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Space Control and the Role of Antisatellite Weapons

by

STEVEN R. PETERSEN, Major, USAF
Research Fellow
Airpower Research Institute

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Space Control and the Role of Antisatellite Weapons

Petersen

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Thank you for your assistance

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Foreword

Enormous changes have occurred in the past year as the world has witnessed the fall of the Berlin Wall and the resurgence of democracy in Eastern Europe. Spurred by these changes, the United States seems headed toward a period of military austerity reflected in a substantially reduced force structure. Notably, however, as terrestrial weapons systems are reduced, space systems increase in numbers and applications. Maj Steven R. Petersen's study represents the first effort to tie together in one document US doctrine, policy, and implementation planning for the use of offensive weapons in space. Structured around the concept of space control, he creates a picture of offensive space operations that are quite similar to traditional air superiority operations. Major Petersen's study provides a timely guide to the evolution of space as another theater of warfare. It identifies key doctrinal and operational challenges that lie ahead.



DENNIS M. DREW, Col, USAF
Director
Airpower Research Institute

About the Author



Maj Steven R. Petersen

Maj Steven R. Petersen was the Air Force Space Command-sponsored research fellow at the Airpower Research Institute, Air University Center for Aerospace Doctrine, Research, and Education (AUCADRE), in 1989-90. He graduated from the US Air Force Academy in 1977 with a bachelor of science degree in engineering science. Major Petersen spent his first two years of active duty as a space systems recovery engineer with the 6594th Test Group at Hickam Air Force Base (AFB), Hawaii. Following this assignment he earned a master of science degree in aeronautical engineering from the Air Force Institute of Technology at Wright-Patterson AFB, Ohio. During the next two years, Major Petersen led several technology development projects for the space-based advanced warning system for the Space Division at Los Angeles AFB, California. In 1983 he was selected to attend the Defense Systems Management College at Fort Belvoir, Virginia. Upon graduating he was assigned to the Air Force Space Technology Center at Kirtland AFB, New Mexico. As program manager and chief of the Survivability Division, Major Petersen managed technology development projects and the associated program elements for several Air Force and Strategic Defense Initiative efforts. In 1987 Major Petersen moved to Falcon AFB, Colorado, where he became the director of engineering and support for the new 73d Space Surveillance Group. Major Petersen's team led the planning, development, and activation of the mission control center and associated communication networks for the Deep Space Tracking System.

Concurrent with his assignment to AUCADRE, he attended the Air Command and Staff College as a member in the class of 1990. He is currently the chief of network operations requirements at the 2d Space Wing, Falcon AFB, Colorado. Major Petersen, his wife, Peggy, their son, Robert, and their daughter, Jennifer, live in Colorado Springs, Colorado.

Preface

I was motivated to do this study by the lack of reasoned, analytical literature on space warfare. Accounts of space technology and system development abound, especially regarding the Strategic Defense Initiative (SDI), but relatively little exists on the larger issues of grand strategy, doctrine, operational considerations, and the general trends of technology as they affect military operations in space.

Two national security objectives form the foundation for this study. The first objective is to preserve deterrence of war at all levels. Should deterrence fail, however, the second objective is to terminate war as quickly as possible on terms favorable to the United States and its allies. These objectives can lead to seemingly contradictory conclusions. In acknowledging that deterrence might fail, the second objective endorses the development and deployment of systems that the first objective seeks to ban because they may be destabilizing. Both objectives reflect the conviction that wars are best avoided by preparing to fight.

Despite having these two objectives as the cornerstones of its national security policy, the United States has not pursued a policy that envisages space as a military battlefield. This study encourages development and deployment of offensive space weapons. The study reviews the history of the US space program and highlights its predominantly peacetime focus. Although the US depends heavily on military space systems, current space doctrine reflects a sanctuary philosophy that ignores the possibility of war in space. Consequently, US space systems lack a war-fighting capability and are vulnerable to threats from foreign space weapons. Protecting vital US interests and assets in space mandates reducing this vulnerability and establishes the need for offensive weapons. An analysis of key doctrinal influences produces a space control doctrine supporting offensive and defensive space operations. This analysis also demonstrates that current national policy strongly supports the development and deployment of antisatellite (ASAT) systems. The planned US implementation strategy integrates these systems into a comprehensive space control capability. Closing comments identify remaining shortfalls and recommend actions to remedy them.

Two caveats are necessary. First, judgments on the advisability of SDI are beyond the scope of this study. While an SDI ballistic missile defense (BMD) would impact space weaponry in many ways, the systems advocated

in this study could be fielded well before SDI, they would not depend on SDI, and they would avoid the treaty issues associated with SDI. Second, this study does not address organizational issues. While such issues are important, they are beyond the scope of this study.

A handwritten signature in black ink that reads "Steven R. Petersen". The signature is written in a cursive style with a prominent initial "S" and a long horizontal stroke at the end.

STEVEN R. PETERSEN, Maj, USAF
Research Fellow
Airpower Research Institute

Acknowledgments

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I thank the people at the Airpower Research Institute who contributed much to the successful completion of this project. My advisor, Dr Lawrence Grinter, provided balance to the presentation. My editor, Tom Lobenstein, helped me organize my writing into intelligible English. I also want to thank Col Dennis Drew, the director of the Airpower Research Institute, and recognize the support and helpful input of Dr David MacIsaac and Lt Col Manfred Koczur.

Most importantly, my deepest appreciation goes to my family for their very special contributions to this effort. The continued support and understanding of my wife, Peggy, my son, Robert, and my daughter, Jennifer, were essential to the completion of this study.

Chapter 1

Outer Space as an Operating Medium

This chapter describes the geography of space and summarizes the military uses of space. Though US public policy emphasizes “peaceful uses,” the US military has a strong presence there. Likewise, the Soviet military employs space in support of terrestrial operations. However, the Soviets apply a war-fighting doctrine that contrasts with a less aggressive US capability.

Geography of Space

Space can be logically divided into a series of zones or regions that are labeled according to their distance from the earth’s surface. Most military applications occur in low earth orbit (LEO), middle earth orbit (MEO), and geosynchronous earth orbit (GEO). Low earth orbit extends out to 3,100 nautical miles above the earth.¹ The US puts many of its navigation, photoreconnaissance, and weather satellites in LEO.² Middle earth orbits can range from 3,100 nautical miles to geosynchronous altitude; MEO includes 12-hour, semisynchronous orbits useful for navigation.³ Geosynchronous orbits are achieved at 22,300 nautical miles altitude with a 24-hour orbit. A geostationary orbit is a geosynchronous orbit with no inclination—satellites in geostationary orbit remain over the same spot above the equator. The United States uses these orbits for many of its communication, navigation, and missile early warning satellites.⁴ As altitude increases, the number of satellites required for full earth coverage decreases (table 1). (Chapter 4 addresses the trade-offs between altitude, performance, and survivability.) The cislunar region extends from GEO to the moon. Beyond the moon, the translunar region continues to the edge of the solar system.⁵ Few military applications exist in these last two regions.

The strength of gravity, rather than straight-line physical distance, determines the energy required to move between orbits (fig. 1). The higher the altitude of a satellite in earth orbit, the less costly its movement, since the effect of the earth’s gravity decreases as the distance from the earth increases.⁶

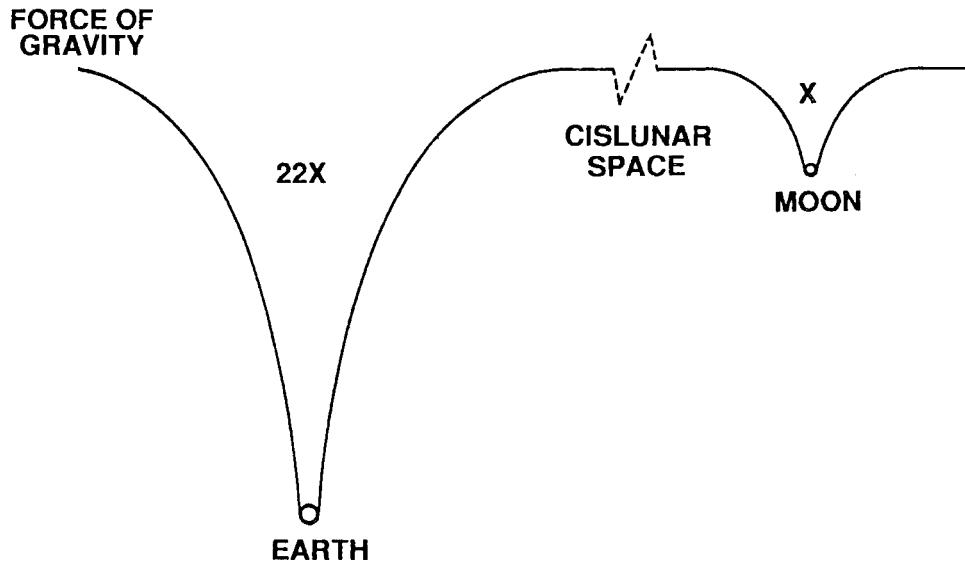
TABLE 1

Single Satellite Coverage Requirements
(Polar Orbit)

No. of Satellites	Altitude (Miles)
60	300
50	400
30	600
25	800
20	1,000
12	2,000
3	23,000

Source: Patrick J. Friel, "New Directions for the U.S. Military and Civilian Space Programs," in *International Security Dimensions of Space*, ed. Uri Ra'anana and Robert L. Pfaltzgraff, Jr. (Hamden, Conn.: Archon Books, 1984), 124.

All nations are on a relatively even footing regarding access to space. Launch technology, rather than terrestrial geography, is the true arbiter of access. The development of launch capabilities rather than exploration of space paced by favorable geography. Still, launch sites near the equator offer modest advantages because the speed of the earth's rotation is greatest in the lower latitudes. Thus, satellites launched from equatorial sites on a trajectory with the spin of the globe will require less additional velocity to attain orbit than those launched from higher latitudes where the speed of the earth's rotation is slower.



Source: Marc E. Vaucher, "Geographical Parameters for Military Doctrine in Space and the Defense of the Space-Based Enterprise," in *International Security Dimensions of Space*, ed. Uri Ra'anana and Robert L. Pfaltzgraff, Jr. (Hamden, Conn.: Archon Books, 1984), 36.

Figure 1. The Gravity Wells of the Earth-Moon System. The earth's gravity decreases as altitude increases. Thus less energy is required to change an orbit at the top of the "gravity well" than near its bottom. The moon has a similar, though "shallower" well since it has a weaker gravitational pull.

First Steps into the Unknown

During the early years of the US and Soviet military space programs, both nations used space to generate international prestige. Each side claimed a peacetime orientation for their programs. In reality, however, both nations demonstrated a strong interest in military applications. The Soviet Union launched the first satellite, but by 1962 the United States had a much stronger program.

US and Soviet efforts began in the latter stages of World War II and the immediate postwar era. In 1945 Wernher von Braun and his V-2 rocket engineering team defected to the United States. His team eventually settled at the Redstone Arsenal in Huntsville, Alabama, and became the Army's cadre for developing tactical and intermediate range missiles.⁷ The Air Force began studies on intercontinental ballistic missiles (ICBM) in 1947 and started work on the Atlas in 1951.⁸ In 1954 the Air Force upgraded the Atlas to top priority and in 1955 began top priority development of the WS-117L reconnaissance satellite.⁹ The Air Force also initiated the Dyna-Soar program for manned orbital reconnaissance and bombing.

The Soviets pursued similar objectives. In the late 1940s they opened two rocket test ranges, one at Kapustin Yar near Stalingrad and the other at Tyuratam in remote Kazakhstan.¹⁰ Soviet ICBM development began around 1954, coinciding with tests on intermediate range ballistic missiles (IRBM).¹¹ On 4 October 1957 the Soviet Union launched *Sputnik I*, the first man-made earth satellite. *Sputnik I* electrified both the Communist and non-Communist world, though the satellite had no military capability and its technology trailed the US state of the art.¹² Four months later, on 31 January 1958, the US launched its first satellite, *Explorer 1*.¹³ National Security Council Directive 5814/1, dated 20 June 1958 and entitled "Preliminary U.S. Policy in Outer Space," summarized the US national mood:

The USSR, if it should be the first to achieve a significantly superior military capability in outer space, could create an imbalance of power in favor of the Sino-Soviet Bloc and pose a direct military threat to US security. The security of the United States requires that we meet these challenges with resourcefulness and vigor.¹⁴

The US responded to the perceived threat by formally organizing its space program into civilian and military branches.

The US activated the National Aeronautics and Space Administration (NASA) on 1 October 1958.¹⁵ NASA's charter emphasized that US efforts in space would be "devoted to peaceful purposes for the benefit of all mankind."¹⁶ It provided that US activities

shall be the responsibility of, and shall be directed by, a civilian agency . . . except that activities peculiar to or primarily associated with the development of weapon systems, military operations, or the defense of the United States (including research and development . . .) shall be the responsibility of, and shall be directed by, the Department of Defense.¹⁷

Thus the NASA charter recognized the need to accomplish national security programs in space. However, President Dwight D. Eisenhower's concerns over Soviet reactions to upcoming reconnaissance satellite overflights led him to de-emphasize the military space program and make "peaceful uses" the hallmark of US public policy.¹⁸ Nonetheless, visible national security programs grew in size and importance.

True to the peaceful uses of space provisions in NASA's charter, the early US efforts in space concentrated on communications, navigation, reconnaissance, and weather applications. In the 1960s the Soviets achieved some success in developing military weapons systems for use in space, but immature technology limited the lifetimes of their satellites. Despite the fact that Soviet technology trailed that of the United States, Soviet military doctrine and policy on war-fighting applications in space leaped ahead.

The US-USSR competition intensified as the US gained confidence and experience. In 1960 the US military program achieved many significant firsts. *Tiros 1*, a joint military-civilian weather satellite, went up on 1 April. It was joined two weeks later by the first navigation satellite, the US Navy's *Transit 1B*.¹⁹ *Midas 2*, the first ICBM early warning satellite, followed in May 1960. *Discoverer 14*, the first successful film reconnaissance satellite, joined the others in August 1960.²⁰ *Samos 2*, with its near-real-time reconnaissance capability, capped these achievements in January 1961.²¹ While the US established a strong lead in unmanned flight, the Soviets continued to press forward with their space program.

The Soviets renewed their bid for space leadership with the first manned launch. On 12 April 1961 Yuri Gagarin made his famous one-orbit space flight. The political propaganda reaped by his flight was dulled by the reality that Soviet space technology trailed that of the United States. The Soviets did not launch their first significant military satellite, *Kosmos 4*, until 6 April 1962.²² From the late 1950s through the 1980s, both superpowers expanded their dependence on space systems and launched numerous new military satellites. (Table 2 shows the total number of military satellites put in orbit by the US and USSR through 1987. Table 3 summarizes US and Soviet active military satellites as of 1987.) Both countries lacked offensive systems for waging war in space.

TABLE 2

US and USSR Military Launches
1957-87

Year	US	USSR
1957	0	0
1958	0	0
1959	5	0
1960	10	0
1961	19	0
1962	31	5
1963	26	7

TABLE 2 (con't)

Year	US	USSR
1964	32	15
1965	28	25
1966	32	27
1967	24	46
1968	20	49
1969	16	51
1970	15	55
1971	10	60
1972	11	53
1973	8	58
1974	6	52
1975	7	60
1976	7	74
1977	9	69
1978	8	60
1979	4	60
1980	5	64
1981	5	59
1982	6	68
1983	7	58
1984	12	63
1985	6	64
1986	3	63
1987	6	62

Source: Congressional Research Service, *Space Activities of the United States, Soviet Union, and Other Launching Countries: 1957-1987* (Washington, D.C.: Government Printing Office, July 1988), 56.

TABLE 3

US and Soviet Operational
Military Satellites as of 1987

Mission	US	USSR
Photographic Reconnaissance	3	3
Electronic Intelligence	6	8
Early Warning	3	9
Communications	63*	73
Navigation	9	25
Meteorology	7	4
Earth Monitoring	1	3
Total	92	125

*Includes civilian communications satellites used for military support.

Source: Nicholas L. Johnson, *Soviet Military Strategy in Space* (New York: Jane's Publishing, 1987), 54.

Significant Air Force efforts to build offensive weapons trace back to the satellite interceptor (SAINT) program. Approved in 1959, the SAINT program sought to develop and deploy a satellite that could inspect and

photograph hostile satellites. SAINT could be easily converted to a nuclear antisatellite (ASAT) weapon by replacing the camera with a nuclear warhead.²³ The Air Force cancelled the SAINT program on 3 December 1962 because of funding, technical, and political problems.²⁴ In 1962 the Soviets orbited their first reconnaissance satellites and by 1963 had ceased to oppose overflights of the Soviet Union by US reconnaissance satellites.²⁵ Following this acquiescence to satellite overflights, the US made significant cuts in its space weapons programs.

President John F. Kennedy limited space weapons development to a pair of nuclear ASAT systems, one for the Army and one for the Air Force. The Army's system was called Nike-Zeus (Program 505). It consisted of a solid-fuel three-stage missile with a nuclear warhead. After development and testing at Kwajalein Atoll in the South Pacific, it became operational in May 1964. However, Nike-Zeus was phased down in 1966 and disbanded in 1967.²⁶ The Air Force's system, Program 437, mirrored the Army's. Using a Thor missile and a nuclear warhead, the project was based at Johnston Island in the South Pacific and became operational in May 1964. Program 437 was cut back in 1970 and terminated in 1975.²⁷ These two nuclear ASAT weapons had limited utility—short of a strategic nuclear exchange, the US would never use them. Moreover, the Limited Test Ban Treaty, signed by the US in 1963, banned nuclear detonations from space.²⁸ The Air Force also failed in its bid to develop offensive space weapons systems usable at lesser levels of conflict. In December 1963 Secretary of Defense Robert McNamara cancelled the Air Force's Dyna-Soar manned space interceptor because there was no validated requirement for the program.²⁹ The manned orbiting laboratory, which replaced Dyna-Soar, was ended later as well.³⁰

After seeing the Soviet Union develop its nonnuclear ASAT weapons, the US pursued programs to build similar weapons. Soon thereafter, however, Congress passed arms control legislation to limit the development and testing of the US systems. These restrictions killed such programs. During this period the Soviets tested components of space systems that would be integral to any operational satellite interceptor weapons. The US had put its programs on hold.

Although both the United States and the Soviet Union intensified research and development on ground-based space weapons in the 1970s, the Soviets held a commanding lead in the development of such ASAT weapons. After 1971 the Soviets halted direct tests of their nonnuclear interceptor but resumed these tests in 1976. The latter action provided the impetus for initiation of the US nonnuclear interceptor program.³¹ Today the United States has renewed its efforts to field a nonnuclear ASAT weapon. The Soviets, on the other hand, are *continuing* to test components of their system. Other nations are just beginning to take early steps into space.

Toward Combat Operations in Space

Soviet planning for space combat operations appeared in Soviet literature as early as 1962. (Annex A details the evolution of Soviet space doctrine and explains that the Soviets view space as another military theater of operations.) Soviet technology finally caught up with Soviet doctrine in the mid-1960s when the Soviets made their first successful launches of navigation and communications satellites.³² The Soviets began testing a ground-based ASAT interceptor in 1967. Unlike the US Program 437, the Soviet satellite interceptor used a nonnuclear warhead to destroy the target. The Soviet advantage became even more important when arms control efforts led to a ban on nuclear ASATs. The Outer Space Treaty of 1967 prohibited the stationing of weapons of mass destruction (nuclear, chemical, biological) in outer space but did not address the more flexible nonnuclear systems.³³

The United States did not begin work on nonnuclear ASAT weapons until the late seventies. In September 1977 Vought Corporation began development of the prototype ASAT interceptor.³⁴ This system called for an F-15 aircraft to carry an ASAT missile aloft and launch it at an altitude between 6.6 and 7.6 nautical miles. The first stage (similar to a short-range attack missile) would propel the interceptor into space, then the second-stage liquid-fueled Altair* missile would complete the boost and position the miniature homing vehicle (MHV) near the target satellite. Using small thruster nozzles the MHV was to maneuver toward the target and destroy it by direct impact.³⁵ The development program suffered numerous cost, schedule, and performance problems. Those shortcomings resulted primarily from immature sensor technology and premature attempts to make the prototype an operational system.³⁶ Meanwhile, the Air Force prepared for the command and control of offensive and defensive space operations by activating the Space Defense Operations Center (SPADOC) on 1 October 1979 inside the Cheyenne Mountain Complex in Colorado. SPADOC grew during the 1980s consistent with its mission to coordinate all ASAT, space surveillance, and satellite survivability operations.³⁷

The US used the 1980s to extend the technological edge achieved in the early 1960s. More importantly, during the Ronald Reagan presidency the US acknowledged for the first time that space had become a war-fighting environment. According to the United States Arms Control and Disarmament Agency (USACDA),

National Security Decision Directive 42 (NSDD-42), dated 12 July 1982, stated that the US national security space program shall support such functions as command, control, and communications; navigation; environmental monitoring; warning; surveillance; and space defense. The United States will seek to ensure the survivability

*Advanced Research Projects Agency long-range tracking and instrumentation radar.

and endurance of US space systems, including all system elements, commensurate with their planned use in crisis and conflict; the threat; and the availability of other assets to perform the mission.³⁸

The USACDA notes that the US ASAT program supported the goals of deterrence and war fighting:

The U.S. ASAT capability has two primary military functions. The first is to deter threats to the space systems of the United States and its allies. The second is to deny to any adversary the use of space-based systems providing support to hostile military forces, within such limits as are imposed by international law.³⁹

NSDD-42 also recognized the need to protect US systems. In the previous 20 years the US had paid little attention to survivability and endurance. In short, NSDD-42 endorsed efforts to establish a space war-fighting posture. Eight months later President Reagan placed renewed emphasis on space by announcing SDI.

On 23 March 1983 the president voiced his intent to begin research on technologies destined to make nuclear missiles "impotent and obsolete."⁴⁰ While the merits of ballistic missile defense are beyond the scope of this study, SDI is important for two reasons. First, most SDI projects are developing technologies applicable to a variety of space weapons. Second, SDI revived Soviet and congressional interest in arms control in space. The Soviet reaction was swift.

Mikhail Gorbachev, secretary of the Communist Party of the Soviet Union, announced a unilateral ban on ASAT tests in August 1983.⁴¹ The US House of Representatives responded by voting for a series of constraints on US ASAT testing for the year 1984.⁴² While the US Senate refused to go along with the House, future years saw both bodies voting for restrictions. In 1985 Congress limited the US program to three tests, and for the succeeding two years it banned testing completely.⁴³ Consequently, the F-15 MHV was tested only once against a live satellite. The MHV successfully intercepted its target in space on 13 September 1985.⁴⁴ In 1988, after three years of test bans, the Department of Defense (DOD) cancelled the MHV program. In 1989 DOD launched a new triservice effort. (That program is detailed in chapter 4.) The Soviets, meanwhile, have continued to employ and refine their ASAT boosters in other programs. Likewise, their rendezvous and docking operations used in their manned space flights provide ample opportunity to continue development of ASAT sensor components.⁴⁵ In 1989 the Soviet Union operated approximately 130 orbiting military satellites.⁴⁶ As the US and USSR expand military space operations in the 1990s, other space-faring powers will join them.

Europe has developed its space expertise primarily through the European Space Agency (ESA), which was created in December 1972.⁴⁷ ESA members include Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Spain, Sweden, Switzerland, and the United Kingdom. Occasionally Austria, Canada, and Norway participate in ESA projects.⁴⁸ ESA's focus is on civil applications but some members are applying their experience to military uses. For example, France developed and launched the *satellite*

pour l'observation de la terre (SPOT) surveillance system.⁴⁹ SPOT's 10-meter resolution offers modest military utility, but the improved SPOT planned for the early 1990s will offer much more refined images.⁵⁰ SPOT's overhead imagery is sold on the open market, thus making it available to countries unable to field their own systems. In addition to ESA efforts, China, India, and Israel are believed to have launched reconnaissance satellites.⁵¹ China, India, and Japan have launched communications satellites.⁵² Japan is developing a fleet of launch vehicles and has placed over 35 payloads in orbit.⁵³ The future promises increased international military space operations.

Summary

This chapter has briefly recounted the history of military space activity. Since the early 1960s the US and USSR have used space to accomplish many functions supporting terrestrial military forces. These include communications, navigation, early warning, reconnaissance, and weather. While the Soviet Union has developed its systems based on a space war-fighting doctrine, the US has followed a less aggressive stance. The next four chapters build on the theme that the US must develop forces that are more survivable and enduring than those which exist today. ASAT weapons form a key part of this strategy. These forces will be developed through national policy, an implementation strategy, and military doctrine. Chapter 2 explores doctrine.

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Chapter 2

Space Doctrine

Doctrine provides the underlying rationale for the development, deployment, and employment of military forces. However, current official US military space doctrine is substantially inaccurate and incomplete because it overlooks the role of technology, the principles of war, and relevant historical experience. In this chapter, rather than attempt a piecemeal “repair” of official doctrine, I analyze the major factors that influence doctrine. I then derive a comprehensive set of insights to guide and focus the synthesis of a new, improved space doctrine. I conclude this chapter with a synthesized military space doctrine that closely resembles some elements of existing unofficial doctrine. The synthesized doctrine is clearer, more environmentally based, less technologically dependent, and more consistent with the implications of the major factors that influence the development of doctrine. This doctrine supports current US policy and implementation planning as described in chapters 3 and 4.

