Space, Commerce, and National Security

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Council on Foreign Relations, January 1999

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Foreword

For most of the space age, popular interest in space has focused on the high adventure of manned space flight and the remarkable scientific discoveries achieved by interplanetary spacecraft. The recent drama surrounding Senator John Glenn's (D-Ohio) return to space and the continued success of space-related movies demonstrates the extraordinary power these aspects of the American space program continue to exert on the public imagination.

Yet, as Colonel Frank Klotz (U.S. Air Force) explains in this lucid and compelling monograph, the United States also has hard national interests in space--both commercial and security--that it must safeguard through balanced government policies. Noting the country's growing technological reliance on satellites for purposes as diverse as cellular telephony, navigating, and observing activities on the Earth's surface, Klotz sifts through competing arguments on how the U.S. government can best protect and advance its interests in the Earth's orbit. His practical prescriptions for maintaining the American lead in space will help steer policymakers and interested individuals toward workable policies to ensure that the United States continues to benefit from the growing uses of space.

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ACKNOWLEDGMENTS

The author wrote this monograph while serving as a Military Fellow at the Council on Foreign Relations and with financial support from the Institute for National Security Studies (INSS) at the U.S. Air Force Academy in Colorado Springs, Colorado.

Several individuals graciously agreed to read and comment on various drafts of this monograph, including: Don Alston, Marc Berkowitz, Richard Betts, Kenneth Cain, George Flynn, Les Gelb, Peter Hays, Jim Hoge, Evan Hoapili, Gary Hufbauer, Dana Johnson, Ben Lambeth, John Logsdon, Mike Peters, Robert Preston, Rick Sturdevant, and Guy Walsh. Though not everyone would agree with every point in the final version, their insights and suggestions were enormously helpful. Needless to say, any sins of commission or omission rest solely with the author.

Special thanks also go to Patricia Dorff, Ed Fogarty, Miranda

Kobritz, Jacqueline Strasser, and Caroline Wadhams at the Council on Foreign Relations, and to Peter Hays, Diana Heerdt, and Jim Smith at INSS, for their invaluable support and wise counsel throughout the research and publishing process.

Finally, the views expressed are the author's own and do not necessarily reflect the official policy of the U.S. Air Force or Department of Defense.

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Executive Summary

Throughout the past decade, space has become increasingly important to all aspects of American life. The information revolution that is now transforming both private activity and global commerce depends to a very large extent on communication, remote sensing, and navigation satellites. Likewise, space has become vitally important to the American military. During the 1991 Gulf War, the victorious coalition forces relied heavily upon the "high ground" of space to support land, sea, and air operations. In future conflicts, a great deal of the information required to direct forces in combat will be supplied by space-based sensors and instantaneously relayed to the battlefield via space-based communication systems.

The increasing importance of space to both commerce and national security has given rise to two major concerns. The first is the potential vulnerability of American space systems to disruption in the event of conflict. The second is the possibility that

future adversaries will try to improve the performance of their own forces by developing indigenous space systems or by taking advantage of the widening array of space goods and services available in the marketplace.

Current administration policy emphasizes the need to develop capabilities to protect American space systems and to deny the hostile use of space by adversaries. There is, however, disagreement over how best to achieve these objectives. Over the past year, the broad outlines of a debate on this subject have taken shape. On one side are those who argue that the United States needs to develop a military capability to secure its vital interests in space. On the other side are those who urge instead that arms control and other cooperative measures are the best means to protect American interests in space, as well as to prevent space from becoming an arena of armed conflict.

This monograph describes and analyzes the issues surrounding this emerging debate. It first describes the specific ways in which recent developments have made space so important to both commerce and national security and, at the same time, blurred the dividing line between the two sectors. It then addresses the various approaches to protecting American space assets and denying the use of space to potential adversaries. It argues that the United States will need options ranging from diplomatic to more forceful alternatives in order to deter and protect against attacks on friendly space systems, and, if necessary, to shut off the flow of space capabilities to adversaries.

The study then focuses on what is perhaps an even greater challenge to American use of space in the foreseeable future: the increasing competition for access to space and the political and economic consequences that result from that competition. Already nations have sought to shape and reshape the international rules governing access to and use of space to suit their own national security and commercial interests. Heated disputes have erupted over the placement of satellites into specific operating locations in space. The proliferation of communication, remote sensing, and perhaps even navigation satellites suggests that such disputes may be even more likely in the future. For most of the space age, the two superpowers dominated the process of establishing the "rules of the road" for space by virtue of their unique capabilities and presence there. As more nations and international consortia launch and operate satellites in space, American preeminence will be subject to increasing challenge. The study thus concludes that the most important task facing American space policy in the immediate future is to sustain the nation's historical leadership in space in order to ensure the establishment of standards and rules for space that support American objectives. To this end, particular attention must be paid to developing low-cost access to space, promoting a dynamic domestic space industry, and achieving greater focus and unity of purpose in the formulation of U.S. space policy.

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THE EMERGING DEBATE

October 1997 marked the 40th anniversary of the launching of Sputnik-the first artificial satellite to orbit the Earth. The original event sent shock waves through the United States, prompting fears that the Soviet Union had pulled ahead in its quest for military and technological superiority over the West. The ensuing "space race" pitted the two superpowers in a competition to develop space capabilities and to land the first humans on the Moon. It also led to highly secret programs to use outer space as a vantage for gathering intelligence and performing other military activities.[1] Given the alarm that accompanied the original event, it seems ironic that Sputnik's 40th anniversary passed with relatively little fanfare. At the time, the media's coverage of space issues focused primarily on the technical difficulties plaguing the Russian-American crew on the space station Mir.

Indeed, the collaboration between the former Cold War rivals exemplified by Mir's joint missions might suggest at first blush that an era of military rivalry in space has given way to a new era of cooperation. In many respects the proponents of the "peaceful use of space" can take heart. Multinational programs for scientific and commercial ventures in space are a growth industry. The International Space Station, for example, involves the combined efforts of 16 nations in an ambitious, multibillion-dollar undertaking. The first building blocks of the space station were lofted into space in late 1998.[2] Yet, two other events in October 1997 demonstrated that space remains an arena in which national security interests continue to play a significant role.

The first was the test firing of the Army's Mid-Infrared Advanced Chemical Laser (MIRACL) at White Sands, New Mexico, against an American satellite. Administration officials stated that the test was designed to assess the vulnerability of satellites to laser attack and was, therefore, "defensive" in nature.[3] Critics-such as Senator Tom Harkin (D-Iowa)-arrived at a different conclusion, describing the event as the test of an "antisatellite weapon" and predicting that it would have "a major, negative impact on arms control."[4] Shortly after plans to conduct the test were made public, Russian President Boris Yeltsin wrote a personal letter to President Clinton expressing "alarm" at the "U.S. military's intention to develop a whole gamut of anti-satellite [ASAT] weapons systems" and suggesting that Americans and Russians engage in a dialogue on such issues.[5]

The second event was the first use of the line item veto in a defense spending bill. Included in the cuts were three programs related to military activities in space.[6] The vetoes drew sharp reactions from conservative commentators, who accused the president of being "enthralled with old-time fears of the 'militarization of space' and clinging to the barren theology of arms control."[7] Subsequently, in January 1998, a group of 43 retired admirals and generals-including some of the most distinguished names in the annals of the American military space program-wrote an open letter to President Clinton expressing the "deepest concern" over the line item vetoes. They predicted that the future would see "great advances in the abilities of potential adversaries to exploit space for aggressive purposes and to interfere with our operations in outer space." Accordingly, they argued, the president should heed the recommendations made by the congressionally mandated National Defense Panel to assure an American capability to "deny our enemies the use of space."[8]

Thus, more than 40 years after Sputnik, a public debate regarding space and its implications for national security is taking shape. On one side are those who argue that the United States needs to develop a military capability to protect its satellites from attack and to deny adversaries access to the benefits of satellite products and services. On the other side are those who contend that weapons should never be employed in space. They urge instead that arms control and other cooperative measures are the best means to protect American equities in space, as well as to prevent space from becoming an arena for armed conflict.

This debate is not new. Both the United States and the Soviet Union had deployed rudimentary antisatellite systems during the Cold War and engaged in bilateral talks on space arms control.[9] The "militarization of space" became a hot topic during the Reagan administration in the wake of two separate, but related, programs: the president's Strategic Defense Initiative (SDI) to provide a multi-layered shield against missile attacks on the American homeland; and the development of a new Air Force antisatellite system based on the F-15 fighter aircraft.[10] The debate, however, never arrived at a definitive conclusion and ultimately faded from public view with the end of the Cold War and the cancellation of the F-15 antisatellite program. Given the passions aroused by the mere mention of weapons in space during the 1980s, military and civilian officials subsequently avoided raising the subject in public-until very recently, that is.

So why has the issue reemerged? The answer has much to do with the phenomenal growth in the importance of space both to national security and to commerce. As the first section of this study describes in greater detail, the information revolution that is transforming both sectors is vitally dependent upon goods and services delivered from or through space. Any disruption of those goods and services could have profound consequences for U.S. interests. In May 1998, the American public got a small taste of those consequences when a technical glitch on a single communications satellite shut down most remote paging systems across the United States and interrupted electronic fund transfers for some companies.[11] A more extensive breakdown in satellite services-either accidental or deliberate-could wreak havoc upon important military, economic, and even societal activities.

Accordingly, some American officials have become increasingly concerned with ensuring U.S. access to space and protecting the substantial investment there. Thus far, the public discourse on the subject has focused on the national security implications of the increasing dependence on space, and a corresponding concern with protecting friendly space systems and denying an adversary access to similar capabilities. These are important issues that are ripe for discussion, particularly as the United States continues to define its military requirements in the new, post-Cold War strategic environment. Accordingly, this study addresses the military dimensions in some detail. To set the stage, it first recounts the public history of American and Soviet antisatellite systems at the height of the Cold War and the political debate that surrounded them in the 1980s. It then describes and evaluates more recent military thinking on alternative approaches to protecting U.S. national security and economic interests in space in the next century.

The military dimension is, however, only one part of the story. The more fundamental issues surrounding American interests in space are far broader in scope. For the greater part of the space age, the United States and the Soviet Union dominated all human activities in space. As the only players in the game, they literally wrote the "rules of the road" for space, both by their practices and in their proposals for international agreements. Key among these rules was unfettered access to space and noninterference with national activities in space. Both countries in fact pursued their respective civil and military space programs with remarkable freedom and few, if any, restrictions imposed by others. More recently, the emergence of additional "spacefaring" nations and the growing importance of space to the global economy have resulted in political and economic challenges to the preeminent position of the major space powers. In the long run, these challenges could pose a more worrisome "threat" to American interests in space than any nascent military capability to deliberately disrupt American or allied space capabilities. The second half of this study thus examines political and economic developments affecting American access to and use of space. It concludes with a discussion of steps the United States can and should take to maintain its status as the preeminent space power-in all its dimensions-so that it can continue to lead the process of setting standards and writing the rules for space in ways that support U.S. interests there.

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THE GROWING IMPORTANCE OF SPACE

One way to measure the growing importance of space to the national life and the global economy is "to do the numbers." The projected increase in satellite launches worldwide is particularly revealing. On average, about 80 satellites a year have been successfully launched by seven different nations or international organizations since the end of the Cold War (see Figure 1). Over the next decade, the average annual rate of satellite launches could more than double, with 1,500 to 1,800 satellites being lofted into space.[12] The growing output of space-related companies is equally dramatic. In 1997, estimated annual revenues for the global space industry were $79 billion. That figure could top $88 billion for 1998 and increase an additional 50 percent by the year 2001 (see Table 1). The space industry currently accounts for more than 960,000 jobs worldwide and is expanding at a rate of 40,000 jobs a year. During the past five years, financial institutions have arranged private-sector deals involving space worth more than $20 billion, with an estimated $65 billion more required to fund new commercial systems during the next five years.[13] Thus, while the public continues to identify space most closely with scientific exploration and high adventure, space has also become a big business and represents a huge investment in terms of capital assets and jobs. The root cause for this explosion in space activity has been the ever-widening array of goods and services satellites provide to both the national security and commercial sectors.

