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Space Policy

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Introduction

General Kevin P. Chilton
Commander, Air Force Space Command

"In this new century, those who effectively utilize space will enjoy added prosperity and security and will hold a substantial advantage over those who do not."

~ US National Space Policy

The *High Frontier* journal continues to evolve into a comprehensive offering dedicated to challenging conventional perspectives on topics impacting the landscape of the Nation's space community. Within these pages, we have gathered a wide range of recognized national space policy experts. Together, these authors offer their opinions and provide us with their insights on the impact of space policy and challenges for the future.

From a Senior Leader perspective, space impacts virtually every facet of life today, from providing governments and civil agencies with space capabilities to sharing technological developments with the international community. Navigation, timing, communications, and weather are all proven capabilities provided to the warfighter on the battlefield and the entire business community. In this issue, Mr. Edward Morris takes this opportunity to highlight the unique contributions of space commerce for our readers, while Brigadier General Rob Worley drills through the layers of national space policy that influence Air Force Space Command's role in developing the tools our Nation needs to remain the leader in space. Together, these perspectives provide an interesting framework for this unique edition.

This is a complex subject with a multitude of interpretations, but we must, as stewards of space, understand the utility and limitations of policy. National sovereignty in the space domain, distinctive views on the function of space in our national industrial complex and unique editorials on possible challenges to our Nation's continued space superiority are all presented by leaders in their fields.

Our "Warfighter Focus" section provides remarkable articles on new capabilities, techniques, and technological developments that enhance our military's abilities to prosecute national objectives. Whether equipping our security forces with state of the art weaponry to protect our Nation's nuclear arsenal or exploiting the transformational aspects of Space Radar for the joint warfighter, the seemingly endless innovation of our warriors continues to promote best practices and charts the course for future growth.

In this issue, there are a number of thought provoking discussions, probing everything from the origins of national space policy to the impacts of evolving space technologies. We hope you enjoy this edition of *High Frontier,* and welcome the opportunity to help us fine tune the ongoing debate and vet key issues facing our Nation.

GENERAL BERNARD A. SCHRIEVER MEMORIAL ESSAY CONTEST

In an effort to stimulate thought, discussion, and debate on the nature and employment of space power, and do so in the memory of a great space power pioneer, I am pleased to announce the establishment of the inaugural General Bernard A. Schriever Memorial Essay Contest. As you read this month's journal, I encourage you to reflect on today's military space challenges. Take a visionary approach to determine critical developments (doctrinal, technological, or otherwise) we might witness in space power over the next 30 years, and the impact that development will have on national security matters. Our Air Force relies on innovative ideas and critical thinking to maintain its edge, and it is my sincere hope that you will take this opportunity to share your ideas with others within Air Force Space Command.

This contest will be hosted by the 50th Space Wing, Schriever AFB, sponsored by the Lance P. Sijan Chapter of the Air Force Association, and is open to all AFSPC military and civilian personnel. Essay submissions must be received by 13 April 2007. Winners will be announced in May 2007. Awards will be presented to our top three essay winners and those receiving "Honorable Mention" at the June 2007 Air Force Association Space Warfare Symposium. Winning essays will be published in the *High Frontier* journal in August 2007. For further information regarding the essay contest, please visit www.schriever.af.mil/library/essaycontest.asp. All related correspondence and essays should be submitted to essay.contest@schriever.af.mil.

General Kevin P. Chilton (BS, Engineering Science, USAFA; MS, Mechanical Engineering, Columbia University) is Commander, Air Force Space Command, Peterson AFB, Colorado. He is responsible for the development, acquisition and operation of the Air Force's space and missile systems. The general oversees a global network of satellite command and control, communications, missile warning and launch facilities, and ensures the combat readiness of America's intercontinental ballistic missile force. He leads more than 39,700 space professionals who provide combat forces and capabilities to North American Aerospace Defense Command and US Strategic Command.

General Chilton flew operational assignments in the RF-4C and F-15 and is a graduate of the US Air Force Test Pilot School. He conducted weapons testing in various models of the F-4 and F-15 prior to joining the National Aeronautics and Space Administration in 1987. General Chilton is a command-rated astronaut and test pilot with more than 5,000 flying hours. He has flown on three space shuttle missions and served as the Deputy Program Manager for Operations for the International Space Station.

The general has served on the Air Force Space Command Staff, the Joint Staff, the Air Staff, and commanded the 9th Reconnaissance Wing. Prior to assuming his current position, he was Commander, 8th Air Force and Joint Functional Component Commander for Space and Global Strike.

Among his many awards, General Chilton has been awarded the Distinguished Service Medal, the Distinguished Flying Cross, and the NASA Exceptional Service Medal. At his promotion ceremony 26 June 2006, he became the first astronaut to reach the rank of four-star general.

The Importance of Space Commerce to National Power

Mr. Edward M. Morris
Director, Office of Space Commercialization
National Oceanic and Atmospheric Administration
United States Department of Commerce

Space has always fascinated the American public and demonstrated our technological prowess to the world. The commercial use of space has provided more than just scientific or militaristic benefits to our Nation. For example, in the 1960s, the creation of International Telecommunications Satellite Organization jump-started a new global industry, brought economic benefits to the US and its allies, and generated substantial international goodwill. Likewise, the US global positioning system (GPS) generated many of the same benefits a quarter century later by giving the world free access to accurate satellite navigation without user fees.

Clearly, the United States' military and civil space capabilities are critical to our national security, public safety, and technological leadership. It is also important to note that the importance of space to the national economy has increased greatly as the private sector has discovered innovative ways to exploit space as a unique enterprise. Space drives lucrative business opportunities and enables the development of major infrastructures for government and commercial customers here on Earth.

In many cases, these activities have become so routine, dependable, and convenient that it is easy for the public to forget that space is involved. Commercial services such as CNN, DirecTV, XM Radio, and Google Earth all rely on space-based assets. The Coordinated Universal Time that is distributed by GPS ensures cell phone networks and ATMs work efficiently and reliably.

Additionally, the federal government directly purchases commercial space capabilities in areas such as satellite communications and imagery to meet its civilian and military requirements. The government also provides data acquired from space-based capabilities to directly support commerce. For example, daily weather forecasts utilized by business would be far less reliable and timely without Earth-observing satellites. It is in the national interest of the US to support space commerce as a key component of our national power and economic security. One of the stated fundamental goals of the 2006 National Space Policy is to "enable a dynamic, globally competitive domestic commercial space sector in order to promote innovations, strengthen US leadership, and protect national, homeland, and economic security."[1] The policy also recognizes the importance of US leadership in space commerce in the international marketplace.[2] Like others before it, the 2006 National Space Policy is an enabler of US space commerce.

As the principle unit for space commerce policy activities within the US Department of Commerce (DOC), the Office of Space Commercialization (OSC) is responsible for ensuring effective implementation of commercial space guidelines of the National Space Policy. The OSC Mission Statement is "to foster the conditions for market-driven economic growth and the technological advancement of the US commercial space industry" in order to meet these responsibilities. To meet this mission, OSC focuses primarily on three high-priority areas of space commerce which have a significant impact on our economic strength, national security, and public safety: positioning, navigation, and timing (PNT); commercial remote sensing (CRS); and National Oceanic and Atmospheric Administration (NOAA) civilian space operations.

Positioning, Navigation, and Timing

In December 2004, President George W. Bush authorized a new national policy that established guidance and implementation actions for space-based PNT programs, augmentations, and activities for US national and homeland security, civil, scientific, and commercial purposes.[3] GPS is the space-based component of PNT that is vital to non-military national interests including economic development and growth, public safety, homeland security, scientific leadership, and overall quality of life. GPS has evolved into a critical information infrastructure that touches the lives of most Americans on a daily basis.

Many components and functions of federal, state, and local governments rely upon GPS technology to fulfill their missions. For example, within the DOC, GPS helps NOAA navigate its vessels, enforce fishery boundaries, improve local weather forecasts, and survey our Nation's coastlines and waterways. The National Institute of Standards and Technology uses GPS to communicate its time standard to customers in industry and to other national laboratories for inclusion in the international time standard. The Census Bureau uses GPS in field enumeration applications to improve efficiency and data quality.

The economic impact of GPS to our national power is diffi-

Enable a dynamic, globally competitive domestic commercial space sector in order to promote innovations, strengthen US leadership, and protect national, homeland, and economic security …

~ US National Space Policy

cult to quantify because it is so pervasive and integrated into the fabric of society. Simply counting the total number of GPS users in the world is a challenge, because the technology is often embedded in other products, such as cell phones. According to ABI Research, global sales of GPS user equipment currently exceed $20 billion a year and will continue growing at a healthy rate for the foreseeable future.[4]

However, equipment sales represent only the tip of the economic iceberg. The true value of GPS is in the increased business productivity and growth the system enables. US industry has created new services and enhanced existing products, like OnStar, by accessing GPS capabilities. The DOC published an article focusing on the quantifiable economic benefits of the next-generation GPS satellites, which began launching in 2006. One of the first upgrades that next-generation GPS delivers is a second civilian GPS signal, known as "L2C," which was specifically designed to enhance the commercial utility of GPS. Under the most likely scenario, the Commerce Department estimates L2C could enable over $5 billion in economic productivity benefits over the next 30 years.[5]

In the area of disaster response and relief, the commercial space-based remote sensing industry has played a vital role in recent years, collecting tens of thousands of square miles of imagery for dissemination to aid workers around the globe.

L2C is just the first of many new civilian upgrades the US government is making to the GPS constellation over the next decade. For example, the US government plans to add a third civil GPS signal that will greatly enhance accuracy, availability, and reliability, especially for safety-critical transportation applications. The aviation community is very interested in the third signal because it will help improve both navigation safety and airspace capacity. Additional signals will also reduce downtime for any business operation that uses GPS where signals are easily dropped, such as under trees. The US is also working with international partners to design a fourth signal that will boost the global availability of space-based PNT, especially in the urban canyons of cities. As these GPS upgrades come online, the importance of space-based PNT to economic, public safety, and other national power interests will continue to increase.

Commercial Remote Sensing

Commercial space-based remote sensing, the collection of Earth imagery from space by private sector firms, is similar to GPS in that it was originally developed for national security purposes, but was eventually released for commercial exploitation in the 1990s due to its economic potential. In April 2003, President Bush authorized a new national policy that establishes guidance and implementation actions for CRS capabilities.[6]

Commercial satellite imagery has a multitude of ground-based applications spanning many sectors of the Nation's economy. Individual farmers and communities use it for precision farming and to monitor crops for disease and deploy localized remedies when needed. Land-use managers use it to assess and plan city growth. Insurance companies use before-and-after imagery to verify damage claims after floods, hurricanes, and other disasters. The media routinely adds satellite imagery to news reports to illustrate where important events have occurred. Software developers incorporate satellite imagery into flight simulators, games, and even wireless handheld devices.

Satellite imagery is most useful when combined with GPS, electronic maps, and localized data into a geographic information system (GIS). Perhaps the most popular example of this is the Google Earth application, which recently made commercial satellite imagery freely available via the Internet. Other examples include Microsoft's Virtual Earth and Yahoo Maps. These mapping portals have brought satellite imagery "down to Earth" and have increased public awareness of space-based imagery.