Doctrine’s Dynamic Role

Col Dennis Drew describes doctrine as “what we believe about the best way to conduct military affairs.”¹ Historically, military leaders have placed a high value on doctrine. Gen Bernard Schriever, leader of the program to develop the Atlas intercontinental missile and an Air Force space pioneer, quoted Gen Henry H. (“Hap”) Arnold, an air power pioneer, as saying,

National safety would be in danger by an Air Force whose doctrines and techniques are tied solely to the equipment and process of the moment. Present equipment is but a step in progress, and any Air Force which does not keep its doctrines ahead of its equipment, and its visions far into the future, can only delude the nation into a false sense of security.²

Maj Gen I. B. Holley, Jr., USAF Reserve, Retired, highlights the need for a comprehensive space doctrine when he observes that “we must explore the full range of the offensive and defensive capabilities of spacecraft. We must study no less avidly their limitations . . . we must not delay our effort to conceptualize the eventual combatant role of spacecraft even if current treaty obligations defer the actual development of hardware.”³ Lt Col Dino Lorenzini, a space weapons advocate, argues persuasively for space doctrine “as unencumbered and as comprehensive as possible” so that it can be used as a “set of irrefutable principles by which we can gauge the

effectiveness of our military space systems, operational concepts, organizational elements, and command and control structure.”⁴ To be useful, space doctrine must “act as a frame of reference for the testing, evaluation, and employment of new concepts, technologies, and policies for military space operations. [It must] be consistent with the principles of war [and] be flexible.”⁵ Furthermore, space doctrine must consider the lessons learned during the past 30 years of space operations along with the physical properties and geography of space.⁶ The next section evaluates the extent to which official space doctrine incorporates these principles, lessons, and properties. This evaluation is important because the Air Force cannot adequately perform the roles of testing, evaluation, and employment that are critical to the development of any weapon system—in this case, space war-fighting weapons—unless it has sound doctrine.

US Official Space Doctrine: Its Problems and Inadequacies

Official space doctrine fails to accommodate the physical differences between the atmosphere and space and attributes capabilities and technologies of aircraft to space systems. Current space doctrine also omits discussion of the principles of war as applied to space. These basic deficiencies render the official space doctrine inapplicable to the testing, evaluation, and employment of space weapons. These deficiencies are so fundamental that their correction requires an examination of the very process of forming doctrine.

Official military space doctrine is published in AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force*, and AFM 1-6, *Military Space Doctrine*. The current edition of AFM 1-1, dated 16 March 1984, views space as an extension of the atmospheric environment. AFM 1-1 explains that *aerospace* and *air* are used interchangeably, and it attributes the characteristics of speed, range, and flexibility to aerospace forces.⁷ AFM 1-6, dated 15 October 1982, provides background on the force-multiplier uses of space and offers a summary of the national policies in effect at the time of its publication. Like AFM 1-1, its focus is on current applications.

Many officers active in space operations and space system development have pointedly criticized the scope, accuracy, and relevance of AFM 1-1 and AFM 1-6 regarding current and future space operations. For example, AFM 1-1 states that “the capacity to maneuver *freely* in three dimensions allows our forces to exploit the characteristics of **speed, range, and flexibility**” (emphasis added).⁸ However, orbital mechanics renders this statement false. Orbital mechanics fixes one speed for any particular circular-orbit altitude.⁹ Since some payloads are optimized for a given altitude, speed cannot be adjusted during a mission because the resulting change in altitude would cause these payloads to degrade or fail. Additionally, unlike

the airplane, faster speed in space is not necessarily an advantage—some systems that remain over a single point on the earth, in effect zero speed relative to the spin of the earth (geostationary orbit), are extremely useful.¹⁰

AFM 1-1 claims that “aerospace allows potentially unlimited horizontal and vertical movement for aerospace warfare systems.”¹¹ It errs when it attributes the exploitation of this potential to aerodynamics technology. Because of the physical vacuum, space systems cannot operate according to the principles of aerodynamics. Finally, flexibility is virtually nonexistent in space. As L. Parker Temple III found, space systems

are not flexible enough to [allow] a software change, or the replacement of some black box, and assume each other’s missions. Even if a satellite could be designed for either navigation or weather observation, the orbits of the two are so distinctly different and incompatible that such flexibility would have no practical purpose. The flexibility of space forces is sharply reduced by the demands of high reliability and the environment in which they operate. Technologically sophisticated, highly reliable space forces are essentially the antithesis of the flexibility ascribed to aerospace forces in *Basic Aerospace Doctrine*.¹²

While AFM 1-1 misstates the capacity of today’s space forces, AFM 1-6 demonstrates more fundamental limitations: it includes some nondoctrinal considerations and omits critical doctrinal elements. Lt Col Charles D. Friedenstien and others note that due to constraints of national policy and international treaties, AFM 1-6 fails to paint a realistic picture of the “unalterable truths” regarding the unencumbered capabilities and limitations of space operations.¹³ They also observe that AFM 1-6 lacks “historical grounding” and does not mention the principles of war as applied to space.¹⁴ Maj Patrick Crotty and his colleagues observe that AFM 1-6 neglects to forecast the use of offensive weapons in space and instead speaks vaguely of a “potential” while refraining from defining it.¹⁵

The above oversights and the dilution of the “unencumbered truths” with policy and force-structure concerns compel one to conclude that the current official military space doctrine is unlikely to engender the development of war-fighting space systems. AFM 1-1 and AFM 1-6 are not founded on the principles of war as applied to space; they misstate the impacts of the physical properties of space; they are not grounded in history; and they do not address the use of offensive weapons in space. One reason current official space doctrine so thoroughly fails these tests is that external factors limit opportunities for gaining experience with offensive space war-fighting operations.

Genesis and Utility of Unofficial Space Doctrines

According to Drew, “the principle source of doctrine is experience [and] the accurate analysis and interpretation of history (experience).”¹⁶ When no empirical experience exists, one must extrapolate from other, known

areas and attempt to project the probable character of future wars.¹⁷ New doctrines (those without historical precedent) frequently emerge from unofficial sources as extrapolations and become official only when forced by war or when conclusively demonstrated by peacetime weapons systems tests or in military exercises. For example, despite their impact on naval warfare, Alfred Thayer Mahan's writings were not officially embraced by the Navy until many years after their release.¹⁸ Col Robert Swedenburg describes how the Air Corps Tactical School played a key role in translating unofficial air doctrines into practice. The school's effectiveness "stemmed from its ability to foresee future concepts of war, and these concepts were thus embodied in the development of air doctrine. Sound doctrine, valid requirements, and new technology were related in an immutable fashion."¹⁹ Though it had to wait for years for the aircraft to be made available, the school was able to eventually evaluate doctrine by flying and testing aircraft. Conclusions about air doctrine and force structure were accepted after extensive weapon demonstrations. While the Air Corps Tactical School made some errors—notably the daylight strategic bombing episode detailed in the next section—it based its approach firmly in analysis and in experience gained from experimentation. This approach adequately satisfies Drew's definition of doctrine. US space doctrine, however, takes a different path.

Just as air doctrine was in its formative years in the interwar period, space war-fighting doctrine is in its infancy today. However, the similarity ends there. First, there is no school of space warfare. The space strategists at the Air Force Space Command and US Space Command may form a school later on but none exists today. Second, unlike the Air Corps Tactical School, which did have some airplanes available, the US military today has no offensive space weapons with which to experiment. The total relevant US space weapons experience lies in the homing overlay experiment tests and the F-15 air-launched antisatellite system tests conducted by the Strategic Defense Initiative Organization (SDIO) and the Air Force, respectively, in the mid-1980s.²⁰ These tests were significant symbolic achievements—the space equivalents of the 1921 aerial-bombing demonstration of the *Ostfriesland* conducted by William ("Billy") Mitchell during air power's infancy. Like the bombing of the *Ostfriesland*, these latter-day demonstrations stimulated public debate over the advisability of the new weapons.

However, the high development costs of space systems, coupled with an evolutionary development focus that centers around inadequate official space doctrine, have hindered further development and experimentation with space war-fighting systems.²¹ The Defense Department tends to pursue systems that extend current operations rather than ones that boldly embrace new mission areas. In short, the lack of war-fighting experience in space restrains the development of official space doctrine, while the lack of official space doctrine inhibits the advocacy and development of space war-fighting systems. Thus, space war-fighting doctrine is limited to unofficial sources.

Three existing studies provide broad statements of unofficial space doctrine. Lt Col David Lupton, in his book *On Space Warfare: A Space Power Doctrine*, identifies four schools of thought on space doctrine and argues convincingly for a "space control" doctrine. In her doctoral dissertation on *The Evolution of U.S. Military Space Doctrine: Precedents, Prospects, and Challenges*, Dana Joyce Johnson critiques existing doctrines and suggests future directions. Finally, the draft version of AFM 2-XK, "Aerospace Operational Doctrine: Space Operations," dated 9 October 1985, is notable for its proactive support of offensive space weapons. Since it was never officially published, AFM 2-XK is treated as an unofficial document and hereafter is called "Draft 2-XK." All three studies acknowledge doctrine's inseparable linkage to the physical environment of space, the principles of war, and relevant experience. All begin with an analysis of these factors and synthesize the results into a space doctrine. However, these writers all make one fatal mistake. They confuse the role of technology and its proper place in space doctrine. They all closely tie existing unofficial space doctrine to existing space technology.

Technology: Means to an End, or End to a Means?

Existing statements of unofficial space doctrine are linked closely to current space technology. Thus, since space technology changes rapidly, they have declining utility. For example, a study by Maj Richard C. Goodwin and others, entitled "Military Space Doctrine for the 21st Century," relies heavily on 1985 technology. Consequently, portions of that study are already obsolete.²² To qualify as enduring guidance on military strategy and operations, space doctrine must not be constrained by estimates of current or near-future space system technology. In contrast with current practices, an untainted doctrine allows one to quickly recognize and coherently exploit opportunities as technology makes them available.

Johnson has observed that present development programs emphasize and are bounded by technology—the limits of what is currently possible—rather than by a doctrine that explains how the US will use the system once it is built.²³ Other students of space doctrine support this claim. Maj Bill Barrantino has acknowledged that the system performance requirements for the joint Department of Defense antisatellite (ASAT) program were determined by establishing the limit of technology—an operational concept embodying doctrinal guidance did not exist.²⁴ While working with the system program offices at Space Division and later with SDIO, I never heard a single reference to doctrine or strategy—other than in Soviet threat briefings—in any of the discussions of system requirements, in contractor briefings, or in government caucuses.

The Reagan administration's experience with SDI illustrates the pitfalls of the technology-focused approach. Early in the program the administra-

tion was unable to coherently explain SDI's purpose. The program's objective changed from one day to the next (it was first a city defense, then a counterforce weapon, etc.). By not thinking through the implications of space-based weapons, SDI advocates were unable to effectively rebut the attacks of SDI critics. Dr Richard P. Hallion, a noted Air Force historian, observed that when technology leaps ahead of doctrine,

projects that are wildly fanciful may result, projects that are unrelated to the realistic needs and requirements of the service. . . . Because technology tended to outstrip doctrine, the German research and development process was critically fragmented and isolated from the operational and planning world, and thus researchers tended to show an alarming trait of doing their own thing. This led to technologically fanciful projects more related to World War III than World War II—projects such as ballistic missiles (a wasteful drain on the German research and development and war economy effort), supersonic research, and even a scheme for an orbital hypersonic bomber. What good technology did exist—such as the first operational jet fighter, the Me 262—was often badly managed and operationally wasted.²⁵

Dr Holley provides further proof of the folly of emphasizing technology at the expense of doctrine. Tracing the development of the airplane, he concluded that “superiority in weapons stems not only from a selection of the best ideas from advancing technology but also from a system which relates the ideas selected with a doctrine or concept of their tactical or strategic application.” Furthermore, “war also demonstrated that where military authorities failed to formulate a doctrine to exploit each innovation in weapons to the utmost they suffered further disadvantage.”²⁶ The well-known example of daytime strategic bombing during World War II illustrates Holley's conclusion. Prior to the war, advocates of strategic bombing offensives at the Air Corps Tactical School stressed the bomber's technical strength against weak air defenses but did not consider its vulnerability to enemy pursuit aircraft. Because the Eighth Air Force adopted a bombing doctrine that did not recognize the need for protective escort by fighters, it incurred tremendous losses on its daytime raids against the German ball-bearing plants at Schweinfurt and Regensburg. When the Eighth Air Force corrected its doctrine and provided long-range escort, losses declined to acceptable levels and air power made a significant contribution to the Allied war effort in Europe.

Occasionally the integration of new technologies and doctrines is highly successful. Maj Stanley Mushaw comments that “the effective use of tanks in the German blitzkrieg against France and the Egyptian decision to achieve air superiority by using ground-based missiles rather than fighter aircraft to counter the Israeli planes are just two vivid examples. The key here is that new doctrine and new weapons go hand-in-hand.”²⁷ Note that these doctrines were not constrained by beliefs about conventional applications of technology, rather they permitted creative uses of technology in previously unforeseen ways. Resolving the gap between space technology and doctrine requires two actions. First, space doctrine must be free of limiting assumptions about current and near-future technologies. Second, the scope of space doctrine must be broad enough to accommodate the

opportunities that technology such as SDI presents. Thus, space doctrine cannot ignore space-based weapons.

In the following sections I develop a space doctrine that not only is free of limiting assumptions about technology but also accommodates space-based weapons. This synthesized doctrine is based on an analysis of how the physical characteristics of space, the principles of war, and relevant experience influence space doctrine. Despite its limitations, "Draft 2-XK" provides an excellent reference point. "Draft 2-XK" constitutes the most comprehensive, straightforward unofficial doctrine. I reference the other unofficial doctrines when appropriate.

Physical Characteristics of Space and Implications for Space Doctrine

Space presents a far different set of operational limitations than are encountered in the traditional war-fighting media—land, sea, and air. Space is limitless and in many respects is a far more hazardous environment than any other combat media. Space can be described more precisely in the following terms.

1. Extent. "The volume of space out to geostationary altitudes is about 50 billion times greater than the air combat arena."²⁸ Others describe this attribute as *vastness*.²⁹

2. Composition. Space is a near vacuum. Debris rather than geographical features is a major concern.³⁰ First Lt Roger C. Burk comments on its *unity* and *openness* due to the absence of natural barriers or local cover.³¹ *Emptiness* is another way of describing this attribute of space.³²

3. Propagation. Electromagnetic energy can pass freely (almost unattenuated) through space.³³

4. Radiation. Space contains numerous radiation hazards.³⁴

5. Temperature. Space has no atmosphere to dampen extreme thermal conditions.³⁵

6. Gravity. Gravity varies with distance from celestial bodies.³⁶ In space, gravity and mass determine the amount of energy required for maneuver.³⁷ Gravity is a key consideration for conducting operations in space.

"Draft 2-XK" does not address the equally important factors of *high ground*³⁸ or *vantage*.³⁹ The space medium surrounds the air environment and offers the highest possible positioning above air, land, and sea. This characteristic of space is highly significant.

"Draft 2-XK" identifies the operational impacts that these features of space have on the capabilities of space forces. Listed below are summaries of each impact.

1. Access. There is no easy access or *shoreline* for space. Launch technology provides access, and geography (launch site latitude) impacts

the relative ease of attaining various orbits.⁴⁰ The terms *remoteness* and *isolation* refer to the separation of space from the terrestrial environment and to the difficulty in reaching space.⁴¹

2. Free overflight. Orbital mechanics is the sole determinant of a space system's trajectory. This condition assumes the nonsovereignty of space.⁴² However, nonsovereignty is basically a political arrangement that would be questionable in wartime. Although some equatorial states have already rejected the nonsovereignty provision of the Outer Space Treaty,⁴³ free overflight would become an issue only if they gained enforcement technology or created alliances with states which have that technology. Since space doctrine should not be limited by political agreements that may be ignored in wartime, the US should not base its space doctrine on an assumed right of passage in space any more than it bases its other operating doctrines on the right of free passage in the air or on the sea.

3. Global coverage. Over a period of time, a satellite in an appropriate orbit can observe any location on the earth's surface. With sufficient numbers of satellites in the proper orbits, we can simultaneously observe the entire surface of the earth.⁴⁴ Lupton prefers *global presence* as more representative of the military value of satellites in space.⁴⁵ Col Kenneth A. Myers and Lt Col John G. Tockston use *pervasiveness* to emphasize that satellites can maintain a continuous presence over enemy territory.⁴⁶

4. Long-duration flight. The lack of atmospheric drag in space enables satellites to continue in orbit for extended periods without the expenditure of additional fuel or refueling.⁴⁷

5. Quasi-positional location. Position in space is predictable once a space system has been tracked and its orbit computed. Space forces can be stationed over specific, desirable positions by selecting appropriate orbits. Conversely, though, an adversary can predict where to find those satellites (unless they maneuver).⁴⁸ Others describe this effect as *stationability*,⁴⁹ *presence*,⁵⁰ and *emplacement*.⁵¹

6. Maneuver. The ability of satellites to maneuver—to change their position and direction of travel—is a function of propulsion technology and expenditure of fuel.⁵² Thus, maneuverability results from trade-offs regarding payload weight, survivability, and performance. In addition to maneuver, satellites may be oriented (pointed) in any direction without changing the direction of travel. Some writers refer to this capability as *pointability*.⁵³

7. Weapon range. Because space has no atmosphere, directed energy and nuclear weapons have much longer ranges and rocket interceptors can travel at higher speeds than within the atmosphere.⁵⁴ Chalton Watters calls this characteristic *energy projection* and notes that "spacecraft have an inherent advantage in energy projection over aircraft, just as aircraft have other advantages over land- and seacraft."⁵⁵

8. Habitability. The hostile environment found in space constrains the design of manned and unmanned systems.⁵⁶ Others label this characteristic *harshness*⁵⁷ or *inhospitable environment*.⁵⁸

9. Decisive positions. Space has points which have significant military value and lend themselves to control by force. "Draft 2-XK" asserts that "geosynchronous orbits, semi-synchronous orbits, [and] sun-synchronous orbits . . . are all key locations for earth observation, force basing, and control of choke points."⁵⁹ Goodwin notes that clusters of systems will appear at these positions.⁶⁰ Lupton describes this clustering as a *congregational tendency*.⁶¹ It has become enough of a problem that the International Telecommunications Union has had to intervene to control the situation.⁶²

10. Long life. "Draft 2-XK" claims that since putting satellites into orbit is difficult, space systems should be built for a long life.⁶³ "Draft 2-XK's" statement is true but long life is not an impact of the space environment. Long life results from design decisions based on trade-offs between cost, performance, and survivability. The environment itself does not require long-lived systems. For example, the Soviets operate in space with frequent launches of short-lived systems. The Soviet approach has military value and is discussed in chapter 4. Space doctrine should not include a tenet requiring that space-based systems be long-lived.

11. Teleoperation. "Draft 2-XK" states that most systems will be unmanned and require ground command and control links.⁶⁴ Actually, cost, survivability, and performance considerations rather than environmental constraints dictate unmanned systems. A requirement for teleoperation does not belong in space doctrine.

12. Uniqueness. The space environment offers unique research opportunities.⁶⁵ This statement, though true, is hardly relevant to military space doctrine.

Additionally, as Burk notes, the lack of natural cover means that space systems are more "in the open" than in other environments.⁶⁶ The implication that space systems may be more vulnerable than earthbound systems relates to weapons technology and is not an inherent condition of operating in space. Thus, Burk's contention is not relevant to formulating space doctrine. Likewise, Crotty's assertion that space "provides an opportunity to escape detection and identification except by the most sophisticated means" reflects the state of surveillance technology rather than an attribute of space per se.⁶⁷

Myers and Tockston attribute a characteristic of timeliness to space forces. They claim that "satellites . . . can provide near-instantaneous response to military commanders anywhere, anytime. . . . [S]atellite operations are conducted at the speed of light, permitting near-real-time transfer of information and facilitating rapid application of force upon an enemy."⁶⁸ By focusing on the technical characteristics of current satellites, Myers and Tockston overlook the fact that these satellites could be attacked and eliminated. This omission is an odd oversight since the Soviets have demonstrated their ASAT capability. Timeliness is really an objective, not a characteristic, of space forces.

Lupton states that environmental influences on today's space force are generally negative. He identifies the "lack of manning" in US military space forces and the altitude-security trade-off against ground-based threats as environmentally induced characteristics of space forces.⁶⁹ Both constraints, however, result from US policy decisions regarding force posture. Neither represents mandatory force characteristics that derive purely from the environment of space.

Likewise, even though Lupton's assessments of launch cost and on-orbit inaccessibility are accurate,⁷⁰ these shortcomings represent a US failure to adopt strategies to minimize the impact of logistics on space forces. They are *not* due to the fundamental nature of space. Additionally, Lupton asserts that we build space systems to not fail because the cost of making repairs in space to one specific satellite is greater than the cost of designing that system so that it will not fail. However, as research for the military-man-in-space study shows, these economic trade-offs are reversed if applied across all space systems (i.e., we build them of modular components, make them serviceable, field a space tug, etc.).⁷¹ Therefore, launch costs and on-orbit inaccessibility are not appropriate elements of space doctrine.

Access, global coverage, long-duration flight, quasi-positional location, maneuver, weapon range, habitability, and decisive positions all have doctrinal implications. The synthesized doctrine must address these considerations and balance them whenever possible with operational experience. While no space combat experience exists, the principles of war embody general conclusions regarding the historical character of war and should apply to space doctrine. An examination of the principles of war adds focus to the space war-fighting doctrine.

Applicability of the Principles of War to Space Warfare

Current official space doctrine fails to apply the principles of war to space. Unofficial doctrines address the principles but couch their tenets in terms of technology. Johnson, Crotty, Friedenstien, "Draft 2-XK," and other sources examine the relevance of the principles of war to the space environment. Their conclusions generally rest on various assumptions about technology.⁷² Maj Edward F. Teigeler III notes that the analysis should include all space system segments, including "user, control, communications links, and logistics."⁷³

AFM 1-1 identifies 12 principles of war. The following analysis examines the applicability of each principle to the space environment.

1. Objective. "Every military operation must be directed toward a clearly defined, attainable objective."⁷⁴ This principle holds regardless of the environment.

2. Offensive (Initiative). "Space forces alone will have the power to control space and, along with air forces, the ability to strike behind enemy lines and directly at the enemy's heartland without first defeating his forces."⁷⁵ This statement of the offensive acknowledges that space does not present any environmental limitations to offensive action, though the technology to enable space-based offense is still in the formative stage. Crotty notes that the "high ground" position of space enhances the offensive.⁷⁶

3. Surprise. "Draft 2-XK" states that the size and character of space enhance the use of surprise, but that space-based sensing makes surprise on land, at sea, and in the air more difficult.⁷⁷ That evaluation of space-based sensing implies that we can prevent surprise by an enemy's earth-based forces merely by imagery, signal, and other technical intelligence analysis. In his study of strategic surprise, Mushaw concludes that "unexpected changes in national doctrine, technological breakthrough, deception, misinterpreted warning signs, failure to comprehend the mind-set of the enemy, and diplomatic confusion, all combine to form the multidimensional character of surprise."⁷⁸

History is replete with examples of deception that enabled surprise despite the warning signs. The key to forestalling surprise is in the interpretation of the data, not merely the fact that technology makes data available. In reviewing Barton Whaley's book on surprise, Mushaw noted that "Whaley found that in only 7 out of 54 cases of surprise was [keeping force movements secret] the determining factor." In all other cases it was deception that "aided the achievement of strategic surprise."⁷⁹ Technology may offer enhanced methods of surprise—for example, directed-energy weapons that can propagate at the speed of light—but it cannot prevent the use of surprise in space any more than it can on earth. The principle of surprise will apply in space.

4. Security. "Security helps prevent surprise by the enemy while allowing freedom of actions, including the use of surprise by friendly forces. . . . The effective use of security will allow the use of surprise and offensive to achieve the objective."⁸⁰ Security applies in space as it does in the other three media of warfare.

5. Concentration of force (mass). "Concentration of force entails the focusing of firepower by space forces against selected targets. It also includes the focusing of all types of force enhancement as support for land, sea, and air forces."⁸¹ Several authors have noted that space offers the opportunity to focus directed energy on a point from a great distance. In his thesis on the use of mass and maneuver in space, Teigeler notes that

mass consists not of just the collocation of troops for superiority, but the concentration of destructive combat power at the decisive point in space and time. This in turn depends upon superior planning, the correct selection of the decisive point, the simultaneous strategic employment of all available forces, the balanced disposition of forces between dispersion and concentration to create the necessary vulnerability and then exploit it, and finally, the resolute execution of the plan with great spirit. One of the chief means to create mass lies in the principle of maneuver.⁸²

Teigeler further notes that land, sea, and air forces may be needed to help attack the "decisive points of the space theater."⁸³ Instead of the traditional firepower-oriented definition, concentration of force in the theater of space may involve the simultaneous, focused use of multiple systems to provide information to support a terrestrial activity.

6. Economy of force. "Draft 2-XK" states that "the quantity of forces used should be enough to successfully accomplish the desired objective [but] sufficient forces must be retained in reserve."⁸⁴ This statement blurs the principle somewhat, since economy of force actually emphasizes "attacks with appropriate mass at the critical time and place without wasting resources on secondary objectives."⁸⁵ Space assets should be used just as judiciously as are land, sea, and air forces.