From the outset of the space age, the military and intelligence agencies recognized the advantages of performing various operations from the "high ground" of space. The original impetus for launching satellites (at least for the United States) was to gather intelligence over the Soviet Union.[14] Though the Soviets initially objected to using space for this purpose, they soon followed suit. In addition to reconnaissance satellites, both nations deployed early-warning satellites to detect the launch of ballistic missiles, as well as communications satellites to ensure "connectivity" between the national command authorities and the strategic nuclear forces. The American military also operated a small fleet of weather satellites to facilitate strategic planning and targeting. While these military satellites were employed in support of routine peacetime activities as well as crises, the underlying rationale for their existence during the Cold War was strategic nuclear deterrence.[15]

The 1991 Gulf War, however, vividly demonstrated the enormous potential of space systems to support conventional military operations. Reconnaissance satellites assisted the targeting of Iraqi forces and helped to assess the effects of the air campaign. Early-warning satellites, originally designed to detect Soviet intercontinental and sea-launched ballistic missiles, picked up the launch of Scud missiles and alerted Patriot missile batteries of their impending arrival. They also played a politically important role in providing civil defense warnings for civilian populations in both Saudi Arabia and Israel. More than 90 percent of all the long distance communications used by American forces in the theater of operations were routed through space, including commercial as well as military communications satellites. Weather satellites helped forecast conditions that could favorably or unfavorably impact military operations, such as rainstorms that would obscure targets from aircraft, cause tanks to get bogged down in the desert sand, or adversely affect the performance of precision guided munitions. By far the biggest space story during the Gulf War was the coalition's use of navigational signals from the Air Force's Global Positioning System (GPS) to guide soldiers across featureless terrain during the large ground assault into Iraq. Tank commanders involved in the action subsequently concluded that it would have been virtually impossible to execute their battle plans with the same speed and precision without GPS. Ironically, the system was not even fully operational in 1991. In fact, the military's inventory of GPS receivers was so limited that many American soldiers purchased their own from commercial sources.[16]

Since Desert Storm, all four U.S. military services have systematically explored ways in which space systems can better support traditional military operations. As a result of improvements in space systems and related ground equipment, the military has grown even more reliant on space. For example, procedures for processing data from early-warning satellites have been streamlined to sharply reduce the time required to alert field commanders of the launch of Scud-class ballistic missiles.[17]The Air Force is also developing a new fleet of satellites designed to provide even more precise detection and tracking of missile launches.[18]Additionally, the military is making more extensive use of GPS navigation data, which continues to dramatically improve the accuracy of battlefield weapons. The Air Force recently demonstrated the ability to conduct precision strikes with the B-2 bomber using conventional bombs aided by GPS. Most new munitions currently in development will employ GPS data in some form.[19]

The military's interest in space will no doubt continue to grow. The so-called "revolution in military affairs" that seeks to capitalize upon the current American lead in information technologies depends in large part on spaced-based sensors and communications.[20]In fact, the major portions of five major military missions closely tied to achieving "information dominance" on the battlefield-communications, navigation, ballistic missile warning, weather observation, and intelligence gathering-have already "migrated" to space. The next military mission that might move there is real-time surveillance by space-based radars capable of detecting the movement of tanks and other vehicles at or near the Earth's surface. The Air Force, the National Reconnaissance Office, and the Defense Advanced Research Projects Agency recently embarked upon a joint project to develop such a capability.[21]For the longer term, the military is giving serious thought to ways in which future technologies, such as space-based lasers and "space planes" (vehicles that can "fly" in both the atmosphere and space) could be employed in military operations.

Even as military use of space grows, its share of the "action"-and ultimately its ability to dominate the space policy process-is being overtaken by the commercial sector. Again, the numbers are revealing. For most of the Cold War, satellites with military and civil (e.g., the National Aeronautics and Space Administration, or NASA) applications far outnumbered commercial satellites. During the 1980s, commercial satellites accounted for less than 10 percent of the payloads lofted into space. Since then, the mix has shifted dramatically. The crossover year for the United States was 1997, when American commercial payloads launched into space exceeded the number of government payloads for the first time in history. Over the next ten years, commercial satellites will represent about 70 percent of the total number placed into orbit.[22]

The rapid growth in commercial satellites has largely been fueled by growth in the telecommunications industry. Communications satellites currently provide a variety of services-including long distance telephony, data transmission, paging, and television broadcasting-that have become routine features of life and business in modern economies. They have also been particularly attractive to developing countries and regions that do not already have a communications infrastructure based on more conventional cable and microwave relay systems.[23]The first international consortium to provide communication satellite services-the International Telecommunication Satellite Organization, or Intelsat-started operations in 1965. At that time, it had fewer than ten member nations; today it has more than 140.[24]Moreover, additional communication satellite providers have entered the market. Recent efforts within the World Trade Organization (WTO) to open up the global telecommunications market presage even more extensive use of satellite communications. Two companies, for example, are currently starting up constellations ranging from 48 to 66 satellites that will provide for instantaneous cellular phone services anywhere on the face of the Earth. Other companies are developing even larger constellations (including one system with 288 satellites) capable of transferring data at the greatly increased rates needed to support Internet access and video teleconferencing.[25]

The second major area of commercial interest in space has been remote sensing. This activity entails the collection of data from the Earth's surface using a variety of techniques, including photography, infrared detection, and radar scanning. The first use of space-based remote sensing was intelligence gathering. However, satellites can provide data of considerable interest to urban planners, cartographers, geologists, farmers, and environmentalists.[26]Commercial remote sensing got off to a slow start, hampered to some extent by widespread governmental unease about the military and economic uses to which neighboring countries could put such data. Still, the U.S. government's decision to commercialize NASA's Landsat program and French sales of imagery from its SPOT remote sensing system led to a general easing of restrictions on the marketing of remote sensing products.[27]In a sure sign that the Cold War is truly over, a Russian enterprise has entered into a partnering arrangement with an American distributor to market photographs from a Rus-sian satellite that can discern objects whose width is as small as two meters. In late 1998, an American company plans to launch a commercial satellite that can take photographs with one-meter resolution.[28]Additionally, several commercial ventures are poised to develop radar satellites that can peer through clouds and darkness to produce images with similar resolutions.[29]

Finally, though no company has yet sought to launch navigation satellites to rival the Air Force's 24 GPS satellites (whose signals are provided free of charge to all users), a brand new industry has emerged to provide GPS gear for customers ranging from car owners to outdoor enthusiasts. The current worldwide GPS equipment market is about $2 billion. Significantly, military sales account for just $80 million, or only 4 percent of that total. The market is expected to exceed $8 billion by the year 2000. Beyond the economic impact, use of GPS has become ubiquitous throughout society. The civil aviation industry has become increasingly reliant on GPS-aided navigation and, as a result, most land-based navigational aids for aircraft will be phased out starting as early as 2005.[30] Several industries use the highly accurate timing signals generated by the GPS satellites' atomic clocks to synchronize their operations. Large telephone companies, financial institutions, and the Internet rely upon GPS for this service.[31] Thus, it is no exaggeration to conclude that GPS is becoming a critical element of the technological infrastructure that underpins the entire global economy.

Before examining the national security implications of the increasing importance of space to both the military and commerce, it is worth noting that the two sectors will become increasingly intertwined in the years ahead. As part of a general reform of the armed services' acquisition practices, the Pentagon has emphasized greater use of commercial products and services as a means of reducing costs, shortening delivery times, and gaining faster access to the latest technologies. Officials at the principal military headquarters for space operations (U.S. Space Command, headquartered at Colorado Springs) have similarly expressed the need to build partnerships with the civil, commercial, and international space sectors to bolster military capabilities and decrease their cost.[32]

Military use of commercial space services is already substantial. During the Gulf War, commercial satellites accounted for 20 to 25 percent of all satellite communications used by U.S. forces in the region.[33] Today, the Pentagon devotes about 20 percent of its $2.5 billion annual budget for satellite communications to pay for commercial services.[34] Moreover, the military has relied heavily upon commercially developed systems to take advantage of

leading-edge communications technology-such as direct broadcast television and mobile telephone services.[35] Similarly, the U.S. Air Force is one of the biggest customers for SPOT commercial remote sensing products. It purchased more than 100 SPOT images of downtown Baghdad during the Gulf War and, more recently, has used SPOT data in virtual reality training for its pilots.[36] A number of analysts have predicted that the U.S. military and other government agencies (and their counterparts in other countries) could become major customers for the even more detailed commercial satellite imagery that will soon be available.[37] The American military will almost certainly have a requirement for communications and remote sensing capabilities unique to armed combat and, therefore, not likely to be offered by commercial vendors seeking the widest possible market.[38] For this reason, it seems likely that the Pentagon will continue to launch and operate military satellites specifically designed to provide such capabilities-such as the fleet of highly capable Milstar communications satellites currently being deployed.[39] Nevertheless, a trend toward greater use of commercial space systems by the military forces is clearly gaining momentum.

The implications of this trend are wide-ranging and presage a fundamental change in the relationship between the national security and commercial space sectors. As Eliot

Cohen and other observers have pointed out, market forces-as opposed to military acquisition and procurement practices-will play a far greater role in developing and fielding new technologies critical to military operations. This in turn raises myriad issues, such as the government's proper role in influencing commercial space development, the most effective military structure for space activities, and the training of military officers savvy in the ways of commerce as well as the art of war.[40]At the same time, the historical military function of protecting commerce will gain renewed saliency, especially for those commercial space systems that directly support military functions. The health and safety of some civilian satellites may become just as important to the outcome of an armed conflict as those of dedicated military satellites. Finally, the actual measures the United States takes to protect American and allied space systems or, if required, to deny its adversaries the use of space, will be rendered more difficult by the increasingly blurred dividing line between national security and commercial space systems.

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THE FLAG FOLLOWS TRADE

The growing importance of space to both the military and commerce has not been lost on government officials. In many respects, the Gulf War served as a "wake-up call." The contribution of space systems to the coalition was immediately obvious and widely heralded. The U.S. Air Force chief of staff at the time referred to Desert Storm as history's "first space war." Many analysts concluded that future wars would entail an even greater reliance upon space systems to support more traditional operations on and near the Earth's surface. Victory would, in turn, depend upon maintaining "control" of space in any conflict.[41]

This line of reasoning ultimately found expression in the Clinton administration's national space policy, released in September 1996. It stressed that "[a]ccess to and use of space is central for preserving peace and protecting U.S. national security as well as civil and commercial interests." Though it did not cite specific threats, the policy stated that the United States would conduct those space activities necessary for national security, which included "assuring that hostile forces cannot prevent our own use of space" and "countering, if necessary, space systems and services used for hostile purposes."[42]

In subsequent pronouncements, the Department of Defense (DOD) has amplified the themes sounded in the presidential policy. For example, the Pentagon's 1997 Quadrennial Defense Review noted that space was one of several areas in which the United States enjoyed a "significant advantage" over potential opponents. It further stated that the "United States must retain superiority in space." To this end, it was imperative to "focus sufficient intelligence efforts on monitoring foreign use of space-based assets" and to "develop the capabilities required to protect our systems and prevent hostile use of space by an adversary."[43]

The following year, the Secretary of Defense's 1998 annual report struck an even more philosophical tone. The report asserted that "[s]pace power has become as important to the nation as land, sea, and air power." The reasons were as much economic as military:

The world is increasingly transitioning to economies in which information is a major engine of prosperity. While U.S. national security interests focused in the past on assuring the availability of oil, the future may require greater interest in protecting and accessing the flow of information. As a result, the importance of space as a principal avenue for the unimpeded flow of information throughout a global market increases. DOD recognizes these strategic imperatives and will assure free access to and use of space to support U.S. national security and economic

interests.

According to the report, the United States should anticipate attacks against U.S. and allied space systems in future conflicts. For this reason, the Department of Defense plans to sustain and improve capabilities to monitor activities in space and to deploy space systems with ensured survivability. At the same time, the report declared that "DOD must have capabilities to deny an adversary's use of space systems to support hostile military forces."[44]

In making this case, administration officials have frequently cited historical precedent. For example, as European commerce began to expand to other regions of the world in earlier centuries, the opening of new trade routes and establishment of overseas outposts were initially undertaken by ostensibly private enterprises, such as the British East India Company. However, the European powers eventually found it necessary to create large navies and expeditionary forces to protect the sea lanes as well as the foreign holdings of their merchants. In other words, the flag followed trade. Moreover, conflicts between the great powers that arose from predominantly local disputes frequently entailed clashes among rival military forces at sea and in territories far removed from European shores. In the same manner, national security officials contend, future conflicts on the Earth's surface will inevitably entail attempts to disrupt the new "lines of communication" in space. And, just as navies were called upon to protect the sea lines of communication, the military has a role in protecting the space lines of communication.[45]

Critics of this particular use of historical analogy might point out that the international political and legal system that existed during the age of European and American expansion and the current situation in space differ significantly. While conventions to avoid conflict at sea and to regulate the scramble for overseas outposts evolved over time, the potential for armed clashes was always present. Space, on the other hand, has always been regarded as an arena open to all nations and reserved for peaceful use. In fact, the United States has traditionally been a leading proponent of this view. At the outset of the space age, the United States insisted on unimpeded access to space and rejected the

notion that nations could interfere with-forcibly or otherwise-satellite operations of any kind. Its original motive was to guar-

antee the right for its satellites to fly over countries at will so that it could conduct reconnaissance over the Soviet Union. The Soviets naturally objected, but they had already undercut their own argument by orbiting Sputnik over the United States and other countries without asking anybody's permission. Indeed, the laws of physics make it impossible to operate satellites in low Earth orbit without overflying the territories of many different nations.[46]To give legal substance to the realities of orbital mechanics, the Americans seized upon an analogy from maritime law. In their view, outer space was similar to the high seas. Just as naval and commercial vessels were free to move across the open oceans, they argued, satellites should be free to move through space. The Soviets initially countered with a legal analogy of their own, contending that space objects ought to be subject to the same degree of regulation and control as aircraft when they passed over a nation's territory. The Soviets' objection was relatively short-lived as they too began to rely more heavily on satellites to gather intelligence.[47]

The principles of unimpeded access and noninterference were ultimately enshrined in a series of U.N. resolutions that culminated in the 1967 Outer Space Treaty.[48]The treaty, which has been ratified by 91 nations, provides the basic framework for the field of international space law. Its preamble captured the prevailing sentiment that the "use of outer space for peaceful purposes" is in the "common interest of all mankind." The treaty's specific provisions likewise affirmed the principle of unimpeded access to space by declaring that outer space, including the Moon and other celestial bodies, "shall be free for exploration and use by all states." Furthermore, outer space "is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by other means." Thus, nations cannot impose restrictions or exert control over any part of outer space in the same way they do over the airspace above their national territory. The treaty also endorsed the principle of noninterference by requiring nations to engage in international consultation if any of their activities in space would cause "potentially harmful interference" with the activities of other nations in the peaceful exploration or use of outer space.