Commercial satellite imagery also provides significant capabilities to the national security community. Remote sensing is a well-known form of reconnaissance, and the US national security community purchases large quantities of commercial imagery to augment its own intelligence gathering capabilities.

On the civilian side, NOAA utilizes commercial imagery, coupled with data recorded from National Aeronautics and Space Administration (NASA) satellites and used throughout the federal government, academia and industry, to monitor and protect fisheries and habitats and to assess coastlines, coral reefs, wetlands, and glaciers all over the world. Additionally, commercial imagery is also used by human rights groups around the globe to monitor and document events in places such as the Darfur region.

In the area of disaster response and relief, the commercial space-based remote sensing industry has played a vital role in recent years, collecting tens of thousands of square miles of imagery for dissemination to aid workers around the globe. Following the 2004 tsunami in Southeast Asia, the 2005 earthquake in Pakistan, and the hurricanes in the Gulf of Mexico in 2005, commercial satellite imagery was used by the US government and other organizations to assist in damage assessments and rescue relief operations in remote areas that could best be observed by satellites. Commercial satellite imagery is also used to help firefighters navigate wildfires by determining which residents should be evacuated and where emergency personnel should be dispatched.

Total sales for the entire commercial remote sensing industry, including both satellite and aerial imagery, were estimated at $2.6 billion in 2003.[7] According to one leading industry analyst, the space-based segment of that market is worth $300 million today and could exceed $1 billion by 2012. The federal government is also a committed customer of commercial remote sensing. The National Geospatial-Intelligence Agency (NGA) will spend up to $500 million over five years on commercial imagery through the ClearView program, which expedites bulk purchases of imagery from US commercial satellite operators for use by various agencies across the federal government. NGA is also planning on purchasing higher resolution US commercial imagery as part of its NextView program.

The two main companies leading the US commercial remote sensing industry are GeoEye and DigitalGlobe. GeoEye was formed from the recent merger of ORBIMAGE and Space Imaging and operates three satellites and more than a dozen international regional ground stations. GeoEye's annual revenue is about $160 million from commercial imagery products and services. DigitalGlobe currently operates one satellite and three ground stations. Within a year, both companies will launch new commercial imaging systems with far greater capabilities than the current systems on orbit. The enhanced level of accuracy of data derived from these systems will enable new applications and keep US industry at the forefront of the increasingly competitive global market for satellite imagery.

A leading provider of information technology market research stated that overall GIS goods and services revenue totaled $1.84 billion in 2003 and projected a 9.7 percent rise to $2.02 billion in 2004, including many products that do not incorporate commercial satellite imagery.[8] However, like GPS, sales numbers only include their GIS cost and do not include the real benefit of productivity gains realized by customers.

National Oceanic and Atmospheric Administration Civil Space Operations

Just as the US government provides GPS as a public good, it also provides accurate and dependable weather forecasting. NOAA, one of the nation's leaders in environmental space-based systems, commands a fleet of meteorological satellites that are on-duty 24 hours a day to support weather forecasting and prediction services critical to our economic and national interests.

Over 105 million US households rely on NOAA's weather and environment forecasts each day and future planned capabilities will provide significantly improved information to the user community including television meteorologists, private weather companies, aviation and agriculture communities, and national and international government agencies. Additionally, weather and climate sensitive industries account for one-third of the Nation's GDP.[9]

One of the most critical functions of NOAA satellites is to support the nation's weather and climate enterprise. Data from NOAA satellites complement other weather observations, which are essential to ensure NOAA's sophisticated computer models use the most current information to simulate future weather, ocean, and climate conditions.

Total annual federal spending for weather information, including satellite data and information, is estimated at about $25 per household (including aviation and defense, in addition to NOAA). A detailed national survey revealed the average value of all current weather forecast information from public and private sectors is approximately $109 per household, with a total national value of $11.4 billion per year.[10] This survey also showed the annual value of improving the daily forecast in terms of more accurate one-day and multi-day forecasts, geographic detail, and frequency of updates is $16 per household, or $1.73 billion per year. The average value of weather forecast information relative to the total federal spending produces a net national benefit of $8.8 billion a year. This does not include benefits in agriculture, transportation, construction, or benefits to households in other countries that rely on weather information from the US.

In a typical hurricane season, NOAA's forecasts, warnings, and the associated emergency response results in $3 billion savings.[11] Two-thirds of these savings are attributed to the reduction in hurricane-related deaths, and one-third is attributed to a reduction in property-related damage because of preparedness actions.

Advances in satellite information, data assimilation techniques, and more powerful computers to run more sophisticated numerical models have led to more accurate weather forecasts and warnings. Accurate five-day forecasts for hurricanes can provide the time necessary for people to implement plans to secure their lives and businesses. For example, these forecasts can save the offshore oil and gas industry significant amounts of money by helping determine if and when operational systems should be taken off-line. Estimates indicate that the value of existing 48-hour hurricane forecast information to oil and gas producers averaged roughly $8 million per year during the 1990s.[12] These accurate forecasts can also help the fishing industry by providing enough time for fishermen to get their boats and equipment to a safe harbor.

Space weather such as solar flares, solar winds, and electromagnetic disturbances in the atmosphere can disrupt electronic and electrical systems that can impact utility companies, airlines, and telecommunication systems. NOAA's Space Environment Center (SEC) utilizes space-based assets to provide national and international warnings of space weather events that can affect people and business operations. The SEC provides forecasts and warnings of solar and geomagnetic activity to energy companies, the airline industry, the US Department of Transportation, NASA, and military and commercial space system operators. Such warnings are critical to the prevention of economic losses from power grid outages, satellite failures, and other avoidable incidents. Commercial communication satellites are also vulnerable to the effects of space weather. A

The US Integrated Earth Observation System is an essential component of the Global Earth Observation System of Systems (GEOSS), which is a global Earth data collection and dissemination initiative to benefit worldwide stakeholders and decision-makers.

geomagnetic storm in 1994 damaged two Canadian communication satellites, which were replaced at a cost of about $400 million. In addition, in January 1997, a geomagnetic storm severely damaged the US Telstar 401 communication satellite, valued at $200 million, leaving it inoperable.[13]

To address the growing requirements for environmental data on national and global scales, NOAA, NASA, and the Office of Science and Technology Policy are leading the implementation of the *Strategic Plan for the US Integrated Earth Observing System*, through the US Group on Earth Observations. The US Integrated Earth Observation System is an essential component of the Global Earth Observation System of Systems (GEOSS), which is a global Earth data collection and dissemination initiative to benefit worldwide stakeholders and decision-makers. GEOSS will allow users to share, compare, and analyze a diverse array of datasets, providing the information necessary to mitigate the impacts of natural hazards. GEOSS will provide the global information required to understand the interactions between Earth processes and thereby improve the forecasting skills for a wide range of natural phenomena, such as a hurricane in the Atlantic, a typhoon in the western Pacific, and the impact of El Niño throughout the globe. GEOSS will also promote improved decision-making in various sectors, including natural resource management, public health, agriculture and transportation. NOAA's environmental satellite systems and NASA's integrated global Earth system science satellite constellation are among the critical components of the GEOSS initiative.

Conclusion

It is clear that space commerce brings value to our economy and broader national objectives. The contribution of the space-based capabilities such as PNT; CRS; and NOAA's civil space operations are key to our national power and international technological leadership. The future benefits of space to our economy are constrained only by American imagination and creativity. National policy decisions have shaped the evolution of space commerce directly or indirectly since the beginning of the space age. The Office of Space Commercialization (OSC) is working to help shape decisions that encourage space commerce while protecting and advancing the national interest. In that spirit, the OSC is taking a leadership role in ensuring continued federal government support of space commerce to realize its vision: *"A robust and responsive US space industry that is the world leader in commercial space capabilities."*

Notes:

[1] *US National Space Policy,* National Security Presidential Directive (NSPD) 49, US Office of Science and Technology Policy, 31 August 2006, 2, goal 5, www.ostp.gov/html/US%20National%20Space%20Policy.pdf (accessed on 23 January 2007).

[2] Ibid., 6

[3] "US Space-Based Positioning, Navigation, and Timing Policy," NSPD 39, 15 December 2004.

[4] *Satellite Positioning Systems and Devices*, ABIresearch, 2005.

[5] IRV Study reference – GPS or GNSS World?

[6] "US Commercial Remote Sensing Policy," NSPD 27, 25 April 2003.

[7] CRSL Industry Statistics, *Space 2003: Exploring the Future of Space Application* (Organisation for Economic Co-operation and Development - OECD Publishing: London, UK, 2004).

[8] Daratech, Inc., "Worldwide GIS Revenue Forecast to Top $2.02 Billion in 2004, Up 9.7% Over 2003," press release, 19 October 2004, Cambridge, MA.

[9] J. Lazo and L. Chestnut, *Economic Value of Current and Improved Weather Forecasts in the US Household Sector*, report, prepared for NOAA's Chief Economist by Stratus Consulting (Boulder, CO: November 2002).

[10] John A. Dutton, "Opportunities and priorities in a new era for weather and climate services," *Bulletin of the American Meteorological Society* 83, no. 9 (September 2002): 1303-1311.

[11] Minutes of the 55th Interdepartmental Hurricane Conference, Hugh Willoughby, *Costs and Benefits of Hurricane Forecasts*, 5-9 March 2001, Orlando, FL.

[12] Timothy J. Considine et al., The Value Hurricane Forecasts to Oil and Gas Producer in the Gulf of Mexico, *Journal of Applied Meteorology 43*, no. 9 (September 2004) 1270-1281.

[13] Arthur W. Green and William Brown, "Reducing the Risk from Geomagnetic Hazards," fact sheet, USDOI and USGS, 177-97.

Mr. Edward M. Morris (BS, Engineering, Rutgers University; MBA, Business Administration, Pepperdine University) was appointed director, Office of Space Commercialization (OSC), National Oceanic and Atmospheric Administration (NOAA), US Department of Commerce in January 2006. He is also the US government representative and co-chair of the US-European Union Global Positioning System (GPS)-Galileo Working Group on Trade and Civil Applications. Prior to his appointment with NOAA, Mr. Morris worked with Orbital Sciences Corporation from 1991 to 2006. His most recent position was senior director of the Washington, DC Operations, responsible for development and implementation of White House, federal agency, and legislative actions and policies related to military, civil, and commercial space matters, as well as, missile defense and tactical weapons programs. He received the Outstanding Management Award in 2001 for outstanding achievement of key company business development goals. In 1997, he was assigned as Director of Business Development for the Launch Systems Group, primarily responsible for technical and marketing roles for missile defense, international, and classified program new business initiatives. Other Orbital assignments included project management and systems engineering of National Aeronautics and Space Administration (NASA) and commercial launch services valued at $100 million.

Mr. Morris served in the US Air Force from 1982 to 1991 in Space Acquisition, Launch Operations, and Headquarters USAF staff positions. He transferred in 1991 to the US Air Force Reserve and continues to be active in his Reserve duties where he has served in a variety of staff and personnel assignments attaining the rank of colonel. His military honors include the Air Force Meritorious Service Medal, Air Force Commendation Medal, and Air Force Achievement Medal. He is a graduate of Air War College, Air Command and Staff College, and Squadron Officer's School.