7. Maneuver. "The ability to maneuver involves repositioning space forces . . . maneuver provides the flexibility for space operations."⁸⁶ According to Teigeler, "the five general concepts which together seem to constitute the principle of maneuver are maneuver to obtain mass; create and use a mobile reserve; seek the highest possible level of mobility; minimize the observation, decision, and implementation cycle time; and maintain flexibility of thought, plans, and operations."⁸⁷ These functions would be operative in space. Friedenstein states that maneuver would not apply because of fuel requirements; but, since this restraint is purely a function of technology, it is irrelevant. Maneuver will apply in space.

8. Timing and tempo. Timing and tempo offer distinct advantages.⁸⁸ High-speed propagation of directed energy through space holds the promise of enhanced tempo. Crotty links the "control of timing in space" to the prepositioning of forces and on-demand launch capability.⁸⁹ These operational considerations are important but should not overshadow the greater challenge of determining how and when to use space forces. Timing and tempo will apply in space.

9. Unity of command. "Draft 2-XK" states that "unless . . . specifically designed to support a unique mission, military space assets, to be used effectively, must be placed under the command of one authority. . . . [E]conomy of effort is most frequently realized when operations are controlled by a single authority."⁹⁰ This statement actually describes control and coordination rather than command. AFM 1-1 defines unity of command as "the principle of vesting appropriate authority and responsibility in a single commander to effect unity of effort in carrying out an assigned task."⁹¹ The US implements this principle by giving terrestrial theater commanders in chief (CINC) combatant command over all forces employed in their theaters (regardless of service). This principle should apply to the space theater; the combatant control structure will likely rest with the US Space Command.

10. Simplicity. Operational procedures and orders should be as simple as possible.⁹² This principle should apply in space as on the earth.

11. Logistics. "The ability to maintain and sustain personnel and equipment is vital to all military environments. . . . The military force that

develops and maintains an effective space logistics system will have a tremendous advantage over any force which does not do likewise."⁹³ This principle was proven valid when the *Challenger* tragedy temporarily suspended the US capability to launch space systems.

12. Cohesion. The "ability to perform in a stressful situation is essential. Cohesion is built through effective training and leadership, and by generating a sense of common identity and shared purpose."⁹⁴ This principle will definitely apply to space operations. It reminds us that people, not machines, fight wars. Crotty discounted cohesion as a factor in space because of the unmanned nature of most systems.⁹⁵ However, the earthbound system controllers and maintenance personnel are a key link. Their cohesion in space battles is just as critical as in land, air, and sea battles.

Despite technology's key role, nothing in the space environment itself would invalidate the applicability of any of these principles of war to space doctrine. A synthesized space doctrine must acknowledge and accommodate the principles of war.

War Gaming and Modeling: Substitutes for Experience

War games and operations research can identify some likely characteristics of space warfare. However, these techniques do not promise "solutions" to the problems of war, rather they illustrate the impact of various assumptions and decisions in space warfare. They highlight the questions and challenges that space combat may pose. By using these techniques, US commanders and planners will learn firsthand the advantages of maintaining the freedom to operate in space while denying a similar capability to the enemy. This conclusion holds regardless of the assumed level of weapons technology. Consequently, it forms the basis for some portions of the war-fighting space control doctrine formulated in the next section.

The two main types of games are analytic simulation and politico-military games. Analytic games model force structures and battlefield tactics. They can provide insight into the effects of different employment theories and force structures, and they can provide experience with scenarios that are too hazardous or expensive to re-create in real life.⁹⁶ Limited data is available on the use of analytical games for space applications. The Applied Physics Laboratory at Johns Hopkins University has developed a simulation for the Department of Defense (DOD) Joint ASAT Program, and SDIO is funding the National Test Bed Facility at Colorado Springs, Colorado. The Aerospace Corporation maintains a space decision model that simulates ASAT engagements and survivability measures.⁹⁷ These simulations

should generate important technical design information, but their main value is to confirm the doctrine created through other means.

Though not strictly an analytical war game, operations research uses mathematical methods and modeling concepts to examine systems and assess strengths, weaknesses, and preferred employment strategies. In a recent report on scenarios constructed to determine the linkage between the various elements of a future Strategic Defense Initiative (SDI) architecture, Dennis Holstein concluded that

space warfare centers on the process of attrition, which comes from the successful delivery of firepower. . . . With space control the U.S. can be assured access to space and deny the use of Soviet space assets to achieve their military objectives. . . . Actions taken to interfere with the enemy's firepower, surveillance and . . . command, control, and battle management process are of fundamental importance. . . . To achieve victory one must effectively attack first.⁹⁸

Holstein's emphasis on the offensive and initiative reinforces the applicability of the principles of war to space. While the focus of this study is on space war fighting in a generic sense (rather than Holstein's space-based strategic defense), these results point to the need to control space.

In contrast to the computer-based analytical games, politico-military games use human players to address "the interactions between U.S. and Soviet [or other countries] strategy and tactics."⁹⁹ Rather than concentrating on numerical calculations and assumptions, these games attempt to identify the major issues and challenges that decision makers face during a crisis. Contextual richness and realism—through scenarios that simulate the political dilemmas and options that actual decision makers would face—replace the body counts and attrition rates of analytical games.¹⁰⁰ Thomas Allen notes that "the value of the game" is that it is "an exercise in understanding what [the] problems are going to be."¹⁰¹ Lt Arthur Mobley, Jr., explains that "strategic games permit players and policymakers to concentrate on broad issues rather than precisely defined variables. . . . Games also cultivate an appreciation for an opponent's strategic culture, and they give players a first-hand feel for the uncertainties of conflict wrought by the fog of war."¹⁰²

In 1986 the Strategic Defense Initiative Organization hired the SRS Technologies corporation to set up and supervise politico-military (strategic) games that assess the utility of strategic defense systems. The results, though subject to the caveats above, provide potentially significant insights for space doctrine. SRS concluded that "the strategic importance of controlling space has emerged clearly from all the games. In virtually every game, both Blue and Red teams realized [that] the side that controlled space would have a major strategic advantage. Securing this advantage proved to be decisive in every game . . . played."¹⁰³

Such insights may be most useful when gained from a combination of analytical and politico-military games.¹⁰⁴ Both types of games confirm the relevance of the principles of war and demonstrate the importance of space control.

Space Control Doctrine

Space control is analogous to air superiority at a specific time and place. Just as the Allied air forces did not need, and never achieved, absolute control of all German air space in World War II, US and allied countries probably would be unable to establish total dominance in space. Space control is the ability to deny the enemy use of a region of space for a specific period; it does not require absolute control of space.

Space control doctrine recognizes the environmental possibilities and limitations of warfare in space and provides ample foundation for the development and employment of space war-fighting weapons. The following considerations will influence the preparation of a valid doctrine of space control.

1. Gravity, extent, harshness, and inaccessibility are key features of space.
2. Space enables long-duration flight.
3. Space permits long weapon ranges.
4. Space has decisive positions.
5. All 12 principles of war apply in space.

Functions of Space Control Operations

Functions. Space control operations gain and maintain space superiority as necessary in crisis and conflict, thereby preventing enemy space forces from influencing the outcome of terrestrial or [space] operations, and assuring freedom for friendly operations. This [is] accomplished by selectively destroying or neutralizing the enemy's space systems and by employing both active and passive means to protect friendly assets.¹⁰⁵

Lupton explains that "control is a capability rather than a condition. [S]pace control will be the same as air and sea control—a peacetime capability serving as a deterrent because it can be employed in wartime."¹⁰⁶ Thus, control as described above does not require the emplacement of a multitude of war-fighting systems. It merely establishes the requirement to possess the capacity to interdict the enemy, analogous to naval and air forces.

Necessity of Space Control

Military Instrument. Space control . . . operations are . . . conducted to eliminate or diminish the enemy space threat. However, because both aerospace and surface operations could be significantly impaired in the face of effective enemy space operations, the outcome of [space control] operations could directly influence all other operations. Therefore, [space control] operations demand the highest priority of all space operations whenever enemy space power presents a significant threat to [friendly] terrestrial operations.¹⁰⁷

Space control is a vital military instrument. Space control doctrine affirms the contribution that enemy space forces make to the terrestrial conflict and the concomitant threat that they pose to friendly forces. Space

control operations thus demand the highest priority of all space-based missions; they strongly support the principle of offensive. Allocations of forces between space control and other missions would depend on the specific scenario, just as air commanders allocate air resources between counterair and other missions.

Employing Space Control Forces

Mission. Space control provides freedom of action in space for friendly forces, while denying it to the enemy.

Concept of Organization. When a hostile space threat exists, [space control] operations require offensive and defensive [space control] actions. Because these actions are mutually supporting and interrelated, they require close coordination and centralized control.

Tasks. a. [Space control] operations include offensive and defensive actions. Offensive [space control] actions are conducted into enemy territory or against enemy spacecraft before they are employed against friendly forces. Defensive [space control] actions are reactive to the initiative of enemy forces. [Space control] actions [thwart or neutralize] enemy space actions.

b. Force enhancement . . . measures include the functions of communications, space surveillance, reconnaissance and navigation/positioning. These functions may be conducted from the earth or from space to enhance [space control] operations.¹⁰⁸

Space control actions support surprise and increase the opportunity to seize the initiative and set the tempo of the battle. Space systems enhance the operating capabilities of other forces as well.

Composition of Space Control Forces

Essential elements. Space control operations employ [the following] systems:

- a. Space intelligence
- b. Space tracking and surveillance systems
- c. Central command and control centers
- d. Antisatellite systems (ASATs)
- e. Defensive satellite systems (DSATs)
- f. Space transportation systems
- g. Trained crews
- h. Logistics, communications, administration.¹⁰⁹

Space control operations rely on a variety of support elements. This list includes elements of cohesion and logistics. It demonstrates that for at least the next 20 years space control will depend on terrestrial support.

Space Control Operations

Offensive [Space Control] Operations. Offensive space control operations seek out and destroy enemy space power before it can be employed against friendly forces. These operations include surface-to-surface, air-to-surface, and space-to-surface attacks against space support facilities or space weapons in enemy territory and attacks against orbiting systems [space-to-space] before they are employed. [Space control]

strikes initiated at the onset of hostilities, and a ready and effective space defense, [can] produce an immediate advantage in the space battle and result in early space superiority. . . . While the enemy space defense system may be the target of a specific offensive [space control] campaign, continued suppression of this threat [may] be required in conjunction with other actions. . . . These actions [will] perform two basic offensive [space control] functions: support of [friendly] space missions through suppression or destruction of hostile space defenses, and systematic destruction of the enemy space network.¹¹⁰

Lupton notes that, except for the geostationary orbits, space systems continuously change position with respect to the earth. Thus, the primary means of control is the destruction of enemy forces. Only in geostationary orbit could a system potentially control space by occupying a fixed position relative to the earth's surface.¹¹¹ Space denial may result when offensive, but not defensive, space control operations are successful. Space is denied when all space systems of all opposing belligerents are eliminated by attrition. Denial exists when replacement satellites are eliminated; denial does not require neutralization of the launch systems themselves.

Defensive Space Control Operations. Space defense consists of measures designed to nullify or reduce the effectiveness of space systems which are being employed against [friendly] interests. . . . Space defense involves active and passive defensive measures.

Active Space Defenses. The basic functions of active space defense measures are detection, identification, interception and disruption or destruction of space vehicles that threaten friendly terrestrial or space forces and installations. Effective space defense requires centralized coordination of space defense weapons. . . . The primary space defense weapons are ASATs and DSATs.

Passive Space Defenses. Passive space defense consists of measures not involving the employment of active weapons to defend friendly terrestrial or space forces from attack by hostile space systems.¹¹²

In addition to denying access to or use of space, the US must have the ability to protect its own space assets from attack or to prevent the denial of its use of space.

The space control doctrine developed in this chapter is consistent with US national policy and implementation strategy (see chapters 3 and 4). Gen John L. Piotrowski—former commander in chief of US Space Command, in an appearance before the Senate Appropriations Committee—summarized the tenets of space control doctrine in the following terms:

The employment of forces in space control operations represents the combat or warfighting mission assigned to USCINCSpace. These space control forces must have the capability, across the spectrum of conflict, to carry out the functions of detecting space objects, identifying their activities as either threatening or nonthreatening, assessing the capability and possible intent of each foreign space system, and engaging or nullifying those that are the war-supporting space systems of an enemy.¹¹³

Compared with current official space doctrine, space control doctrine is clearer, more environmentally based, less technologically dependent, and more consistent with the implications of the major factors that influence the development of doctrine. Space control doctrine should play a key role in the testing, evaluation, and employment of space war-fighting weapons.

Chapters 3 and 4 describe US military space policy and implementation strategy. Both policy and strategy bear on weapons testing, evaluation, and employment.

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Chapter 3

Feasibility of Space Control

The present administration's national security policy strongly endorses space control and the unofficial doctrine developed in chapter 2. The threat of a strong Soviet space program, significant Soviet and US dependence on space systems to support terrestrial forces, the US national security objectives of deterrence and controlling escalation, and congressional and public support for space war-fighting capabilities will determine to what extent we achieve a viable space control doctrine, develop effective space control weapons, and derive sound strategies for employing those systems. The national security objectives of terminating conflict quickly and deterring war, the perceived military threat, estimates of the nature of future warfare, doctrine, and risk management all argue that the US will jeopardize vital national security interests by relying heavily on unprotected force-enhancing space systems. These systems are vulnerable to attack by enemy space systems that have demonstrated and potential antisatellite (ASAT) capabilities.

Essentiality of Space Weapons

To correct this weakness in our national security posture, the Bush and Reagan administrations have advocated developing a space control capability through building and deploying ASAT weapons and associated systems.¹ Space weapons are controversial, however. Some in Congress and among the public at large dispute the nature and seriousness of the threat. The Antiballistic Missile (ABM) Treaty figures strongly in the congressional debate over whether to build space weapons or to negotiate new treaties. Both the Bush and Reagan administrations have considered ASAT arms control measures as inequitable, unverifiable, and not in the interest of national security. The following discussion amplifies the logic behind each administration's decision to embrace space weapons rather than treaties.

Each administration develops national security policy based on perceived threats to US national objectives and the options available to counter those threats. National security policy has two broad goals. First, it seeks to deter war at all levels. Credible deterrence forces the enemy to recognize that he cannot achieve his objectives through armed conflict. Second, US policy states that should deterrence fail, the US will seek to ensure swift

termination of hostilities at the lowest possible level on terms favorable to the US and its allies.² Space weapons can greatly enhance the capacity of our national security forces to achieve these aims. Satellites provide a range of capabilities that underpin deterrence by ensuring combat effectiveness in war. Our forces depend on these systems for crucial aspects of operational readiness—for communications, surveillance, navigation, warning services, and environmental monitoring (weather). These missions are provided by a comparatively small but highly capable and absolutely vital force structure of space-based systems which have become critical tools of support for a modern military force.³

Two examples illustrate the usefulness of force enhancement systems. Photoreconnaissance satellites can provide Army commanders with valuable information about their opponents: knowledge of massing and massed forces denies elements of surprise, limits the enemy's initiative (places observer inside enemy's planning cycle), denies the enemy the ability to concentrate against the observer's weaknesses, and increases the enemy's risk in force allocation decisions; knowledge of air defense sites and status degrades counterair effectiveness and supports friendly air suppression plans; knowledge of command, control, and communications (C³) centers supports targeting and aids in order of battle development; knowledge of support and sustaining bases contributes to estimates of combat sustainment and supports battle damage assessment of raids against deep targets including air bases.⁴ Likewise, environmental information assists the naval commander in many ways.

- Sea surface wind analysis facilitates flight and ship routing. Wave and surf forecasts are critical for amphibious operations and underway replenishment.
- Sea surface temperature analyses help determine potential hiding places for submarines, and support antisubmarine warfare (ASW) tasks including sonar range predictions, weapon settings, sonobuoy spacing, and sonar tow depths.
- Ice data assists submarine surfacing and navigation.⁵

The requirement to end conflict "at the lowest possible level" implies the need to control escalation. In theory, controlling escalation enables one to fight effectively while avoiding actions that would force the enemy closer to nuclear war. The government's decision to develop or forswear war-fighting systems in space is determined by a variety of complex factors, two of which are the severity of the threat and the impact of war-fighting systems on the two primary national security goals of deterrence and ending conflict quickly. The Soviet threat from space has intensified in recent years. Thus, the United States has had to make space control an essential aspect of its national security and space policies. However, as we shall see, many other factors also affect the decision to develop space weapons.

Foreign Space War-fighting Threats

Vital US interests are at risk in space. The space threat consists of hostile space systems that provide force enhancement to enemy terrestrial forces and ASAT systems that threaten the force-enhancement systems of the US and its allies. ASAT systems include all weapons and techniques that can “degrade, neutralize, disable, or destroy a satellite.”⁶ Several such systems have been tested or lie within the bounds of current technology (table 4).

TABLE 4

Antisatellite Systems

<i>Dedicated</i>	<i>Residual</i>
Electronic countermeasures	Modified ICBMs (nuclear)
Ground-based, directed-energy weapons	Modified ABMs (nuclear)
Direct attack (nuclear, conventional, impact)	
Coorbital	
Direct ascent	
Space-based mines	

Source: Adapted from Maj Hal E. Hagemeyer, USAF, “Space Warfighting Information Needs” (Maxwell AFB, Ala.: Air Command and Staff College, 1987), 10; and Paul B. Staros, “The Threat to Space Systems,” in *The Search for Security in Space*, ed. Kenneth N. Luongo and W. Thomas Wander (Ithaca, N.Y.: Cornell University Press, 1989), 47.

The Soviet Union presents the greatest spaceborne challenge to US and allied space forces, just as it does on land, at sea, and in the air. Briefly, the Soviets view space as a theater of war. Their doctrine integrates space systems into a combined-arms approach involving all environments—war in space logically accompanies war on land, at sea, and in the air.⁷ (Annex A presents a detailed description of Soviet space doctrine.)

The Soviets possess a variety of ASAT systems, the best known is the coplanar interceptor. Launched by an SL-11 booster, the interceptor maneuvers close to its target and detonates a shrapnel-type warhead. The system accomplishes the interception in one to two revolutions of the earth. Between October 1968 and June 1982 the Soviets tested their system 20 times. Whereas optical guidance systems performed poorly, radar systems demonstrated a 65-percent success rate.⁸ The Soviets have coordinated their system tests with their nuclear exercises. According to *Aviation Week and Space Technology*, the Soviets conducted a comprehensive exercise on 18 June 1982 involving an ASAT test and launches of two intercontinental ballistic missiles (ICBM), one intermediate range ballistic missile (IRBM), one sea-launched ballistic missile (SLBM), and two Soviet satellites.⁹ In

August 1983 the USSR announced a unilateral ASAT test ban.¹⁰ However, the ban does not devalue the demonstrated performance of their system. Indeed, the SL-11 booster is tested each time it launches other military payloads, and the ASAT guidance systems may be tested whenever one space vehicle docks with another.¹¹ Comments by Yevgeniy Velikhov, vice president of the USSR Academy of Science, confirmed the Soviet belief that "if we can dock with a satellite, then clearly, we can dock with an American satellite, but a bit carelessly, and thus destroy it."¹² Frequent testing also characterizes the other Soviet ASAT programs.

The Soviet Union also possesses a vigorous ground-based laser program. At Semipalatinsk the Soviets operate an explosively driven pulsed iodine laser, which analysts have judged as having "military potential."¹³ In 1987 *Aviation Week and Space Technology* published imagery taken by the French *satellite pour l'observation de la terre* (SPOT). The images showed elements of Soviet strategic lasers located at Sary-Shagan and Nurek.¹⁴ Government sources have confirmed that some Soviet lasers possess a lethal range capability out to 250 nautical miles and a general damage capability to 400 nautical miles.¹⁵ The 1989 edition of *Soviet Military Power* confirms the operational status of the ground-based laser threat and identifies additional residual capabilities.¹⁶

The dedicated interceptor and laser systems are complemented by the residual capability inherent in the antiballistic missile system deployed around Moscow. The ABM system was originally designed to intercept and destroy incoming missiles by exploding a nuclear warhead. ABMs could be converted to ASAT duty by modifying their guidance systems to enable detonation at a predetermined point in space. Since this modification is straightforward, the US sees Soviet ABMs as ASAT capable.¹⁷

Soviet electronic countermeasures (ECM) systems are equally threatening. However, pinpointing their location in the Soviet Union is difficult. While the open literature does not describe specific systems, Soviet doctrine has long stressed the importance of ECM. Flexibility and adaptability characterize this class of weapons. They are the only ASAT weapons that can be used against high- and low-altitude targets, and they offer the ability to degrade but not permanently destroy the target.¹⁸ Col Alfred R. Garcia, Jr., characterizes ECM as "the most serious space system weapon available today."¹⁹ ECM systems put all friendly force-enhancement systems at risk. The Soviet spaceborne challenge also includes many nonoffensive systems.

Like the United States, the Soviets operate several types of satellites in support of their ground forces. (See table 3.) The Soviets have roughly 50 different satellite systems, with approximately 160 satellites in orbit during 1988.²⁰ Missions include reconnaissance, surveillance, strategic and tactical targeting, launch detection, attack warning, communications, navigation, and weather. The Soviets integrate the products of these systems to obtain the best possible picture of the "strategic and tactical posture of the

enemy.²¹ Soviet photoreconnaissance satellites assist the army and navy as the previous examples illustrated.

Similarly, Soviet ELINT* ocean reconnaissance satellites (EORSAT) and radar ocean reconnaissance satellites (RORSAT) assist in maritime operations. By orbiting these types of satellites in tandem, the Soviets achieve real-time targeting of US naval assets. The RORSAT attempts to identify ship positions. If a US ship jams the RORSAT, the EORSAT homes in on the jamming signal and notes its position.²² Soviet photoreconnaissance satellites provide intelligence information on ship movements and intentions.²³ In 1987 the Soviet Union unveiled a major effort to build and field satellites capable of detecting submerged US submarines.²⁴ Should the Soviets succeed, they would have the capability to target the most survivable leg of the US strategic triad. While Soviet satellite systems perform many functions, their inefficient peacetime structure provides important wartime advantages. Because orbiting Soviet satellites have short lifetimes, the Soviets have developed a rapid replenishment capability. During an ASAT exchange, superior Soviet reconstitution capability could provide a decided advantage over the United States' longer-lived but almost irreplaceable systems.²⁵

While the US and the Soviet Union are the predominant military users of space, other countries have significant programs. The European Space Agency's Ariane boosters provide access to space, and France is developing its own communications and surveillance systems.²⁶ China, India, Israel, and Japan possess varying degrees of launch capability.²⁷ China has fielded communications and possibly reconnaissance and electronic intelligence satellites.²⁸ India operates communications satellites and reconnaissance systems.²⁹ Israel is believed to have launched reconnaissance satellites and appears to be developing a reconnaissance capability.³⁰ Japan is developing a fleet of launch vehicles and has placed over 35 payloads into orbit. These payloads include surveillance, weather, and communications satellites.³¹ These new space-faring countries are learning to use space to enhance their national security. The proliferation of space-faring powers—friendly, hostile, and nonaligned—complicates the US-USSR competition for the use of space and threatens to make unprotected US space assets even more vulnerable.

Implications for Strategy

The following three scenarios explore the future nature of war in space and the impact on US and allied strategy for the use of spaceborne systems. Three scenarios—each representing a different level of conflict—examine the consequences of losing friendly satellites during conflict. These

*electronic intelligence

scenarios highlight specific shortfalls. The scenarios demonstrate that weak survivability and the lack of an ASAT capability undermine the ability of the United States to influence the outcome of war in space and perhaps in the air, on land, or at sea.

The first scenario involves nuclear war between the US and the Soviet Union. Given nuclear deterrence and the apparent collapse of the Warsaw Pact, nuclear war seems the least likely, but most devastating, of all possible conflicts. In such an exchange, both nations would depend on space for early warning, command and control of nuclear forces, and reconnaissance of the resulting damage (assuming ground stations survive—a questionable proposition at best). Satellites would play a critical role at the beginning of the war, but their loss by either side would not endanger the second-strike capability that both sides possess. Neither ASAT attacks on satellites nor the unimpeded use of force-enhancing satellites would neutralize the effectiveness of the second-strike force.³² Likewise, the invulnerability of the second-strike force guarantees that ASAT weapons themselves would not provoke a nuclear war any more than would tanks, submarines, bombers, and similar conventional weapons. The next two scenarios are different.

The second scenario involves a major conventional war between either the superpowers or their allies. Both superpowers would use their satellites to provide targeting, damage assessment, and communications. Soviet doctrine—which stresses initiative, striking first, and massive force—and Western reliance on space systems that are inherently unsurvivable would tempt Soviet ASAT attacks on US and allied space systems.³³ Losses from hostile ASAT attacks, coupled with the current US inability to replace satellites, would deprive friendly forces of force enhancement and place them at a substantial disadvantage. This attrition and vulnerability would be particularly true in the event of a Soviet invasion of central Europe.³⁴ For example, one analyst notes that

the United States would attempt to maintain open sea lines of communication (SLOCs) across the Atlantic, Indian and Pacific Oceans. Because the Soviet Navy operates only a limited number of surface ships and submarines . . . in these oceans, the control of space assets supporting these areas would be quite disruptive and could give them a decided advantage.³⁵

Knowledge of the value of satellite-derived data would strengthen Soviet motivation to conduct ASAT attacks.