Yet, despite the Outer Space Treaty's emphasis on peaceful use and the specific provisions on unimpeded access and noninterference, the existing legal regime does not-as is often supposed-categorically rule out the use of space for military purposes. It is true that there are limits on the deployment of certain weapons. Prior to the conclusion of the Outer Space Treaty, the 1963 Limited Test Ban Treaty prohibited nuclear weapon test explosions in space.[49]The Outer Space Treaty itself forbids the placing of nuclear weapons and other weapons of mass destruction in orbit, on celestial bodies, or anywhere else in space. It also rules out military bases, weapons tests, and maneuvers on the Moon and other celestial bodies. And the 1972 Anti-Ballistic Missile (ABM) Treaty prohibits the development, testing, or deployment of space-based ABM systems or components.[50]But in the final analysis, international space law imposes few restrictions on the use of space for military activities or the deployment of space weapons. Whatever merits the Outer Space Treaty and other agreements may have in establishing the ground rules for national activities in space, they alone do not preclude the possibility that nations could engage in military action to interfere with access to space or the safe operation of satellites. In the absence of a well-established and widely accepted legal regime in space, the historical analogy of the need to protect lines of communication in the traditional sense may not be all that farfetched.

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COLD WAR ASATs AND ARMS CONTROL

In fact, even while they were constructing the legal framework for peaceful use of and unimpeded access to space during the Cold War, both the United States and the Soviet Union deployed limited antisatellite systems to forcibly impede the other side's use of space systems. In the late 1950s, the U.S. Air Force pursued a satellite interceptor program, known by its acronym of SAINT, and at one point actually test-launched a missile from a B-47 bomber toward an American Explorer satellite. However, at the time, the Defense Department's emphasis was clearly on developing the intercontinental ballistic missile. The resulting budgetary constraints and fears of jeopardizing the principle of uncontested access to space (particularly for American reconnaissance satellites) served as a brake on ASAT developments during the Eisenhower administration. Accordingly, no systems were ever fielded.[51]

Interest in ASATs intensified during the Kennedy administration. Concerns that the Soviet Union might deploy nuclear bombs in space ultimately led the United States to deploy limited antisatellite systems at Kwajalein Atoll and Johnston Island, both in the Pacific. The first system, known as Program 505, employed the Army's Nike Zeus antiballistic missile-demonstrating early on the potential overlap between ABM and ASAT capabilities. The system was declared operational in May 1964 with one missile on alert. However, because of its limited range (about 200 miles), Program 505 was phased out two years later. The second system, known as Program 437, consisted of a one-megaton nuclear warhead mounted on an Air Force Thor missile. It was capable of intercepting satellites as they passed within 1,500 nautical miles of Johnston Island at altitudes up to 700 nautical miles. After the Outer Space Treaty put an end to fears about Soviet nuclear weapons in orbit, the United States began to phase out Program 437. The final test launch took place in 1970, though the program was not officially terminated until 1975.[52]

Meanwhile, in the late 1960s, the Soviet Union developed and deployed an antisatellite system of its own. The Soviet program consisted of a satellite interceptor mounted atop modified SS-9 intercontinental boosters based at the Tyuratam space launch complex in Kazakhstan. The interceptor was designed to enter the same low Earth orbit as its intended target and, after one or two hours, maneuver close enough to destroy it with shrapnel. While the Americans initially fielded Program 437 to deal with the possibility of nuclear weapons in orbit, the purpose of the Soviet co-orbital system is less clear. One unofficial account notes that a number of American low Earth orbiting satellites of military value, including several reconnaissance satellites, would have been within range of the Soviet system.[53]The Soviets reportedly conducted 20 tests of their system between 1968 and 1982, when they abruptly stopped as part of a self-imposed moratorium on ASAT testing.[54]However, at the time, American officials described Soviet capabilities as involving more than just that country's co-orbital interceptor. According to a Reagan administration report to Congress, it also included "ground-based test lasers with probable ASAT capabilities, . . . possibly the nuclear-armed GALOSH ABM interceptors, and the technological capability to conduct electronic warfare against space systems."[55]

The existence of an operational Soviet ASAT system provided impetus for the development of a new American system to replace the one that had been based on Johnston Island. The same year that Program 437 was officially terminated, the Air Force embarked upon a program that envisioned using an F-15 fighter aircraft to launch a rocket carrying a miniature homing vehicle. This device was designed to destroy its target by smashing into it at high speed and did not, therefore, rely upon a nuclear warhead as had the earlier American ASAT program. Actual flight testing of the system did not begin until 1983, with the first missile launch the following year. In September 1985, the system successfully struck and destroyed an Air Force space test satellite that had originally been launched in 1979 to collect data on the sun.[56]

Perhaps spurred on by the new American ASAT program, the Soviets launched a public diplomacy campaign in the early 1980s to limit weapons in space. Exploratory talks between the Americans and Soviets on restricting ASATs had actually taken place during the Carter administration, but were overshadowed by the strategic arms talks and were put on indefinite hold after the Soviet invasion of Afghanistan.[57] In 1981, the Soviets resurrected the issue with a series of proposals and draft resolutions in the United Nations to prohibit weapons in space. The Reagan administration was decidedly cool toward the Soviet proposals, citing the problems of verification, the existing Soviet ASAT program, and the Soviets' objections to the U.S. space shuttle as a potential military platform. Though the issue of space weapons was ultimately incorporated in the gamut of arms control issues under discussion in Geneva after 1985, the focus of attention on both sides had by then shifted to the American Strategic Defense Initiative.

Whether by design or coincidence, the Soviet public diplomacy campaign against weapons in space did contribute to scuttling the F-15 ASAT program. From its very inception, the program had been mired in political controversy. Its opponents viewed it as an unnecessary and dangerous extension of the arms race into space, as well as a threat to strategic stability, because an ASAT could threaten the early-warning and communications satellites used to control nuclear weapons during a crisis or actual attack.[58] The Reagan administration countered that the primary purpose of the system was deterrence. If the Soviet Union had an operational ASAT system and the United States did not, then the Soviets could employ their system against American satellites without fear of a response in kind. On the other hand, an operational American system would give the Soviets an incentive not to use their ASAT. Despite the emphasis on deterrence, the Reagan administration did publicly admit that another rationale for an American ASAT system was to "deny any adversary the use of space-based systems that provide support to hostile military forces."[59]

Unpersuaded by the administration's justification and frustrated by its apparent unwillingness to negotiate with the Soviets on limiting weapons in space, Congress twice restricted or prohibited the expenditure of government funds for testing the F-15 ASAT program. In 1984, it limited the number of tests that could be performed and, as a condition for testing, required the president to certify that the United States was negotiating in good faith with the Soviets on ASAT arms control. In 1985 and again in 1986, Congress banned tests against any objects in space. Though the Air Force carried out two tests in 1986, the miniature homing devices were aimed at stars instead of satellites as their "targets." Faced with these obstacles, as well as reported technical difficulties, the Air Force canceled the program in March 1988.

The end of the Cold War thus found the political debate on ASATs and space arms control in a state of suspended animation. The original rationale for developing a new American ASAT based on the F-15-deterrence of the Soviet Union in general and its operational ASAT in particular-had fallen away. Both of the major space powers had stopped testing satellite interceptors. Consequently, interest in negotiating a ban on the deployment or use of weapons in space had waned. Finally, the debate on ASAT within the American government had been so bruising that defense officials cautiously avoided even mentioning the subject in public.

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PROTECTION AND DENIAL

Now, however, the issue is making a comeback. This development has much to do with the growing importance of space to the military and commercial sectors and the concern about protecting U.S. assets and capabilities in space discussed previously. As Lawrence Freedman has observed, "In strategic thinking, dependence soon becomes a vulnerability and, by extension, a potential target."[60]Though not faced with an immediate threat, American defense officials have been increasingly open in expressing concern about the future. For example, the U.S. Space Command's recently released Long Range Plan argues that American adversaries will certainly recognize the importance that space systems hold for the U.S. military and economy. This dependence on space will offer opportunities for low-cost, "asymmetric" strategies for inflicting significant damage on the United States without having to confront the full brunt of U.S. military forces. For that reason, potential adversaries may develop "counterspace weapons aimed against U.S. space systems." Lesser powers and other actors, according to the report, may prefer "jamming, information operations, and other techniques." Wealthy states, on the other hand, will prefer directed-energy weapons (e.g., lasers) that can permanently or temporarily disable critical satellite functions.[61]A White House spokesman reportedly estimated that 20 to 30 nations might already have laser technology that could conceivably be put to such use.[62]

At the same time, there is growing concern that future adversaries could use space to support their own forces in conflicts with the United States. The Gulf War vividly demonstrated the enormous importance of space systems to the American military. It also suggested to thoughtful observers that the United States should not count on an indefinite monopoly in this field--particularly as spaced-based products and services became increasingly available in the commercial market. The consequences of facing an enemy with the same or similar capabilities of observing the battlefield from space or providing precise navigation data to its forces would be profound. If, for example, Iraq had had access to this kind of information, the coalition's victory would not have been as easy. Commercially available satellite imagery might have unmasked

preparations for the ground force's "left hook" into Iraq. As satellite communications, remote sensing, and navigation services become more widespread, future adversaries-including those with otherwise limited military capabilities-would be able to acquire, process, and quickly disseminate information that could be used against American forces. As a rule, military commanders seek to gain the high ground--not to share it. Thus, in future conflicts, the United States would no doubt want to deny the use of space capabilities to its enemies, lest they achieve the same advantages in space. The central dilemma is how to accomplish both ends-protecting one's own use of space, while at the same denying it to an adversary.

Space experts have wrestled for a long time with the problem of protecting space systems-including the satellite, its associated ground equipment, and the communications links between the two--from either natural or man-made phenomena. A variety of different technical approaches have been examined over time. In his classic and widely quoted work on the subject, Robert Giffen describes these as including: "hardening" or shielding systems against physical effects; enhancing the capability to maneuver out of harm's way; proliferating the number of systems in existence; hiding or disguising the purpose of a particular system; increasing a satellite's ability to operate autonomously from ground stations; and establishing the means to quickly replace or "reconstitute" a given system.[63] However, as Giffen and others point out, each approach entails real as well as opportunity costs. For example, weight is a major factor in the design, operational longevity, and total cost (including launch) of a satellite. Every kilogram devoted to hardening is a kilogram that could conceivably be used for more operational equipment or for additional fuel to maintain a satellite in the desired orbit. Likewise, satellites and rockets are big-ticket items, a fact that militates against building and launching more than are absolutely required to perform a particular mission. Thus, despite a general acknowledgment that more could and perhaps should be done to physically protect space systems, the costs involved have had an inhibiting effect, particularly in the absence of an immediate threat. As one senior military official recently lamented, military and civilian satellites as a rule do not even have on-board systems to signal if and when they have been deliberately attacked: "We have ways of telling something happened to the satellite, but why did it quit? Did it quit because of fatigue, or an electromagnetic pulse from deep space, or because somebody lased it? We can only make an educated guess."[64]

An altogether different approach to the protection of space systems is suggested by arms control. As some proponents have argued, the international legal regime could be strengthened to afford greater protection to satellites beyond that already provided by existing treaties. Since it potentially has the most to lose in an environment in which satellites were considered legitimate targets, the United States, they contend, should strongly favor measures to either restrict systems that have an antisatellite role or restrict activities that directly threaten satellites. This line of reasoning admittedly has some appeal as well as a respectable pedigree. After all, the Eisenhower administration refrained from developing ASATs in part to avoid lending any legitimacy to potential attacks on American reconnaissance satellites. That said, the prospect of addressing vulnerability of satellites through arms control measures has never engendered much enthusiasm. During the late 1980s, several significant articles analyzed various approaches to space arms control that could be characterized as either banning things or banning actions.[65] However, as previously mentioned, the preliminary discussions on space arms control with the Soviet Union during the Reagan administration made little headway. More recently, Clinton administration officials have emphatically stated that arms control discussions to ban antisatellite testing or systems are neither "underway, envisioned, or under consideration."[66] In fact, upon closer examination, formal arms control agreements would not appear to hold much promise as an approach to protecting U.S. military and commercial satellites in the emerging space environment.