The New National Space Policy and Air Force Space Command's Role in International Cooperation

Brig Gen Robert M. Worley II
Director of Strategic Plans, Programs, Analyses, Assessments and Lessons Learned
Air Force Space Command, Peterson AFB, Colorado

Domestic and international media accounts of the new National Security Presidential Directive establishing US National Space Policy could cause the casual observer to believe the US is taking a unilateral, almost gunslinger approach in space with little regard to international considerations. Editorial headlines regarding the policy such as: *America wants it all–life, the Universe and everything; New space policy revolves around US; US turns space into its colony;* and *Toward American 'Space Dominance,'* reinforce a common perception that the US intends to go-it-alone in space.[1] I hold a much different view based on both the policy content and the international nature of many of the operations and activities conducted by Air Force Space Command (AFSPC). International cooperation has been a consistent theme in US space policy for nearly 50 years, and the latest National Space Policy is no exception. In fact, encouraging international cooperation with foreign nations is one of the fundamental goals of the new policy. I submit that AFSPC has practiced the spirit and intent of this aspect of the policy since it was established. After briefly describing the nature of policy in general and providing some information on US space policy in particular, I will provide an overview of the new National Space Policy, and then describe how AFSPC is engaged in international cooperation to collectively provide space effects from a secure space domain in support of joint operations worldwide.

> *"the exploration and use of outer space … shall be carried out for the benefit and in the interests of all countries, irrespective of the degree of their economic or scientific development, and shall be the province of all mankind."* ~ Outer Space Treaty, 1967

Space policy, like all government policy, reflects broad statements of high-level guidance, and exists to articulate national goals and objectives for a particular topic or domain. Policy is typically general in nature and forms a basis for action for subordinate organizations and agencies. International audiences also closely monitor US policy. Our policy shapes international perceptions and communicates messages that affect our international relationships. Policy is also political and can vary based on changes in administration, congressional priorities, political climate and many other factors.

Interestingly, US space policy has been relatively consistent since the days of the Eisenhower administration during which time the decision was made to pursue the peaceful uses of outer space. This thinking greatly shapes how people use space today and how people view space use for tomorrow. The current outer space legal regime recognizes that "the exploration and use of outer space … shall be carried out for the benefit and in the interests of all countries, irrespective of the degree of their economic or scientific development, and shall be the province of all mankind."[2] Moreover, it declares that "outer space … is not subject to national appropriation by claim of sovereignty."[3] It also abides by the rules and decision-making procedures calling for registration of space objects and restrictions on weapons of mass destruction in space.[4] Although the release of the new space policy resulted in some criticism of the US, there is no question in my mind that this country is committed to the existing space legal regime. All actions taken in space by this nation are consistent with US law, regulations, treaties and other agreements to which it is party, as well as applicable international law and US foreign policy.

President Bush signed the new National Space Policy, on 31 August 2006; an act which culminated an extensive review of US policy in this area. The policy replaces the previous one signed by President Clinton in 1996 and is the fifth in a series of space-related policies signed by President Bush in the last four years. These include documents on commercial remote sensing; space exploration; space-based precision, navigation and timing; and space transportation. The new National Space Policy is consistent with past policies. It specifies that the conduct of US space programs will be a top priority and will be guided by certain principles; the first and foremost of which is that "the United States is committed to the exploration and use of outer space by all nations for peaceful purposes, and for the benefit of all humanity."[5] It states that this "peaceful purposes" principle allows "US defense and intelligence-related activities in pursuit of national interests."[6] Another principle listed in the policy is that the US "rejects any claims to sovereignty by any nation over outer space … and rejects any limitations on the fundamental right of the United States to operate in and acquire data from space."[7]

Additionally, the policy is clear that space capabilities, including space segments and supporting links are "vital to its national interests," and that the US will preserve freedom of action in space.[8] It even goes so far to say that, "Freedom of action in space is as important to the United States as air power and sea power."[9] New to this space policy is the mention of homeland security with respect to the stated space policy goals. It specifically calls on the Nation's space leadership to ensure that "space capabilities are available in time to further US national security, homeland security, and foreign policy objectives."[10] This policy also promotes the need for "a robust science and technology base supporting national security, homeland security, and civil space activities."[11] Other goals in the policy include seeking to enable a competitive domestic commercial space sector, unhindered operations in and through space, and increasing the benefits of exploration. The policy also provides general guidelines which address the development of space professionals, improving space system development and procurement, strengthening interagency partnerships, and bolstering US space-related science, technology, and industrial base. The policy goes on to provide more specific guidelines in the areas of national security, civil space, commercial space, space nuclear power, radio frequency spectrum, and orbital debris.

International space cooperation plays a prominent role in the latest National Space Policy. As one of the top three guiding principles, the policy states, "The United States will seek to cooperate with other nations in the peaceful use of outer space to extend the benefits of space, enhance space exploration, and to protect and promote freedom around the world."[12] Additionally, one of the policy's seven stated fundamental goals is to, "Encourage international cooperation with foreign nations and/or consortia on space activities that are of mutual benefit and that further the peaceful exploration and use of space, as well as to advance national security, homeland security, and foreign policy objectives."[13] Finally, there is a separate section dealing exclusively with international space cooperation which encourages cooperation with foreign nations on mutually beneficial activities. Areas in which the policy specifically addresses cooperation include space exploration, providing space surveillance information, as well as developing and operating Earth-observation systems.

Efforts currently underway within the national security space sector, and AFSPC in particular, are consistent with the international cooperation guidelines outlined in the National Space Policy. AFSPC is inherently a global command with personnel and facilities located around the world in the United Kingdom (UK), Greenland, Australia, Germany, Spain, Norway, Diego Garcia, Kwajalein, and Ascension Island to name a few. The agreements we have in place with our international partners go a long way toward fostering understanding and support of the mutual interests and foreign policy objectives of all involved. We have long operated hand-in-hand with Canada under the North American Aerospace Defense Command Agreement in conducting the critical mission of defending North America. This takes the form of, among other things, the integration of Canadian military members into our crew/watch activities in the US, as well as in places like Thule AB, Greenland. As a former base commander at Thule, I speak first hand that there is no substitute for working side-by-side with our allies (in this case both Canada and Denmark) to accomplish an important mission on behalf of our respective countries. Space operations missions are an important part of our relationship with the UK as well, and we likewise exchange military members at various locations within the US and the UK. Additionally, we share close ties with Australia, exchanging military officers and engaging in space operations activities of mutual interest and benefit.

When it comes to providing space data and capabilities to our allies and the broader international community, I believe AFSPC and the Air Force are delivering in a significant way. We provide space surveillance information (specifically called out in the space policy) as the maintainers of the catalog of space objects. Customers around the world, with a validated need to know, have Web access to information from our space surveillance network under the Commercial and Foreign Entities (CFE) program which assists all concerned with exact satellite location information. This information is critical for situational awareness in space and preventing objects from colliding. We also share missile warning data, weather information and intelligence, not to mention the most pervasive US contribution to the international community, free of charge, the positioning, navigation, and timing information provided by the global positioning system. Rounding out this list are AFSPC international cooperative efforts in fielding future military satellite communications systems.

The new National Space Policy recognizes US national security is critically dependent on space capabilities and that this dependence will continue to grow in the future. Given the criticality of space capabilities to the US and our allies, the Air Force, and AFSPC are working diligently to enhance and expand international cooperation in many areas to include using exchange officers in the Joint Space Operations Center

Given the criticality of space capabilities to the United States and our allies, the Air Force, and Air Force Space Command are working diligently to enhance and expand our international cooperation in many areas to include using exchange officers in the Joint Space Operations Center at Vandenberg AFB, California, offering training and education courses from the National Security Space Institute, and expanding opportunities for use of exchange officers in key space organizations.

As a global command with facilities and people located around the world, Air Force Space Command has been actively involved for many years, at many levels in international space cooperation.

at Vandenberg AFB, California, offering training and education courses from the National Security Space Institute, and expanding opportunities for use of exchange officers in key space organizations. Furthermore, AFSPC has an active and longstanding engagement program hosting frequent visits of our command facilities by allied military and civilian leaders from Latin American nations, the Pacific Rim, as well as many North Atlantic Treaty Organization members. These activities are not new. In 1994, I was fortunate to have the opportunity to serve as the Air Force and AFSPC senior representative to a Latin American space symposium organized and hosted by Chile. Additionally, AFSPC has recently hosted dignitaries and staff members from Australia, the Republic of Korea, the UK, and Canada to name just a few. It is through these and other efforts that we are able to foster trust and take initiatives which advance international space cooperation to the benefit of all involved.

Notwithstanding the assessments in some press accounts, the new National Space Policy is not a "go-it-alone" policy. True, it asserts certain rights of freedom of action in space, rejects claims of sovereignty, and reaffirms the long-held tenet that we are committed to the use of space for peaceful purposes for the benefit of all humanity. The policy also recognizes that space capabilities are increasingly vital to US national interests and that to ensure our national security, homeland security, and foreign policy objectives, we must have robust, effective, and efficient space capabilities. To be sure, many US government agencies are working in concert with the principles and goals of the new space policy as it relates to international space cooperation, but AFSPC leads the way in the national security space sector. As a global command with facilities and people located around the world, AFSPC has been actively involved for many years, at many levels in international space cooperation. Now, more than ever, we must continue to build and expand these valued relationships. The security of our Nation and our allies, as well as our position in the international community depend on it.

Notes:

[1] Bronwen Maddox, "America wants it all - life, the Universe and everything," *Times Online,* 19 October 2006, http://www.timesonline.co.uk/article/0,,30809-2410592,00.html (accessed 31 January 2007); Marc Kaufman, "New space policy revolves around US," *San Francisco Chronicle*, 19 October 2006, http://www.sfgate.com/cgi-bin/article.cgi?file=/c/a/2006/10/19/MNGA0LRRTR1.DTL (accessed 31 January 2007); Ehsan Ahrari, "US turns space into its colony," *Asia Times Online,* 20 October 2006, http://www.atimes.com/atimes/Front_Page/HJ20Aa02.html (accessed on 31 January 2007); Michael Moran, "Toward American 'Space Dominance,'" Council on Foreign Relations, 5 December 2006, http://www.cfr.org/publication/12179/toward_american_space_dominance.html?breadcrumb=%2Fbios%2F11490%2F%3Fgroupby%3D0%26page%3D1%26hide%3D1%26id%3D11490 (accessed on 31 January 2007).

[2] Outer Space Treaty (OST), Article I, 1967.

[3] Outer Space Treaty (OST), Article II, 1967.

[4] Outer Space Treaty (OST), Article VII, IV, 1967.

[5] *US National Space Policy,* fact sheet, White House, US Office of Science and Technology Policy, released October 2006, www.ostp.gov/html/US%20National%20Space%20Policy.pdf (accessed on 31 January 2007), 1.

[6] Ibid.

[7] Ibid.

[8] Ibid.

[9] Ibid.

[10] *US National Space Policy,* 2.

[11] Ibid.