At present the US can attack the Soviets' force-enhancing satellites only by striking ground control sites located within the Soviet Union. Risking nuclear war with an attack on the Soviet homeland seems a very unlikely choice, given the absence of a direct threat to the continental United States.³⁶ Such strikes would be escalatory. Since it lacks an ASAT capability, the US could not attack Soviet satellites. According to Soviet analyst Nicholas Johnson, this asymmetry offers the Soviets the opportunity to conduct a series of selective attacks in space to achieve "limited

political-military objectives.³⁷ In effect, the US forfeits protection of friendly satellites to Soviet indulgence.³⁸

Thus, in this type of scenario the US (or its allies) needs two types of capabilities. It must ensure that US (and allied) satellites survive the Soviet ASAT threat. Replenishment and deterrence are two possible solutions. Besides survivability, the US needs to negate hostile Soviet force-enhancement satellites.³⁹ Some satellites might be negated by deception and good luck (e.g., some claim that the EORSAT/RORSAT can be eluded by controlling electronic emissions and can be avoided in bad weather), but neutralizing others like communication and weather satellites requires an ASAT attack.

The third scenario involves conflict between two developing or third-world countries. This scenario is the most likely of the three and paints a more restrained picture. Neither combatant has space systems, so they find sponsors. One possibility is that the US and the Soviet Union would each support the country possessing a similar political ideology. Concerns about escalation would prompt both superpowers to avoid direct confrontation. Analysts speculate that the US would employ "optical and electronic intelligence, communications and control, and precise delivery of weapons so as to minimize damage to noncombatants. . . . These [systems] will be important both for obtaining local political support and support in the United States and elsewhere in the West."⁴⁰ Low-cost space systems could "make it possible to monitor large areas, day and night, regardless of weather or terrain, and [they] have the additional advantage that they will in some measure be substituting for aircrews who might be lost or taken hostage."⁴¹ The Soviets would likely use ECM against US assets, since ECM provides a bloodless capability to degrade but not destroy its target.⁴² Again, US-aided forces would operate at a disadvantage after loss of force enhancement. While escalation concerns may prohibit retaliation against Soviet ECM ground sites, a US ASAT capability could prove useful in deterring Soviet ECM attacks against US satellites and could permit a response in kind against Soviet satellites. While this scenario represents less of a direct threat to US vital interests, it could lead to diminished US prestige, could cost victory for an ally, and could contribute to lessened long-term US international influence.

Together these scenarios illustrate the challenges that space war holds for an unprepared United States. These scenarios demonstrate several essential points. First, space will not remain a sanctuary from conventional war.⁴³ The advantages that space systems offer to both sides make these systems attractive targets. Second, Soviet doctrine and the lack of US response options make such attacks more likely. The Defense Department concluded, in its *Report on Space Control* to Congress, that "failure to provide a response in kind to the operational Soviet [ASAT] system would perpetuate the existing destabilizing situation in which the Soviet Union can attack our space systems, based on the knowledge that their systems are not vulnerable to counterattack."⁴⁴ Third, the scenarios demonstrate

that there is little difference between the so-called stabilizing uses of space (surveillance, communications, reconnaissance, etc.) and the weapon uses (ASATs).⁴⁵ Both uses of space play a key role in helping each side's military forces achieve their goals. Analysts note that "there is no absolute way of separating offense from defense in space any more than on the surface of the earth or in the oceans or in the atmosphere."⁴⁶

Future war in space (excluding ballistic missile defense) probably will have a direct impact only on conventional conflict. ASAT attacks in and of themselves would neither change the nuclear balance nor provide "victory" to either side. Thus, ASATs are unlikely to destabilize nuclear deterrence and their use would not force a nuclear exchange. During conventional conflict, however, the Soviet Union's ASAT capability would enable its forces to make unlimited use of space for force enhancement while eliminating any potential for the US and its allies to use their space assets for force enhancement. This asymmetry places US vital interests in an untenable position. The Defense Department judges that the US ability to assure US and allied freedom of action in space "has become as important to the United States as sea control capabilities are to the exercise of maritime strategy and air power is to the land and air campaigns."⁴⁷ Former secretary of defense Frank Carlucci stressed this point in his January 1989 testimony on the fiscal year 1990 budget. He stated that lack of an ASAT capability was the "single most vulnerable point" in the country's defense.⁴⁸ Presidents Reagan and Bush asked Congress to adopt an approach responsive to US needs: space control. The space control policy is an exercise in risk management.

As illustrated by these nuclear, major conventional, and limited conventional scenarios, space will not remain a sanctuary during war. Hence, space control must be an integral part of the United States' national security structure. The following sections describe space control in detail and discuss the steps necessary to implement it.

Components of Space Policy

Space control requires versatile ASAT systems and a supporting network of tracking, intelligence, analysis, command, and control functions. ASAT weapons provide the means to deny space capabilities to the enemy. Space control also requires survivable and endurable friendly systems. Space activities encompass command and control, communications, navigation, environmental monitoring, warning, surveillance, and force application.⁴⁹

US goals and principles in space, as stated by President Bush, include activities . . . in support of [the United States] inherent right of self-defense and its defense commitments to its allies. . . . The United States rejects any claims to sovereignty by any nation over outer space . . . and rejects any limitations on the fundamental right of sovereign nations to acquire data from space. The United States considers the space systems of any nation to be national property with the right of

passage through and operations in space without interference. Purposeful interference . . . shall be viewed as an infringement on sovereign rights.⁵⁰

National policy specifically directs that “survivability and endurability of national security space systems, including all necessary system elements, will be pursued commensurate with the planned use in crisis and conflict, with the threat, and with the availability of other assets to perform the mission.”⁵¹

Since policy goals translate into critical performance and survivability requirements for space weapons systems, developers must plan for space as a wartime environment rather than as a sanctuary from conflict. In wartime space forces will have to perform four basic operations: space support, force application, force enhancement, and space control.⁵² Space support provides launch and satellite tracking and control systems. Force application projects force from space to the earth’s surface. Force enhancement provides information useful for traditional terrestrial war—weather, navigation, communications, reconnaissance, and similar applications. Space control provides and maintains freedom of action in space. These mission categories overlap considerably, and each function requires support from the others.⁵³ For example, force-enhancement satellites require the ground tracking and control assets grouped under space support. Likewise, force enhancement depends upon satellite protection, a key element of space control. The aim of space control is to assure freedom of action in space.

Space control requires “an integrated combination of antisatellite, survivability, and surveillance capabilities.”⁵⁴ National policy directs that an ASAT system be developed and fielded “at the earliest possible date.”⁵⁵ DOD policy provides for “a flexible, responsive mix of ASAT weapon systems . . . to deny the enemy, permanently or temporarily, global or selective area support from his space-based systems, thereby decreasing the effectiveness of his ground, air and sea forces. ASAT weapon systems must also provide a response-in-kind to potential enemy attack against U.S. space systems.”⁵⁶

The response-in-kind requirement relates to the national goal to achieve “swift termination at the lowest possible level of conflict.” In the above scenarios the lack of an ability to respond in kind forced the US to choose between no response, thereby forfeiting space control, or escalation through attacks on the Soviet homeland. Analysts agree that escalation control is best provided by the ability to respond in kind.⁵⁷ National security policy also directs that our military acquire an “integrated attack warning, notification, verification, and contingency reaction capability” to confirm and respond to threats to national space systems.⁵⁸ (Chapter 4 will explain how all these elements are pieced together.) Elements of this policy and its advocacy of a space control capability for our military forces have proven controversial in Congress. The chief congressional concerns center around questions of whether current treaties permit the development and deployment of space control technology and whether peace can be better attained and maintained through arms control.

Impact of Arms Control Limitations on Space Control

Judgments on the usefulness of arms control are polarized. Some see it as "the principal method of achieving a lasting peace," while others view it as "a trap for democratic societies, a trap that invariably prevents them from pursuing necessary programs for defense and security."⁵⁹ This section provides an overview of arms control philosophy and describes treaties and international law governing activities in space. Only three exert a major influence: the Limited Test Ban Treaty of 1963, the Outer Space Treaty of 1967, and the ABM Treaty of 1972. This section discusses these three treaties at length because their successes and failures figure strongly in the congressional debate. (Copies of the existing treaties that apply to space activities appear at annex B.)

In its early years the Reagan administration took a dim view of arms control agreements with the Soviet Union, citing Soviet violations of the 1925 Geneva Protocol, the 1972 ABM Treaty, the 1972 Biological Weapons Convention, and the 1975 Helsinki Final Act.⁶⁰ Experience, however, establishes that achievements in arms control reflect the state of political relations between the parties and the status of the weapons of interest.⁶¹ The willingness of signatories to observe the treaties springs from the threat each party perceives rather than from the specific language or conditions of the treaty. Weapons that do not exist are easier to ban than systems fielded or under advanced development.⁶² Once nations possess weapons, laws cannot guarantee that those weapons will not be used. Historically, only threats of reprisal have effectively deterred the use of such weapons, but even then only if both sides possessed the same type of weapons.⁶³ Finally, regardless of the type of ban or the status of its weapons, the US should consider that any treaty will likely remain in effect for decades.⁶⁴

The Limited Test Ban Treaty of 1963 prohibits nuclear explosions under water, in the atmosphere, and in outer space.⁶⁵ It does not materially restrain the implementation of space control as described in chapter 4. Unlike the Limited Test Ban Treaty, the Outer Space Treaty of 1967 focuses purely on activities in outer space. It affirms rights and establishes restraints on states participating in space activities. Article 2 "establishes the principle that outer space, including the celestial bodies, is not subject to national appropriation by claim of sovereignty, by use or occupation or by any other means." In effect this article recognizes free passage for satellites in orbit.⁶⁶ It also "prohibits the creation of territorial buffer zones around [satellites] but would permit the establishment of nonsovereign zones for safety and security."⁶⁷ Article 3 extends the jurisdiction of international law and the United Nations Charter to space activities. Article 51 of the charter recognizes the use of armed force for self-defense. Self-defense can be exercised "not only in response to an actual armed attack, but also to remove a threat of imminent armed attack."⁶⁸ Article 4

of the Outer Space Treaty prohibits the stationing of weapons of mass destruction in orbit or on celestial bodies.⁶⁹ "Mass destruction" refers to nuclear, chemical, and biological weapons.⁷⁰ The treaty has worked, encouraging the use and exploration of space while excluding the deployment of nuclear, chemical, and biological weapons in outer space.

The ABM Treaty does not merit similar respect. Signed in 1972, the ABM Treaty was an outgrowth of the Strategic Arms Limitation Talks (SALT), which were aimed at controlling the growth of nuclear weapons. The ABM Treaty seeks to preserve US and Soviet nuclear deterrence by restricting the defensive systems used to shoot down attacking nuclear missiles and warheads. The absence of defensive systems enhances deterrence by ensuring that neither nation could launch a nuclear strike and protect itself from its enemy's response.⁷¹ This strategy also requires that the superpowers limit their offensive systems. Otherwise, one side might simply overwhelm the other with a massive first strike consisting of a much higher number of offensive systems.

Opponents of the ABM Treaty point out many omissions and loopholes and use these shortfalls to argue against future treaties. Arms control supporters, meanwhile, oppose ASAT programs and fear that the US will unfairly exploit these same loopholes.⁷² The following discussion highlights the treaty's shortfalls. The analysis is detailed but essential to understanding the issues.

Article 3 permits each side two small, fixed, land-based ABM systems.⁷³ Later agreements reduced this to one. Article 5 prohibits development, testing, and deployment of air-, sea-, space-, and mobile land-based ABM systems or components.⁷⁴ These two articles seemingly limit ABM systems to the fixed, ground-based variety. However, Agreed Statement D fails to state whether development and testing are permitted before deployment discussions are concluded in accordance with Article 13.⁷⁵ This omission leads to strong disagreement between SDI advocates and opponents. In 1985 the US Arms Control and Disarmament Agency (USACDA) supported the pro-SDI interpretation permitting development and testing, but intense political pressure forced the administration to accept the more narrow interpretation prohibiting component development and testing.⁷⁶

An equally intense debate occurred over the treaty's failure to address non-ABM weapon systems that might be adapted to ABM usage. ASATs are a prominent example.⁷⁷ Unilateral Statement B, entitled "Tested in ABM Mode," establishes that components tested as ABMs are counted as ABMs, while components not tested as ABMs are not considered ABMs. Thus, one could develop ABM technologies and components and remain legal by testing and deploying them against satellites or other non-ABM targets. Before reaching operational ABM status the component would certainly require ABM testing, but at that point the violator would have gained valuable knowledge and saved the years of development time that precede testing.

This advantage creates two problems. First, it encourages development of borderline systems like the Soviet SA-X-12B Giant antitactical ballistic missile (ATBM).⁷⁸ Coupled with deployment of covertly stockpiled ABM-X-3 interceptors, it would allow the Soviets to make a rapid breakout from the treaty, thereby shifting the strategic balance.⁷⁹ Second, the ASAT and ABM missions share technology to a large degree so development of ASAT technology might produce advances in ABM technology. Thus, some ABM opponents perceive and oppose the ASAT program as a backdoor to ABM weapon development irrespective of the merits of ASAT systems.⁸⁰ Some SDI advocates complicate the issue by urging development and testing of ABM technologies as ASATs, in effect openly advocating circumvention of the ABM Treaty via Statement B.⁸¹ The solution to both problems lies in effective verification.

However, the treaty fails to adequately address this critical issue. Article 12 permits the use of national technical means (NTM) of verification. Surveillance satellites are the primary type of NTMs. However, NTMs are sufficient only when the threat is physically large enough to be visible from overhead. Given that many ABM interceptor production lines supply the one authorized Soviet ABM site and that the ABM interceptors are small in size, it is impossible to determine if other interceptors are stockpiled elsewhere.⁸² Only unlimited on-site verification would ensure against a breakout. Similarly, "verification that [borderline] ATBM systems do not possess capabilities against strategic systems (ICBM and SLBM) would be extremely difficult."⁸³

The ABM Treaty's major omissions and loopholes regarding advanced technology, development of similar weapon systems, and verification undermine the treaty's avowed goal of "curbing the race in strategic offensive arms."⁸⁴ Indeed, the Reagan and Bush administrations have argued that the Soviets exploited loopholes in the ABM Treaty to expand their arsenal dramatically between 1972 and 1982.⁸⁵ Meanwhile, legislation proposed in the wake of the ABM Treaty threatens to restrict the US space weapon programs to those intended to meet conventional threats to vital US interests.⁸⁶

Disarming the Heavens: ASAT Arms Control Issues

While Congress has been legislating limits on the development of space control weapons, both Presidents Reagan and Bush have stated that the US needs to build offensive and defensive space weapons capabilities. Both administrations have further stated that any ASAT treaties that might be negotiated would be as unverifiable and inequitable as the ABM Treaty has been and, hence, would not be in the national interest. Indeed, given the US rationale, the negotiations that have been under way for the past decade

and a half are not likely to produce anything beyond limited agreements involving confidence-building measures such as data exchanges.

Negotiations on ASAT arms control treaties range back to 1978. Initial ASAT arms control talks took place between the US and USSR during June 1978, January–February 1979, and April–June 1979. Preparations for the talks revealed problems in defining weapons that had ASAT capabilities, particularly the residual weapons. Verification quickly emerged as a key issue.⁸⁷ During the negotiations the Soviets claimed that the space shuttle had residual ASAT capability. After the invasion of Afghanistan, the talks broke down completely.⁸⁸ In 1981 and 1983 the Soviets submitted draft treaties to the United Nations. The Committee on Disarmament tabled the proposals without further action. In 1985 the Defense and Space Talks began in Geneva.⁸⁹ These talks continue today and include ASATs in their scope. The Soviets proposed another ASAT ban in 1985 but later lost interest in their proposal after Congress extended prohibitions on US ASAT testing.

The US Congress became formally involved with ASAT arms control in July 1983. In approving the Tsongas amendment to the fiscal year 1984 Department of Defense Authorization Act, the Senate prohibited all ASAT testing in space until the president could certify two conditions.⁹⁰ These conditions required that the US conduct ASAT arms control negotiations in good faith with the Soviets and that ASAT testing be in the interest of national security.⁹¹ During August 1983, Yuri Andropov, secretary of the Communist Party of the Soviet Union (CPSU), met with US senators in Moscow and announced a unilateral moratorium on Soviet ASAT testing.⁹² Congress then requested a report on US ASAT arms control policy.

The report, submitted by President Reagan on 31 March 1984, concluded that no arrangements or agreements beyond those already governing military activities in outer space have been found to date that are judged to be in the overall interest of the United States and its allies. The factors that impede the identification of effective ASAT arms control measures include significant difficulties of verification, diverse sources of threats to US and allied satellites, and threats posed by Soviet targeting and reconnaissance satellites that undermine conventional and nuclear deterrence.⁹³ Congress responded by approving a fiscal year 1985 ban which, upon presidential certification similar to that of fiscal year 1984, allowed three tests in space.⁹⁴ In 1986, 1987, and 1988 Congress approved legislation banning all tests in space “until and unless” the Soviets tested their system.⁹⁵ Congress, however, defeated a bill to make the ban permanent beginning in 1989; thus there are no current restrictions on US ASAT testing. In its 1990 report on ASAT arms control, the Defense Department reasserts the 1984 position that ASAT arms control is unverifiable, inequitable, and not in the national interest.⁹⁶ ASAT arms control is part of the broader question of the future of SDI. With congressional support for ASAT weapons perhaps approaching a turning point, these three aspects of the arms control debate become even more significant.

Verification

Verification depends substantially on the scope of the ASAT ban. Key factors include the types of ASAT weapons, types of restricted activities, techniques of verification, and term of the ban. Comprehensive bans include all possible types of ASAT weapons. More limited bans emphasize a given class of weapon, such as rocket interceptors or ground-based lasers. Bans on activities offer a choice between banning possession of ASAT systems (hardware) and banning system testing in an ASAT mode.⁹⁷ Verification techniques such as NTMs are limited to large-scale activities, while on-site inspections can address smaller, potentially covert activities.⁹⁸ Verification must yield unambiguous evidence of violations or the government may not have the political will to respond.⁹⁹

The Reagan administration addressed a variety of bans in its March 1984 report. The report rejected comprehensive ASAT bans on possession because "anything that can be placed in space and is maneuverable could be used as an ASAT if needed, and there are ground-based systems that could threaten satellites [and the] existence [of such systems] might not be known until they were used."¹⁰⁰ Known residual types such as ICBMs would also merit removal.¹⁰¹

These shortfalls apply to bans on possession and testing. Verification is particularly critical for the US because it depends heavily on a relatively small number of satellites. According to the USACDA, "any cheating on ASAT limitations, even on a small scale, could pose a disproportionate risk to the United States and allied security."¹⁰² Since comprehensive bans cannot be verified, the debate turns toward limited bans. Limited bans on possession are difficult to draft. Regardless of the scope, eventually there will be new, equally effective "technologies or techniques" that are not subject to restraint.¹⁰³ Some favor limited bans on testing, but verification challenges still appear severe.¹⁰⁴

Equitability

Arms control negotiations must also produce agreements that provide equal advantages to and restraints on both parties. Restraints on the ability to gain a huge advantage by unilaterally abrogating the agreement and quickly fielding previously banned systems—that is, a breakout—are the key. Restraints on breakout may be impossible when one side has experience with a previously permitted system that the other side lacks.¹⁰⁵ Soviet ASAT proposals, even those which promise destruction of the Soviet interceptor inventory, fail the breakout test because they preserve Soviet experience while blocking US development of similar or more advanced systems. While equitability and verification focus on specific treaty issues, national interests take a broader view that considers national security objectives in the combined-arms environment.

National Interests and Bans on ASAT Weapons

The US views the current US-Soviet ASAT asymmetry as destabilizing because the US cannot present a real threat to Soviet satellites, nor, if deterrence fails, respond in kind and avoid escalation.¹⁰⁶ Thus, possession of effective ASATs is more essential than banning them. The US also considers comprehensive ASAT bans not to be in the national interest since they would create a spaceborne sanctuary for Soviet targeting satellites.¹⁰⁷ This sanctuary could provide substantial wartime advantage to the Soviets. For example, in some combined-arms scenarios the US (as a maritime power) is much more dependent on sea control than the Soviets. Soviet satellites operating in a safe haven, space, would track US vessels with impunity. Therefore, the mutual sanctuary provided by a totally verifiable, breakout-proof comprehensive ban is not in the US national interest.

The March 1984 report does not totally foreclose future arms control agreements. It notes that "since we must in any event be able to protect our satellites against threats that could be developed without our knowledge, there is a premium on finding ways to limit [through] arms control those ASAT systems that create the most difficult survivability problems."¹⁰⁸ One approach to survivability examines ways to quickly identify and react to threats.

Self-Defense Zones: A New Factor

One such approach is to use self-defense zones (SDZ) or other rules of the road to determine hostile intent, provide reaction time, and establish a clearer definition of self-defense in space.¹⁰⁹ Albert Wohlstetter and Brian Chow propose a series of SDZs extending from semisynchronous altitude to beyond geosynchronous altitude.¹¹⁰ For geosynchronous orbits the scheme consists of 36 sectors, each 10 degrees wide—each sector is referenced to equatorial longitudes. Just as geostationary orbits enable a satellite to remain above a fixed point on the earth's surface, geostationary self-defense sectors remain above the same area of the earth's surface. These sectors would extend in altitude from 18,600 to 24,800 nautical miles. This range would provide a safe buffer distance from nongeostationary threats passing near geostationary satellites. Each sector would be large enough to accommodate a moderate number of satellites, and there would be enough sectors to provide all parties roughly equal access (visibility) to terrestrial areas of interest. Below and above geostationary altitude the sectors are replaced by spherical shells.¹¹¹ The self-defense zones do not extend to low earth orbit because earth-based threats, such as interceptors, can reach the zones.¹¹²

Under Wohlstetter and Chow's proposal, the sectors and shells would be assigned to three groups of users. One group would consist of the United States, NATO, and their allies; the second would include the USSR, Warsaw Pact, and their allies; and the third would take in nonaligned nations. Each group would have unrestricted transit rights within its zones; satellites belonging to members of one group could intrude into other nations' zones only in making innocent (nonthreatening) adjustments in orbits. In the event of multiple, simultaneous zone violations, the "owners" of an SDZ could designate the intruding satellite as hostile and take any action necessary to render the intruding satellite harmless.¹¹³ SDZs may be workable in peacetime but solid technical and political arguments caution against their adoption.

The technical shortfalls of such zones outweigh their advantages. For example, zones do not protect against directed-energy weapons (DEW) because the effectiveness of such weapons does not depend on close physical proximity.¹¹⁴ Indeed, grouping friendly targets in predictable areas would aid enemies in targeting and attacking those satellites with both DEW and kinetic energy weapons. This grouping enhances hostile weapon system employment by bounding performance (maneuverability) requirements. In addition, attempting to verify the sanctity of these zones would place extraordinary demands on space surveillance systems. The US Space Surveillance Network (SSN) has major weaknesses beyond semi-synchronous orbit and would require major upgrades to ensure that hostile satellites do not breach the SDZ of the US, NATO, or another ally (see chapter 4). The SSN might be countered by space mines constructed with stealth technology that would become apparent only after an attack. The zones' major advantages are that they would allow nations to forecast initial hostile actions by non-DEW systems. However, an opponent would likely initiate his attack with less obvious methods than breaching the SDZ in order to preserve his strategic (not necessarily tactical) advantage. The SDZ's modest technical advantages pale in comparison to the political drawbacks.

SDZs would create three major political problems. First, these zones would violate national space policy and provisions of the Outer Space Treaty against national claims of sovereignty in space.¹¹⁵ Second, as currently proposed, the zones exclude the nonaligned countries from two-thirds of the geosynchronous belt. Other nations would likely characterize the US proposals as unjust, and Soviet concurrence in SDZs is difficult to envision. Finally, the zones would create a false sense of security. Since these zones would be the result of voluntary political arrangements, they would likely be inoperative during war.¹¹⁶ Together these technical and political shortfalls disqualify SDZs from further consideration as an element of US space policy. However, a requirement still exists to clarify self-defense actions and the situations that warrant them.

A precedent for self-defense agreements pertaining to space navigation exists in the US-USSR bilateral agreement on "Prevention of Incidents On

and Over the High Seas (INCSEA)" and in international agreements such as the "International Regulations for Preventing Collisions at Sea."¹¹⁷ Even though these agreements do not prevent the "intermingling" of the fleets, establish keep-out distances, restrict the numbers of transits, or provide for enforcement rights during peacetime, they nonetheless help eliminate misunderstanding and prevent needless conflict.¹¹⁸ The US needs a similar set of peacetime agreements for space.¹¹⁹

Such agreements would build trust among space powers and avoid accidental incidents and, unlike SDZs, would not foster a false sense that US satellites would be protected during wartime.¹²⁰ Although the Soviets dug their feet prior to accepting the tacit understanding permitting free peacetime passage of surveillance satellites, they have shown a willingness to negotiate on matters of space law, as evidenced in their signing of the Outer Space Treaty.¹²¹ These negotiations have not demilitarized space, however. Indeed the current discussions in Geneva have only addressed confidence-building measures such as data exchanges, prelaunch notifications, and test observation.¹²² These measures may pave the way for more substantive future agreements.