The basic problem with limiting capabilities is determining just what capabilities to limit. During the Cold War, the major arms control initiatives dealt almost exclusively with fielded military capabilities and relatively mature technologies. Even so, there was considerable room for debate over the "units of account"-that is, what things should or could reasonably be subject to limits. For example, in the first strategic arms control talks, negotiators could not agree on ways to constrain intercontinental ballistic missiles directly, so they settled upon limiting their launchers, or silos. The problem is compounded in the case of antisatellite weapons. In the absence of an extant threat, an agreement aimed at weapons that could pose a threat to satellites can only speculate as to the types of systems, capabilities, or activities that should be subject to restriction. Space technology is developing so rapidly that entirely unforeseen threats could emerge within the life of a formal arms control treaty. Thus, limiting a particular kind of capability-such as the rocket-mounted satellite interceptors developed by the United States and the Soviet Union during the Cold

War-would provide little protection against systems based on entirely new or different technology and could engender a false sense of security.

Additionally, some of the systems that might be used to attack satellites, which would therefore be subject to limitation, might also have other, entirely legitimate civilian or military purposes. Reductio ad adsurdum, any satellite that can be maneuvered in such a way as to collide with another satellite could theoretically be used for "antisatellite" purposes. While one might counter that the functions of individual satellites are generally widely known, not everyone will agree. The Soviet Union, for example, objected to the U.S. space shuttle as a potential antisatellite platform since it had the capability to "snatch" satellites in orbit.[67]Even those future systems that have been popularly identified as having a possible antisatellite role--such as space-based lasers or a military spaceplane--could also perform a variety of other missions. The former has in fact been most closely identified with defense against ballistic missile warheads. The latter could be used to perform routine but cost-effective logistical tasks, such as repair, refueling, or replacement of satellites in orbit. Thus, unless a system is unmistakably identified as an antisatellite weapon--either by declaration or unequivocal action--it may be exceedingly difficult to apply an ASAT label to it. Limiting a system simply because it possesses a potential antisatellite capability would be unduly restrictive and could deny the nation capabilities that might prove militarily or economically important. Finally, attempting to place limits on multiple-use systems only if they were equipped for an ASAT role would pose obvious verification and enforcement problems or, conversely, opportunities for cheating by one or more parties.

Likewise, restricting certain activities that ostensibly constitute deliberate interference or "attacks" on satellites would also add little value. The international legal regime already contains provisions for noninterference. As noted earlier, the 1967 Outer Space Treaty endorses the principle of noninterference in the peaceful exploration or use of space. Similarly, the 1973 International Telecommunications Convention states that all "space objects" must be operated in such a way as to avoid harmful interference to the radio services or communications of others. Additionally, "military radio installations" must "observe statutory provisions relative to . . . the measures to be taken to prevent harmful interference."[68]Finally, the strategic arms treaties between the United States and the successor states to the Soviet Union prohibit interference with national technical means of verifying the treaty, which include some space systems.[69]Thus, in peacetime at least, deliberate interference with the satellites and their signals is already enjoined by international agreement.

Actual hostilities are a different matter. The provisions of the Outer Space Treaty about noninterference may not apply in this instance since the treaty also acknowledges that nations will conduct their activities in space in accordance with the U.N. Charter, which explicitly recognizes every nation's inherent right to individual or collective self-defense. Only rarely has international law specifically prohibited the use of particular weapons or specific activities in warfare, and then usually in cases where the treatment of noncombatants is at issue or considerable opprobrium is attached to the weapon or activity in question--such as poison gas. While attacks on satellites might have profound military or economic consequences, they would hardly generate the same kind of moral outrage. Thus, it stretches the imagination to believe any nation would ever consent to an arms agreement that would categorically foreclose the option of attacks on space systems in wartime or would actually refrain from attacking a satellite if it concluded that significant military advantage could be gained from doing so. For all these reasons, a categorical ban on attacks on satellites would seem to hold little promise.

While legally banning antisatellite systems or activities associated with their use would not appear to add much value at the moment, it may be possible for nations to mutually refrain from activities that might be construed as threatening to the satellites of others. Such undertakings are not without precedent. When it has been within their general interests, nations have held back from employing certain weapons and engaging in certain activities during wartime, even in the absence of specific agreements. For the most part, the major powers avoided the use of chemical weapons during the Second World War. None of the nuclear states have employed their nuclear arsenals in military conflicts since the attacks on Hiroshima and Nagasaki in August 1945. Gven the cost of developing weapons in space and the ramifications of attacking a satellite and thereby inviting some sort of retaliation (either against one's own space systems or elsewhere), nations might conclude that the long-term costs are not worth the potential gains. As long as such mutual restraint is exercised, it may be possible for the space powers to uphold the principle of unfettered access to space without the need to actually employ antisatellite weapons either to deter or defend against their use by others.

There may also be several useful opportunities for the United States to engage the other space powers in discussions on rules of the road in space to enhance understanding and confidence in their respective space activities.[70]The U.S. Space Command currently operates a "laser clearinghouse" to preclude laser beams that are routinely fired into space for scientific and other peaceful purposes from inadvertently being discharged when a satellite is overhead. Clinton administration officials have announced that there have been preliminary discussions with the Russians about the possibility of expanding this service to include them.[71]Existing international agreements call upon nations to register the space objects they launch with the secretary general of the United Nations. The information required is minimal, including only the name of the launch state, registration number or other designator, date and territory of the launch, basic orbital parameters, and general function of the space object.[72]This approach could be extended to provide for greater transparency concerning satellite payloads in order to reduce uncertainties about possible threats posed by a particular space object and to foster a climate of greater openness. The growing use of space and the problem of orbital debris suggest another area in which greater international cooperation would be beneficial.[73]The standards and practices that govern air traffic worldwide might be applied to space, perhaps in the form of a "space Federal Aviation Administration [FAA]." These examples are suggestive and by no means exhaustive. The main point is that there are significant opportunities for greater cooperation and collaboration in defining proper activities in space that have immediate importance and are more likely to sustain peaceful operations in space than a narrowly drawn arms control agreement that attempts to ban antisatellite weapons or activities.

As noted earlier, a central dilemma in fashioning future U.S. space policy is balancing the need to protect one's own capability to use space and, at the same time, to deny that same capability to an adversary. Even if it were possible to devise an effective arms control regime to protect satellites from interference or attack during hostilities, it might not be worth the price if it prevented the United States from taking actions necessary to stop an enemy from using space to its advantage or, conversely, to American or allied disadvantage. Armed conflict has historically entailed efforts to confuse or disrupt the opponent's gathering of timely intelligence, communicating with and controlling its forces, and navigating across the battlefield. The rapid tempo and lethality of modern warfare place an even higher premium on maintaining an information edge over the opponent. Because such information is increasingly derived from or transmitted through space systems, success in future conflicts could very well depend upon the ability to shut off (perhaps only temporarily) an adversary's ability to obtain and use space products and services.

The possible means of accomplishing this particular task are quite varied. The overall mission of protecting satellites and denying their use to adversaries-commonly referred to as space control-actually entails several interrelated activities and objectives. These include, inter alia, assuring access to space and the ability to operate there; surveilling objects in space; protecting space systems from attack; preventing unauthorized access to or use of friendly space systems; and negating space systems that pose a risk to U.S. and allied interests.[74]Significantly, all of these objectives can be achieved by nonmilitary means, including even the denial or "negation" task. For example, licensing agreements can and have been formulated to give the government a say in the distribution of satellite products in the event of crisis or conflict. Similarly, export control regimes--such as those established for missile technology and chemical weapons precursors--can be instituted on a multilateral basis to restrict the flow of satellite technology and products to suspect states. Finally, the United States can make use of traditional tools of diplomacy to persuade state actors or multinational consortia to refrain from providing satellite communications services or imagery to an adversary.[75]

Conventional military forces can also be employed to deny an adversary access to space goods and services. A satellite is only one segment of the total system that is required to deliver space products and services. Equally important are ground-based antennas, control centers, relay stations, and distribution nodes. All of these segments can be targeted by familiar military tactics (e.g., bombing or missile attack), as well as emerging techniques popularly referred to as information or cyber-warfare. In addition, the headquarters and other facilities in which space products and services are actually used by an adversary can also be attacked. In short, highly specialized weapons will not always be necessary to deny an adversary the use of space. In many cases, it may be faster, easier, and cheaper to accomplish the same objective using forces that perform other functions closer to the Earth's surface.[76]

That said, for the longer term, the United States may need additional arrows in its quiver to provide a sufficient range of options to deny an adversary access to space capabilities. Diplomatic approaches may fall short, particularly when a provider of space goods and services has strong political or commercial motives to continue supplying an adversary. This will probably not be a major problem with respect to American allies, particularly if they generally support U.S. policies and actions vis-à-vis the country in question. France, for example, blocked Iraqi access to imagery from its SPOT remote sensing satellite during the Gulf War.[77]However, restricting the availability of space services and products from uncooperative third parties or those obtained indigenously by the adversary would obviously be more difficult. Likewise, conventional military solutions to shutting off the flow of space-borne information might face any number of constraints depending upon the specific scenario. Ground targets might not be readily accessible due to distance, sophisticated defenses, or the lack of American or allied forces in the region. Concerns about overflight and collateral damage might impose political or operational restrictions. Therefore, as U.S. Space Command has argued in its Long Range Plan, the United States should have at its disposal military capabilities specifically tailored to quickly and precisely "produce reversible and permanent effects against all nodes of a potential adversary's space systems (emphasis added)." Additionally, such capabilities should be flexible enough to account for the fact that both friends and foes may be using space services from satellites in the same vicinity. According to U.S. Space Command, candidate systems that hold promise for meeting these desiderata over the next 10 to 15 years include ground-based lasers, and relocatable radio frequency and laser jammers. By the year 2020, its candidate list grows to also include space-based jammers and lasers, as well as a space operations vehicle (the current term of art for a military spaceplane).[78]

Whether all or any of these systems will eventually be deployed is uncertain and depends as much, if not more, on political will as on technological developments. However, with a capability to take actions beyond diplomatic and traditional military measures, the United States would be in a stronger position to deter adversaries from interfering with friendly satellites and, at the same time, have added clout to persuade foreign countries or firms to voluntarily refrain from delivering space goods and products to its enemies. And, if all else fails, the United States would also have the means to take direct action to stop its adversaries from using space in support of operations against American and allied forces.

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THE INTERNATIONAL POLITICS OF SPACE

While the preceding analysis has focused primarily on the military aspects of protecting the new lines of communications in space, the more immediate and potentially more worrisome threats to American use of space are in fact political and economic in nature. For most of the space age, the United States and the Soviet Union--by virtue of the level of their activity and their presence-dominated space and, in the process, wrote the rules of the road for national activities there. Key among these rules was free and unimpeded access to space. However, as the potential economic benefits of space have become more apparent and the number of players in the game has expanded, the preeminent position of the major space powers has been challenged. The net result has been calls for limits on the use of space by the space powers and, in some cases, the mutual acceptance of restrictions on totally unfettered access to space. So far, these have been relatively modest. The central question is whether the continuing proliferation of actors and activities in space will lead to even more challenges to American leadership and a more restrictive regime in space.