[12] Ibid.

[13] Ibid.

Brig Gen Robert M. Worley II (BS, Organizational Behavior, US Air Force Academy; MA, Industrial Psychology, St. Mary's University) has been selected for reassignment as Deputy Director, Programs, Deputy Chief of Staff for Strategic Plans and Programs, Headquarters US Air Force, Washington, DC. Currently General Worley is the Director of Strategic Plans, Programs, Analyses, Assessments and Lessons Learned, Headquarters Air Force Space Command, Peterson AFB, Colorado. He is responsible for programming and advocating resources for the command; planning for the command's force structure, bases and facilities; managing the command's international relations and foreign disclosure programs; and overseeing the command's modeling, simulation, and scientific analysis activities.

General Worley was commissioned through the US Air Force Academy in May 1978. His initial assignment involved test development for the Weighted Airman Promotion System. He was then assigned to the Pentagon as an Air Staff Training officer, and later worked global positioning system phase-in issues and Strategic Defense Initiative architectures and employment concepts. He has served as the director of Operations for the Global Positioning System Squadron during operations Desert Shield and Desert Storm, and then moved to the US Space Command staff working wartime employment issues for satellite systems.

General Worley has commanded the 12th Missile Squadron, 12th Space Warning Squadron, 50th Operations Group, and 30th Space Wing, where he led spacelift operations and directed the Western Test Range at Vandenberg AFB, California. Prior to his current assignment, he was the Director of Mission Support, Headquarters Air Force Space Command, where he advised the commander on all matters relating to civil engineering, services, personnel, public affairs, history, chaplain services, and contracting support.

General Worley has been awarded the Legion of Merit with oak leaf cluster, Defense Meritorious Service Medal, Meritorious Service Medal with three oak leaf clusters, Air Force Commendation Medal and Air Force Achievement Medal with oak leaf cluster. The General is also a graduate of Squadron Officer School, Air Command and Staff College, and Air War College.

Human Space Flight and National Power

Dr. John M. Logsdon
Director, Space Policy Institute
The George Washington University

At great expense, the United States has developed the capability to launch people in to space, and in the past 45 years sent 290 different men and women into orbit and beyond, some of them several times. There are many reasons for carrying out such a sustained program of human space flight. This article focuses on one particular rationale: the assertion that human space flight contributes significantly to US spacepower, and through it, to US power overall.[1]

As used here, *power* is defined as "the ability to effect the outcomes you want, and if necessary, to change the behavior of others to make this happen." Harvard Professor Joseph Nye identifies three types of national power: **military power**, the ability to threaten the use of, and use if necessary, force; **economic power**, the ability to influence the operation of the global market in ways that advance one's national interests; and **soft power**, the ability of a country to "obtain the outcomes it wants in world politics because other countries want to follow it, admiring its values, emulating its example, aspiring to its level of prosperity and openness."[2] Does human space flight contribute to one or more of these types of national power?

Human Space Flight and Military Power

Since the very start of the space age in 1957—indeed even before—the US military has been seeking to demonstrate to government leaders that having military crews operating in orbit can contribute to US military power. From the visionary proposals of General Bernard A. Schriever during the 1950s for a major US Air Force role in space, through the cancellation of the Manned Orbital Laboratory (MOL) program in 1969, there were many suggestions for human space flight activities under dedicated military auspices. Both the Dynasor X-20 program and the MOL program got close to flight testing. Ultimately the lack of a clearly defined mission that could not be performed either more cheaply or more effectively by other means doomed these programs.[3]

From 1971 to 1986, military planning for human space flight focused on the Space Shuttle, to be operated by the National Aeronautics and Space Administration (NASA) but to be used by the national security community as its sole means of access to space once declared operational, which happened in 1982.[4] A number of military officers trained as Shuttle pilots and mission specialists, national security payloads were redesigned so that they could take advantage of the Shuttle's capabilities for orbital operations, and dedicated military and national security missions, some of them at high classification levels, were carried out, with more in the planning stage. The US Air Force bore the high costs of a Shuttle launch facility at Vandenberg AFB, California to be used for missions into polar orbit. Even the Under Secretary of the Air Force, E. C. "Pete" Aldridge, trained to be an astronaut aboard the first launch from the Vandenberg facility. On 1 August 1985, Pete Aldridge issued the following guidance:

> The Air Force has been examining the potential role of military man in space for over two decades. Thus far, our military space missions have not required man's presence in space. Thus, there has not been an identified role for the military man in space. However, with the advent of the space shuttle and man's routine presence in space, there is a greater opportunity to exploit man's unique capabilities. Accordingly, the following policy should be used in the planning of future space systems by the Air Force: "The Air Force policy is to ensure that the unique capabilities that can be derived from the presence of military man in space shall be utilized to the extent feasible and practical to enhance existing and future missions in the interest of national security objectives."[5]

This guidance quickly became obsolete. Among the many myths that was punctured by the 28 January 1986 *Challenger* accident was the notion that the Space Shuttle could be an affordable and routine means of conducting national security operations in space. By the start of 1987, Department of Defense (DoD) planning for future uses of the Space Shuttle had ceased (although several previously planned national security missions were carried out once the Shuttle returned to flight in 1988), and the US Air Force reactivated its production lines for the Delta and Titan expendable launch vehicles. (The production of what became the Titan IV launcher had been authorized in 1985 as a backup to the Shuttle for the most critical national security payloads.)

The unfortunate experience of the DoD in becoming dependent on what was in essence an experimental system, controlled by a civilian agency, did not completely dampen military interest in human space flight. The DoD for a few years beginning in 1986 became with NASA a co-funder of the National Aerospace Plane, a technology development effort aimed at a system that could fly directly into orbit after a runway takeoff. When the program ran into significant technological hurdles, the DoD withdrew from the effort.

The Titan IV was developed to provide assured capability to launch space shuttle-class payloads for the Air Force.

Over the past 15 years, there have been sporadic expressions of military interest in developing dedicated systems for human space flight.[6] Research and some development, but at a relatively modest level of funding, continue, and there are advocates for human space flight within the military services and the defense research establishment. It is fair to conclude, however, that the 50-year quest to demonstrate the contribution of human space flight to US military power has not borne fruit.

Human Space Flight and Economic Power

There are few students of the US space program who would argue that human space flight has had to date direct payoffs in terms of US economic power vis-à-vis the other countries of the world. To the degree that the skills and technologies developed for human space flight programs have strengthened the US high technology industrial base, they indeed may have added to US economic power, but this is at best an indirect benefit. There are indeed those who would argue that the hundreds of billions of dollars spent to date on human space flight by the United States has had a significant opportunity cost in terms of diverting those funds away from other, more economically productive sectors.

This assessment *could* change in the future if, as some predict, public space travel, more colloquially known as space tourism, becomes an economic success. There are predictions that public space travel could become a multi-billion dollar annual business.

The United States is in the lead in developing, through privately-funded efforts, the systems that might make travel to orbit and even beyond affordable enough and safe enough to create a business akin to today's commercial air travel. Just as US manufacturers for most of the time since scheduled air travel began have dominated the passenger aircraft market, thereby being a major contributor to the US balance of trade and economic strength, one could speculate that the equipment for commercial space travel could be an important segment of the US economy at some point in the future, especially if it is developed in such a way to also favor US operators using US equipment to offer the service.

Human Space Flight and Soft Power

What the above analysis suggests is that if human space flight has made, and will continue to make, a significant contribution to US national power, that contribution will come in the form of "soft power."

That this could be the case has been recognized from the start of the US human space flight program. For example, the first comprehensive statement of US space policy, approved by President Dwight D. Eisenhower in January 1960, declared, "To the layman, manned space flight and exploration will represent the true conquest of outer space. No unmanned experiment can substitute for manned exploration in its psychological effect on the peoples of the world."[7] The May 1961 DoD memorandum suggesting to President John F. Kennedy that he set a manned lunar landing as a national goal noted that "Dramatic achievements in space … symbolize the technological power and organizing capabilities of a nation," that "This nation needs to make a positive decision to pursue space projects aimed at national prestige. Our attainments are a major element in the international competition between the Soviet system and our own. … 'civilian' projects such as lunar and planetary exploration are, in this sense, part of the battle along the fluid front of the cold war," that "such undertakings may affect our military strength only indirectly if at all, but they have an increasing effect on our national posture," and that "It is man, not machines, that captures the imagination of the world."[8]

The case for the soft power payoffs from human space flight may have most clearly and pungently been stated by former Secretary of Defense Caspar Weinberger, who in 1971 was deputy director of the Office of Management and Budget (OMB). Writing to President Richard M. Nixon about recommendations of the OMB staff to cancel the two remaining Apollo flights and to not approve Space Shuttle development decision which would have had the effect of ending the US human space flight program, Weinberger suggested:

> Recent Apollo flights have been very successful from all points of view. Most important is the fact that they give the American people a much needed lift in spirit, (and the people of the world an equally needed look at American superiority). [Canceling Apollo 16 and 17 and not approving Shuttle development] would be confirming in some respects a belief that I fear is gaining credence at home and abroad: That our best years are behind us, that we are turning inward, reducing our defense commitments, and voluntarily starting to give up our super-power status, and our desire to maintain world superiority.[9]

Twelve years later, NASA made much the same argument in the briefing to President Ronald W. Reagan which asked him to approve the development of a space station, saying that "The presence of man is the key to leadership in space."[10]

Unfortunately, neither the Space Shuttle nor the International Space Station (ISS) programs have lived up to their promised performance, and thus it is a fair question to ask whether human space flight as carried out by NASA over the past quarter century has been a significant contributor to US soft power. The recent contribution of human spaceflight to US national prestige is uncertain, particularly given the uneven record of the international partnership on the ISS. However, the ability to carry non-US astronauts on the space shuttle is a useful foreign policy tool.

Even so, space achievements involving direct human presence remain a potent source of national pride, and that such pride is the primary underpinning reason why the US public continues to support human spaceflight. Certainly, space images—an American astronaut on the Moon, a Space Shuttle launch—rank only below the American flag and the bald eagle as patriotic sym-

International Space Station (ISS) photographed following separation from the Space Shuttle Discovery, 19 December 2006.

bols, and such patriotism is a foundation of US soft (and hard) power. The self-image of the United States as a successful nation is threatened when we fail in our space efforts, and catastrophes such as *Challenger* and *Columbia* seem to tap deep emotions.

Space Exploration and National Power

President George W. Bush announced a new US "Vision for Space Exploration" on 14 January 2004; that vision aims at "a sustained and affordable human and robotic partnership to explore the solar system and beyond," with an initial human return to the Moon and the human missions to Mars. The fundamental goal of the vision is "to advance US scientific, *security*, and economic objectives." [emphasis added][11] In what ways can human exploration of the Moon, Mars, and beyond contribute to space power, and thus to national security?

This question has been eloquently addressed by the current NASA administrator, Dr. Michael D. Griffin: "The most enlightened, yet least discussed, aspect of national security involves being the kind of nation and, doing the kinds of things, that inspire others to want to cooperate as allies and partners rather than to be adversaries. And in my opinion, this is NASA's greatest contribution to our Nation's future in the world." He added,

> Today, and yet not for much longer, America's ability to lead a robust program of human and robotic exploration sets us above and apart from all others. It offers the perfect venue for leadership in an alliance of great nations, and provides the perfect opportunity to bind others to us as partners in the pursuit of common dreams. And if we are a nation joined with others in pursuit of such goals, all will be less likely to pursue conflict in other arenas.

