations Center. In addition to the large systems, the demonstration program also developed technologies affecting communications available to the individual soldier or unit. These include the Iridium phone system, which provided a truly global phone for the soldier in the field; the Pager Alert Warning System, to notify troops in the expected impact zone of tactical ballistic missile attacks; and the Joint Expeditionary Digital Information program that combined these capabilities with a laser range finder, GPS satellite positioning, and text messaging to send and receive information via satellite.

The Space and Missile Defense Acquisition Center centralized materiel development and testing operations. As initially configured, its numerous elements included the Joint Land Attack Cruise Missile Defense Elevated Netted Sensors System Project Office, the Ballistic Missile Targets Joint Project Office, the Army Space Program Office, the High Energy Laser Systems Test Facility, and the U.S. Army Kwajalein Atoll. One of the more intriguing elements was the Joint Land Attack Cruise Missile Defense Elevated Netted Sensors System. Unmanned sensors, suspended in a compartment below the aerostat, would provide a 360° picture enhanced by Identification Friend or Foe systems. This data is relayed to a ground-processing center through a fiber optic tether, which would notify relevant interceptor systems. An aerostat can provide round the clock surveillance for up to thirty days. The system's primary focus was missile surveillance, tracking, and fire control for the various anti-missile systems using an aerostat, a tethered balloon designed with an inner ballonet.

The Missile Defense and Space Technology Center continued to support the Ballistic Missile Defense Organization and the Program Executive Office for Air and Missile Defense. It also established a space technology directorate to identify promising technology and set up a long-range research and development program. This organization's achievements are evident in the progress made by the variety of missile defense systems under development. While the technology associated with interceptor systems remains its primary focus, the center continued to explore innovations. Directed energy once again has its attention and the SMDC wrote the first Directed Energy Master Plan in 1999. Sensor technology has also advanced. One example sought to improve the interceptor systems' ability to interpret what they see, while another was designed to expand the area covered. The Technology Center's goal remains flexibility in order to respond rapidly to new programs and marketing opportunities.

The Army Space Command continued to support the warfighter with space products and capabilities, including communications through the Defense Satellite Communications System. It also managed the Army Astronaut Detachment at the Johnson Space Center.

The Army's attempt to normalize and operationalize its space assets were highlighted in the *Army Space Master Plan* and TRADOC Pamphlet 525-3-14, *Concept for Space Operations in Support of the Objective Force*. Both documents emphasized the individual unit's dependence on space-based assets to carry out the Objective Force's overarching mission. Space and missile defense emerged as key enablers to these missions in these documents. Space control's contribution to the Army's Objective Force and to the joint force commander cannot be overemphasized. The doctrinal and training implications of space control and missile defense technology hold the potential for changing warfare.

After the end of the Cold War, the fires that fed the missile defense debate appeared to have been banked by the disappearance of the Soviet threat. As new threats emerged, specifically the proliferation of both guided missiles and weapons of mass destruction, missile defense became a more urgent matter. When missile defense returned to the national stage, it seemed as though the debate had the same parameters that bound it when Robert McNamara thought it was both technologically and economically unfeasible. Partisans on both sides shed more heat than light on the subject, overshadowing the work of the Army's engineers and contractors, who performed amazing technological feats. As we conclude, missile and nuclear proliferation have compelled the United States to begin constructing a missile defense system.

The Army's earlier efforts in space and missile defense played out against a background of war and Cold War. The Army's earlier space and missile defense efforts operated in tandem through the late 1950s and produced breakthroughs in rocket and sensor technologies. After the Eisenhower Administration's forcible separation of the Army's space and missile defense programs, greater attention was paid to missile defense and communications. As the missile defense technologies matured and grew more sophisticated, the organizations supporting them became functionally organized. Army missile defense organizations developed to combine research and development, testing and evaluation, and acquisition functions in one place. They slowly evolved into centrally organized functions-based organizations. While not the result of an overt design, the change promoted collaboration and worked to short-circuit duplication of effort and pointless competition for scarce resources.

A series of events beginning with the end of the Army's Vietnam experience and the beginning of its participation in the TENCAP and ending with the publication of AirLand Battle Doctrine signaled a new interest in space and missile defense. The way missile defense and space-based systems were used in the Gulf War vindicated the Army senior leadership's decision to reenter space in order to influence the ways in which the systems it used would be developed. The centralization of the Army's space and missile defense programs that began in 1992 is creating a new organizational form. In 1997, the Army established its newest major command, the U.S. Army Space and Missile Defense Command, to serve as its proponent for space and national missile defense and overall integrator for theater missile defense. The new command would be tailored to suit the Army's needs in the new century for an entity that centralized

combat and materiel developments, acquisitions, and operations. Integrating these functions in a single organization would save time, effort, and money by reducing the competition for space and missile defense resources within the Army, enabling it to better explore the global reach of the assets of the command.