The first challenge to unimpeded access to space concerned the placement of satellites into a so-called geosynchronous orbit. As noted above, the most dynamic market for commercial ventures in space has been the telecommunications industry. Many communications satellites are placed into an orbit roughly 23,000 miles above the equator. At this altitude, a satellite can "see" and therefore receive and transmit signals to a very large portion of the globe.[79]Equally important, the satellite also circles the Earth at the same rate as the Earth revolves on its axis-hence the term "geosynchronous." The satellite thus appears to an observer on the ground to be stationary. This phenomenon confers important technical advantages and cost savings because it does not require sophisticated tracking equipment to follow the satellite and home in on its signal. For these reasons, geosynchronous orbit is an attractive place to park communications satellites. However, the number of satellites that can be put into a given location 23,000 miles above the equator is limited by the need to prevent radio interference.[80]To preclude an unregulated scramble for geosynchronous "slots," nations turned to the already existing International Telecommunications Union (ITU)--an agency loosely affiliated with the United Nations--to allocate the satellite positions and frequencies in geosynchronous orbit. At first, the ITU discharged this task on a first-come, first-served basis. However, as the United States and other space powers launched increasing numbers of communications satellites, the developing nations grew concerned that the geosynchronous belt would be "filled up" before they developed the technical and financial wherewithal to enter the market.[81]

The developing nations attempted to break the space powers' perceived dominance of the geosynchronous belt on several different fronts. For example, in 1976, eight countries signed the so-called Bogotá Declaration, which asserted that the portions of the geosynchronous belt directly over the nations along the equator were part of their national territory and therefore subject to their jurisdiction. This position directly contradicted the Outer Space Treaty's prohibition against national claims in space. Not surprisingly, it attracted little support from non-equatorial countries.[82]The developing nations had more success in the mid-1980s by forcing the ITU to revise its procedures for allocating satellite positions and frequencies in geosynchronous orbit by reserving at least some slots for every member nation to use itself or lease to others.[83]

Their concerns about access to the geosynchronous belt were not, however, completely resolved by the ITU's new procedures, because the right to an orbital slot did not guarantee the holder could benefit economically from it. At the urging of nations belonging to the Group of 77 and the Group of Latin American and Caribbean States, the subject remains on the agenda of the United Nations' Vienna-based Committee on the Peaceful Uses of Outer Space (COPUOS) despite the efforts of some nations to drop an issue that for the moment seems to have gone as far as it can.[84]Still, as a result of crowding of the geosynchronous belt, access to that region of space is no longer entirely "free"; rather, it is subject to limits and restrictions imposed by a perceived need on the part of most nations, including the United States, to coordinate their activities and to accept the authoritative allocation of an increasingly scarce resource by an international body.[85]

Some nations have also expressed objections to the unrestricted use of space to conduct remote sensing over their territory. These objections are based on two concerns. The first is national security. As the market for remote sensing products has expanded (albeit slowly) and the quality of commercial satellite imagery has improved dramatically, several governments have expressed fears that their potential adversaries will purchase remote sensing products or technology on the open market to obtain information with intelligence or military value that would not otherwise be available to them. The Israeli government, for example, has been especially sensitive to the possibility that the deliberate uncertainty surrounding its nuclear and ballistic missile potential would be undermined by commercially available high-resolution imagery.[86]The second objection to unrestricted remote sensing has been economic. The developing nations in particular have expressed concerns that nations who can acquire detailed economic data from space will have an unfair advantage in competing for contracts to develop indigenous resources. Other countries have worried about paying higher costs for obtaining remote sensing data from private companies as opposed to governments.[87]

Efforts to restrict remote sensing have taken essentially two forms. First, within the context of the United Nations and its Committee on the Peaceful Uses of Outer Space, several nations have sought to establish internationally agreed rules of the road for remote sensing. Early views ranged from requiring prior approval by the nation being remotely observed to creating an international agency to control the gathering and distribution of remote sensing data. In 1986, after 14 years of deliberation within COPUOS, the U.N. General Assembly adopted a resolution on principles relating to remote sensing. They state, among other things, that remote sensing should be carried out for the benefit and in the interests of all countries, taking into particular consideration the needs of the developing countries. Additionally, remote sensing activities should not be conducted in a manner "detrimental to the legitimate rights and interests of the sensed State." Likewise, when one country acquires data over another country, the sensed country should have access to the data on a "non-discriminatory basis and on reasonable cost terms."[88]Yet in no way were any specific restrictions or regulatory mechanisms imposed on remote sensing by these principles. What is more, the major space powers do not consider the principles to be binding.[89]

A second approach has been to bring pressure to bear on individual governments to restrict the activities of their domestic companies in the sale and distribution of remote sensing products. Lobbying by the Israeli government is widely credited with convincing the U.S. Congress to specifically prohibit companies licensed by the American government from selling images of Israel that are of higher resolution than is available from non-U.S. commercial sources. There also have been suggestions to establish multilateral mechanisms along the lines of various export control regimes (for example, those concerning missile technology) to monitor and where necessary restrict the sale of remote imaging equipment and products.[90]

The high-water mark and ultimately the denouement of the political challenges within the United Nations to the position of the United States and the other space powers was the 1979 Moon treaty.[91]Its basic purpose was to establish the ground rules for extracting resources from the Moon and other celestial bodies (such as near-Earth asteroids). Paradoxically, though 12 American astronauts had landed on the Moon between July 1969 and December 1972, neither the United States nor any other party was in any near-term position to begin mining there. In this sense, the treaty was an extraordinary attempt to create international law governing activities that had not yet even come into existence. Lacking any customary practice to draw from, it borrowed heavily from the notion of the "common heritage of mankind" associated with Antarctica and the Law of the Sea Convention during the 1970s.[92]The treaty itself calls for the establishment of an international regime for licensing and regulating mining on the Moon. Nations are prohibited from laying claim to resources "in place." Moreover, the benefits derived from resource extraction on the Moon are to be shared in part with the entire international community.

Unlike the 1967 Outer Space Treaty, the Moon treaty garnered little support. The agreement was adopted by the U.N. General Assembly in 1979, but it took five years to obtain the ratifications needed for it to enter into force. To date, only eight countries have actually ratified the treaty. None of the major space powers have done so; the United States has not even signed it. A major objection to the Moon treaty is that it actually discourages any development of resources on the Moon and other celestial bodies, and thus removes a compelling reason for humans to eventually return there or to journey even farther into space. Since the costs and risks of mounting expeditions to these forbidding locations would be so enormous, no public or private entity would be willing to assume them if it was subsequently forced to share any returns with nations that had absolutely nothing to do with the venture. Moreover, the treaty had almost no natural constituency. Mining on the Moon is generally considered to be a distant prospect and not an issue that generates much enthusiasm even among interest groups that routinely deal with resource development issues.[93](However, recent discoveries that suggest substantial quantities of frozen water may exist on the Moon have rekindled interest in returning there.)[94]

With the collapse of the Moon treaty, the U.N. system has largely been marginalized as a force in developing international space law. COPUOS and its two subcommittees continue to address such issues as the definition and delimitation of space, geosynchronous orbit, remote sensing, space debris, and nuclear power sources in space. Yet, despite lengthy discussion and the drafting of weighty reports, no major agreements on space have emerged from within the United Nations for nearly two decades. Thus, in the final analysis, the attempts within multilateral fora and bilateral discussions to place some limits on the unrestricted use of space have had little impact on the ability of the American military or companies to operate in space. In part, this is a result of continued American leadership in the field and the corresponding ability to set the agenda and write the rules.[95]

Whether the United States will continue to be as influential is by no means certain. More nations are becoming involved in space. To date, nine countries and one international organization (the European Space Agency) have actually launched satellites into orbit. Several other nations are developing indigenous launch systems and many more own and operate satellites launched by other nations or commercial launch services. The development of alternative, lower cost launch technologies may lead to the proliferation of space launch capabilities just as the commercial aircraft industry has enabled virtually every country to operate a modern airline fleet.

As the number of launches and payloads in orbit rises sharply over the next decade, the technical challenges of operating in space will require a good deal more coordination among nations. The perceived crowding in the geosynchronous belt led to acceptance of the ITU's regulation of slots and frequencies--a mutually agreed to restriction, but a restriction nonetheless. At present, there are few international mechanisms for managing routine "traffic" to and from space, coordinating the placement of satellites into low Earth orbit (which will become increasingly crowded as the large telecommunication satellite constellations become operational), or dealing with common "environmental" issues--such as the proliferation of space debris from spent boosters and defunct satellites. The need to manage these new issues will no doubt give impetus to new international regulatory mechanisms for space. The best course of action for the United States would be to remain at the forefront of this process to ensure the outcomes do not unduly impinge upon its activities in space. Its success in doing so will in turn depend upon its continued leadership in space-both military and commercial-and the ability to articulate and pursue a coherent space policy in its dealing with other nations.

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THE NOT-SO-INVISIBLE HAND

While the political challenges to American interests in space have had some impact with the promise of more to come in the future, forces in the marketplace are already proving more nettlesome. An example of what can happen occurred in late 1997. The formal body for approving the allocation of frequencies used by satellites is the ITU's World Radiocommunication Conference (WRC), which meets every two years in Geneva. At the November 1997 session, a group of European nations proposed to "share" a portion of the frequency spectrum currently allocated to navigation systems, including the U.S. Air Force's GPS satellites. The Europeans wanted to use the frequencies for a fleet of new telecommunications satellites in low Earth orbit. They claimed that such use would not interfere with the GPS signal. The American delegation, which was reportedly caught off guard by the attempted raid, countered that the possibility of interference had not been conclusively ruled out and that any disruption of GPS service would be catastrophic to all who rely upon it for navigation and timing. The European delegations nevertheless continued to press the case and it took a last minute demarche by senior Washington officials to their European counterparts to win a reluctant agreement to postpone the issue until the next WRC meeting in 1999. In the meantime, the potential for interference is being studied and tested. At the same conference, however, the Europeans successfully pushed through a proposal to permit new constellations of low Earth orbiting satellites to share frequencies used by many communications satellites currently in geosynchronous orbit.[96]

While the dispute over frequency allocation within the bandwidth reserved for navigation was at least temporarily resolved by the ITU process, it has been less effective in dealing with other conflicts resulting from economic competition. Even when the ITU formally allocates a particular slot or frequency to a nation, differences still arise. For example, in early 1997, officials of Tongasat, the national satellite company of the South Pacific island nation of Tonga, accused Indonesia of deliberately interfering with the signals of a satellite occupying a geosynchronous slot assigned to Tonga by the ITU. The alleged motive was an Indonesian demand that one of their satellites be allowed to operate in that same slot. To complicate matters, the affected satellite actually belonged to a Hong Kong firm that had leased the slot from Tonga. Indonesia denied the charge that it was jamming the satellite and claimed it had a right to "share" the slot based on an earlier agreement with Tongasat. At the moment, the orbital slot is still occupied by the Chinese Apstar 1A satellite.[97]More recently, two European consortia-the Paris-based Eutelsat and Société Européenne des Satellites (SES) headquartered in Luxembourg-have engaged in a heated dispute over the right to use the geosynchronous orbital slot at 29 degrees east longitude. At stake is a share of the burgeoning European direct-to-home television market.[98]Additionally, the Philippine government and Intelsat have locked horns in a dispute over the use of two orbital slots over Asia.[99]

The scramble for geosynchronous slots and frequency allocations may in fact intensify as even more telecommunications satellites are launched and space becomes even more "crowded." For the most part, the ITU has resolved most conflicts. Nevertheless, the occasional breakdowns in the process for managing and regulating this competition give pause for concern. Interference--inadvertent or deliberate--could in fact pose a more immediate threat to U.S. military and commercial interests than any nascent capability on the part of potential adversaries to deliberately attack American space systems in crisis or conflict. The possible interruption of the GPS signal by commercial communications satellites-with all its implications for military operations and the global information infrastructure-is a case in point.