In sum, an ASAT ban between the US and the Soviet Union is unlikely in the near-term. Limited peacetime agreements like INCSEA offer more potential than comprehensive or limited weapons bans or zoning schemes. One must also consider the impact of ASAT arms control on the broader question of national security policy as a whole and on SDI.

The SDI-ASAT Debate

SDI research seeks to develop the technologies needed to identify, track, and destroy incoming nuclear warheads. This mission is more difficult than the ASAT mission and it requires more advanced forms of the same basic technologies. For example, a modestly capable SDI platform, even one of those under consideration for the early phase of SDI, would possess excellent ASAT capability.¹²³ Conversely, however, a moderately good ASAT weapon would probably not be effective at attacking ballistic missiles or warheads, though it would be useful against an opponent's spaceborne SDI elements. SDI supporters and detractors both demonstrate strong interest in ASAT arms control discussions. Pro-SDI forces realize that any ASAT ban would likely bar the deployment of, and accompanying research on, not only ASAT systems but also SDI weapons. In effect this would kill the SDI program.¹²⁴ Anti-SDI forces see bans on ASAT weapons as an effective way to eliminate both ASAT systems and SDI at the same time.¹²⁵ The Bush administration advocates a strong SDI research program and appears unlikely to support any ban beyond the existing ABM Treaty. It also acknowledges the ABM Treaty limitations on deployment and urges deployment of less capable ASAT systems.

US national space policy considers ASAT deployment to be a necessary step in the national interest but refrains from similarly endorsing SDI. Lt Col Robert L. Bridge's perspective on the relationship between technology and law highlights the prudence and caution that characterize the US approach.

Historically the development of the law has lagged behind the technology it is designed to regulate. This is . . . desirable. If we cannot predict with any certainty where technology will take us in the next five, ten or twenty years it would seem presumptuous and ill-advised to try to erect a legal regime to control the unknown. For example, early air law specialists advocated an "open skies" regime similar to the maritime law principle of "freedom of the seas." The efficiency of military aircraft in World War I demonstrated that such a proposition was inherently dangerous to all nations and the proponents of an open skies regime disappeared.¹²⁶

A Coherent and Integrated Policy

Thus, the Bush administration's national space policy is consistent with space control doctrine. Space control doctrine states that if deterrence fails space control will provide space superiority during times of conflict and will prevent enemy forces from influencing terrestrial and space operations. Enemy space systems are neutralized or destroyed and friendly forces are protected through a combination of active and passive measures. These doctrinal assertions are entirely consistent with national policy.

National space policy principles dictate the objectives of "(1) deterring, or if necessary, defending against enemy attack; (2) assuring that forces of hostile nations cannot prevent our own use of space; (3) negating, if necessary, hostile space systems; and (4) enhancing operations of United States and Allied forces."¹²⁷ The US Department of Defense favors ASATs, surveillance upgrades, and survivability programs. Space control doctrine forecasts the need for these programs and integrates their functions into a space control combat capability. National space policy balances the need to preserve nuclear deterrence with the requirement to prepare for conventional conflict in space. The US supports the narrow interpretation of the ABM Treaty, but has refrained from broader restraints such as ASAT bans. The US policy legitimizes the doctrine of space control and pursuit of a space control strategy. Developing deployable ASAT systems will help realize one of the basic principles laid out by the ancient Chinese warrior Sun Tzu:

The art of war teaches us to rely not on the likelihood of the enemy's not coming, but on our own readiness to receive him; not on the chance of his not attacking, but rather on the fact that we have made our position unassailable.¹²⁸

Notes

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Chapter 4

Implementing Space Control

This chapter assesses the capabilities of existing space control organizations and systems and describes additional systems that are currently under development to fulfill the space control mission. Current implementation plans and programs represent a strong push to field an effective space control capability. The section on employment describes likely targets and their locations. This first section outlines the constraints on the use of ASAT weapons and protective systems and discusses the role of the national command authorities (NCA) in the space control mission. The next section details the functions and systems that are required for space control and explains how battle staffs will manage those systems. When completed, space control systems will integrate antisatellite weapons and tracking systems with survivability tactics.¹ A centralized battle management and command, control, and communications staff will coordinate surveillance and tracking of resident space satellites, warnings of new launches, negation of hostile space systems, and protection for friendly space systems.² The final section addresses the choice between wartime deployment and forward basing. While current and planned systems and organizations adequately address the minimum requirements for space control, improved survivability techniques and eventual development and deployment of space-based systems would significantly enhance US capability.

Employing Space Control Systems

Space control operations will include routine and wartime activities, depending on the function. Space surveillance systems operate continuously regardless of the threat level. Other systems such as ASAT weapons could be actively employed during wartime or possibly during a crisis but not during peacetime. The employment strategy for existing or likely space warfare systems specifies the probable targets, geographical environments, and conditions for use of space control forces. These parameters bound appropriate weapon and command and control development programs. The Joint Chiefs of Staff (JCS) Multiple-Command Required Operational Capability SM-77-88, dated 5 February 1988, defines the requirements for a space control capability.³ The focus of space control operations will be against enemy space systems and operations that threaten friendly space systems (and their launch and control segments)

and hostile force-enhancement systems supporting enemy terrestrial operations.⁴ These threats include units such as special forces teams capable of attacking friendly ground stations. Table 5 summarizes the threats to space control operations while table 6 lists typical orbits for Soviet force-enhancement satellites. Many countries already have the capability to conduct attacks against critical US tracking stations overseas.⁵ The loss of key ground stations for the US Defense Satellite Communication System and Defense Meteorological Satellite Program could cripple those systems.⁶ Therefore, space control operations will include not only those operations controlled in outer space but also measures taken on the earth's surface.⁷ Covert threats such as space mines may occur throughout outer space. In addition to the Soviet Union, other countries can and will field threats.

The national command authorities will direct active space control operations through the US Space Command (USSPACECOM).⁸ The NCA will decide whether to proceed with selected actions and target sets based on estimates of hostile activities, projections of friendly vulnerabilities, escalation control, space orders of battle, and other political considerations.⁹ USSPACECOM plans to operate with a philosophy of "centralized command and decentralized control."¹⁰ Actions to protect US assets would seek to prevent enemy exploitation of strategic and tactical surprise. Actions to disrupt, degrade, or destroy enemy assets would seek to gain the advantage of surprise, just like actions in the land, sea, and air mediums.¹¹

TABLE 5

Types of Threats

<i>Threats to Friendly Space Systems</i>	<i>Types of Hostile Force Enhancement Systems</i>
Space Segment	
Electronic countermeasures Directed-energy weapons Ground-based Space-based	Surveillance Photoreconnaissance Weather Geodesy Early warning Space station ELINT Communications Navigation
Direct attack (nuclear, conventional, impact) Coorbital Direct-ascent Space mines	
Ground and Maritime Segments	
Electronic countermeasures Terrestrial	Ground stations Land-based

TABLE 5 (cont'd)

<i>Threats to Friendly Space Systems</i>	<i>Types of Hostile Force Enhancement Systems</i>
Host government revokes access	Sea-based
Utility interruptions	Launch complexes
Component failures	
Demonstrations	
Sabotage	
Terrorism	
Conventional	
Nuclear	

Sources: Adapted from Lt Col Hal E. Hagemeyer, USAF, "Space Warfighting Information Needs" (Maxwell AFB, Ala.: Air Command and Staff College, 1987), 10; Alex Glksman, "Options for Space Arms Control," in *America Plans for Space* (Washington, D.C.: National Defense University Press, 1984), 162; Secretary of the Air Force (AQSD), "Department of Defense ASAT Program" (U), briefing to Air Staff Board and Air Force Council, 5 December 1988 (SECRET—unclassified information only used from this source); and Department of Defense, *Report to the Congress on Space Control* (U), July 1989, 1-2. (SECRET) Unclassified information only used from this report.

TABLE 6

Soviet Threat Locations

<i>Satellite Type</i>	<i>Orbit</i>
Molniya communications	Molniya
Store and dump (communications)	LEO ^a
Communications	GEO ^b
Missile warning	Molniya
Photoreconnaissance	LEO
ELINT—electronic intelligence	LEO
RORSAT—radar ocean reconnaissance	LEO
EORSAT—ELINT ocean reconnaissance	LEO
GLONASS—navigation	MEO ^c
Navigation	LEO
Meteor—weather	LEO
GOMS ^d —weather	GEO
Launch complexes	3 sites within USSR
Terrestrial control sites	7 ground sites within USSR, plus a fleet of ships.

^aLow earth orbit
^bGeostationary earth orbit
^cMiddle earth orbit
^dGeostationary operational meteorological satellite

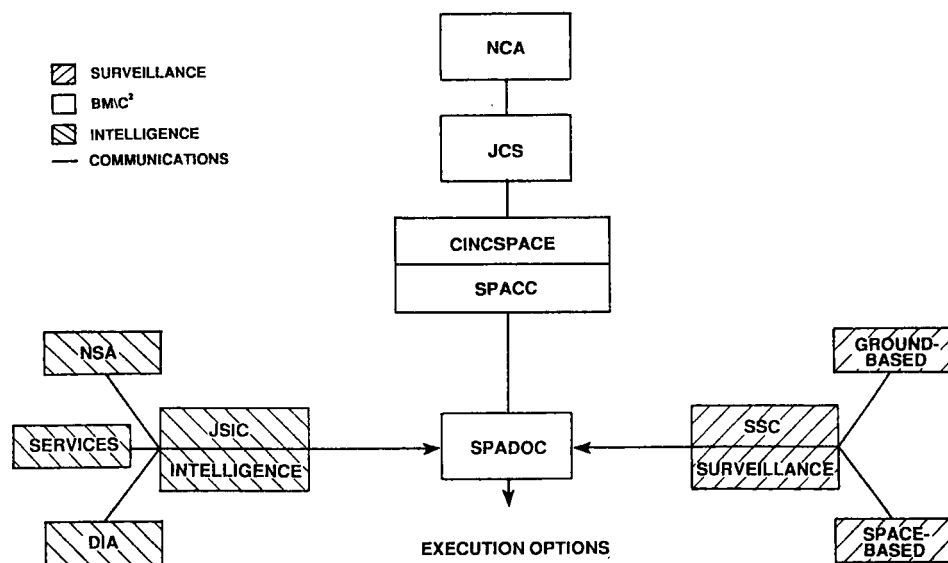
Sources: Aspen Strategy Group, *Seeking Stability in Space: Anti-Satellite Weapons and the Evolving Space Regime*, ed. Joseph S. Nye, Jr., and James A. Schear (Lanham, Md.: University Press of America, 1987), 40-45; and Nicholas L. Johnson, *Soviet Military Strategy in Space* (New York: Jane's Publishing, 1987), 79, 84-85.

Some analysts believe that in space, more than the other environments, attacking first is of paramount importance.¹² The ability to forecast offensive enemy actions and quickly detect hostile acts bears strongly on the use of space control assets. The NCA will issue rules of engagement (ROE) to guide active space control operations. These rules of engagement encompass "a variety of rules, procedures, and restrictions, specified by command

authority, for the conduct of operations [and are] scenario dependent.”¹³ Space control operations, then, will be conducted against hostile ASAT weapons and force-enhancement systems based on NCA-issued direction or ROE applied throughout terrestrial and outer space. This requirement necessitates a timely, accurate suite of weapon systems and supporting elements.

Space Control Functions

Successful space control operations will entail five separate, but interrelated, functions: monitoring space, assessing threats, informing satellite controllers, protecting friendly space systems, and negating hostile threats when directed by the NCA. Existing organizations such as the Space Surveillance Center (SSC), the Space Command Center (SPACC), the Joint Space Intelligence Center (JSIC), and the Space Defense Operations Center (SPADOC) currently perform some of these functions. The planned Space Engagement Node (SEN), active and passive survivability systems, and a variety of other ASAT systems will add to the US capability to achieve space control. Figure 2 shows the relationships among these units.



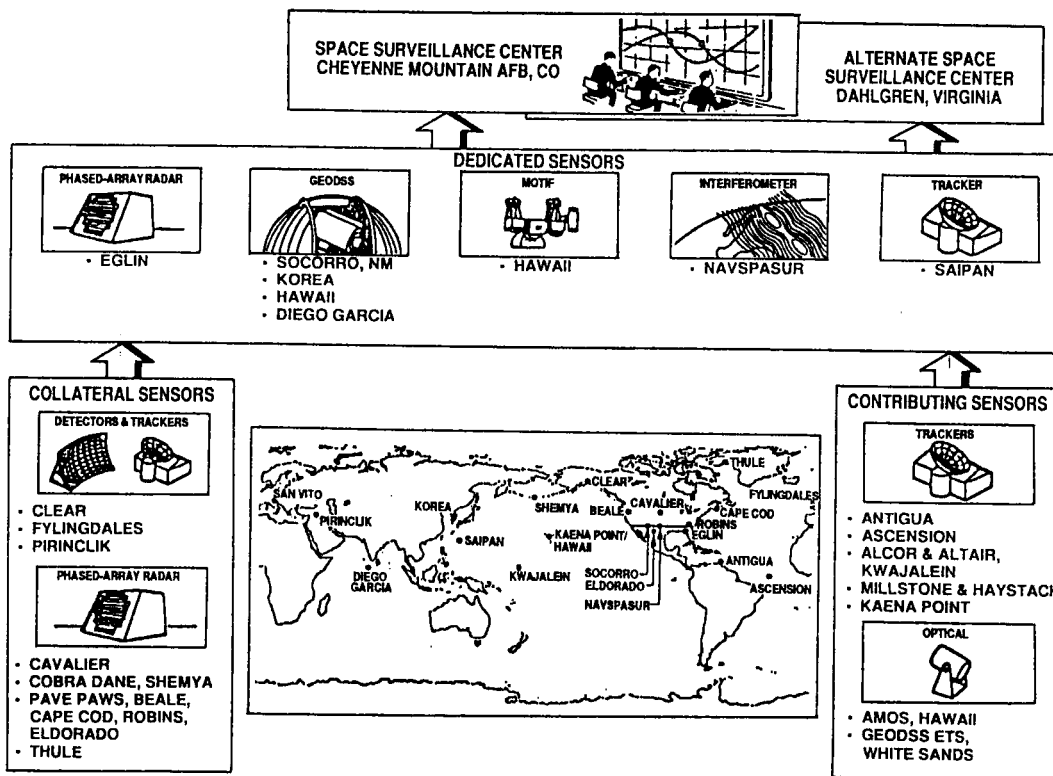
Source: Secretary of the Air Force, Directorate of Space and SDI Programs (SAF/AQS), briefing, 1990.

Figure 2. The Space Control System

Monitoring, Assessing, and Informing

Several organizations gather and analyze the surveillance and intelligence information needed for space control operations. The Space Defense Operations Center located inside Cheyenne Mountain, Colorado, performs

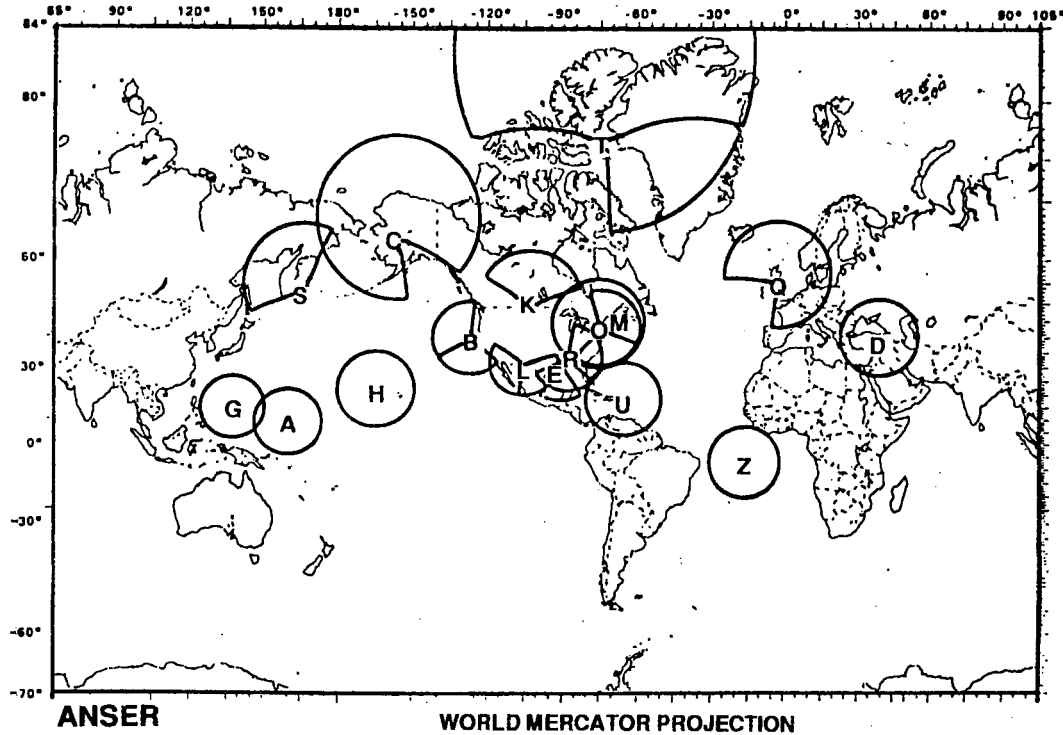
the battle management and command, control, and communications functions. SPADOC depends on the SSC and the JSIC for timely surveillance and threat information. The SSC monitors the space environment and controls all space surveillance operations. It tasks the Space Surveillance Network (SSN) to collect surveillance data on targets of interest. The SSN then processes the data to catalog orbiting objects, element sets, and signature data. The cataloged information facilitates overflight prediction through satellite reconnaissance advance notice and strike assessment.¹⁴ The Space Surveillance Network (fig. 3) consists of 27 sensor sites with dedicated, collateral, or contributing responsibilities.¹⁵ The SSN feeds data to the Space Surveillance Center at Cheyenne Mountain, Colorado, and to the alternate SSC operated by the Navy at Dahlgren, Virginia.¹⁶



Source: Air Force Space Command (AFSPACECOM/XPD, SSN & Command & Control Studies), briefing, November 1989.

Figure 3. Space Surveillance Network

SSN sensors provide various degrees of accuracy and timeliness. The SSN does not provide continuous space coverage; rather it uses a predictive algorithm to project and update positions.¹⁷ Major gaps exist at low and high altitudes (figs. 4, 5, 6, and 7)¹⁸ because many SSN sensors cannot



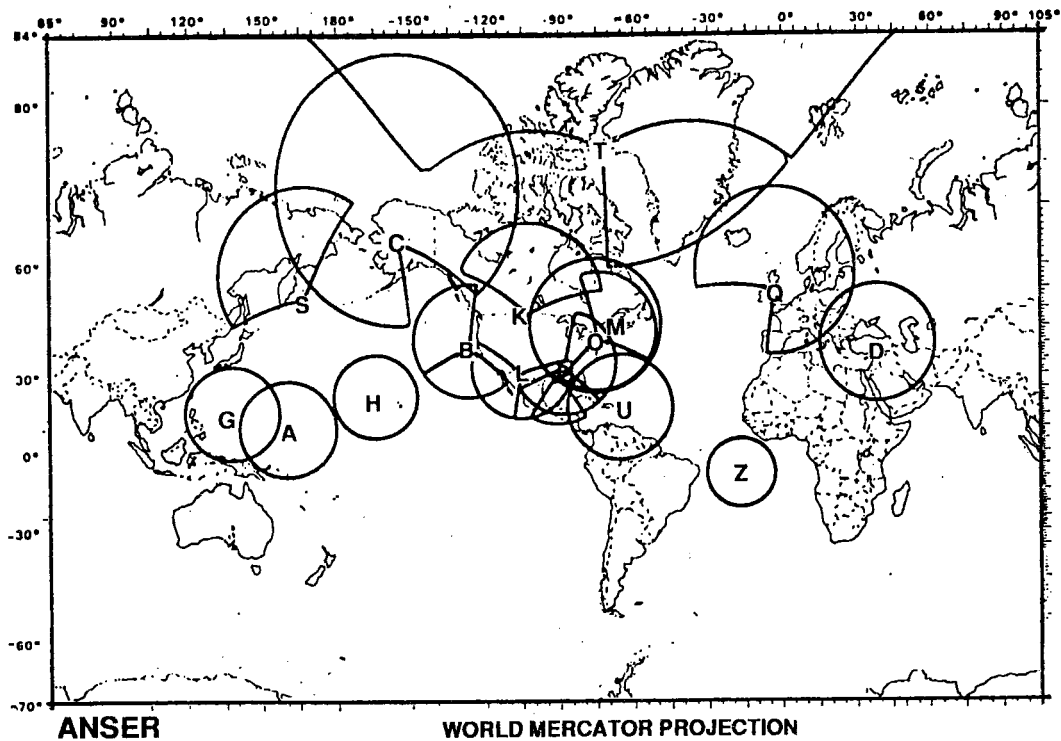
LEGEND:

A-Kwajalein	M-Milestone
B-Beale	O-Otis
C-Clear	Q-Fylingdales
D-Pirincik	R-Robins
E-Eglin	S-Shemya
G-Saipan	T-Thule
H-Kaena Point	U-Antigua
K-Parce	Z-Ascension
L-Eldorado	

Source: Secretary of the Air Force, Directorate of Space and SDI Programs (SAF/AGS), briefing, 1990.

Figure 4. Space Surveillance Network Coverage (target altitude 100 nautical miles)

provide the high-quality, wide-band images helpful in identifying new foreign payloads.¹⁹ Thus, in 1989, the Air Force Space Command (AFSPACECOM) studied the SSN's ability to support the space control mission. The study examined the following areas: catalog maintenance, sensor tasking, strike reporting, screening (debris, field of view, proximity), and predicting target orbits.²⁰ The study team concluded that major weaknesses existed in strike assessment for nonfragmented kills—which occur when the target does not break apart into many pieces—and in predicting the orbits of new foreign launches.²¹ Additionally, the SSN has difficulty tracking some geosynchronous payloads.²² Performance of the network worsens when the defense condition increases to level 3 and some ground-based radars are diverted from space surveillance to ballistic



LEGEND:

A-Kwajalein	M-Milestone
B-Beale	O-Otis
C-Clear	Q-Fylingdales
D-Pirincik	R-Robins
E-Eglin	S-Shernya
G-Saipan	T-Thule
H-Kaena Point	U-Antigua
K-Paras	Z-Ascension
L-Eldorado	

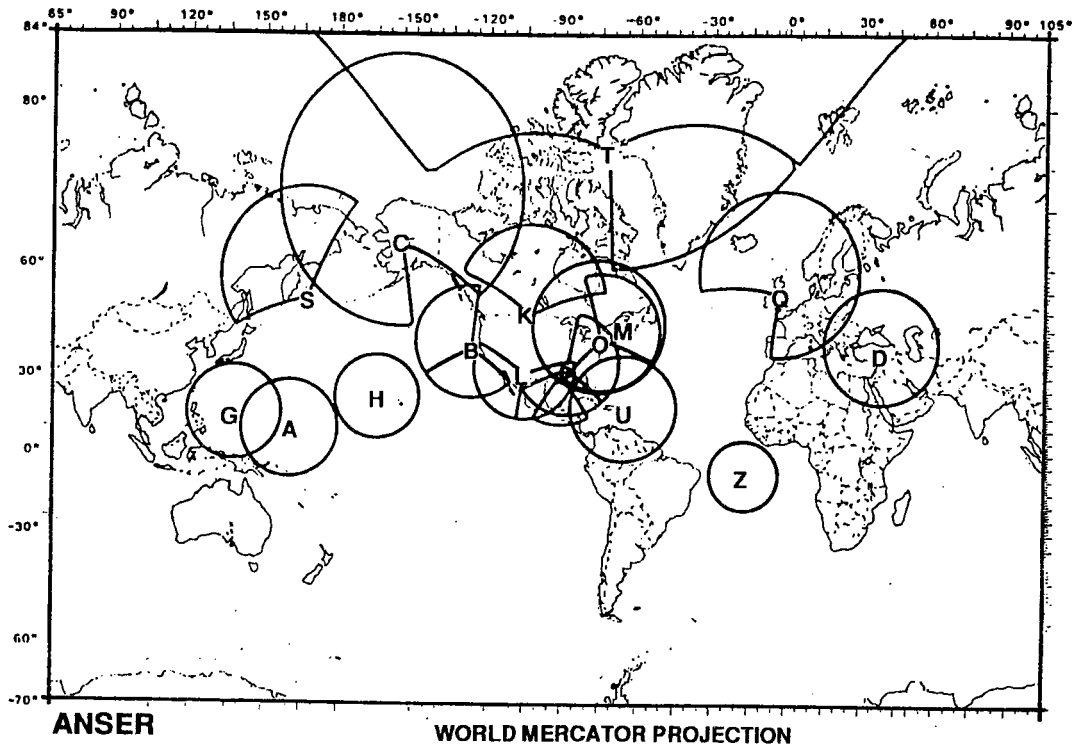
Source: Secretary of the Air Force, Directorate of Space and SDI Programs (SAF/AQS), briefing, 1990.