Griffin went even further in his analysis: "Imagine if you will a world of some future time—whether it be 2020 or 2040 or whenever—when some other nations or alliances are capable of reaching and exploring the Moon, or voyaging to Mars, and the United States cannot and does not. Is it even conceivable that in such a world America would still be regarded as a leader among nations, never mind *the* leader?" He asked "Are we willing to accept those consequences?"[12]

These remarks have been quoted at some length because they sum up the core argument of this essay—that human space flight, well conceived and well executed, is a valuable source of soft power for the United States. Whether or not direct military or economic benefits flow from having the ability to send people to orbit and beyond, human space flight will continue to make an important contribution to having the rest of the world see the United States as a great country.

Notes:

[1] This article is based on a presentation to the National Defense University Spacepower Theory Group on 11 August 2006.

[2] Joseph S. Nye, Jr., *The Paradox of American Power: Why the World's Only Superpower Can't Go It Alone* (Oxford: Oxford University Press, 2002), 4-9.

[3] See David N. Spires, *Beyond Horizons: A Half Century of Air Force Space Leadership* (Washington, DC: Air Force Space Command in association with Air University Press, 1998) for an account of US Air Force aspirations with respect to human space flight.

[4] By contrast, the Department of Defense was opposed to NASA's 1982-1983 plans to develop a space station, fearing that such a development would distract NASA from Shuttle operations.

[5] E.C. Aldridge, to the vice chief of staff, USAF, from the Office of the Under Secretary, memorandum, "Air Force Policy on Military Man-In-Space – INFORMATION," 1 August 1985.

[6] See, for example, John Tirpak, "In Search of Spaceplanes," *Air Force Magazine,* December 2003.

[7] National Aeronautics and Space Council, "US Policy on Outer Space," 26 January 1960, reprinted in John M. Logsdon et al., *Exploring the Unknown: Selected Documents in the History of the US Civil Space Program, Volume I, Organizing for Exploration* (Washington: NASA Special Publication 4407, 1995), 365.

[8] James E. Webb and Robert McNamara, for the vice president, memorandum, "Recommendations for the National Space Program: Changes, Policies, Goals," 8 May 1961, reprinted in *Exploring the Unknown*, 444, 446.

[9] Caspar Weinberger, for the president, "Future of NASA," memorandum, 12 August 1971, reprinted in *Exploring the Unknown*, 547.

[10] NASA, "Revised Talking Points for the Space Station Presentation to the President and Cabinet Council," 30 November 1983, with the attached "Presentation on the Space Station," 1 December 1983, reprinted in *Exploring the Unknown*, 597.

[11] The White House, "A Renewed Spirit of Discovery: The President's Vision for US Space Exploration," January 2004.

[12] Michael Griffin, National Space Symposium, remarks, 6 April 2006, http://www.nasa.gov/pdf/146291main_NationalSpaceSymposium_new.pdf (accessed 24 January 2007).

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Dr. Logsdon is the author of *The Decision to Go to the Moon: Project Apollo and the National Interest* and is general editor of the eight-volume series *Exploring the Unknown: Selected Documents in the History of the US Civil Space Program.* He has written numerous articles and reports on space policy and history. He is frequently consulted by the electronic and print media for his views on space issues.

Dr. Logsdon is a member of the NASA Advisory Council and of the Commercial Space Transportation Advisory Committee of the Department of Transportation. In 2003, he served as a member of the Columbia Accident Investigation Board. He is a recipient of the NASA Distinguished Public Service and Public Service Medals, the 2005 John F. Kennedy Award from the American Astronautical Society, and the 2006 Barry Goldwater Space Educator Award of the American Institute of Aeronautics and Astronautics. He is a fellow of the American Institute of Aeronautics and Astronautics and the American Association for the Advancement of Science. He is a member of the International Academy of Astronautics.

Protecting America's Freedom of Action in Space

Mr. Marc J. Berkowitz
Former Assistant Deputy Under Secretary of Defense for Space Policy

After several years of interagency deliberations, President George W. Bush signed a new National Space Policy on 31 August 2006 to guide the conduct of United States activities in outer space.[1] Despite slight differences in tone and emphasis, the new policy statement remains largely consistent with its predecessors. Since President Dwight D. Eisenhower promulgated the first US space policy, every president has reaffirmed the fundamental principle of the "freedom of space."[2] As a matter of national policy, US space systems are sovereign property with the right of passage through and operations in space without interference.[3]

The preservation of this right will be *the* space policy issue for the US in the coming years. The medium of outer space is becoming a significantly more complicated operating environment. There is a clear trend toward challenges to the freedom of space. This trend is evidenced by the increasing prevalence of foreign efforts to interfere with satellite operations. For example, Iraq jammed US satellite positioning, navigation, and timing signals in 2002, Libya and Iran interfered with international communications satellite transmissions in 2005, and China apparently lased a US imaging reconnaissance satellite in 2006.[4] After China's successful test of a direct ascent anti-satellite (ASAT) weapon in January 2007,[5] there should be no failure of imagination in foreseeing threats to US interests in space.

In 2001, the Commission to Assess US National Security Space Management and Organization observed that "the threat to the US and its allies in and from space does not command the attention it merits from the departments and agencies of the US Government charged with national security responsibilities."[6] It went on to state "the question is whether the US will be wise enough to act responsibly and soon enough to reduce US space vulnerability."[7] The Commission underscored this point with the statement that "we are on notice, but have not noticed."[8]

The US national security establishment must notice and undertake preparations to preserve our freedom of action in space. This article addresses the policy rationale for space defense capabilities and the range of options available to ensure the survivability and operational continuity of critical space missions. It examines how to dissuade and deter those who might seek to impede our uses of space, protect US and allied space capabilities in the event deterrence fails, and respond to hostile interference with US interests in space.

Space Defense Imperative

The US is the world's leader in the exploration and use of outer space. America has leveraged this asymmetric advantage to enhance our international prestige, economic well-being, and national security. Space activities are indelibly woven into the socioeconomic fabric of the nation. While transparent to many Americans, space is imbedded in financial, energy, transportation, telecommunications, entertainment, and emergency services central to our daily lives. Moreover, space systems are now integral to the American way of war. They provide global command, control, communications, intelligence, surveillance, and reconnaissance (C3ISR) support for all phases of military operations, from mission planning to execution.

Indeed, the reliance of US combatant commanders and military forces upon the global capabilities provided by space systems has never been greater. The data collected, generated, and relayed by our defense and intelligence satellite systems, as well as civil and commercial satellites used to augment national security assets, are crucial for deterrence and warfighting. Space systems enable the knowledge necessary to maintain military preparedness, implement joint operational concepts, and support the planning and conduct of military operations across the conflict spectrum. US national security satellite systems are now critical to the decision superiority of our armed forces. They are part of the glue that holds together US defense strategy. Disruption or loss of critical space mission capabilities thus would substantially decrease our combat effectiveness and increase the risks and costs of military operations.

In the post-Cold War period, the threats posed to our satellite systems were expected to diminish with the dissolution of the Soviet Union. This outlook affected decisions regarding the modernization of our defense and intelligence space capabilities. Opportunities for improved mission protection were traded-off to reduce costs and/or improve performance. In addition, collection and analysis of potential threats to our space assets lacked priority in the competition for resources.

America's national security space program is now at a historic crossroads. We are in the midst of recapitalizing nearly our entire space force structure. Concurrently, the operational environment we must confront is dramatically more difficult than expected. It may not be a choice for US policy-makers to decide whether or not space will be made a battlefield; that decision could be made by an adversary. Indeed, the threshold for an attack has decreased since the end of the Cold War because conflict in space is no longer closely linked to concerns about igniting the powder trail to global thermonuclear war.

The ability to hold US space capabilities at risk or negate them is no longer solely the province of major powers. Access to space is less expensive and more widely available than ever before. Unfortunately, knowledge of our space systems has been compromised by foreign espionage, media disclosures, and our own diplomatic demarches. Amateur astronomers track US government and commercial satellites and post their orbits on the Internet.

Many nations and sub-national groups can develop weapons systems to impede America's right of passage through space. The means to attack the ground segments and supporting critical infrastructure of our satellite systems remains present, while the global diffusion of dual-use radio and laser technology that could be used to interfere with our assets on-orbit is worrisome. Moreover, the continuing proliferation of nuclear weapon and ballistic missile technology is increasing the probability of a nuclear detonation in space.

> *The United States will view purposeful interference with its space systems as an infringement on its rights … and will dissuade or deter others from either impeding those rights or developing capabilities intended to do so.* ~ US National Space Policy, 2006

America is more dependent upon its space capabilities than any other nation or sub-national group. Our dependence upon vulnerable satellite systems is provocative. Adversaries must be expected to understand the importance of space assets to the US. One of the lessons relearned from recent military operations obviously was the value of our space capabilities for warfighting. This lesson undoubtedly will be acted upon by our foes.

Operation Iraqi Freedom should be a wake up call for the US national security community. In contrast to the 1991 Gulf War, enemy forces attempted to challenge our use of space to enhance the combat effectiveness of coalition military operations. Although Iraqi efforts to jam global positioning satellites' (GPS') signals employed by our weapons platforms and munitions for the delivery of precision strikes did not succeed, it would be imprudent to conclude future enemies will not attempt to neutralize our space capabilities.[9]

History shows that no other medium has ever remained a sanctuary from armed conflict once it was exploited for national security purposes. During crisis or conflict, adversaries may target America's space assets as an asymmetric means of countering US military operational effectiveness, intelligence capabilities, economic vitality, or political will. They may attack our space systems as symbols of our military and economic prowess to reduce our international status as a global superpower. We should expect that America's freedom of action in space will be forcibly challenged. One of the most important policy choices facing American decision-makers is whether or not the US will have the capabilities to defend effectively its national interests in space.

Deterrence and Dissuasion

During the Cold War, the US grand strategy of "Containment" was underpinned by nuclear deterrence. America successfully relied upon the threat of nuclear retaliation against the USSR's political leadership, armed forces, and society to help deter the expansion of Soviet power and influence through aggression. National security satellite systems played a central role in helping policy-makers manage the exigencies of the American-Soviet confrontation.

The US was confronted by a closed Soviet system, enforced by a coercive control structure, which denied access to information about the intentions of its political leadership and the capabilities of their armed forces. The National Reconnaissance Office was established as a covert organization to develop and operate satellites that could help to pierce that veil of secrecy. US national security space assets were primarily oriented towards peacetime support of the president and preparation of our strategic war plan. Civil and commercial space assets were not relied upon for national security missions. With some exceptions, defense and intelligence satellite systems were not expected to survive very far beyond the onset of nuclear hostilities. The umbrella of nuclear deterrence was relied upon to extend protection to US space systems and reassure allies about the reliability of our defense commitments.