Economic factors also have a major bearing on another aspect of the national security dimensions of space-ready access to space goods and services by unfriendly states and non-state actors. As mentioned earlier, the American government's decision to ease restrictions on the sale of commercial high-resolution remote sensing products was largely motivated by a concern that Russian and European enterprises would capture a large share of this emerging market if American companies were frozen out. In other words, economic considerations won out over fears that opening up the market for high-resolution imagery might prove militarily useful to nations that would not otherwise have access to satellite reconnaissance. In the end, the government attempted to mitigate the downside risks by guaranteeing, as part of the licensing process, that it could monitor the kind of data for sale and the customers to whom it was being provided. The government also retained the right to limit data collection and distribution "during periods when national security or international and/or foreign policies may be compromised." The power to impose such limits (popularly referred to as "shutter control") was assigned to the Secretary of Commerce, in consultation with the Secretary of Defense and Secretary of State. Additionally, the sale of sensitive remote sensing technology would remain subject to the existing controls on the sale of military equipment to foreign countries.[100]

Economic considerations are also forcing changes in the approach the United States has heretofore taken to restrict the use of global positioning satellites by an adversary in the event of war. Since its inception, the GPS satellites have broadcast two different signals-an encrypted signal for military users, and an unencrypted but deliberately degraded signal for everyone else. The former signal allows for more precise calculation of one's position (within 20 meters) and is therefore more suitable for the military applications described earlier. Because it is encrypted, it can only be used by U.S. forces or those friendly forces to whom the United States has provided the key. The advertised accuracy of the degraded signal is only 100 meters. Thus, its military applications are limited, but it is useful for many civilian activities.[101]

Commercial users, however, have pressed for even greater accuracies. In response to consumer demand, commercial firms have developed techniques to "improve" the accuracy of the civilian signal to just a few meters or better. The most common technique, called "differential GPS," uses a known and fixed reference point to measure inaccuracies in the civilian signal and then broadcast corrections to suitably equipped users. Simultaneously, the commercial GPS industry has lobbied the government to end the practice of deliberately degrading the civil GPS signal. In March 1996, President Clinton approved a comprehensive policy on GPS that, among other things, directed an end to this practice within a decade "in a manner that allows adequate time and resources for our military forces to prepare fully for operations without [it]."[102]

The potential proliferation of differential GPS systems and the eventual end to the deliberate degrading of the civilian GPS signal will theoretically permit any user-friend or foe-access to highly accurate positioning data for both maneuvering forces and attacking targets. To guard against this possibility, the presidential directive also instructed the Department of Defense to develop measures to prevent the hostile use of GPS and ensure that the United States retains a military advantage "without unduly disrupting or degrading civilian uses." Accordingly, the Pentagon has embarked upon a program, known as Navigation Warfare (NAVWAR), to ensure American and allied access to GPS, to prevent the use of GPS by adversary forces, and "to preserve routine GPS service to all outside the theater of operations."[103]Despite this sensitivity to civilian interests, concern continues to be expressed in Europe and Japan about relying upon the military to operate a system that is becoming increasingly vital to the global economy. Some European space officials have in fact expressed a desire for a separate and independent satellite navigation capability as demand for satellite navigation services outside the United States grows. The European Commission and European Space Agency recently agreed to decide by 1999 whether to proceed with development of their own civil satellite navigation system.[104]Until now, the costs involed have ruled out any near-term deployment of such a system. And, as long as the United States continues to provide the GPS service free of charge and its operation remains reliable, it will still be difficult to craft an economic or security rationale for a competing system that would sway cash-strapped European capitals. Thus, for the foreseeable future, the United States will most likely continue to write the rules and set the standards for satellite navigation.

As will be argued below, the existence of a robust and dynamic commercial space industry is essential to retaining American leadership in space and, by extension, its ability to protect its interests there in the future. Therefore, the easing of restrictions on the sale of satellite goods and services contributes in a fundamentally important way to the broader national security agenda. Nevertheless, it does increase the difficulty of curbing an adversary's access to space goods and services that may have military applications. The challenge is and will continue to be maintaining an appropriate balance between the two competing demands, which in turn requires an open and cooperative dialogue among the military, civil, and commercial space sectors.

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A SPACE POWER NATION

In this environment of mounting political and economic pressures, a principal objective of the United States should be to maintain a leadership role in all aspects of human activity in space. One way or another, rules of the road for national activities in space will evolve to account for the phenomenal growth in its importance for both the military and commerce. For much of the space age, the United States and the Soviet Union wrote these rules-first by actual practice, and then by leading the process of codifying them into treaties and international agreements. Other nations have, as has been shown, achieved modest success in influencing international practice and law on space, particularly in the allocation of geosynchronous orbital slots and radio frequencies. But the failure of the Moon treaty and other efforts to circumscribe the activities of the major space powers shows the importance of a major and continuous U.S. presence in space to writing the rules in such a way as to promote (or at least not hinder) American interests there.

Thus, the most important order of business for the United States in the years immediately ahead is to maintain and build upon its status as the leading spacefaring nation. This not a new aspiration. As John Logsdon has pointed out, "the quest for leadership has been a central feature of U.S. space policy from the very beginning."[105]However, the objective is changing. During the Cold War, leadership in space was perceived by senior American leaders to be an important element in a multifaceted competition with the Soviet Union for the hearts and minds of the rest of the world. Demonstrated accomplishment in space was thought to confer prestige that translated into international influence writ large. Today, leadership in space assumes a different, more focused dimension as the best means of influencing the evolution of the international regime in space in response to clearly emerging political, economic, and military challenges.

One way to frame the basic elements of a strategy for sustaining and exercising national leadership in space is to borrow from the American theorists of sea power and air power. Both Alfred Thayer Mahan and General Henry "Hap" Arnold emphasized the fundamental importance of a national capacity to build ships, in the first instance, and aircraft, in the latter, and to put them out to sea or in the air for a variety of commercial and military ends. The ability to operate across the globe in both mediums meant wider access to markets and the ability to bring economic and military power to bear where national interests were at stake. A robust technological and industrial infrastructure was considered essential not only to sustaining a worldwide presence, but also to providing the intellectual know-how and material capacity to produce and employ large fleets of naval and air forces in the event of armed conflict.[106]The tie between national power and the domestic industrial base may have been lessened during the Cold War when the calculus of nuclear deterrence dominated strategic thought and a highly specialized defense industry produced the unique elements of the nuclear force posture. Moreover, the determinants of national power have certainly become more varied and complex with the globalization of trade and the growing interdependence of national economies. Nevertheless, in the words of one observer, "the pendulum has begun to swing back, and economic strength may again prove easily translatable into military power."[107]If so, the classical principles for exercising national power at sea or in the air may be at least suggestive for the new medium of space.

The most obvious lesson to be drawn from adopting such an approach is that national power in space depends upon a strong and visible presence there. This in turn requires, at the most fundamental level, a robust capability to actually get into orbit. Indeed, for most of the space age, U.S. and Soviet preeminence in space rested upon unrivaled numbers of successful space launches. However, immediately following the Challenger disaster in 1986, the number of American launches and the United States' share of the global launch market dropped sharply as other launch providers-particularly the French--took advantage of the temporary lull in the American ability to launch substantial payloads. The Americans ultimately gained back market share with the space shuttle's return to service and with new expendable boosters for both military and commercial launches. For their part, the Russians experienced a steady decline in the overall number of space launches following the collapse of the Soviet Union in 1991, though the number of commercial launches has increased since 1994. Over the same period, the European Space

Agency, using the Arianespace family of boosters, has remained a major force in the global space launch industry (see Figure 2). As the demand for launch services soars to meet requirements for large constellations of telecommunications and other satellites, the worldwide space launch industry will no doubt remain extraordinarily competitive with France, Russia, China, and new U.S.-led multinational consortia offering a variety of launch services.

The United States' ability to maintain its preeminent launch capability in the face of this competition will depend largely on the health of the nation's launch infrastructure. There are some concerns in this regard. For example, the bulk of the domestic launch industry is tied to two major launch facilities--Cape Canaveral, in Florida, and Vandenberg Air Force Base, near Santa Barbara, California-both of which date from the very beginning of the space age. Because of competing priorities, they have been neither standardized nor fully automated. The time required to reconfigure the launch facilities between launches takes far longer than it would with more modern technology. As a result, they must struggle to keep up with the heavier launch schedule. According to one senior military official, the number of launches scheduled for Cape Canaveral in 1999 already exceeds the launch site's capacity.[108]

At the same time, the costs of getting into space remain relatively high. The price tag for a launch varies depending upon the booster rocket, which in turn depends on the type of satellite being launched, the intended orbit, and certain nonmarket factors-such as political or regulatory restrictions on access to foreign launchers. Despite this variability, there is broad agreement among government and commercial space experts that the costs of getting into space can and must be driven down from thousands of dollars per pound to hundreds of dollars per pound.[109]A more responsive and less costly means of getting into space would allow for repair and replenishment of existing satellites-the same role, incidentally, that overseas coaling stations and air bases played in the rise of American sea power and air power. It would also allow for quick replacement of satellites that had been destroyed by environmental effects, debris, or the deliberate actions of an adversary.

Because the ability to get into space and to maintain a significant presence there is the sine qua non of leadership in both military and commercial space, the U.S. government should pursue policies that encourage the development of alternative domestic launch services and facilities, update the capabilities of the two major space ports and facilities, and dramatically reduce the cost of getting into orbit in order to make space operations more routine. There are already significant efforts to do this. The Air Force is sponsoring the development of a new family of expendable launch vehicles that will standardize and streamline launch operations, as well as reduce the cost of both military and commercial launches. NASA and an American aerospace company are jointly developing a "technology demonstration" project that may eventually serve as the basis for a commercial spaceplane. Both NASA and the Air Force are actively exploring new propulsion technologies for the first time in more than 20 years. One objective is to prove low-cost approaches for near-term use by industries.[110]A number of entrepreneurs and firms are investing in various reusable launch vehicles and developing new launch facilities, including one at sea. Not all of these efforts will bear fruit. But some may eventually pave the way to better, cheaper, and faster access to space in the next century. At the moment, the exploration of different approaches in the commercial launch industry is buoyed by the ready availability of capital-seeking investment opportunities in space. The challenge for the United States will be to sustain development of new space launch systems if and when the economy sags.[111]

Beyond attending to the domestic launch infrastructure, a second and related requirement is to encourage a flourishing industry in other space goods and services, especially the manufacture of satellites. At first blush, this recommendation may appear unnecessary. Despite strong foreign competition-much of which is still subsidized by governments--the American space industry is already the envy of the world and is poised for even more dramatic growth as new space applications become feasible. Nevertheless, some barriers to growth of the American space industry remain as a result of lingering Cold War concerns and practices, as well as a slowness to adapt to technological change. For example, congressional leaders have criticized NASA for a reluctance to change existing ways of doing business by making greater use of commercial goods and services, which would of course promote the commercial space sector.[112]In a different vein, procedures for licensing the sale of high-resolution satellite imagery-a product that was formerly the exclusive province of government intelligence agencies--are still not completely resolved. According to some industry officials, different approaches by different agencies to licensing and the specific manner in which restrictions would be imposed for reasons of national security give rise to uncertainty that is inimical to attracting private investment to the remote sensing industry.[113]

Likewise, the sale of commercial communications satellites and the use of foreign launch services for American satellites have become embroiled in a political controversy that has implications for the American space industry. For a variety of reasons-costs, scheduling constraints at U.S. launch facilities, concern with relying on a single type of launch vehicle-American companies have frequently turned to Russian, Chinese, and European launch services to put their satellites in orbit. In the summer of 1998, allegations surfaced that American firms may have improperly disclosed sensitive missile technology in a report on a Chinese Long March rocket accident. The underlying concern was that China could use this information to improve the capabilities of its ballistic missile forces. At roughly the same time, it was also reported that the Chinese military was using commercial communications satellites purchased from American firms to maintain contact among its far-flung units. The ensuing debate included calls by some commentators for a ban on the export of American satellites to China. Others urged that responsibility for granting licenses for satellite exports be shifted from the Department of Commerce to the State Department, where national security considerations would presumably take precedence over business interests. Administration officials countered that adequate procedures to protect against the release of sensitive information already existed. They also argued that a ban on either the export of satellite technologies or the use of foreign launchers would seriously harm the American space industry and pave the way for greater European penetration of the growing market in space goods and services. As of this writing, the question of what specific legislative or administrative actions may result from the controversy had not been finally decided.[114]

Whatever the merits of the respective arguments, the fact remains that national space power requires a healthy and dynamic commercial sector. Striking a balance between economic and national security interests in the sale of advanced technology has alwys entailed a judgment about relative risks and the establishment of safeguards that serve both interests. The danger is that well-intentioned efforts to maximize one interest could cause the other to suffer. In striking this balance, it is probably best at the moment to err on the side of promoting the development and competitiveness of the American space industry. The current period of "strategic pause"--in which the United States is at peace and faces no serious military "peer competitor" in space or elsewhere-makes this emphasis both possible and desirable. Prudent and reasonable restrictions on technology exports that would directly aid and abet proliferation of weapons inimical to American and allied interests are certainly called for. However, the imposition of draconian restrictions on American space exports (such as an outright ban on the sale of satellites or satellite services to other than the so-called "rogue" states) could open the door to greater competition from other countries. The end result could be a relative decline in the overall American ability to set the standards and write the rules for space. Such an outcome could have far graver consequences for U.S. national security interests in the long run than the occasional (though regrettable) leak of technology that could and would in all likelihood eventually be supplied by other countries.[115]

The third area that needs attention is the organization of the national space effort (see Figure 3). At the moment, there is no single focus for space policy. Several different government agencies have major roles in the formulation of space policy: NASA; the Departments of Defense, State, Commerce, and Transportation; the Federal Communications Commission; and the intelligence agencies. In those instances in which responsibility for a particular function is shared among executive agencies, the task of coordinating policy usually falls to the White House. In the case of space, however, responsibility for policy falls not to one but two White House groups: the National Security Council and the National Science and Technology Council. In addition, Congress and certain key legislators are playing an increasingly active role.[116]

As with many other issues, the institutional norms and procedures of the key players differ and are not always in agreement. For example, in the area of remote sensing policy discussed above, the Departments of Defense and State have generally been perceived as taking a more conservative approach to licensing commercial ventures, while the Department of Commerce is viewed as being more "business-friendly." These kinds of differences can have negative consequences, such as creating conditions of uncertainty that scare off potential investors.[117]It can also create conditions in which the proverbial ball is allowed to fall between the cracks. The attempted European raid on the frequencies used by the GPS satellites that was narrowly averted at the end of 1997 was partly attributable to lack of coordination and communication among all the government agencies that had a stake in the outcome.