Figure 5. Space Surveillance Network Coverage (target altitude 200 nautical miles)

missile warning missions.²³ Finally, if a satellite being tracked can maneuver, the network's ability to track that satellite diminishes.²⁴

To correct these deficiencies, several upgrades in space control systems have been funded. These include better procedures for handling orbital element-set data and reporting hit assessments, the development of an uncorrelated target processor to help sort tracking data on unidentified objects, and an improved network tasking and control system to enhance the tasking of sensors and the assessing of hits on friendly and hostile satellite systems.²⁵ Timely and accurate data is necessary for assessing threats.

The JSIC combines data from the SSC with all-source intelligence to assess the threat. A key part of this process is analyzing signature data



LEGEND:

- | | |
|---------------|---------------|
| A-Kwajalein | M-Millstone |
| B-Baale | O-Otis |
| C-Clear | Q-Fylingdales |
| D-Pirincik | R-Robins |
| E-Eglin | S-Shernya |
| G-Saipan | T-Thule |
| H-Kaena Point | U-Antigua |
| K-Parcs | Z-Ascension |
| L-Eldorado | |

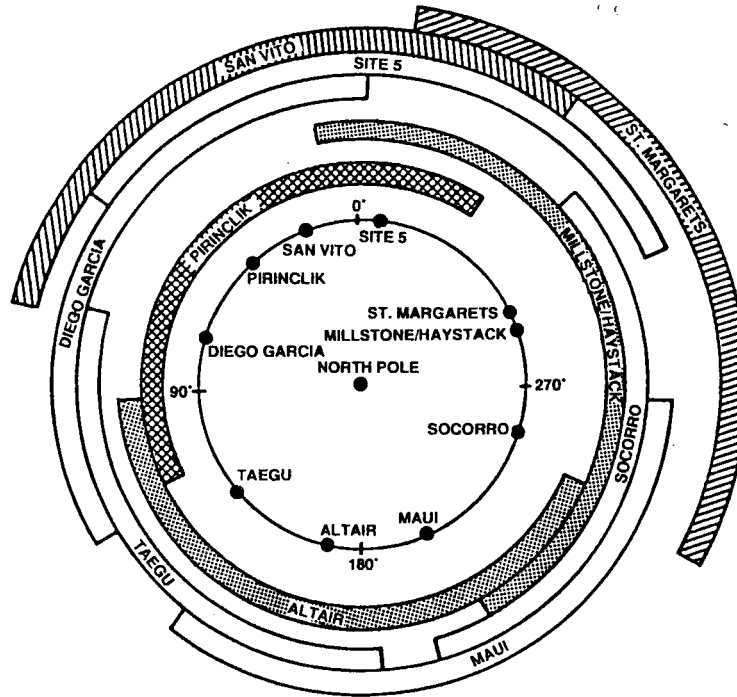
Source: Secretary of the Air Force, Directorate of Space and SDI Programs (SAF/AQS), briefing, 1990.

Figure 6. Space Surveillance Network Coverage (target altitude 300 nautical miles)

derived from infrared and radar-imaging sensors in the SSN. The JSIC uses this data to determine the function and status of each satellite and to gauge the severity of the threat it may pose.²⁶ The AFSPACECOM review noted deficiencies in the current signatures data base, which is used to correlate observations with known foreign satellites. Inclement weather and the unavailability of equipment constrain the collection of better data.²⁷ Funded space control projects will enhance data collection capabilities.²⁸

SSC and JSIC data will enable SPADOC crews to direct space control operations. First, SPADOC crews will monitor SSC information on new launches and/or maneuvers by resident (orbiting) satellites. Second, the crews will evaluate JSIC mission payload assessments in light of the evolving tactical situation. Third, SPADOC personnel will maintain a space

VIEW OF THE EARTH FROM ABOVE THE NORTH POLE



LEGEND
 [Cross-hatched box] RADAR [Grid box] RADAR (LESSER QUALITY/CAPABILITY)
 [White box] GEODSS [Diagonal lines box] BAKER-NUNN
 NOTE: IOC FOR SITE 5 IS EARLY 1990s.
 COVERAGE SHOWN IS ESTIMATED

Source: *Final Report of the Surveillance/Command and Control (C²) Evaluation Study*, vol. 2 (Colorado Springs, Colo.: Science Applications International Corporation, 24 May 1989), 2-3.

Figure 7. Deep Space Coverage Diagram

order of battle (table 7) on friendly (Blue) and hostile (Red) satellites. The ASAT mission will require a near-real-time order of battle.²⁹ Thus, when the tactical situation warrants, SPADOC will develop a satellite attack warning estimate and provide an early warning to the satellite operators and users so that they can take protective actions.³⁰ This process, when fully implemented, will reduce the vulnerability of satellites to interference and preserve mission continuity. The command authority United States commander in chief, Space Command at the Space Command Center will approve these warnings. SPACC will direct the appropriate protective measures for those systems assigned directly to USSPACECOM. SPADOC crews presently carry out these tasks to some extent in support of daily operations. In the future, though, space control operations will require that the improvements identified above be realized.

TABLE 7

**Space Order of Battle Elements for
Each Segment of Every Space System**

Status

Configuration
 Location/Ephemeris
 Value of each component during:
 Peace
 Crisis
 Wartime
 Hostile threat to each component
 Defensive countermeasure status
 Reconstitution capability

Source: Col Richard R. Schehr, USAF, "A Space Defense Operational Function," in *A Book of Readings for the USAFA Military Space Doctrine Symposium, 1-3 April 1981*, vol. 1, ed. Maj Peter Swan, USAF (Colorado Springs, Colo.: US Air Force Academy, 1981), 239.

Negating and Protecting

Negation and protection involve SPADOC, US ASAT systems, and improved protection for friendly force-enhancement systems. SPADOC directs negation and protection operations through battle management and command, control, and communications (BM/C³) tasks. Battle management is a

structure of decision aids and decision makers that obtains a picture of the battlefield from external sensors, gets status of forces [data] through upchannel reporting from external weapons systems, gets direction from prepositioned plans and from external command authorities and translates these into directions to forces and lower levels of command.³¹

Battle management and command, control, and communications include the following functions: assessing tactical situations, selecting response plans, predicting intercept opportunities, identifying targets, allocating weapons to targets, computing mission data loads, tasking and executing resources, and assessing strikes.³²

Funded upgrades in the SPADOC 4C modernization program provide a partial BM/C³ capability. These upgrades include the command and weapon allocation functions for individual ASAT weapons.³³ Additional upgrades to the ASAT program will improve communications and will include development of the Space Engagement Node.³⁴ The SEN will determine windows of opportunity for defeating (destroying or neutralizing) hostile threats and will direct the ASAT weapon operators to accomplish detailed engagement planning.³⁵ The SEN will "optimize global engagements in support of US and allied forces" and will allow the US to decentralize the negation mission.³⁶ The surveillance and command and control timelines will be critical. For example, a hostile target may maneuver to avoid attack, which, in turn, will increase the data-processing load on the SSC. As the SSC and SEN attempt to reacquire the target and

recompute the target's position, the time available for intercept will decrease.³⁷ The SEN will have to ensure that US and allied systems do not destroy friendly interceptors (fratricide).³⁸ ASAT operations will begin only after the CINC approves the engagement plan and releases weapons.

The current capability to protect USSPACECOM satellites presents similar command and control challenges. A separate staff within SPADOC handles these operations. Based on the space order of battle and satellite attack warning, the staff directs appropriate responses. Today most US satellites have relatively few protection options.

Space Control Research and Development

The Department of Defense is exploring several technologies to fill this gap in protection capabilities. Research is currently under way on a variety of negation programs and tactics.

Antisatellite Systems

In 1989 DOD initiated a triservice program to provide the negation capability through a balanced set of ASAT projects. These projects currently fund development of kinetic and directed-energy weapons. Robert Giffen accurately describes the program goals as follows:

The ultimate goal of defeating any space system is to prevent . . . that system from . . . neutralizing either the space segment, the ground segment, or the communications, command, and control link between the [space and ground] segments. In planning the method of attack, two factors are critical. . . . First, the attack strategy should be efficient. Second, that strategy ought not to enhance the risk of escalating the level of conflict.³⁹

Because kinetic-energy technology is the most mature, DOD selected it for use on the first ASAT weapons to be fielded. The Army heads up the Joint Kinetic-Energy Weapon Program Office (JPO) headquartered in Huntsville, Alabama. The Army leads development of ASAT weapons (interceptors, firing batteries, etc.). The Air Force leads development of the necessary BM/C³ systems. In January 1990 a Defense Acquisition Board (DAB) reviewed the completed cost and operational effectiveness analysis (COEA) on a variety of generic weapon design and basing options.⁴⁰ The COEA measures of effectiveness included not only such operational factors as survivability, availability, reliability, and flexibility, but also such growth potential and performance factors as altitude and range coverage, new foreign launch opportunities, satellite negation time, and coorbital ASAT engagement opportunities.⁴¹ The JPO considered land- and sea-based options and excluded air- and space-based systems.⁴² The DAB approved the start of the demonstration and validation phase for a kinetic energy weapon (KEW) system.

The approved KEW performance requirements, however, address only a portion of the ASAT requirement identified by the JCS. The JPO system

excludes targets in Molniya orbits and at middle and high altitudes.⁴³ The KEW system will feature solid-propellant booster stages, onboard target discrimination, and homing during the final stage.⁴⁴ Though the DAB selected a land-based option, the Navy's vertical launch system concept may be adopted at a later time.⁴⁵ The Army and Air Force, then, are developing a ground-based kinetic energy weapon. Future weapons may include directed-energy systems. A mix of kinetic and directed-energy weapons systems offers significant advantages over either type alone (table 8). Funding currently supports a variety of directed-energy weapons (DEW) projects.

TABLE 8

Mixed ASAT System Concepts

ASAT benefits

- Most flexible and robust
- Highest operational effectiveness
- Severely complicates enemy survival changes and countermeasures

Qualitative advantages of kinetic energy ASAT weapons

- Rapid system response
- Good low-altitude cross range (precludes stepover from orbit to orbit)
- All-weather

Ground-based laser (GBL)

- Very low cost per shot
- Soft kill potential (no debris hazard)
- Edge of lethal volume never certain in enemy's mind (sure safe zone vs sure kill zone)
- Can counter enemy measures taken to defeat KE weapons—maneuver, decoys

Source: Office of Under Secretary of Defense (Acquisition), "Anti-Satellite Systems Program" (U), briefing, 24 April 1989. (SECRET) Unclassified information only used from this source.

Developing Negation Technology

Negation technologies under study include lasers and particle beams. DOD is currently developing lasers and particle beams and will make a review of laser technologies in 1991. The best-known laser project is the mid-infrared advanced chemical laser (MIRACL) located at White Sands, New Mexico. The Navy owns and operates this system at the Army's High-Energy Laser System Test Facility. The Navy has used MIRACL to successfully track subsonic and supersonic tactical missiles.⁴⁶ Currently funded upgrades will add low-megawatt capability to the laser and make it capable of damaging solar panels on satellites in low orbits. Although the laser will be capable of only one shot a day, it will provide a valuable research and testing capability.⁴⁷ Long-term efforts include the free-electron laser

(FEL), chemical-oxygen-iodine laser (COIL), and excimer laser. The Army manages the FEL program through Los Alamos National Laboratory.⁴⁸ The Air Force Weapons Laboratory manages the COIL and excimer programs. The COIL and excimer approaches are less risky than the FEL.⁴⁹ A major drawback to directed-energy weapons is that they require good weather. However, for targets that do not have to be destroyed at particular or critical times, DEWs could be very effective.⁵⁰ DOD plans a Defense Acquisition Board for a directed-energy ASAT milestone 1 in the mid-1990s. The decision to develop a directed-energy ASAT weapon will hinge on the demonstrated capabilities of these technologies.

Particle beam weapons are even further from demonstration. Particle beams depend on an exotic technology that will not likely mature until the late 1990s. Particle beams have the potential to penetrate satellites and destroy internal systems such as electronics.⁵¹ The beam-experiment-aboard-rocket (BEAR) test confirmed basic particle beam physics. However, according to project managers at the Los Alamos National Laboratory, many engineering challenges remain.⁵²

Electronic countermeasures (ECM), in theory, provides additional ASAT capabilities. However, the US apparently does not currently have this capability. Giffen urges development of these systems: "One of the most effective means of defeating a space system is to jam or block the communications link between either the satellite and the user or the satellite and the ground command and control station."⁵³ He adds that "the advantage of spoofing [jamming or radiating with low power] an enemy satellite derives from the possibility that the enemy may never know what happened. Even if he suspects foul play, he may have difficulty proving it."⁵⁴ Clearly, ECM bears consideration as yet another method of negating enemy space systems. Its ability to cause temporary rather than permanent degradation marks it as a strong candidate for use in low-intensity conflicts. ECM, particle beams, and lasers can all contribute to US negation capabilities.

Techniques of Protecting Space Assets

Protection of US satellites is as important as the ability to negate hostile satellites. National space policy requires that satellites be protected commensurate with their intended missions.⁵⁵ This section describes several protection techniques. Since descriptions linking specific techniques to current satellites are mostly classified, this section focuses on the generic strengths and weaknesses of the techniques. It also examines some new approaches that offer potentially high payoffs. Table 9 lists the satellite options currently used or under study by DOD to ensure survivability. Some of these options apply to individual satellites, while others apply to entire architectures. Whether such protective measures are feasible or not

is a function of the extra weight they add to satellites, the extra fuel needed for maneuvering, and the relative importance of the satellite's mission during crisis or wartime.

TABLE 9

Satellite Survivability Options

<i>Space Segment</i>	<i>Command and Control Link</i>	<i>Ground Segment</i>
Proliferation	Antijam	Proliferation
On-orbit spares	Cross-links	Mobility
Silent		
Standby	Encryption	
Ground spares		Hardening
Maneuver		Physical security
Deception/Decoys		Antenna placement location
Optimized orbits		
Nuclear hardening		
Laser hardening		
Autonomy		
DSAT countermeasures		
Lasers		
Missiles		
Jammers		

Source: Department of Defense, *Report to the Congress on Space Control* (U), July 1989, IV-15 (SECRET); and Lt Gen Thomas S. Moorman, USAF, "US Air Force Space Systems Survivability" (U), April 1989; briefing. (SECRET) Unclassified information only used from both sources.

Survivability techniques accomplish one of three purposes: they make the satellite or system hard to find, hard to hit, or hard to kill. Deception techniques hide the satellite or system. They include stealth or masking designs (reduced radar and infrared/optical signatures).⁵⁶ Satellites can also be placed in deep-space storage orbits (even beyond geosynchronous) and maneuvered down as needed.⁵⁷ When an enemy discovers and targets one of our satellites, we can make interception difficult or impossible by maneuvering the satellite or by ejecting decoys from the satellite. These protective measures demand prompt satellite attack warning.⁵⁸ Sensors must detect laser illumination, jamming, impacts, and other aggressive acts.⁵⁹ The satellite onboard attack reporting system (SOARS) program is an effort to develop attack warning sensors⁶⁰ that will enable satellites to evade an attacker by breaking the tracking loop or by altering the orbit to move out of range of ground-based ASAT coverage.⁶¹ However, maneuvers must be balanced against the need to replan subsequent satellite usage, the likelihood of temporarily disrupting the mission, and the decrease in satellite lifetime caused by the expenditure of limited fuel.⁶² Space mines present unique survivability problems for satellites in geosynchronous orbits.⁶³ As Giffen explains,

The best defense against a space mine is to avoid using geosynchronous orbits for satellites performing wartime missions. This defense is quite costly because the advantages of geosynchronous orbits would be lost. To provide approximately the same coverage as three geosynchronous communications satellites, eight satellites in Molniya orbits (or four, to provide the same coverage just in the northern hemisphere) would have to be used. Although mines placed in orbits other than geosynchronous would still constitute a threat, the act of placing them there would immediately telegraph enemy intentions. A geosynchronous orbit has only one unique orbital plane with an exact altitude [22,300 nautical miles]; placing a payload next to another satellite in this orbit can be justified easily by mission requirements alone. Putting a similar satellite in a Molniya orbit, however, cannot be justified, because there is literally an infinite number of other orbits that would satisfy the same mission requirements.⁶⁴

While Molniya orbits may be useful, other methods such as autonomy and encryption may also enhance survivability.

Those satellite systems which can function relatively free from dependence on vulnerable ground stations can react to events faster.⁶⁵ Such autonomy is particularly useful for satellites in low earth orbit. Since those satellites move in and out of ground station coverage frequently, controllers may not have enough time to analyze or react to threats and send commands for the satellite to take appropriate countermeasures.⁶⁶ The technology for autonomous operational survivability (TAOS) program will explore ways to integrate autonomy and survivability techniques. TAOS should provide insight into operational issues connected to autonomy.⁶⁷

The US could also choose to position defensive satellites (DSAT) near its high-value systems. DSATs would use active means to eliminate attacking ASAT weapons. Options could include space-based ECM, kinetic energy interceptors, and DEWs.⁶⁸ DSATs would be particularly useful for pursuing and eliminating space mines.⁶⁹ High-value satellites could also carry DSAT systems on board as integral parts of their payload. Finally, nuclear and laser hardening would prevent easy kills, lengthen system lifetimes, and complicate an opponent's damage assessment process. The above survivability techniques would improve survivability by making satellites hard to find, hard to hit, and hard to kill.

Existing capabilities provide a reasonable level of security and survivability for command, control, and communications links. Communications links are protected with encryption, cross-links, and antijamming measures. Encryption protects the data by scrambling its content and rendering it indecipherable. Encryption also makes it difficult for an opponent to spoof a satellite.⁷⁰ Cross-links pass data by a laser link operating directly between satellites. Intercepting these data links requires positioning exactly along the line of sight. Since positioning is unfeasible, cross-links are very secure. Antijamming involves selection of frequencies that are not vulnerable to electromagnetic interference.⁷¹ Milstar uses this technique to provide strong antijamming capabilities in all environments.⁷² In addition to the satellite and communications segments, we must also protect the ground segment.

Mobility and redundancy are excellent ways to improve ground segment survivability.⁷³ Mobile ground stations make targeting and attack difficult. Redundant and backup systems enhance effectiveness against sabotage and terrorism.⁷⁴ Satellite autonomy also helps ground segment survivability by reducing ground equipment and communication requirements.⁷⁵ Physical hardening, physical security, and care in orienting critical antenna components round out the measures to ensure the survival of individual ground segments. These approaches bear consideration for use with the Space Surveillance Network. The SSN is currently the least survivable element of the planned ASAT system.⁷⁶ Overall, the above approaches offer significant survivability to individual system components. Other, broader approaches require consideration of the system architecture as a whole. Focusing on the survivability of architectures can enhance the US capability to protect its space systems.

The architecture approach to survivability considers the performance of an entire constellation of satellites, rather than just an individual satellite. By taking this top-down perspective, system designers and planners can realize additional survivability by sizing and positioning satellite segments in nontraditional ways. Most of these efforts hinge on satellite proliferation, especially through the use of smaller satellites dedicated to one mission.

Designers could allocate satellite capability to a distributed network rather than to a few high-value satellites, thus reducing reliance on any single satellite. Users would then be able to avoid a quick, catastrophic loss of their mission capability. The Soviets have adopted this approach for their tactical communications relay system. A constellation of 24 small satellites (each weighing only 90 pounds) provides survivability by distributing communications requirements across the entire network.⁷⁷ The US Defense Advanced Research Projects Agency (DARPA) is assessing a multiple-satellite system consisting of 240 small communications satellites located in three different low earth orbits.⁷⁸ The Air Force Systems Command's Space Systems Division is studying development of a universal bus that could be fitted with "communications, surveillance, or navigation payloads" and launched quickly in a crisis.⁷⁹ Proliferation could be difficult for complex systems such as high-resolution reconnaissance. However, Giffen argues that it is suitable for communications relay, nuclear detection, and tactical reconnaissance.⁸⁰ Col Charles E. Heimach also advocates this approach but notes that it

will require some rethinking as to the structuring of individual space systems. No longer will the programs be allowed to optimize for performance and no longer will system architectures be done within individual SPOs. Space systems will have to be designed and operated within a "grand" strategy that evaluated survivability consequences both from a philosophical and a probability of kill point-of-view.⁸¹

Control segments for these systems could also be proliferated, including airborne segments for highly critical applications.⁸² Proliferation acknowledges that some attrition is likely during wartime. Thus an important

aspect of any survivability planning requires addressing the requirement to replace lost assets.

Replacement requires available ground spares and a capacity for making quick-response launches.⁸³ Fabrication and ground storage of spare satellites offers three advantages. First, these reserves disguise the exact number and type of replacements. Second, they permit enhancements and changes before a satellite is launched. Thus, the military space community could react to new or changing threats without building entire new satellites. Finally, maintaining stockpiles of spare satellites allows the military to tailor its space fleet to wartime missions.⁸⁴ Hans Mark notes, for example, that greater autonomy (and, by implication, less stressing technical performance) is necessary during wartime.⁸⁵ Current US satellites tend to be large and heavy, and require extensive periods of ground preparation and on-orbit checkout. While efficient in peacetime, these systems do not lend themselves to rapid replacement.⁸⁶ Thus, the need for rapid replacement drives the need to build smaller satellites.

Survivable, flexible launch systems are also essential. Options include mobile ground, air, or sea systems capable of launching small payloads quickly.⁸⁷ Although really an aspect of the space support mission area, launch capability is discussed here because space control depends on it.⁸⁸ One possible solution is the Pegasus air-launched rocket, which DARPA is funding. Launched from a B-52, the Pegasus rapid-response booster can place a 400-pound payload in low earth orbit.⁸⁹ The rapid launch of small satellites in great numbers (proliferation) holds great promise as a means of achieving survivability but will require changes to the development process. The developer can provide many protection and negation options to the operator. These options will influence future decisions on system deployment.

Deploying Space Control Systems

This section explains the deployment options of forward basing and wartime deployment. Current cost and technology factors will force a near-term wartime deployment strategy that relies on ground-based tracking and negation systems. In the long-run, however, tracking and negation systems will have to be stationed in space.

Forward basing puts a weapon system and its support facilities close to the expected area of use. For terrestrial weapons this strategy offers a number of advantages. It saves the transportation time from CONUS, can increase readiness, and helps training. However, forward-based terrestrial weapons are generally more vulnerable to initial attack. Costs may also be higher since simultaneous forward basing in several locations requires a set of weapons at each location.

By analogy, forward basing for space control systems is the stationing of tracking and negation systems on orbit, close to the threat, and in a state

of readiness. Forward-based tracking and negation systems have several advantages. Given sufficiently large constellations of satellites, forward basing eliminates the delay that ground-based ASAT weapons and tracking sites incur in waiting for hostile space systems to pass overhead. Basing space weapons in orbit will reduce reaction times. The disadvantage of predeploying space systems is it allows the enemy, through his tracking and surveillance network, to determine the location, size, and structure of the constellation of US and allied space systems, thereby gaining an advantage in negating them.⁹⁰ Additionally, depending on the level of technology, autonomy, and orbits, space-based systems may rely on overseas ground stations that may be vulnerable to attack during low-intensity and conventional conflicts—space-based systems would not benefit from the homeland sanctuary accorded to ground-based systems located within CONUS. While forward basing in space does not require duplicate weapons for possible simultaneous use in separate theaters, as terrestrial applications do, space-based systems still cost more than ground-based systems. Technology for space-based ASAT weapons and tracking systems is under development but requires additional work. However, these systems are not yet deployable due to technology shortfalls and high costs. DOD, therefore, has opted to base its near-term space assets on the ground within the continental United States rather than placing them in orbit (i.e., forward basing).

Wartime deployment means that tracking and negation systems will be based on the ground until their use in space is required during a war. Kinetic energy ASAT weapons are the only space control systems that must actually enter space to perform their mission; they will be launched from the ground at the appropriate time. Ground-based systems are cheaper than space-based systems and the CONUS-based elements may exploit homeland sanctuary. However, the need to wait for the hostile threat to pass overhead and the resulting delays in computing the element set and ASAT weapons launch time and trajectory are major drawbacks. Since ground-based tracking and negation systems cannot be airlifted to the theater of conflict as are conventional forces, these drawbacks will hold true throughout the duration of any conflict. The performance of ground-based tracking systems suffers compared to space-based tracking systems because of the limited field of view. Specific basing locations for the ASAT are still under study, but it is reasonable to assume that overflight restrictions will be a factor. To avoid having spent boosters crash on inhabited areas, launch sites will likely be established at coastal locations that enable booster flight over international waters.⁹¹ Tracking and command and control elements will remain at their current locations.

One option for deploying ASAT systems would improve negation by exploiting a unique aspect of ground geometry. All satellites, regardless of their launch point or inclination, must pass through their antipodal point during their first orbit. The point is located directly opposite the launch site, 180 degrees around the earth. Antipodal points for the three current

Soviet launch complexes are clustered in the same area of the South Pacific.⁹² A ship carrying ASATs and operating in this area could theoretically destroy new Soviet satellites within one-half orbit of launch. Reaction times would stress SSN and BM/C³ systems; however, shipborne radars and predefined ROEs could help eliminate these shortfalls.⁹³ As technology and performance advance and costs decline, negation and tracking systems will logically begin to move into space. Thus, while a wartime deployment strategy is planned for near-term systems, the long-term trend will present a combination of CONUS wartime deployment and forward basing in space.

This chapter examined current and planned space control programs in terms of employment, development, and deployment strategies. These systems may be employed throughout terrestrial and outer space against hostile threats as directed by the NCA. Space control requires development and enhancement of systems to perform monitor, assess, inform, negate, and protect functions. Systems will reflect a wartime deployment strategy but are likely to evolve toward a combination of forward basing and wartime deployment. These systems complement the space control doctrine developed in chapter 2. Chapter 5 offers recommendations for future actions.