America continues to rely upon deterrence to protect US freedom of action in space. The National Space Policy states "the United States will view purposeful interference with its space systems as an infringement on its rights … and will dissuade or deter others from either impeding those rights or developing capabilities intended to do so."[10] Moreover, Defense Space Policy states "the US may take all appropriate self-defense measures, including, if directed by the National Command Authorities the use of force, to respond to such an infringement on US rights."[11]

The utility of deterrence with respect to space activities should not be considered in the narrow context of war or peace in the medium of space. Despite limited war theories and the notion of establishing a "space threshold" to deter or isolate conflict in the space environment, the pertinent issue is war or peace—not war or peace in space. Whether or not an adversary could be dissuaded from fighting in space and deterrence could function to protect space systems will depend upon the stakes of the conflict and the enemy's assessment of the risks of escalation.

Establishing the necessary conditions for deterrence to work, of course, will be dependent upon the specific adversary. Deterrence works in the minds of those we seek to deter. Deterrence should work when the threatened consequences are believed by the adversary to be proportionate to the interests at stake. The costs of aggression must be seen by the adversary to outweigh the risks. Threats of punishment or denial must be credible to ensure the consequence.

Given that America's potential adversaries may include near-peer nation states, rogue states with weapons of mass destruction, and transnational terrorist groups, the threat of nuclear retaliation may not be a credible means of establishing deterrence. The new US strategic Triad, comprised of nuclear as well as non-nuclear (kinetic and non-kinetic) capabilities, gives defense planners a broader set of tools for creating strategic effects that can be tailored for specific adversaries. Increased flexibility in the design and conduct of military campaigns provides a more credible basis upon which to base deterrent threats. It also gives policy-makers an expanded set of options.

Deterrence will not work, however, if the US fails to convince the adversary (or the adversary misunderstands) that it is committed to the protection of our vital interests. Given the current asymmetry of space dependence between the US and prospective adversaries, this will be a challenge if the US does not reduce the vulnerability of its space assets. It must be noted, of course, that it is also possible for a madman, religious fanatic, or terrorist to be beyond deterrence. Consequently, while deterrence could contribute to the survivability of US space systems, it would be imprudent to rely upon deterrence alone as the means to achieve mission protection. Rather, passive and active defenses are also essential to ensure the resilience and endurance of space assets in the event of conflict.

Passive and Active Defenses

While impregnable defenses have never been built, defenses will succeed if they limit damage and permit US space systems to perform their intended missions. The scope of the space mission protection challenge is determined by national policy and strategy. National policy establishes the ends we seek to achieve. National strategy determines the nexus of those ends and the means to achieve them. The specific ends (e.g., deter an attack on Taiwan, defeat and punish Iranian aggression) establish what is required, how much is needed, and for how long, of our national security space systems. Defenses must be sufficiently effective to allow critical US space assets to operate for the time span relevant to the defense, intelligence, or homeland security missions they support.

Surprise attack in space is a real possibility and it must be recognized that an enemy may attempt a clandestine or covert attack. Defenses will work if they withstand, delay or disrupt an attack, or compel the attacker to expend a disproportionate amount of scarce resources. In particular, defenses must be constructed to preclude a prompt, "cheap shot" that would have a significant adverse impact on strategic effectiveness.

The objective for the US should not be the design of invulnerable space systems. Rather, the requirement should be to design space systems—not individual orbital platforms—to ensure the graceful degradation of the overall system commensurate with the forces it is supporting for mission survivability. Space systems, of course, are comprised of launch, ground control, communications, processing, and orbital elements. While each segment poses different opportunities and challenges for attack and protection, the system will only be as resilient as its weakest segment.

There is of course a broad array of potential passive measures for enhancing space system survivability. Indeed, there are architectural countermeasures for dealing with the range of prospective threats to deceive, disrupt, deny, degrade, or destroy space assets. Some measures obviously will be militarily infeasible or prohibitively expensive. However, the US is not without the benefit of operational experience or the technological and industrial competence to create a space force structure capable of mitigating attack.

When confronted by a Soviet adversary with the capability and intention to deny use of space in wartime, the US relied upon a variety of passive defense measures to ensure that critical defense and intelligence space assets were sufficiently robust to protect our national interests. While the national reconnaissance program primarily relied upon security measures to maintain the covertness of vital imaging and signals intelligence assets, the defense space program expended considerable resources to protect space-based strategic forces C3ISR assets such as Milstar and GPS through hardening, redundancy, proliferation, autonomy, variety of orbital planes, warning sensors, and other passive measures.

In particular, the US must be prepared to deal with the consequences of surprise and attrition of critical space assets in a deep crisis. Similarly, we must be prepared for a sudden threat surge against space-based strategic forces C3ISR systems during nonnuclear hostilities and a multi-weapon space control campaign during a regional or global conflict. Decision-makers must determine how to mitigate susceptibilities, eliminate single point failures, prioritize the allocation of protection efforts, and field the appropriate mix of survival aids for critical missions.

The timing for decisions on survivability enhancements to critical US space systems is propitious. Much of the space force structure is in transition with either new system starts or block upgrades. The legacy of these decisions will remain with us for at least the next few decades as those systems are fielded, conduct operations, and fly out.

Given that the offense is probably the stronger form of warfare in space and absolute survivability is impossible, the potential contributions of active defense measures for space mission protection also must be considered. Future US space architectures may need to be capable of some form of self-defense or defense by escort space vehicles. Space control weapons systems should be examined for their utility in defensive satellite roles against certain classes of anti-satellite weapon (ASAT) threats such as co-orbital interceptors, space mines, or other systems with kill mechanisms that require proximity.

Indeed, the survivability of US space assets clearly would benefit from a broader counterforce mission for active space defense, that is, neutralization of an adversary's space control force structure. The ease of targeting an enemy's arsenal of ASAT systems, however, would depend among other things upon the scale and diversity of the weapons inventory. While similar targeting challenges would also apply to countering an enemy's space weapons-related command and control (C2), the high-leverage results if such countermeasures are feasible are obvious. Perhaps the greatest payoff in terms of space system defense would be provided by suppression of an enemy's space object surveillance and identification capabilities for space control targeting. US efforts to maintain effective space mission capabilities in the event of conflict could only be enhanced if such suppression denied the enemy knowledge of satellite launches, orbital paths, and maneuvers.

Space control weapons may not function perfectly in a defensive satellite role. Such capabilities clearly would not be able to protect every element of critical US government and commercial space systems. Their importance for helping to secure unhindered passage for US and allied on-orbit assets, however, should not be overlooked. The US has invested billions of dollars in space and related assets. Defending the space lines of communications is critically important for the conduct of military operations, execution of national policy, and global commerce. Not to field capabilities to protect the freedom of space would be the equivalent of a major maritime nation deciding to forego deploying a navy.

Arms Control

As a leading space-faring nation, US diplomacy and operating behavior (by establishing precedents for customary international law) helped to shape the extant outer space international legal regime. The US is party to bilateral and multilateral treaties and agreements that place prohibitions and limitations on the conduct of certain types of military activities in space. This includes, for example, prohibitions on the deployment of weapons of mass destruction in orbit, detonation of nuclear weapons in space, and interference with the "national technical means" used to verify strategic arms reduction treaties.

For several decades, US administrations determined that additional space arms control measures would not be verifiable, equitable, effective, or compatible with the nation's security interests. Both the Clinton and Bush administrations asserted that there is no need for such measures because there is no arms race in space and the current body of international law governing space activities is adequate. Nonetheless, some foreign governments, members of Congress, and the extra-governmental arms control community continue to advocate new negotiations. Russia, China, France, and Canada, for example, have proposed new space arms control measures in the United Nations.[12]

Space arms control advocates have proposed measures for restricting ASAT deployment, testing, and use, as well as collateral measures for regulating space activities more generally. Restrictions on deployment could be either comprehensive or limited. The objective of a comprehensive deployment ban would be to eliminate all ASAT capabilities, while a limited deployment ban would aim to restrict the deployment of specific types (e.g., kinetic energy), numbers, or locations (e.g., space-based) of such weapons. A "no-new-types" agreement, restricting the parties to existing (i.e., ground-based kinetic energy) weapon systems, is an example of a limited deployment regime.

The basic objective of proposals for restrictions on testing is to undermine confidence in the ability of the weapon to execute its mission. The logic behind such proposals is that uncertainty about weapons reliability would arise without regular testing. Like ASAT deployment restrictions, testing restrictions could be either comprehensive or limited. The most comprehensive restriction would ban all "testing in an ASAT mode." This tends to be defined as testing against an object in space. More limited testing restrictions would limit the type, frequency, or location of tests. A high-altitude test ban is an example of a limited test regime. In addition, restrictions on the use of ASAT capabilities would prohibit hostile acts against satellites. The purpose of a "no-use" agreement would be to establish an ASAT attack as an unambiguous threshold providing warning or further hostile intentions.

Rather than placing constraints on ASAT testing, deployment, and use, proposals for collateral measures would build on the body of international laws regulating the orderly use of space. For example, so-called "rules-of-the-road" agreements would specify certain rules for space operations or orbits. Detailed rules for minimum separation distances between satellites would establish "keep-out zones" in space. The main objective of such measures is to reduce the prospect of operational misunderstandings arising from instances where apparently provocative or threatening actions are observed but not readily explained. They also could be constructed to improve verification and increase the effectiveness of unilateral survivability measures.

Placing controls on dedicated ASAT weapons would not eliminate the threat posed to US space systems. Such arms control measures are flawed by problems of definition, commonality between civilian and military technologies, information disclosure, verification, and enforcement. Controls on dedicated ASAT weapons would not eliminate the threat posed by non-dedicated systems (e.g., modified ballistic missiles or space launch vehicles, exo-atmospheric ballistic missile defense interceptors, electronic warfare systems, maneuvering spacecraft, etc.) to US space systems. Even a treaty banning ASAT testing, deployment, and use would not ensure the survivability of the space systems' launch, communications, processing, and ground segments. Such arms control measures simply could not substitute for unilateral survivability measures.

Moreover, such arms control would not constrain the threat posed by an adversary's use of space systems for purposes hostile to US national interests. Indeed, controlling ASAT weapons while permitting space-based force enhancement assets to run free would ensure a sanctuary for an enemy's "gun sights" in space. Space systems which support hostile operations against the US homeland and military forces should be placed at risk.

Nonetheless, certain collateral arms control measures might complement active defense. A rules-of-the-road agreement that establishes "keep-out zones" in space could make intruders unambiguously subject to direct attack. Such an agreement might facilitate defense against surprise attack with some types of space mines and other forms of kinetic energy weapons. It would have no utility, however, with respect to protecting US space systems against weapons with radio-frequency or directed energy kill mechanisms that project over longer distances.

Response Planning

Before considering how to respond to deliberate interference with America's freedom of action in space, it is necessary to contemplate whether we would even *know* if we were attacked. Space systems are complex and anomalies caused by technical malfunctions and space weather phenomena are a reality. It is conceivable that an adversary might seek to make its strike against our space assets as ambiguous as possible to mask its origin. National policy-makers will expect the commander of US Strategic Command and the commander of the Joint Functional Component Command for Space to be able to detect, characterize, and attribute if US or friendly space assets are under attack.