The task of formulating policy to guide and develop American space power in the years ahead demands more coherence and visibility than currently exists. There have in fact been a number of efforts to break down many of the bureaucratic "stovepipes" that were erected during the early space age and continue to persist despite the end of the Cold War. Within the Defense Department, the commander-in-chief of U.S. Space Command was recently designated as the single focal point for all military space operations.[118]Over the past two years, the U.S. Space Command, NASA, and the National Reconnaissance Office have made a concerted effort to reduce overlap and costs by combining their efforts and working more closely together. The veil of secrecy that has surrounded many space programs since the Kennedy administration-and hindered cooperation among the various space sectors--is likewise diminishing. For example, before the end of the Cold War, government spokesmen could neither confirm nor deny the existence of the National Reconnaissance Office. Today, the NRO has its own publicly accessible web site. As a result, the various communities within the American space program are less constrained in sharing ideas on ways to benefit from common programs. Perhaps the biggest beneficiaries from the greater openness have been the "customers"-both military and civilian-who have gained a greater appreciation of what space can offer.[119]That said, the senior leaders of the major space organizations have openly acknowledged some internal, lower-level resistance to changing established practices and breaking down the institutional walls that still exist.

One means of encouraging coherent policy and greater cooperation would be to create a single, senior interagency body within the executive branch with responsibility for all aspects of space policy-governmental and commercial, classified and unclassified. A National Space Council performed this function in earlier administrations; however, as noted above, the current administration has chosen to vest responsibility for space within different White House staffs. An added benefit to such an arrangement would be to raise the visibility of space within the government and to provide industry a single point of entry for expressing its views and airing its concerns.

In summary, the most immediate task for the United States in the years ahead is to sustain and extend its leadership in the increasingly intertwined fields of military and commercial space. This requires a robust and continuous presence in space, which in turn depends upon ready and affordable access to orbit. As was the case with the great seafaring and air power nations of history, this presence will be provided in the first instance by large fleets of commercial launchers and satellites providing a variety of products and services to the nation and the global economy. At the same time, the commercial space industry will supply much of the know-how and many of the capabilities the military needs to conduct operations on or near the earth's surface-and in space. With this end in mind, every effort should be made to reduce the regulatory and bureaucratic impediments to a flourishing space industry. An essential step in doing so, however, is to reduce the institutional barriers that stand in the way of a coherent national space policy that nurtures not only the nation's space capabilities, but confronts America's competitors and rivals with a strong and united voice.

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Council on Foreign Relations Press

New York

October 1997

[1]An excellent narrative on the "space race" between the United States and the Soviet Union during the Cold War years is provided in the Pulitzer Prize-winning history by Walter A. McDougall, ...The Heavens and the Earth: A Political History of the Space Age (Baltimore: The Johns Hopkins University Press, 1997). David N. Spires, Beyond Horizons: A Half Century of Air Force Space Leadership (Washington, D.C.: U.S. Government Printing Office, 1997), focuses more specifically on the history of U.S. military activities in space. For the most recent scholarly analysis on the immediate American reaction to Sputnik, see Robert A. Divine, The Sputnik Challenge:

Eisenhower's Response to the Soviet Satellite (New York: Oxford University Press, 1993), and David Callahan and Fred I. Greenstein, "Eisenhower and U.S. Space Policy," in Roger D. Launius and Howard E. McCurdy, Spaceflight and the Myth of Presidential Leadership (Chicago: University of Illinois Press, 1997).

[2]Space News, November 16, 1998, pp. 8-12.

[3]Defense Daily, October 17, 1997, p. 3; also, U.S. Department of Defense, News Briefing, October 23, 1997.

[4]Senator Harkin press release, dated October 2, 1997. Available on: www.senate.gov/~harkin.

[5]The conservative Center for Security Policy published excerpts purportedly from the Yeltsin letter. Available on: www.security-policy.org.

[6]The specific programs were the military spaceplane, the Army's Kinetic Kill Antisatellite weapon, and Clementine II (a program to explore asteroids using equipment developed for space-based antimissile interceptors).

[7]Wall Street Journal, November 17, 1997, p. 26.

[8]Lt. Gen. James A. Abrahamson (USAF, Ret.), et al., to President Clinton, January 15, 1998. The National Defense Panel's recommendations were published in its Transforming National Defense: National Security in the 21st Century (Washington, D.C.: National Defense Panel, December 1997).

[9]An official history of the SAINT (originally an acronym for "satellite interceptor"), Project 437, and F-15 antisatellite (ASAT) programs is provided in Curtis Peebles, High Frontier: The United States Air Force and the Military Space Program (Washington, D.C.: U.S. Government Printing Office, 1997), pp. 59-67. More detailed accounts of both the American and Soviet efforts can be found in Paul B. Stares, The Militarization of Space: U.S. Policy, 1945-1984 (Ithaca, NY: Cornell University Press, 1985) and in his subsequent Space and National Security (Washington, D.C.: Brookings Institution, 1987).

[10]Peebles, High Frontier, p. 67.

[11]New York Times, May 21, 1998, p. A1.

[12]Estimates of satellite launches over the next decade vary widely. The actual number will ultimately depend upon the commercial success of new satellite-based telecommunications systems. Space Log 1996 (Redondo Beach, CA: TRW Space and Electronics Group, 1997), pp. 62-63, and U.S. Department of Defense, Report of the Secretary of Defense to the President and the Congress, 1998 (Washington, D.C.: U.S. Government Printing Office, 1998), p. 68.

[13]State of the Space Industry-1998 Outlook (Bethesda, MD: Space Publications, 1998), pp. 8, 20.

[14]For the most recent accounts of the early American intelligence satellite programs (based on newly released records) consult the National Reconnaissance Office's web site (www.nro.odci.gov); and Dwayne A. Day, John M. Logsdon, and Brian Latell, eds., Eye in the Sky: The Story of the CORONA Spy Satellites (Washington, D.C.: The Smithsonian Institution Press, 1998).

[15]Lawrence Freedman, The Revolution in Strategic Affairs, Adelphi Paper 318 (London: The International Institute for Strategic Studies, 1998), pp. 20-21.

[16]Numerous accounts describe the important role space systems played in supporting land, sea, and air operations during the Gulf War. Only three are cited here: U.S. Department of Defense, Final Report to Congress on the Conduct of the Persian Gulf War

(Washington, D.C.: U.S. Government Printing Office, 1992), pp. 801-9; Lt. Gen. Thomas S. Moorman Jr., USAF, "Space: A New Strategic Frontier," Airpower Journal, Vol. 6, No. 1 (Spring 1992), pp. 14-23; and James A. Winnefeld, Preston Niblack, and Dana J. Johnson, A League of Airmen: U.S. Airpower in the Gulf War (Santa Monica, CA: RAND Corp., 1994), p. 197 ff.

[17]Aviation Week & Space Technology, February 23, 1998, p. 108.

[18]The system, known as the Space-Based Infrared System (SBIRS), will consist of both a "high" element (with four satellites in geosynchronous orbit and two "hosted sensors" in highly elliptical orbit) and a "low" element (with a yet-to-be-determined number of satellites in low Earth orbit). U.S. Department of Defense, Space Program, Executive Overview for FY 1999-2003, February 1998, p. 19.

[19]Aviation Week & Space Technology, April 21, 1997, p. 64; and Air Force News Service, "Space Capabilities Vastly Improved since Gulf War," March 11, 1998.

[20]U.S. Department of Defense, Space Program, Executive Overview for FY 1999-2003, p. 8. For a survey and analysis of the major themes associated with the "revolution in military affairs," see Eliot A. Cohen, "A Revolution in Warfare," Foreign Affairs, Vol. 75,

No. 2 (March/April 1996), and Freedman, The Revolution in Strategic Affairs.

[21]Statement of Keith R. Hall, director of the National Reconnaissance Office, before the Senate Armed Services Committee Strategic Force Subcommittee, March 11, 1998. Available on: www.nro.odci.gov.

[22]Keynote address by Deputy Secretary of Commerce Robert L. Mallett to the 1998 National Space Symposium, Colorado Springs, Colorado, April 8, 1998; and U.S. Department of Transportation, Federal Aviation Administration, Commercial Space Transportation: 1997 Year in Review, January 1998, Appendix.

[23]Heather E. Hudson, Communication Satellites: Their Development and Impact (New York: The Free Press, 1990), pp. 246-47. According to one industry count, 75 percent of the world's telephones are found in the nine major countries of the Organization for Economic Cooperation and Development (OECD) and more than 70

countries do not have a terrestrial fiber line capable of carrying Internet traffic: Aviation Week & Space Technology, April 13, 1997, p. 72.

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[25]U.S. Department of Transportation, Federal Aviation Administration, 1998 LEO Commercial Market Projections, May 1998, pp. 3-4, 8-9.

[26]William F. Beloken, et al., chap. 1 of Multispectral Imagery Reference Guide (Fairfax, VA: LOGICON Geodynamics, Inc., 1997).

[27]SPOT is an acronym for Satellite Pour l'Observation de la Terre. For contrasting perspectives on the political and security sensitivities associated with remote sensing satellites, see Bhupendra Jasani, ed., Outer Space: A Source of Conflict or Cooperation? (Tokyo: United Nations University Press, 1991); Vipin Gupta, "New Satellite Images for Sale," International Security, Vol. 20, No. 1 (Summer 1995); and Gerald M. Steinberg, Dual Aspects of Commercial High-Resolution Satellites (Ramat Gan, Israel: Bar-Ilan University, February 1998).

[28]U.S. Department of Transportation, Federal Aviation Administration, 1998 LEO Commercial Market Projections, p. 10.

[29]Space News, June 22, 1998, pp. 1, 28.

[30]However, because of the potential vulnerability of GPS to interference, inadvertent or deliberate, some officials have cautioned against relying exclusively on GPS for civil aviation navigation. Aviation Week & Space Technology, February 2, 1998, p. 58.

[31]Irving Lachow, "The GPS Dilemma: Balancing Military Risks and Economic Benefits," International Security, Vol. 20, No. 1 (Summer 1995), p. 131n.

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www.spacecom.af.mil/usspace.

[33]Bob Preston, Plowshares and Power: The Military Use of Civil Space (Washington, D.C.: National Defense University Press, 1994), p. 132.

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[35]Bill Gregory, "Covering the Globe," and Glenn W. Goodman Jr., "Hitching a Ride," in Armed Forces Journal International, Vol. 135, No. 12 (July 1998), pp. 36-41.

[36]Winnefeld et al., A League of Airmen: U.S. Air Power in the Gulf War, p. 201.

[37]Space News, November 9, 1998, p. 7.

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p. 8.

[39]David N. Spires and Rick W. Sturdevant, "From Advent to Milstar: The United States Air Force and the Challenge of Military Satellite Communications," Journal of the British Interplanetary Society, Vol. 50 (1997), p. 211.

[40]Cohen, "A Revolution in Warfare," p. 43; and Dana J. Johnson, Scott Pace, and C. Bryan Gabbard, Space: Emerging Options for National Power (Santa Monica, CA: RAND Corp., 1998).

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[42]U.S. White House, Fact Sheet: National Space Policy, September 19, 1996. Available on: www.whitehouse.gov.

43U.S. Department of Defense, Quadrennial Defense Review, May 1997.

[44]U.S. Department of Defense, Report of the Secretary of Defense to the President and Congress, 1998, pp. 67-69.

[45]The use of historical precedent in advocating the need for military space capabilities can be found in U.S. Space Command, Vision for 2020, ca. 1997.

[46]Satellite orbits are commonly categorized by their respective distance from the Earth's surface: low Earth orbit or LEO (up to 520 miles), medium Earth orbit or MEO (roughly 12,500 miles), and geosynchronous orbit or GEO (22,300 miles). The orbit used by a particular satellite is determined by its function and the operational advantage conferred by the different orbits.

[47]M.J. Peterson, "The Use of Analogies in Developing Outer Space Law," International Organization, Vol. 51, No. 2 (Spring 1997), p. 252; and Glenn H. Reynolds and Robert P. Merges, Outer Space: Problems of Law and Policy, 2d ed. (Boulder, Colorado: Westview Press, 1997), pp. 25-42.