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92. A. Karemaa, "What Would Mahan Say About Space Power," *US Naval Institute Proceedings* 144, no. 4 (April 1988): 48-49, quoted in Lt Susan L. Higgins, USN, "The Navy ASAT: A Framework for Assessment" (Monterey, Calif.: Naval Postgraduate School, 1988), 86.
93. Barrantino, "Final Review"; and Applied Physics Lab, "Cost and Operational Effectiveness Analysis," 298.

Chapter 5

Recommendations

The previous chapters discussed the doctrines, policies, and strategies that bear on the use of offensive weapons in space. Chapter 2 presented a synthesized space control doctrine based on some of the major influences on doctrine. Chapter 3 showed that a doctrine of space control is compatible with and even supported by national security and space policies. Chapter 4 detailed how the US is implementing space control through employment, development, and deployment plans and programs. This chapter presents recommendations for future actions.

Doctrine

As explained in chapter 2, official space doctrine is inaccurate, incomplete, and fails to reflect what the US is currently doing to develop war-fighting space systems. Despite the lack of war-fighting experience to guide the formation of space doctrine, military leaders should focus and institutionalize the process of developing space doctrine.

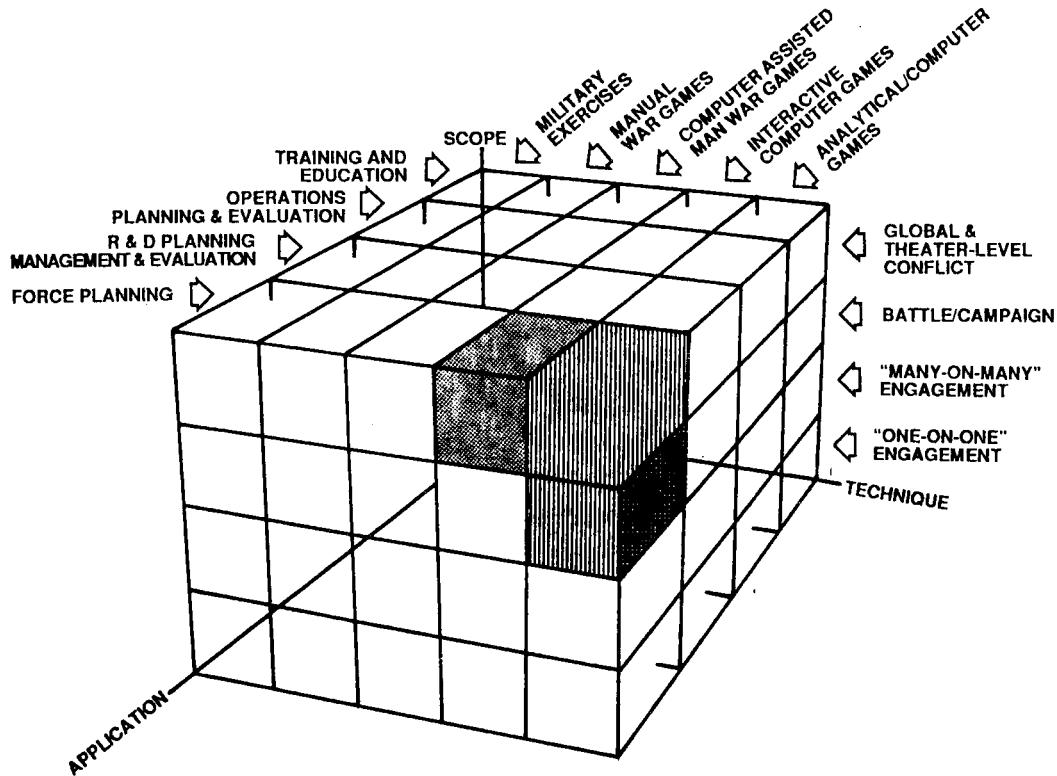
The single most important requirement is to establish an operationally and technically balanced organization to lead the effort. This organization would mirror the Air Corps Tactical School (ACTS) in that it would orchestrate the planning, develop requirements, conduct experiments, and evaluate results—all tasks that are essential to formulating space doctrine. This group would be staffed with senior and midlevel officers possessing experience with space operations and development.

As its first task the group should consolidate and publish the lessons learned during the past 32 years of space operations. While space combat is still on the horizon, certainly much experience exists regarding space operations. Gen I. B. Holley, Jr., assessed the impacts of ignoring similar accumulated air experience:

For want of a full appreciation of the need for retaining every last possible lesson of experience, the Air Service lost or abandoned many vital policies, procedures, methods, and practices which had to be relearned by painful practice in the subsequent years of peace and war.¹

Next, the group should refine and publish some form of doctrine patterned after the draft of AFM 2-XK, "Aerospace Operational Doctrine." A more intensive approach could lead to additional insights and enhance the resulting doctrine, and it would represent a significant step in the evolution

toward meaningful written guidance. These efforts should address key factors such as the principles of war. Finally, the group should begin sponsoring, structuring, and participating in analytical and politico-military games. (Figure 8 depicts a variety of war-gaming applications and techniques.) The National Test Bed Facility under development by the Strategic Defense Initiative Organization is a national asset that will offer the ability to simulate many forms of space warfare.²



Source: Thomas B. Allen, *War Games* (New York: McGraw-Hill, 1987), 294. Thomas credits L. J. Low, *Proceedings on the Workshop on Modeling and Simulation of Land Combat* for this illustration.

Figure 8. War-gaming Cube—its sides labeled *application*, *technique*, and *scope*—symbolizes the complexity of modern gaming. *Application* ranges from leadership training to decisions on the size, composition, and arms of military units. *Techniques* span military exercises and analysis based on purely computer games. *Scope* begins with man-to-man duels and soars to theater-level and global warfare.

These activities would reflect the role the Air Corps Tactical School played in the 1930s. While it may be impractical to establish a “school,” leaders must do more than merely forming a committee or adding these tasks as additional duties. The formation of the unified US Space Command (USSPACECOM) was a strong step in the right direction, but that command has yet to embrace ACTS-type responsibilities. Since US policy urges

weapon development, the military must develop the doctrinal underpinnings for such weapon systems now.

National Policy

National policy strongly supports space weapon development. However, space operators and developers need accurate knowledge of the fundamental principles of space control, arms control, and international treaties. Most pilots can explain the purpose and role of their aircraft, at least in terms of air superiority and support of the ground battle. Based on my experience as a student at the Air Command and Staff College, the military space community lacks a similar knowledge of space control. As space control programs proliferate (both in numbers of space weapons and in terms of survivability enhancements), an accurate understanding of the military and legal environment will prove absolutely essential in explaining and advocating these systems to the American public and the services. Thus, I recommend that military space leaders cultivate a better awareness of space concepts and issues within their organizations. Support for space control policy translates directly into a strong, balanced strategy.

Implementation Planning

The military space community and the supported commanders in chief (CINC) should consider the proliferation and quick launch options discussed in the survivability section of chapter 4 in planning future space operations and strategy. These techniques may prove valuable during a conflict if the promises of low cost, simple logistics, and adequate performance hold true. Operators must focus the requirements for these systems on likely wartime needs and communicate the requirements clearly to the developers. Developers must recognize that proliferation may require architecture-level decisions that reduce the traditional level of system program office control over design and performance parameters.

The architecture-level decisions on system size, performance, and survivability point to the major operational question, What tactics will be employed during the conflict? The answer depends on the weapon mix, strategic and tactical goals, rules of engagement, and experience. War games can provide valuable insight and help bound the problem. Likewise, participation in joint exercises with the supported CINC and in USSPACECOM-specific exercises offers the opportunity to gain realistic training and experience. Through these exercises the operators will learn how to integrate their performance and survivability options into the overall campaign plan. For example, an exercise might simulate threats to US satellites during a Soviet invasion of central Europe. The participants

would have to decide whether to employ survivability measures, such as maneuvers, or accept likely losses in order to provide the greatest short-term performance. Such challenges are valuable because they can identify shortfalls in procedures, highlight required reaction times, and teach the participants to work together.³

The US lacks focused planning and experience with space warfare. Lest space control advocates become frustrated at the pace of progress, they should remember Dr Holley's conclusion that a detailed "study of military history shows that new and more effective weapons have generally been adopted only slowly in spite of their obvious advantages."⁴

Notes

1. Maj Gen I. B. Holley, Jr., *Ideas and Weapons* (Washington, D.C.: Office of Air Force History, 1983), 176-77.

2. National Test Bed Team, "NTB Overview," briefing, 1988.

3. Maj Gen James S. Cassity, Jr., USAF, Col Raymond H. Lee, USAF, and Maj David J. Fitzgerald, USAF, "C³ Systems Planning for the United States Space Command," in 10th Air Force Aerospace Power Symposium, 10-12 March 1986, *The Impact of Space on Aerospace Doctrine*, appendix I, proceedings of sessions I and II (Maxwell AFB, Ala.: Air War College, 1986), 47.

4. Holley, 175.

Annex A

Soviet Doctrine

This annex summarizes Soviet military space doctrine. Soviet articles on the military uses of outer space appeared in the early 1960s. The Soviets view space as another theater of war. Soviet doctrine stresses the integration of space forces into the combined arms. Soviet military doctrine has political and military-technical components. The political component addresses war in general and establishes the goals of the state. Space forces will perform their part in accomplishing the political goals of the state. The military-technical component focuses on the equipment and techniques used to fight wars.¹

Soviet military doctrine also addresses the organization of the armed forces, war-fighting training and preparation for the military and civilian populations, the conduct of war, and weapons development.² Thus, military doctrine plays a critical role in Soviet society. According to William R. Van Cleave, "in the USSR, military doctrine receives the highest political imprimatur, publications on such doctrine have political approval, and the Soviet military occupies a central role in Soviet political-military affairs unparalleled in the West."³ At the Military Space Doctrine Symposium in 1981 a panel assessed the state of Soviet military space doctrine. In the Symposium's Final Report, panelists concluded that "space must be considered a potential medium of conflict [because] Soviet space systems appear to have been integrated with the existing force structure under the general warfighting and war winning philosophy of the Soviet military."⁴

Elements of Soviet organizational space doctrine began appearing in Soviet writings in the 1960s. Editions of *Voyennaya Strategiya* (Soviet Military Strategy) edited by Marshal of the Soviet Union V. D. Sokolovskiy appeared in 1962, 1963, and 1968.⁵ In the first edition, the air defense forces—*Protivovozhdushnaya Oborana* (PVO) *Strany*—are assigned the missions of antimissile (*protivokosmicheskaya oborana*—PRO) and antispace (*protivoraketnaya oborona*—PKO) defense.⁶ The second edition discussed space warfare in greater detail.

The rapid development of spacecraft and specifically of artificial earth satellites, which can be launched for the most diverse purposes, even as vehicles for nuclear weapons, has put a new problem on the agenda, that of defense against space devices—PKO. It is still early to predict what line will be taken in the solution of this problem, but as surely as an offensive weapon is created, a defensive one will be too.⁷

In 1971 Ivan I. Anureyev published a study entitled *Antimissile and Space Defense Weapons*. His discussion of space defense and space weapons

indicated that the Soviets were actively applying their doctrine. For example, he conceived of potential countermeasures to antimissile defense, such as decoys of "metallized plastic or metal screen" and "inflated balloons, dipole reflectors, etc."⁸ Such concepts are the product of a substantial PRO program. The basics of the material in these sections of Anureyev's work trace back to a 1967 study by P. V. Morozov, "Combat with Air and Space Targets."⁹ While technical approaches were discussed in the 1960s, the following decade saw strategic thought develop.

In the 1970s Soviet literature began to refer to space as a *teatr voennyleh deisturi* (TVD), or theater of military operations.¹⁰ Some judge that the TVD concept confirms Soviet determination to plan for combat in space.¹¹ Anureyev characterized the reaction against new offensive weapons as "the intensive search for the 'antidote.'"¹² His comments were entirely consistent with basic Soviet doctrine stressing the "defense of the Motherland."¹³ Uri Ra'anan observed that classified issues of the military journal *Voyennaya mysl* (Military Thought) stress the achievement of surprise, including destruction of reconnaissance systems and jamming of communications.¹⁴ Nicholas L. Johnson added that the use of surprise and the disruption of C³ links are key elements of Soviet terrestrial doctrine and their use in space would be consistent with current practice.¹⁵ Finally, Soviet military expert Harriet F. Scott speculated that in the coming years Soviet military space doctrine may place an equally high value on manned military systems.¹⁶ These new strategies required similarly advanced weapons technology.

Soviet doctrine affirms the decisive impacts of technology upon weaponry and the conduct of war. Marshal N. Ogarkov, chief of the Soviet General Staff, stressed the importance of integrating doctrine with technology. He observed that

on the basis of scientific and technical progress the main weapons systems change every 10-12 years. In these conditions sluggishness, failure to revise outlooks, and stagnation in the development, and particularly in the practical assimilation, of new methods of employing armed forces in war are fraught with serious consequences.¹⁷

Historically the Soviets have sought to establish doctrines well in advance of the enabling technology, and then develop the "scientific-technical components" for implementation.¹⁸ Perhaps Ogarkov sensed the potential dominance of technology, consistent with the US experience.

In summary, Soviet doctrine emphasizes a combined arms approach that includes antimissile and antispace operations. Soviet basic doctrine also stresses "the overwhelming offensive application of superior military force" and applies it to space operations.¹⁹ The official Defense Intelligence Agency summary of Soviet military space doctrine concludes that

the Soviet Armed Forces shall be provided with all resources necessary to attain and maintain military superiority in outer space sufficient both to deny the use of outer space to other states and to assure maximum space-based military support for Soviet offensive and defensive combat operations on land, at sea, in air, and in outer space.²⁰

Notes

1. Alfred L. Monks, "Soviet Military Doctrine in the 1980's: Implications for the SDI," in *Soviet Views on Military Operations in Space* by Jacob W. Kipp et al. (College Station, Tex.: Center for Strategic Technology, Texas Engineering Experiment Station, Texas A&M University, July 1986), 129-30.
2. Ibid.
3. William R. Van Cleave, "Soviet Doctrine and Strategy: A Developing American View," in *Political Implications of Soviet Military Power*, ed. Lawrence L. Whetten (New York: Crane, Russak, 1976), 44, quoted in "Systems Approach in Soviet Military Space Thought" by Capt Robert E. Brassell, Jr., USA (Monterey, Calif.: Naval Postgraduate School, 1988), 12.
4. *The Final Report from the United States Air Force Academy Military Space Doctrine Symposium, 1-3 April 1981*, ed. Maj Paul Viotti (Colorado Springs, Colo.: US Air Force Academy, 1981), 109-12.
5. Jacob W. Kipp, "Technological Surprise vs. Technological Initiative: Reflections on the Strategic Defense Initiative," in Kipp et al., 36.
6. Ronald J. Wright, Kevin D. Stubbs, Joseph J. Muniz, "The Soviet Concept of a Theater of Military Operations: Implications for Outer Space," in Kipp et al., 232-33; and Sayre Stevens, "The Soviet BMD Program," in *The Search for Security in Space*, ed. Kenneth N. Luongo and W. Thomas Wander (Ithaca, N.Y.: Cornell University Press, 1989), 101.
7. V. D. Sokolovskiy, *Military Strategy*, 3d ed., trans. Harriet Fast Scott (Wright-Patterson AFB, Ohio: Foreign Technology Division, 1968), 260, quoted in Brassell, 33.
8. Ivan Ivanovich Anureyev, *Antimissile and Space Defense Weapons*, trans. Joint Publications Research Service, Department of Commerce (Springfield, Va.: National Technical Information Service, 31 October 1972), 47.
9. See Brassell, 39.
10. Richard E. Thomas, "Overview," in Kipp et al., 8.
11. Ibid., 261.
12. Anureyev, 201.
13. Nicholas L. Johnson, *Soviet Military Strategy in Space* (New York: Jane's Publishing, 1987), 194.
14. Uri Ra'anan, "The Soviet Approach to Space: Personalities and Military Doctrine," in *International Security Dimensions of Space*, ed. Uri Ra'anan and Robert L. Pfaltzgraff, Jr. (Hamden, Conn.: Archon Books, 1984), 51.
15. Johnson, 208-9, 215.
16. See Harriet F. and William F. Scott, *Soviet Military Doctrine: Continuity, Formulation, and Dissemination* (Boulder, Colo.: Westview Press, 1988), 256.
17. Quoted in Kipp, "Technological Surprise," 96.
18. Ibid., 108-9.
19. Defense Intelligence Agency, *Soviet Military Space Doctrine* (Washington, D.C.: 1 August 1984), vii.
20. Ibid.

Annex B

Treaties

This annex identifies existing treaties (table 10) that may impact US space operations, and it contains the text of the Outer Space and Antiballistic Missile treaties. The annex complements the detailed discussion of the Outer Space and ABM treaties provided in chapter 3.

TABLE 10

Treaties that Limit Activities in Space

- United Nations Charter (1947)
- Limited Test Ban Treaty (1963)
- Direct Communications Link Agreements (1963, 1971, 1984)
- Outer Space Treaty (1967)
- Astronaut Rescue and Return Agreement (1968)
- Agreement to Reduce Risk of Nuclear War (1971)
- Antiballistic Missile Treaty (1972)
- Accidental Measures Agreement (1973)
- International Telecommunication Convention (1973)
- Convention on Registration (1974)
- Environmental Modification Convention (1980)

Sources: Compiled from *Space Handbook*, ed. Lt Col Curtis D. Cochran, Lt Col Dennis M. Gorman, and Maj Joseph D. Dumoulin (Maxwell AFB, Ala.: Air University Press, 1985), 15-2, 15-3; and Dana Joyce Johnson, "The Evolution of U.S. Military Space Doctrine: Precedents, Prospects, and Challenges" (PhD diss., University of Southern California, December 1987), 339-42.

Table 11 summarizes the relevant content of these treaties; it lists prohibited or constrained space activities, the applicable treaty, and the probable impact on space operations.

TABLE 11

Restrictions and Impacts

<i>Restricted Activity</i>	<i>Impact on Space Operations</i>
Appropriation of outer space by claims of sovereignty, including the moon and other celestial bodies (Outer Space Treaty)	Self-defense zones (SDZs) may be illegal
Testing nuclear devices in space (Limited Test Ban Treaty)	Nuclear-driven, space-based weapons cannot be tested in space

TABLE 11 (cont'd)

Restricted Activity

Threatening or using force against another state's territorial integrity (United Nations Charter, Outer Space Treaty)

Deploying weapons of mass destruction in outer space or on the moon or other celestial bodies (Outer Space Treaty)

Building military bases on the moon or other celestial bodies (Outer Space Treaty)

Weapons testing and military maneuvers on the moon or other celestial bodies (Outer Space Treaty)

Developing, testing, or deploying space-based ABM systems or components (ABM Treaty)

Interference with Soviet national technical means (NTM) of verification (ABM Treaty, Limited Test Ban Treaty)

Interfering with other states' space-related activities without prior consultation (Outer Space Treaty)

Contaminating the moon or other celestial bodies (Outer Space Treaty, Environmental Modification Convention)

Launching space objects without notifying UN (Registration of Space Objects)

Using environmental modification techniques in outer space to damage, destroy, or injure another state (Environmental Modification Convention)

Hindering the rescue and return of astronauts and space objects (Astronaut Rescue Agreement)

Failure to notify Soviet immediately of detection of unidentified space objects by missile warning systems, or of signs of interference with those systems or related communications facilities, if risk of nuclear war is created (Agreement to Reduce Risk of Nuclear War, Accidental Measures Agreement)

Impact on Space Operations

Allows necessary and proportional self-defense, including preemptive actions

Nuclear, chemical, and biological weapons are banned; conventional ones are allowed

Prohibits moon bases but no limits on military space stations

Prohibits activities on moon but allows conventional tests in space

Prohibits space-based systems without consultation with Soviets

Self-defense permits interference with non-NTM satellites only

No definition of interference but jamming is probably illegal

Does not impact operations in space

Reporting "when practicable" after launch; orbits can be subsequently changed

No obvious impacts

No restriction on inspection of objects (to determine capability) before return to launching party

Constrains attacks on missile warning and communication systems during peacetime and crisis

TABLE 11 (cont'd)

<i>Restricted Activity</i>	<i>Impact on Space Operations</i>
Interfering with communication systems of other states without prior consultation (International Telecommunication Convention, Direct Communications Link Agreements)	Interference probably includes electronic or other jamming

Sources: The bulk of this table comes from Dana Joyce Johnson, "The Evolution of U.S. Military Space Doctrine: Precedents, Prospects, and Challenges" (PhD diss., University of Southern California, December 1987), 143-53, 336-42; see also *Space Handbook*, ed. Lt Col Curtis D. Cochran, Lt Col Dennis M. Gorman, and Maj Joseph D. Dumoulin (Maxwell AFB, Ala.: Air University Press, 1985), 15-2, 15-3; and Comdr Lawrence C. Schaffer, USN, "The Anti-Satellite Threat: Current Soviet Capabilities and Intentions" (Newport, R.I.: Naval War College, 1986), II-1.

International law permits any act that is not specifically prohibited.¹ Therefore, according to the *Space Handbook*,

in the aggregate there are very few legal restrictions on the use of space for nonaggressive military purposes. . . . [I]nternational law permits . . . surveillance, reconnaissance, navigation, meteorology . . . communications . . . the deployment of military space stations . . . the testing and deployment in earth orbit of nonnuclear, non-ABM weapon systems, [and] the use of space for individual and collective self-defense.²

Significantly, most treaties are designed for peacetime only. Thus, the US reserves the right to review and modify treaty compliance during wartime on a case-by-case basis.³ This annex concludes with the full text of the Outer Space and ABM treaties and agreed statements.⁴

Notes

1. *Space Handbook*, ed. Lt Col Curtis D. Cochran, Lt Col Dennis M. Gorman, and Maj Joseph D. Dumoulin (Maxwell AFB, Ala.: Air University Press, 1985), 15-4.

2. *Ibid.*

3. Dana Joyce Johnson, "The Evolution of U.S. Military Space Doctrine: Precedents, Prospects, and Challenges" (PhD diss., University of Southern California, December 1987), 166-68.

4. United States Arms Control and Disarmament Agency, *Arms Control and Disarmament Agreements* (Washington, D.C.: Government Printing Office, 1984), 51-55, 139-47, 162-63.

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies

Done at Washington, London, and Moscow January 27, 1967;

Ratification advised by the Senate of the United States of America April 25, 1967;

Ratified by the President of the United States of America May 24, 1967;

Ratification of the United States of America deposited at Washington, London, and Moscow October 10, 1967;

Proclaimed by the President of the United States of America October 10, 1967;

Entered into force October 10, 1967.

The States Parties to this Treaty,

Inspired by the great prospects opening up before mankind as a result of man's entry into outer space,

Recognizing the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes,

Believing that the exploration and use of outer space should be carried on for the benefit of all peoples irrespective of the degree of their economic or scientific development,

Desiring to contribute to broad international co-operation in the scientific as well as the legal aspects of the exploration and use of outer space for peaceful purposes,

Believing that such co-operation will contribute to the development of mutual understanding and to the strengthening of friendly relations between States and peoples,

Recalling resolution 1962 (XVIII), entitled "Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space," which was adopted unanimously by the United Nations General Assembly on 13 December 1963,

Recalling resolution 1884 (XVIII), calling upon States to refrain from placing in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction or from installing such weapons on celestial bodies, which was adopted unanimously by the United Nations General Assembly on 17 October 1963,

Taking account of United Nations General Assembly resolution 110 (II) of 3 November 1947, which condemned propaganda designed or likely to provoke or encourage any threat to the peace, breach of the peace or act of aggression, and considering that the aforementioned resolution is applicable to outer space,

Convinced that a Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, will further the Purposes and Principles of the Charter of the United Nations,

Have agreed on the following:

Article I

The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.

Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.

There shall be freedom of scientific investigation in outer space, including the moon and other celestial bodies, and States shall facilitate and encourage international co-operation in such investigation.

Article II

Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

Article III

States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding.

Article IV

States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.

The moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall also not be prohibited.

Article V

States Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas. When astronauts make such a landing, they shall be safely and promptly returned to the State of registry of their space vehicle.

In carrying on activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance to the astronauts of other States Parties.

States Parties to the Treaty shall immediately inform the other States Parties to the Treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the moon and other celestial bodies, which could constitute a danger to the life or health of astronauts.

Article VI

States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing

supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

Article VII

Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies; and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the moon and other celestial bodies.

Article VIII

A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

Article IX

In the exploration and use of outer space, including the moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty. States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the

moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the moon and other celestial bodies, may request consultation concerning the activity or experiment.

Article X

In order to promote international co-operation in the exploration and use of outer space, including the moon and other celestial bodies, in conformity with the purposes of this Treaty, the States Parties to the Treaty shall consider on a basis of equality any requests by other States Parties to the Treaty to be afforded an opportunity to observe the flight of space objects launched by those States.

The nature of such an opportunity for observation and the conditions under which it could be afforded shall be determined by agreement between the States concerned.

Article XI

In order to promote international co-operation in the peaceful exploration and use of outer space, States Parties to the Treaty conducting activities in outer space, including the moon and other celestial bodies, agree to inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results of such activities. On receiving the said information, the Secretary-General of the United Nations should be prepared to disseminate it immediately and effectively.