Indeed, consistent with the laws of armed conflict and standing rules of engagement, the necessary prerequisite to justify taking any military action in self-defense is the determination of hostile act or hostile intent. Military commanders have the inherent right and obligation to use all necessary means, consistent with the requirements for necessity and proportionality, to protect their units from hostile acts or demonstrations of hostile intent. The authority to conduct some types of defensive actions for national or collective self-defense, however, may be reserved by the president and secretary of defense because of their political sensitivity or strategic significance.

Policy-makers will want answers to a series of questions in order to help comprehend the situation and authorize responses to an attack on a US space asset. Military commanders and defense planners should expect, among other things, to be asked: *Who* committed the hostile act or demonstrated hostile intent? *What* is the nature of the attack? *What* are the consequences? *When* will we recover disrupted or lost capability? *Where* did the attack originate? *How* conclusive is the evidence of an attack? *Why* did the attack happen—what is the purpose of the attack?

The ability to make a determination of hostile act or intent and answer such questions, of course, will depend upon US intelligence, surveillance, and reconnaissance (ISR) capabilities for space situational awareness (SSA). The transition from space surveillance to a more capable SSA should lead the intelligence community and force providers to deliver enhanced capabilities for indications and warning (I&W), attack reporting, ISR and targeting support for space operations, and space environmental monitoring. Improved ISR is, of course, fundamental to strengthening our SSA capabilities, enhancing I&W, and being able to attribute the source of an attack. The lack of improved SSA for characterization and attribution will constrain policy and operational responses.

Similarly, the ability of US military commanders to address space threats with speed, precision, and confidence will depend upon our space C2 capabilities. Smart, agile, and responsive space C2 is essential for the US to predict and assess the effectiveness of its space assets, develop courses of action, and react to developing situations. The establishment of the Joint Space Operations Center at Vandenberg AFB, California, as the focal point for space C2 is a key step toward providing the robust and persistent shared SSA required for the planning and execution of joint regional or strategic operations to defend US freedom of action in space.

Given that doing nothing in the face of enemy aggression in space is not an attractive option, and diplomatic demarches and economic sanctions may not achieve the desired results, national security planners must be prepared in advance with a range of options for the impending contingency of responding to hostile interference with US interests in space. The tailoring of responses involving military activities must take into account the possibility that the adversary may not own or operate spacecraft or find a tat-for-tat response sufficiently compelling to change its behavior. Deterring additional strikes and disarming the enemy's ability to inflict further damage on critical US space assets should take priority.

Countering the enemy's space control weapons, C2, and targeting, as noted above, will be important approaches to achieving such a counterforce mission objective. It is important to recognize, however, this most likely would entail extending the geographic scope of the conflict. Operations planners should expect that concerns about the escalatory risks of conducting attacks against targets within the adversary's homeland might lead to political constraints on offensive responses in some contingencies. National decision-makers will be concerned about discrimination and restraint in the use of force. In particular, the president and secretary of defense could be averse to authorizing strikes against ground-based laser or direct ascent ASAT sites on the soil of a nuclear armed opponent in retaliation for an attack on a US satellite because it could entail the risk of a nuclear attack on North America.

Should concerns about a nuclear firebreak be given greater weight than the homeland threshold in planning response options? Will the adversary's political leadership expect their homeland to remain a sanctuary once they have initiated non-kinetic or kinetic strikes against US sovereign property? How serious are the escalatory risks of crossing the homeland threshold with a non-kinetic response? The US national security policy and operational communities will have to address these and many other difficult questions in the years ahead to plan adequately for the protection of America's freedom of action in space. It is clear, however, that policy-makers can expect to face decisions about the types of effective actions they are willing to authorize in order to deter or neutralize the effect of an adversary's space campaign.

The idea that America cannot afford to fight for its right of passage through space because it has the most to lose if the medium becomes a battlefield is specious. Policy-makers should be willing to take risks of escalation to respond appropriately to an enemy's campaign to interfere with our space operations. If not made aware of the stakes and implications of inaction, it should be recognized that the American leadership and public might be insensitive to hostile interference with satellite operations that does not involve the direct loss of life. Consequently, informed decision-making will require the stewards of our space power to educate policy-makers, combatant commanders, and the American public about the political, military, and economic consequences of being denied the use of important space capabilities.

Conclusion

The decision whether America can utilize its space assets to protect and advance its national interests must not be placed in the hands of our adversaries. The need to undertake serious preparations to preserve the right of US space systems to pass through and operate in space without interference is an imperative. America urgently needs to confront the impending challenge to the freedom of space. It would be extremely imprudent for the US to neglect to pursue a broad range of tactical, technical, and procedural approaches to enhancing the survivability and endurance of satellite systems.

Given the strength of the offense in space, and America's need to exploit the medium rather than simply deny an enemy its use, a mix of active and passive defense measures should be the approach to providing both the credible deterrent and warfighting capability necessary to protect our space assets. In general, such a mix will be more robust than relying upon either active or passive measures alone because of the synergy produced by a combination of offense and defense. The danger of pursuing such a course is less the risk of inciting an arms race than America creating an Achilles Heel because of the extent of its dependence upon space assets and an inadequate approach to their mission protection.

The United States should never find itself in a position where an adversary's threat or use of armed force against our space assets would deter us from protecting our national interests and supporting our security commitments to allies. Reducing the vulnerability of critical satellite systems is needed to diminish the risk of self-deterrence or security failure. America is a nation at war and we must not be lax about space mission protection. Considerations of convenience and efficiency should not be allowed to foreclose such defense preparations. Protecting America's freedom of action in space requires that space assets employed for national security be provided mission protection commensurate with their value to the Nation.

Notes:

[1] *US National Space Policy,* fact sheet, White House, US Office of Science and Technology Policy, released October 2006, www.ostp.gov/html/US%20National%20Space%20Policy.pdf (accessed on 23 January 2007).

[2] National Security Council (NSC) 5520, "US Scientific Satellite Program," 20 May 1955. See also R. Cargill Hall, "Origins of US Space Policy: Eisenhower, Open Skies, and Freedom of Space," in John M. Logsdon, et. al., eds., *Exploring the Unknown: Selected Documents in the History of the US Civil Space Program, Volume I: Organizing for Exploration* (Washington, DC: National Aeronautics and Space Administration History Office, 1995), 213–29.

[3] *US National Space Policy,* 1.

[4] Jeremy Singer, "War in Iraq Boosts Case for More Jam Resistant GPS," *Space News*, 8 April 2003; "Libya 'Jammed' Media Satellites," *Middle East Times*, 5 December 2005; "Iran Jams TV Channels," *The Courier Mail*, 7 June 2005; Vago Muradian, "China Tried to Blind US Sats with Laser," *Defense News*, 25 September 2006, 1, 6; Warren Ferster and Colin Clark, "NRO Confirms Chinese Laser Test Illuminated US Spacecraft," *Defense News*, 2 October 2006, 28; "Top Commander: Chinese Interference with US Satellites Uncertain," *Inside the Pentagon,* 12 October 2006.

[5] Edward Cody, "China Confirms Missile Test," *The Washington Post*, 23 January 2007.

[6] Report of the Commission to Assess US National Security Space Management and Organization (Washington, DC: 11 January 2001), xv.

[7] Ibid.

[8] Ibid.

[9] Donna Miles, "Iraq Jamming Incident Underscores Lessons About Space," *American Forces Press Service*, 15 September 2004.

[10] *US National Space Policy,* 1.

[11] *Space Policy,* Department of Defense Directive 3100.10, 9 July 1999, 6.

[12] See, e.g., "French-Russian Declaration on Strategic Issues," Signed by President's Jacques Chirac and Vladimir Putin, 10 February 2003 (CD/1700); "Possible Elements for a Future International Legal Agreement on the Prevention of Deployment of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects," (CD/1679) submitted to the Conference on Disarmament by Russia and China; and "The Non-Weaponization of Outer Space," Department of Foreign Affairs and International Trade, Canada.

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The Perfect Storm: International Reaction to the Bush National Space Policy

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When the White House released President George W. Bush's new National Space Policy (NSP) at five o'clock in the evening on the Friday before Columbus Day (6 October 2006) with a posting on the website of the Office of Technology Policy there can be little doubt that administration officials were hoping the document would receive as little public attention as possible.[1] There was no accompanying press release; key Congressional staff had been given only a brief heads-up, along with assurances that the new policy differed little in substance from its 1996 predecessor signed by President William J. "Bill" Clinton. When the next week saw little media attention, this public relations strategy at first seemed to be working. The situation changed dramatically with the publication of a front-page story by *The Washington Post* on 18 October 2006 triggering a barrage of negative coverage—both at home and abroad.[2] The criticism did not come solely from media outlets and pundits that might be reliably expected to bash the Bush administration at any opportunity. Louis Friedman, president of the Planetary Society, published an op-ed on the *SpaceDaily.com* website titled, "Belligerent Tone Mars Bush Administration Space Policy."[3] Joan Johnson-Freese, chair of the National Security Decision Making Department at the Naval War College, wrote: "The blunt and even confrontational language of the new policy puts the United States at odds with the priorities of the other space-faring nations. … The language … is so broad that it reads more like a blanket claim to hegemony in space…"[4] An editorial in *Aviation Week & Space Technology* called the policy "jingoistic" and fretted that it could hurt National Aeronautics and Space Administration's (NASA's) ability to find international partners.[5] The *Times of London*, generally considered a conservative voice in the British media, published an article that captured the tone of much of the foreign coverage (headlined "America wants it all – life, the Universe and everything"), calling the new policy "comically proprietary in tone about the US's right to control access to the rest of the solar system."[6]

Meanwhile, official reaction from other space-faring nations ran the gamut from a Russian bluster regarding a military response by Moscow to any US deployment of space-related weapons to a near-deafening silence from Washington's North Atlantic Treaty Organization allies—all of which are publicly dedicated to negotiations on a treaty to ban space weapons. Most worrisome, however, was the 11 January 2007 Chinese test of a direct-ascent anti-satellite (ASAT) weapon that may or may not have been timed as a response—an action that, no matter what the motivation, nonetheless is bound to have wide-ranging negative repercussions for US-Sino relations in space.[7]

The controversy prompted belated moves by the Pentagon and State Department to seek to "clarify" media reports by insisting that the policy had not changed significantly from previous US policies and to soothe ruffled feathers internationally. But by the time the first on-the-record briefing was held—in Washington on 13 December 2006 by Robert Joseph, State Department undersecretary for arms control and international security—the damage had already been done. The new NSP appears to have cemented long-standing concerns among friendly and not-so-friendly nations (as well as the US public) that the US intends to use force both in space and from space, while undercutting international norms against such actions and distancing itself from international law and institutions regarding space. This harsh perception has been created by a "perfect storm" of factors, including:

- The fact that the NSP language is itself undiplomatic and unilateral in tone.[8]
- Preceding Department of Defense (DoD)/US Air Force policy and doctrinal documents on space operations defining the missions of "space force application" and "space control" (freedom "to attack" as well as "from attack.")[9]
- Preceding actions and statements by the US government regarding space within international fora that have isolated the US vis-à-vis the rest of the world.[10]
- The continued political fall-out from the Iraq War.
- An inept public relations strategy for the policy's release.
- Lack of public diplomacy on military space issues in general, and the new policy in particular, especially with regard to allies.