[48]The treaty's formal title is "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies" found in U.S. Department of State, United States Treaties and Other International Agreements, Vol. 18, pt. 3, 1967 (Washington, D.C.: U.S. Government Printing Office, 1969), p. 2410.

[49]Article I, "Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water," 1963. Available on: www.acda.gov/treaties.

[50]Article V, "Treaty between the United States and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems," 1972. Available on: www.acda.gov/treaties.

[51]Stares, The Militarization of Space, pp. 112-23; Peebles, High Frontier, pp. 59-64.

[52]Stares, The Militarization of Space, pp. 117-128.

[53]Stares, Space and National Security, pp. 85-91.

[54]Richard L. Garwin, Kurt Gottfried, and Donald L. Hafner, "Antisatellite Weapons," Scientific American, Vol. 250, No. 6 (June 1984), p. 47.

[55]U.S. Congress, House of Representatives, U.S. Policy on ASAT Arms Control, 98th Cong., 2d. sess., 1984, H. Doc. 98-107, p. 8.

[56]The target satellite was the P78-1 Solwind satellite, which was orbiting the earth at an altitude of 320 miles. Peebles, High Frontier, p. 67.

[57]Donald L. Hafner, "Averting a Brobdingnagian Skeet Shoot: Arms Control Measures for Anti-Satellite Weapons," International Security, Vol. 5, No. 3 (Winter 1980/81), p. 41.

[58]Stares, Space and National Security, p. 140.

[59]U.S. Congress, House of Representatives, U.S. Policy on ASAT Arms Control,

pp. 7-8.

[60]Freedman, The Revolution in Strategic Affairs, p. 52.

[61]U.S. Space Command, Long Range Plan, April 1998, "Foreword" and pp. 3-4.

[62]Defense Daily, October 17, 1997, p. 3. Not everyone agrees with the assessment that more than one or two nations could realistically develop a credible antisatellite capability-or would even want to do so. See, for example, Freedman, The Revolution in Strategic Affairs, p. 54.

[63]Robert B. Giffen, "Space Systems Survivability: Strategic Alternatives for the 1990s," in Uri Ra'anan and Robert L. Pfaltzgraff Jr., eds., International Security Dimensions of Space (Hamden, CT: Archon Books, 1984), pp. 87-93; and, more recently, Allen Thomson, "Satellite Vulnerability: A Post-Cold War Issue," Space Policy, Vol. 11, No. 1 (February 1995), pp. 27-29.

[64]General Howell Estes, recently retired commander-in-chief of U.S. Space Command, quoted in Aviation Week & Space Technology, August 10, 1998, p. 22.

[65]The distinction between "banning things and banning actions," particularly as it applies to antisatellite systems, is discussed in Hafner, "Averting a Brobdingnagian

Skeet Shoot," p. 54, and Giffen, "Space Systems Survivability: Strategic Alternatives for the 1990s,"

p. 87. Other important articles during this period include: Garwin et al., "Anti-Satellite Weapons"; Stares, The Militarization of Space; and Ashton B. Carter, "Satellites and Anti-Satellites: The Limits of the Possible," International Security, Vol. 10, No. 4 (Spring 1986).

[66]Remarks by Robert G. Bell, Special Assistant to the President for National Security Affairs, to the 1998 National Space Symposium, Colorado Springs, Colorado, April 10, 1998.

[67]Stares, Space and National Security, p. 112.

[68]Articles 35 and 38, "International Telecommunication Convention," 1973, found in U.S. Department of State, United States Treaties and Other International Agreements, Vol. 28, pt. 3 (1976-77), pp. 2530-32.

[69]See narratives and texts on the Strategic Arms Limitation Talks (SALT) I, SALT II, and Strategic Arms Reduction Talks (START) I. Available on: www.acda.gov/treaties.

[70]For a discussion of the full range of possible confidence building measures, see the chapter entitled "Out of Our Lane," in U.S. Space Command, Long Range Plan,

pp. 137-39.

[71]Letter from Robert G. Bell to General Bryce Poe et al., February 26, 1998 (copy provided at author's request). Bell is a senior member of the National Security Council staff. His letter was in response to the open letter to President Clinton from 43 retired admirals and generals cited above.

[72]The U.N. Secretariat has maintained a registry of launches since 1962 in accordance with General Assembly Resolution 1721 B (XVI). The 1974 Convention on the Registration of Objects Launched into Outer Space requires its parties to provide launch information to the United Nations.

[73]As of the beginning of 1998, NASA and the U.S. Space Command had catalogued more than 8,500 man-made objects in space, the great majority of which are found in low Earth orbit. Of these, operational satellites account for only about 7 percent, rocket bodies are 15 percent, and inactive satellites and other orbital debris make up the remainder. However, this figure represents only a small fraction of the total number of man-made objects in space. The current space surveillance network can only track objects that are ten centimeters across or larger. NASA studies estimate that there may be as many as 150,000 objects one to ten centimeters in size-large enough to cause catastrophic damage to spacecraft. Orbital Debris Quarterly News, Vol. 3, No. 1 (January-March 1998); NASA, Marshall Space Flight Center, Project Orion: Orbital Debris Removal Using Ground-Based Sensors and Lasers, October 1996; and U.S. White House, National Science and Technology Council, Interagency Report on Orbital Debris-1995, (November 1995).

[74]U.S. Space Command, Long Range Plan, p. 21ff.

[75]Ibid., p. 38; also, Steinberg, Dual Use Aspects of Commercial High-Resolution Imagining Satellites, pp. 41-43.

[76]U.S. Space Command, Long Range Plan, p. 45; and Giffen, "Space Systems Survivability: Strategic Alternatives for the 1990s," pp. 83-84.

[77]Winnefeld et al., A League of Airmen: U.S. Airpower in the Gulf War, p. 202.

[78]U.S. Space Command, Long Range Plan, pp. 42-47.

[79]In fact, a constellation of only three satellites in geosynchronous orbit can provide worldwide coverage, with the exception of the polar regions.

[80]Reynolds and Merges, Outer Space: Problems of Law and Policy, pp. 18-19; and Hudson, Communication Satellites: Their Development and Impact, pp. 246-47.

[81]Hudson, Communication Satellites: Their Development and Impact, pp. 251-55. According to one industry journal, there were 259 satellites in geosynchronous orbit at the beginning of 1998: "Geosynchronous Satellite Location Guide," Launchspace, Vol. 3, No. 1, February/March 1998, pp. 43-45.

[82]Mahindra Naraine, "Constraints in the Use of the Geostationary Orbit," in Jasani, ed., Outer Space: A Source of Conflict or Cooperation?, pp. 108-9.

[83]Ibid., pp. 112-15.

[84]U.N. General Assembly, Fifty-second Session, Official Records, Supplement 20, Report of the Committee on the Peaceful Uses of Outer Space 1997, p. A/52/20.

[85]Stephen D. Krasner, "Global Communications and National Power: Life on the Pareto Frontier," World Politics, Vol. 43, No. 3 (April 1991), p. 363.

[86]Steinberg, Dual Use Aspects of Commercial High-Resolution Imaging Satellites, p. 32.

[87]John Logsdon and Tracie Monk, "Remote Sensing from Space: A Continuing Legal and Policy Issue," reprinted in Reynolds and Merges, Outer Space: Problems of Law and Policy, pp. 190-96. Also, Bupendra Jasani, "Space as a Source of Conflict: An Overview," in Jasani, ed., Outer Space: A Source of Conflict or Cooperation?, p. 23.

[88]U.N. General Assembly, "Principles Relating to the Remote Sensing of the Earth from Space," Resolution 41/65.

[89]However, elements of these remote sensing principles have been incorporated into the U.S. Land Remote Sensing Policy Act and are, therefore, binding on U.S. companies.

[90]Steinberg, Dual Use Aspects of Commercial High-Resolution Imaging Satellites, pp. 41-43.

[91]The treaty's formal name is "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies."

[92]On the application of "common heritage of mankind" principles to Antarctica, see Frank G. Klotz, America on the Ice: Antarctic Policy Issues (Washington, D.C.: National Defense University Press, 1990), pp. 108-16.

[93]Nathan C. Goldman, Space Policy: An Introduction (Ames, IA: Iowa State University Press, 1992), p. 29; and chapter 4 of Reynolds and Merges, Outer Space: Problems of Law and Policy.

[94]See editorials in Space News, March 30, 1998, p. 15, and April 6, 1998, p. 23.

[95]Krasner, "Global Communications and National Power: Life on the Pareto Frontier," p. 363.

[96]Aviation Week & Space Technology, December 1, 1997, pp. 30-31, 65; Space News, November 24, 1997, pp. 1, 19.

[97]Satellite News, Vol. 20, No. 9 (March 3, 1997); and "Geostationary Satellite Location Guide," Launchspace, Vol. 3, No. 1 (February/March 1998), p. 44.

[98]Space News, March 2, 1998, p. 3, and July 20, 1998, pp. 1, 19.

[99]Space News, July 27, 1998, p. 3.

[100]U.S. White House, Fact Sheet: Foreign Access to Remote Sensing Space Capabilities, March 10, 1994. Available on: www.whitehouse.gov.

[101]Trimble Navigation Limited, "Presidential Decision Directive on GPS," 1996. Available on: www.trimble.com/home/pdd; and, Peter Grier, "GPS in Peace and War," Air Force Magazine, Vol. 79, No. 4 (April 1996).

[102]U.S. White House, Fact Sheet: U.S. Global Positioning System Policy (March 29, 1996). Available on: www.whitehouse.gov.

[103]U.S. Department of Defense, Annual Report to the President and the Congress (1998), p. 71.

[104]Aviation Week & Space Technology, January 26, 1998, p. 20, and Space News, October 26, 1998, p. 8.

[105]John M. Logsdon, "National Leadership and Presidential Power," in Launius and McCurdy, Spaceflight and the Myth of Presidential Leadership, pp. 205-6.

[106]See, for example, the chapter on Mahan in Peter Paret, ed., Makers of Modern Strategy from Machiavelli to the Nuclear Age (Princeton: Princeton University Press, 1986), and H.H. Arnold and Ira C. Eaker, This Flying Game, 3rd ed. (New York: Funk and Wagnalls, 1943). On page 139 of the latter, the two airpower pioneers write: "the nation of the future which will exercise the greatest national influence, will be the country that has the foresight and the wisdom to provide a predominant air

force. . . .This national recognition will have been demonstrated in two ways: by providing great military air forces for the expression of national influence; and by the provision of great air fleets for the transport of commerce."

[107]Cohen, "A Revolution in Warfare," p. 51.

[108]Space News, March 2, p. 7, and April 20, p. 14. See also the comments of General Howell Estes, quoted in Aviation Week & Space Technology, August 10, 1998, p. 23.

[109]State of the Space Industry-1998, pp. 36-39.

[110]Aviation Week & Space Technology, May 4, 1998, p. 51.

[111]State of the Space Industry-1998, pp. 36-39.

[112]See, for example, interview with Rep. Dana Rohrabacher (R-Calif.) in Space News, February 9, 1998, p. 22.

[113]Space News, January 5, 1998, p. 20.

[114]The debate over satellite export policy and the use of Chinese launch services was extensively reported in national newspapers and the trade press. Detailed summaries of the main issues are provided in Aviation Week & Space Technology, June 1, 1998,

pp. 22-25.

[115]For a slightly different treatment of the same issue, see Michael Hirsh, "The Great Technology Giveaway? Trading with Potential Foes," Foreign Affairs, Vol. 77, No. 5 (September/October 1998), pp. 2-9.

[116]See chaps. 7 and 8 in Goldman, Space Policy: An Introduction. The National Security Council has been in existence since 1947. The National Science and Technology Coun-

cil is perhaps less widely known. It was created by executive order in November 1993 to coordinate policy in science, space, and technology. The president is the ex officio chairman and members include the vice president, the assistant to the president for science and technology, and 22 other department secretaries, agency heads, and White House staff members. U.S. White House, 1997 Annual Report of the National Science and Technology Council, April 1997. Available on: www.whitehouse.gov.

[117]Space News, April 6, 1998, pp. 3, 32.

[118]Aviation Week & Space Technology, April 20, 1998, p. 29. According to this report, this designation was formally incorporated into the U.S. military's Unified Command Plan (UCP). The UCP, however, stopped short of endorsing U.S. Space Command's recommendation to make space a dedicated Area of Responsibility (AOR)-analogous to the assignment of responsibility for covering the European and Pacific regions to separate U.S. military commanders.

[119]Remarks by Keith R. Hall, director of the National Reconnaissance Office, to the 1998 National Space Symposium, Colorado Springs, Colorado, April 9, 1998. Available on: www.nro.odci.gov.