Article XII

All stations, installations, equipment and space vehicles on the moon and other celestial bodies shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity. Such representatives shall give reasonable advance notice of a projected visit, in order that appropriate consultations may be held and that maximum precautions may be taken

to assure safety and to avoid interference with normal operations in the facility to be visited.

Article XIII

The provisions of this Treaty shall apply to the activities of States Parties to the Treaty in the exploration and use of outer space, including the moon and other celestial bodies, whether such activities are carried on by a single State Party to the Treaty or jointly with other States, including cases where they are carried on within the framework of international inter-governmental organizations.

Any practical questions arising in connection with activities carried on by international inter-governmental organizations in the exploration and use of outer space, including the moon and other celestial bodies, shall be resolved by the States Parties to the Treaty either with the appropriate international organization or with one or more States members of that international organization, which are Parties to this Treaty.

Article XIV

1. This Treaty shall be open to all States for signature. Any State which does not sign this Treaty before its entry into force in accordance with paragraph 3 of this article may accede to it at any time.

2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland and the Union of Soviet Socialist Republics, which are hereby designated the Depositary Governments.

3. This Treaty shall enter into force upon the deposit of instruments of ratification by five Governments including the Governments designated as Depositary Governments under this Treaty.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification of and accession to this Treaty, the date of its entry into force and other notices.

6. This Treaty shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

Article XV

Any State Party to the Treaty may propose amendments to this Treaty. Amendments shall enter into force for each State Party to the Treaty accepting the amendments upon their acceptance by a majority of the States Parties to the Treaty and thereafter for each remaining State Party to the Treaty on the date of acceptance by it.

Article XVI

Any State Party to the Treaty may give notice of its withdrawal from the Treaty one year after its entry into force by written notification to the Depositary Governments. Such withdrawal shall take effect one year from the date of receipt of this notification.

Article XVII

This Treaty, of which the English, Russian, French, Spanish and Chinese texts are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

In Witness Whereof the undersigned, duly authorized, have signed this Treaty.

Done in triplicate, at the cities of Washington, London and Moscow, this twenty-seventh day of January one thousand nine hundred sixty-seven (117:51-55).

Texts of the 1972 ABM Treaty, Its Agreed Interpretations, and Its 1976 Protocol

Treaty between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems

Treaty signed at Moscow May 26, 1972;

Ratification advised by the Senate of the United States of America August 3, 1972;

Ratified by the President of the United States of America September 30, 1972;

Ratified by the Union of Soviet Socialist Republics May 29, 1972;

Ratifications exchanged at Washington October 3, 1972;

Proclaimed by the President of the United States of America October 3, 1972;

Entered into force October 3, 1972.

With agreed interpretations, common understandings, and unilateral statements.

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Proceeding from the premise that nuclear war would have devastating consequences for all mankind,

Considering that effective measures to limit anti-ballistic missile systems would be a substantial factor in curbing the race in strategic offensive arms and would lead to a decrease in the risk of outbreak of war involving nuclear weapons,

Proceeding from the premise that the limitation of anti-ballistic missile systems, as well as certain agreed measures with respect to the limitation of strategic offensive arms, would contribute to the creation of more favorable conditions for further negotiations on limiting strategic arms,

Mindful of their obligations under Article VI of the Treaty on the Non-Proliferation of Nuclear Weapons,

Declaring their intention to achieve at the earliest possible date the cessation of the nuclear arms race and to take effective measures toward reduction in strategic arms, nuclear disarmament, and general and complete disarmament,

Desiring to contribute to the relaxation of international tension and the strengthening of trust between States,

Have agreed as follows:

Article I

1. Each Party undertakes to limit anti-ballistic missile (ABM) systems and to adopt other measures in accordance with the provisions of this Treaty.

2. Each Party undertakes not to deploy ABM systems for a defense of the territory of its country and not to provide a base for such a defense, and not to deploy ABM systems for defense of an individual region except as provided for in Article III of this Treaty.

Article II

1. For the purposes of this Treaty an ABM system is a system to counter strategic ballistic missiles or their elements in flight trajectory, currently consisting of:

(a) ABM interceptor missiles, which are interceptor missiles constructed and deployed for an ABM role, or of a type tested in an ABM mode;

(b) ABM launchers, which are launchers constructed and deployed for launching ABM interceptor missiles; and

(c) ABM radars, which are radars constructed and deployed for an ABM role, or of a type tested in an ABM mode.

2. The ABM system components listed in paragraph 1 of this Article include those which are:

(a) operational;

(b) under construction;

(c) undergoing testing;

(d) undergoing overhaul, repair or conversion; or

(e) mothballed.

Article III

Each Party undertakes not to deploy ABM systems or their components except that:

(a) within one ABM system deployment area having a radius of one hundred and fifty kilometers and centered on the Party's national capital, a Party may deploy: (1) no more than one hundred ABM launchers and no more than one hundred ABM interceptor missiles at launch sites, and (2) ABM radars within no more than six ABM radar complexes, the area of each complex being circular and having a diameter of no more than three kilometers; and

(b) within one ABM system deployment area having a radius of one hundred and fifty kilometers and containing ICBM silo launchers, a Party may deploy: (1) no more than one hundred ABM launchers and no more than one hundred ABM interceptor missiles at launch sites, (2) two large phased-array ABM radars comparable in potential to corresponding ABM radars operational or under construction on the date of signature of the Treaty in an ABM system deployment area containing ICBM silo launchers, and (3) no more than eighteen ABM radars each having a potential less than the potential of the smaller of the above-mentioned two large phased-array ABM radars.

Article IV

The limitations provided for in Article III shall not apply to ABM systems or their components used for development or testing, and located within current or additionally agreed test ranges. Each Party may have no more than a total of fifteen ABM launchers at test ranges.

Article V

1. Each Party undertakes not to develop, test, or deploy ABM systems or components which are sea-based, air-based, space-based, or mobile land-based.

2. Each Party undertakes not to develop, test, or deploy ABM launchers for launching more than one ABM interceptor missile at a time from each launcher, nor to modify deployed launchers to provide them with such a capability, nor to develop, test, or deploy automatic or semi-automatic or other similar systems for rapid reload of ABM launchers.

Article VI

To enhance assurance of the effectiveness of the limitations on ABM systems and their components provided by this Treaty, each Party undertakes:

(a) not to give missiles, launchers, or radars, other than ABM interceptor missiles, ABM launchers, or ABM radars, capabilities to counter strategic ballistic missiles or their elements in flight trajectory, and not to test them in an ABM mode; and

(b) not to deploy in the future radars for early warning of strategic ballistic missile attack except at locations along the periphery of its national territory and oriented outward.

Article VII

Subject to the provisions of this Treaty, modernization and replacement of ABM systems or their components may be carried out.

Article VIII

ABM systems or their components in excess of the numbers or outside the areas specified in this Treaty, as well as ABM systems or their components prohibited by this Treaty, shall be destroyed or dismantled under agreed procedures within the shortest possible agreed period of time.

Article IX

To assure the viability and effectiveness of this Treaty, each Party undertakes not to transfer to other States, and not to deploy outside its national territory, ABM systems or their components limited by this Treaty.

Article X

Each Party undertakes not to assume any international obligations which would conflict with this Treaty.

Article XI

The Parties undertake to continue active negotiations for limitations on strategic offensive arms.

Article XII

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law.

2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1 of this Article.

3. Each Party undertakes not to use deliberate concealment measures which impede verification by national technical means of compliance with the provisions of this Treaty. This obligation shall not require changes in current construction, assembly, conversion, or overhaul practices.

Article XIII

1. To promote the objectives and implementation of the provisions of this Treaty, the Parties shall establish promptly a Standing Consultative Commission, within the framework of which they will:

(a) consider questions concerning compliance with the obligations assumed and related situations which may be considered ambiguous;

(b) provide on a voluntary basis such information as either Party considers necessary to assure confidence in compliance with the obligations assumed;

(c) consider questions involving unintended interference with national technical means of verification;

(d) consider possible changes in the strategic situation which have a bearing on the provisions of this Treaty;

(e) agree upon procedures and dates for destruction or dismantling of ABM systems or their components in cases provided for by the provisions of this Treaty;

(f) consider, as appropriate, possible proposals for further increasing the viability of this Treaty, including proposals for amendments in accordance with the provisions of this Treaty;

(g) consider, as appropriate, proposals for further measures aimed at limiting strategic arms.

2. The Parties through consultation shall establish, and may amend as appropriate, Regulations for the Standing Consultative Commission governing procedures, composition and other relevant matters.

Article XIV

1. Each Party may propose amendments to this Treaty. Agreed amendments shall enter into force in accordance with the procedures governing the entry into force of this Treaty.

2. Five years after entry into force of this Treaty, and at five year intervals thereafter, the Parties shall together conduct a review of this Treaty.

Article XV

1. This Treaty shall be of unlimited duration.

2. Each Party shall, in exercising its national sovereignty, have the right to withdraw from this Treaty if it decides that extraordinary events related to the subject matter of this Treaty have jeopardized its supreme interests. It shall give notice of its decision to the other Party six months prior to withdrawal from the Treaty. Such notice shall include a statement of the extraordinary events the notifying Party regards as having jeopardized its supreme interests.

Article XVI

1. This Treaty shall be subject to ratification in accordance with the constitutional procedures of each Party. The Treaty shall enter into force on the day of the exchange of instruments of ratification.

2. This Treaty shall be registered pursuant to Article 102 of the Charter of the United Nations.

Done at Moscow on May 26, 1972, in two copies, each in the English and Russian languages, both texts being equally authentic.

For the United States of America:

Richard Nixon
President of the United States of America

For the Union of Soviet Socialist Republics:

L. I. Brezhnev
General Secretary of the Central Committee of the CPSU

Agreed Interpretations, Common Understandings, and Unilateral Statements

1. AGREED INTERPRETATIONS

(a) *Initialed Statements.*—The document set forth below was agreed upon and initialed by the Heads of the Delegations on May 26, 1972:

AGREED STATEMENTS REGARDING THE TREATY BETWEEN THE UNITED STATES OF AMERICA AND THE UNION OF SOVIET SOCIALIST REPUBLICS ON THE LIMITATION OF ANTI-BALLISTIC MISSILE SYSTEMS

[A]

The Parties understand that, in addition to the ABM radars which may be deployed in accordance with subparagraph (a) of Article III of the Treaty, those non-phased-array ABM radars operational on the date of signature of the Treaty within the ABM system deployment area for defense of the national capital may be retained.

[B]

The Parties understand that the potential (the product of mean emitted power in watts and antenna area in square meters) of the smaller of the two large phased-array ABM radars referred to in subparagraph (b) of Article III of the Treaty is considered for purposes of the Treaty to be three million.

[C]

The Parties understand that the center of the ABM system deployment area centered on the national capital and the center of the ABM system deployment area containing ICBM silo launchers for each Party shall be separated by no less than thirteen hundred kilometers.

[D]

In order to insure fulfillment of the obligation not to deploy ABM systems and their components except as provided in Article III of the Treaty, the Parties agree that in the event ABM systems based on other physical principles and including components capable of substituting for ABM

interceptor missiles, ABM launchers, or ABM radars are created in the future, specific limitations on such systems and their components would be subject to discussion in accordance with Article XIII and agreement in accordance with Article XIV of the Treaty.

[E]

The Parties understand that Article V of the Treaty includes obligations not to develop, test or deploy ABM interceptor missiles for the delivery by each ABM interceptor missile of more than one independently guided warhead.

[F]

The Parties agree not to deploy phased-array radars having a potential (the product of mean emitted power in watts and antenna area in square meters) exceeding three million, except as provided for in Articles III, IV, and VI of the Treaty, or except for the purposes of tracking objects in outer space or for use as national technical means of verification.

[G]

The Parties understand that Article IX of the Treaty includes the obligations of the US and the USSR not to provide to other States technical descriptions or blueprints specially worked out for the construction of ABM systems and their components limited by the Treaty.

(b) *Common Understandings.*—Common understanding of the Parties on the following matters was reached during the negotiations:

A. LOCATION OF ICBM DEFENSES

The U.S. Delegation made the following statement on May 26, 1972:

Article III of the ABM Treaty provides for each side one ABM system deployment area centered on its national capital and one ABM system deployment area containing ICBM silo launchers. The two sides have registered agreement on the following statement: "The Parties understand that the center of the ABM system deployment area centered on the national capital and the center of the ABM system deployment area containing ICBM silo launchers for each Party shall be separated by no

less than thirteen hundred kilometers." In this connection, the U.S. side notes that its ABM system deployment area for defense of ICBM silo launchers, located west of the Mississippi River, will be centered in the Grand Forks ICBM silo launcher deployment area. (See Agreed Statement [C].)

B. ABM TEST RANGES

The U.S. Delegation made the following statement on April 26, 1972:

Article IV of the ABM Treaty provides that "the limitations provided for in Article III shall not apply to ABM systems or their components used for development or testing, and located within current or additionally agreed test ranges." We believe it would be useful to assure that there is no misunderstanding as to current ABM test ranges. It is our understanding that ABM test ranges encompass the area within which ABM components are located for test purposes. The current U.S. ABM test ranges are at White Sands, New Mexico, and at Kwajalein Atoll, and the current Soviet ABM test range is near Sary Shagan in Kazakhstan. We consider that non-phased array radars of types used for range safety or instrumentation purposes may be located outside of ABM test ranges. We interpret the reference in Article IV to "additionally agreed test ranges" to mean that ABM components will not be located at any other test ranges without prior agreement between our Governments that there will be such additional ABM test ranges.

On May 5, 1972, the Soviet Delegation stated that there was a common understanding on what ABM test ranges were, that the use of the types of non-ABM radars for range safety or instrumentation was not limited under the Treaty, that the reference in Article IV to "additionally agreed" test ranges was sufficiently clear, and that national means permitted identifying current test ranges.

C. MOBILE ABM SYSTEMS

On January 28, 1972, the U.S. Delegation made the following statement:

Article V(1) of the Joint Draft Text of the ABM Treaty includes an undertaking not to develop, test, or deploy mobile land-based ABM systems and their components. On May 5, 1971, the U.S. side indicated that, in its view, a prohibition on deployment of mobile ABM systems and components would rule out the deployment of ABM launchers and radars which were not permanent fixed types. At that time, we asked for the

Soviet view of this interpretation. Does the Soviet side agree with the U.S. side's interpretation put forward on May 5, 1971?

On April 13, 1972, the Soviet Delegation said there is a general common understanding on this matter.

D. STANDING CONSULTATIVE COMMISSION

Ambassador Smith made the following statement on May 22, 1972:

The United States proposes that the sides agree that, with regard to initial implementation of the ABM Treaty's Article XIII on the Standing Consultative Commission (SCC) and of the consultation Articles to the Interim Agreement on offensive arms and the Accidents Agreement, agreement establishing the SCC will be worked out early in the follow-on SALT negotiations; until that is completed, the following arrangements will prevail: when SALT is in session, any consultation desired by either side under these Articles can be carried out by the two SALT Delegations; when SALT is not in session, *ad hoc* arrangements for any desired consultations under these Articles may be made through diplomatic channels.

Minister Semenov replied that, on an *ad referendum* basis, he could agree that the U.S. statement corresponded to the Soviet understanding.

E. STANDSTILL

On May 6, 1972, Minister Semenov made the following statement:

In an effort to accommodate the wishes of the U.S. side, the Soviet Delegation is prepared to proceed on the basis that the two sides will in fact observe the obligations of both the Interim Agreement and the ABM Treaty beginning from the date of signature of these two documents.

In reply, the U.S. Delegation made the following statement on May 20, 1972:

The U.S. agrees in principle with the Soviet statement made on May 6 concerning observance of obligations beginning from date of signature but we would like to make clear our understanding that this means that, pending ratification and acceptance, neither side would take any action prohibited by the agreements after they had entered into force. This understanding would continue to apply in the absence of notification by

either signatory of its intention not to proceed with ratification or approval.

The Soviet Delegation indicated agreement with the U.S. statement.

2. UNILATERAL STATEMENTS

(a) The following noteworthy unilateral statements were made during the negotiations by the United States Delegation:

A. WITHDRAWAL FROM THE ABM TREATY

On May 9, 1972, Ambassador Smith made the following statement:

The U.S. Delegation has stressed the importance the U.S. Government attaches to achieving agreement on more complete limitations on strategic offensive arms, following agreement on an ABM Treaty and on an Interim Agreement on certain measures with respect to the limitation of strategic offensive arms. The U.S. Delegation believes that an objective of the follow-on negotiations should be to constrain and reduce on a long-term basis threats to the survivability of our respective strategic retaliatory forces. The USSR Delegation has also indicated that the objectives of SALT would remain unfulfilled without the achievement of an agreement providing for more complete limitations on strategic offensive arms. Both sides recognize that the initial agreements would be steps toward the achievement of more complete limitations on strategic arms. If an agreement providing for more complete strategic offensive arms limitations were not achieved within five years, U.S. supreme interests could be jeopardized. Should that occur, it would constitute a basis for withdrawal from the ABM Treaty. The U.S. does not wish to see such a situation occur, nor do we believe that the USSR does. It is because we wish to prevent such a situation that we emphasize the importance the U.S. Government attaches to achievement of more complete limitations on strategic offensive arms. The U.S. Executive will inform the Congress, in connection with Congressional consideration of the ABM Treaty and the Interim Agreement, of this statement of the U.S. position.

B. TESTED IN ABM MODE

On April 7, 1972, the U.S. Delegation made the following statement:

Article II of the Joint Text Draft uses the term "tested in an ABM mode," in defining ABM components, and Article VI includes certain obligations concerning such testing. We believe that the sides should have a common understanding of this phrase. First, we would note that the testing provisions of the ABM Treaty are intended to apply to testing which occurs after the date of signature of the Treaty, and not to any testing which may have occurred in the past. Next, we would amplify the remarks we have made on this subject during the previous Helsinki phase by setting forth the objectives which govern the U.S. view on the subject, namely, while prohibiting testing of non-ABM components for ABM purposes: not to prevent testing of ABM components, and not to prevent testing of non-ABM components for non-ABM purposes. To clarify our interpretation of "tested in an ABM mode," we note that we would consider a launcher, missile or radar to be "tested in an ABM mode" if, for example, any of the following events occur: (1) a launcher is used to launch an ABM interceptor missile, (2) an interceptor missile is flight tested against a target vehicle which has a flight trajectory with characteristics of a strategic ballistic missile flight trajectory, or is flight tested in conjunction with the test of an ABM interceptor missile or an ABM radar at the same test range, or is flight tested to an altitude inconsistent with interception of targets against which air defenses are deployed, (3) a radar makes measurements on a cooperative target vehicle of the kind referred to in item (2) above during the reentry portion of its trajectory or makes measurements in conjunction with the test of an ABM interceptor missile or an ABM radar at the same test range. Radars used for purposes such as range safety or instrumentation would be exempt from application of these criteria.

C. NO-TRANSFER ARTICLE OF ABM TREATY

On April 18, 1972, the U.S. Delegation made the following statement:

In regard to this Article [IX], I have a brief and I believe self-explanatory statement to make. The U.S. side wishes to make clear that the provisions of this Article do not set a precedent for whatever provision may be considered for a Treaty on Limiting Strategic Offensive Arms. The question of transfer of strategic offensive arms is a far more complex issue, which may require a different solution.

D. NO INCREASE IN DEFENSE OF EARLY WARNING RADARS

On July 28, 1970, the U.S. Delegation made the following statement:

Since Hen House radars [Soviet ballistic missile early warning radars] can detect and track ballistic missile warheads at great distances, they have a significant ABM potential. Accordingly, the U.S. would regard any increase in the defenses of such radars by surface-to-air missiles as inconsistent with an agreement.

Protocol to the Treaty between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems

Signed at Moscow July 3, 1974

Ratification advised by U.S. Senate November 10, 1975

Ratified by U.S. President March 19, 1976

Instruments of ratification exchanged May 24, 1976

Proclaimed by U.S. President July 6, 1976

Entered into force May 24, 1976

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Proceeding from the Basic Principles of Relations between the United States of America and the Union of Soviet Socialist Republics signed on May 29, 1972,

Desiring to further the objectives of the Treaty between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems signed on May 26, 1972, hereinafter referred to as the Treaty,

Reaffirming their conviction that the adoption of further measures for the limitation of strategic arms would contribute to strengthening international peace and security,

Proceeding from the premise that further limitation of anti-ballistic missile systems will create more favorable conditions for the completion of work on a permanent agreement on more complete measures for the limitation of strategic offensive arms,

Have agreed as follows:

Article I

1. Each Party shall be limited at any one time to a single area out of the two provided in Article III of the Treaty for deployment of anti-ballistic missile (ABM) systems or their components and accordingly shall not exercise its right to deploy an ABM system or its components in the second of the two ABM system deployment areas permitted by Article III of the Treaty, except as an exchange of one permitted area for the other in accordance with Article II of this Protocol.

2. Accordingly, except as permitted by Article II of this Protocol: the United States of America shall not deploy an ABM system or its components in the area centered on its capital, as permitted by Article III (a) of the Treaty, and the Soviet Union shall not deploy an ABM system or its components in the deployment area of intercontinental ballistic missile (ICBM) silo launchers as permitted by Article III (b) of the Treaty.

Article II

1. Each Party shall have the right to dismantle or destroy its ABM system and the components thereof in the area where they are presently deployed and to deploy an ABM system or its components in the alternative area permitted by Article III of the Treaty, provided that prior to initiation of construction, notification is given in accord with the procedure agreed to in the Standing Consultative Commission, during the year beginning October 3, 1977 and ending October 2, 1978, or during any year which commences at five year intervals thereafter, those being the years for periodic review of the Treaty, as provided in Article XIV of the Treaty. This right may be exercised only once.

2. Accordingly, in the event of such notice, the United States would have the right to dismantle or destroy the ABM system and its components in the deployment area of ICBM silo launchers and to deploy an ABM system or its components in an area centered on its capital, as permitted by Article III (a) of the Treaty, and the Soviet Union would have the right to dismantle or destroy the ABM system and its components in the area centered on its capital and to deploy an ABM system or its components in an area containing ICBM silo launchers, as permitted by Article III (b) of the Treaty.

3. Dismantling or destruction and deployment of ABM systems or their components and the notification thereof shall be carried out in accordance with Article VIII of the ABM Treaty and procedures agreed to in the Standing Consultative Commission.

Article III

The rights and obligations established by the Treaty remain in force and shall be complied with by the Parties except to the extent modified by this Protocol. In particular, the deployment of an ABM system or its components within the area selected shall remain limited by the levels and other requirements established by the Treaty.

Article IV

This Protocol shall be subject to ratification in accordance with the constitutional procedures of each Party. It shall enter into force on the day of the exchange of instruments of ratification and shall thereafter be considered an integral part of the Treaty.

DONE at Moscow on July 3, 1974, in duplicate, in the English and Russian languages, both texts being equally authentic.

For the United States of America:

Richard Nixon
President of the United States of America

For the Union of Soviet Socialist Republics:

L. I. Brezhnev
General Secretary of the Central Committee of the CPSU

Glossary

ABM	antiballistic missile
ACTS	Air Corps Tactical School
ASAT	antisatellite
ATBM	antitactical ballistic missile
BEAR	beam-experiment-aboard-rocket
BMD	ballistic missile defense
BM/C³	battle management/command, control, and communications
C²	command and control
C²/BM	command and control/battle management
C³	command, control, and communications
CINC	commander in chief
CINCSPACE	commander in chief, Space Command
COEA	cost and operational effectiveness analysis
COIL	chemical-oxygen-iodine laser
CPSU	Communist Party of the Soviet Union
DARPA	Defense Advanced Research Projects Agency
DEW	directed-energy weapon
DIA	Defense Intelligence Agency
DOD	Department of Defense
DSAT	defensive satellite
ECM	electronic countermeasures
ELINT	electronic intelligence
EORSAT	ELINT ocean reconnaissance satellite
ESA	European Space Agency
FEL	free-electron laser
GBL	ground-based laser
GEO	geosynchronous earth orbit

ICBM	intercontinental ballistic missile
IRBM	intermediate range ballistic missile
JCS	Joint Chiefs of Staff
JPO	Joint Kinetic-Energy Weapon Program Office
JSIC	Joint Space Intelligence Center
KE	kinetic energy
KEW	kinetic energy weapon
LEO	low earth orbit
MEO	middle earth orbit
MHV	miniature homing vehicle
MIRACL	mid-infrared advanced chemical laser
NASA	National Aeronautics and Space Administration
NCA	national command authorities
NSA	National Security Agency
NTM	national technical means
ROE	rules of engagement
RORSAT	radar ocean reconnaissance satellite
SAINT	satellite interceptor
SALT	Strategic Arms Limitation Talks
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization
SDZ	self-defense zone
SEN	Space Engagement Node
SLBM	sea-launched ballistic missile
SLOC	sea lines of communication
SOARS	satellite onboard attack reporting system
SPACC	Space Command Center
SPADOC	Space Defense Operations Center
SPOT	<i>satellite pour l'observation de la terre</i>
SSC	Space Surveillance Center
SSN	Space Surveillance Network

TAOS	technology for autonomous operational survivability
USACDA	United States Arms Control and Disarmament Agency
USSPACECOM	US Space Command