The rest of this article attempts to lay out the key factors behind the international reaction, both public and official; survey official reaction in various space-faring powers (largely based on interviews with diplomats by this author); and postulate the possible repercussions.

Putting Reactions in Context

Given basement-level public approval ratings abroad for both President Bush and the US writ large, the media and public reaction outside of the US to the new NSP should not be surprising. A survey by a group of newspapers in Britain, Canada, and Israel in October 2006 found that 69 percent of respondents from Britain thought the US had made the world a more dangerous place since 2001, and voted President Bush as more dangerous to international security than North Korean strongman Kim Jong-il. Even in Israel the survey found dramatically sliding support for the Bush administration, with 36 percent saying that President Bush's actions had made the world more dangerous versus only 25 percent who said the opposite.[11] America-bashing has become almost *de rigeur* in Russia; and, as the nightly news confirms, US standing in the Middle East and Arab world is even lower. The Iraq war and the events leading up to it have been the catalyst for the precipitous decline in US popularity abroad and for the widespread view of the US as a militaristic, unilateralist superpower. Consequently, the new space policy—even if substantially comparable to the Clinton era policy—is being viewed through an already darkened prism.

While other nations may be overly sensitive about US unilateralism, the new NSP does nothing to disabuse that perception. The short unclassified version of the document heavily emphasizes national security to the extent of stridency. Many NSP phrases, such as the following, forward the perception of US unilateralism in space:

The United States:

- Rejects any limitations on the fundamental rights of the United States to operate in and acquire data from space.
- Will … dissuade or deter others from either impeding those rights or developing the capabilities intended to do so.
- Will take those actions necessary to protect its space capabilities, respond to interference and deny, if necessary, adversaries the use of space capabilities to US national interests.
- Will oppose the development of new legal regimes or other restrictions that seek to prohibit or limit US access to or use of space. Proposed arms control agreements or restrictions must not impair the rights of the United States to conduce research, development, testing and operations or other activities in space for US national interests.[12]

It also must be remembered that the European public, in particular, has traditionally been actively hostile to the concept of ASAT operations and weapons in space—for example, President Ronald W. Reagan's Strategic Defense Initiative in the early 1980s prompted widespread controversy (and even demonstrations) in Europe. While the new NSP does not explicitly commit the US to the development and/or deployment of ASATs, space-based missile defenses, and space-based offensive weapons, it does not rule out such actions—and its language arguably threatens the use of force in space against adversaries, thus implying the use of such weaponry.[13] Further, statements by administration officials and other official DoD documents regarding space-based missile defenses and "space control" make clear that there is a desire within the US government to pursue these capabilities and technologies.[14] For example, in June 2006, John Mohanco, deputy director of the State Department's Office of Multilateral Nuclear and Security Affairs, told the Conference on Disarmament in Geneva that the US government "will continue to explore the possible role that space-related weapons may play in protecting our assets."[15]

Finally, the apparent attempt by the White House to downplay the new policy—which was signed on 31 August 2006 by President Bush but not released until a three-day holiday weekend a month and a half later—further created the impression in the media, both foreign and domestic, that something nefarious was afoot. Indeed, it can be argued that if the White House or State Department had held a formal briefing on the new policy—which administration officials characterize as merely a continuation of past US policies—the media frenzy might have been significantly dampened.[16]

In a similar vein, official reactions (or lack thereof) from overseas also could be seen as relatively predictable.

First, the language in the Bush NSP, while more muscular and direct than that of its predecessor, nonetheless is similar on the controversial issue of space control used by the Clinton administration.[17] With regard to the new policy's rejection of new arms control treaties or other "restrictions" on US access to or use of space, this again could be read as merely a blunt admission of the policies already being followed in practice by the Bush administration, which are familiar to its international interlocutors. For example, the US in October 2005 voted "no" for the first time on the annual United Nations (UN) General Assembly resolution on the need for a treaty on the Prevention of an Arms Race in Outer Space (PAROS), whereas the traditional US action for at least the past decade has been to abstain. (The US was the only "no" vote; Israel abstained; 160 countries voted "yes.")[18] Similarly, the US was the only "no" vote on a resolution made by Russia at the October 2005 meeting asking member states to provide their views on the need for transparency and confidence-building measures for space (158 nations voted "yes;" Israel abstained.)[19] Mr. Mohanco, in his June 2006 statement to the Conference on Disarmament, explained the US position by arguing that PAROS is unnecessary as there is "no arms race in outer space."[20] Thus, the relatively muted response in Europe to the new NSP by foreign governments was explained by one European diplomat who described the US policy as essentially more of the same, just more loudly.

Further, European space experts noted that the complicated lines of organizational responsibility for space activities in Europe make coordinated policy-making extremely difficult. Not only are there various agencies within each European nation with space-related responsibilities, there also are several European organizations involved: the European Union, the European Space Agency and the European Commission. This means reluctance by officials to speak out on space issues for fear of running afoul of one or another of the bureaucracies, according to European diplomats. This also is "a serious problem" for Europe in crafting any political and/or public response to US space policies and initiatives, these sources said.

Second, the rather more robust Russian response—including a thinly veiled scolding from Russian President Vladimir Putin regarding "illegimate, unilateral" actions in space—is in line with previous Russian criticism of US space policies and practices, and the increasing level of anti-Americanism in Russia.[21] Russia has been one of the chief promoters of a space weapons ban treaty, having submitted a draft treaty—along with China and several other co-sponsors—to the Conference on Disarmament in 2002,[22] and in 2004 pledged not to be the first to deploy weapons in space.[23] Yet, Russian military officials have not hesitated to rattle their light-sabers on occasion. For example, in June 2005, Russian Defense Minister Sergei Ivanov threatened that Russia would take "retaliatory steps" if any country were to deploy weapons in space. While he did not name a specific country of concern, the timing of his remarks, following a rash of media reports about the NSP review, made it clear the target was the United States.[24]

The negative media reaction in China was also to be expected, given the recent 'war of words' between China and the US regarding military space, although the lack of official Chinese commentary is somewhat unusual for a government that has typically been publicly critical of US policies, strategies and actions regarding space. However, the official silence may have had much to do with Chinese plans for an ASAT test—which is obviously as spectacular (if negative) a response as possible.

All that said, it is clear that the new NSP has pushed both US allies and potential adversaries to focus more intently on the issues of space security and space weapons than any time in the recent past in ways both obviously negative but perhaps in some cases also positive.

Official Reaction: From Silence to Resignation to Hostility

While there is little on the public record, it is fairly clear that neither the new NSP nor US strategic thinking regarding space is being viewed in a positive light by the government of any major space power. Certainly, no other government came out to endorse the new NSP, and with the exception of Israel, there is no other government that has publicly backed the US refusal to negotiate or discuss using international regimes to prevent an arms race in space. Instead, reactions by foreign officials and diplomats have run the gamut from quietly resigned to publicly critical to, in the case of China, overtly hostile.

Among American allies, concern is focused on two aspects: the unwillingness of Washington to engage in meaningful dialogue on cooperative measures to ensure the future of space security; and the fear that the new US policy chips away at the established norm against the deployment of ASATs and space-based weapons. Allies were further dismayed at the lack of engagement regarding the new NSP prior to its release; indeed, the paucity of US diplomacy regarding space, especially military space, is routinely raised by allied space officials as an ongoing frustration.

British officials have been the most silent, although British diplomats have reiterated the UK government's support for PAROS and the discussion of confidence-building measures for space operations. In a similar vein, a Norwegian diplomat said simply that Oslo is concerned by any national action that could be seen as undercutting international norms and processes.

The German response, too, has been laconic. German diplomats said informal discussions were held between the German Aerospace Center, the Foreign Office and the Ministry for Economics and Technology, as well as NGOs, but that there was little "excitement" within government circles since the policy's substance was to be expected. Said one German diplomat: "The document is seen as stating—in a more direct way—the US goals and objectives in space, but it does not include any new or surprising information."[25] Another noted that future reaction to the policy by other nations will depend on how exactly the US implements the policy.

In France, a meeting of domestic space agencies and experts was called to examine the NSP and its implications for France and the European Union. According to French diplomats and space experts, the key issue is not what the new policy says, or even its aggressively unilateral tone, but why the US felt it necessary at this time to more strongly state its well-known positions and risk breaking the status quo. As one French diplomat explained, "it long has been France's view that the current norm against testing or deploying space weapons is good for all space-faring powers, maintaining a relative stability in military space competition while not preventing research and development needed to back a hedging strategy against 'break out.'" Since the NSP is a presidential document and thus of high political import, it could be seen as legitimizing space-weapons testing and use, especially in China, thus creating a more dangerous space environment—a concern that seems to have been proven correct.

According to Canadian sources, Prime Minister Stephen Harper's conservative-led coalition government has deliberately been taking a more low-key approach to the US regarding the issue of space weapons—opposition to which has been a long-standing tenet of Canadian foreign policy. Canada's methods are switching from strong public advocacy and criticism of the US position toward a more behind-the-scenes attempt at influencing US thinking. Further, diplomats said, the new policy is seen in Canada as a continuation of the Clinton policy of "keeping all options open." However, Canadian diplomats maintain that the government remains strongly opposed to space weaponization and will continue to work to enable a broad vision of space security that rests on international cooperation. On the bright side, said one diplomat, there seems to be a softening in the US position regarding discussions of space-related, confidence-building measures.

As noted, the Russian reaction has been more publicly critical. Although he didn't name names, President Putin in a speech in Moscow on 8 November 2006 chastised those who would weaponize space. With his eye clearly on the new US NSP, Putin said: "Some nations are trying to untie their hands to deploy weapons in space. …" and further criticized "illegitimate, unilateral actions by some powers, as well as attempts by some to unceremoniously hammer through their positions while fully ignoring legitimate interests of partners."[26] Vitaly Davidov, deputy head of the Russian space agency Roskosmos, pulled even fewer punches regarding the NSP. "This document can be seen as toward a serious deepening of the military confrontation in space," he was quoted in the English-language Moscow News. "Now the Americans are saying they not only want to go to space but they want to dictate to others who else is allowed to go there."[27]

While there were a handful of extremely negative press reports in China—including charges that the NSP was aimed directly at China, there was no official reaction made public, according to Chinese experts here and in Beijing.[28] China is the most vocal proponent in international circles of PAROS, and publicly has committed itself to opposing the weaponization of space. Further, Chinese diplomats have not hesitated to criticize the US regarding its military space policy and its position at the Conference on Disarmament in opposition to PAROS at nearly any opportunity, so the silence was rather unexpected.[29] Then, on 17 January 2007, came reports of the Chinese ASAT test using a missile to destroy an aging Chinese weather satellite, FY-1C, orbiting at about 850 km in altitude.[30] The US DoD for several years has been asserting that China is already developing ASAT technologies. Most recently, the Pentagon's 2006 annual report on Chinese military power stated that one such ASAT program "appears to be a ground based laser designed to damage or blind imaging satellites"[31]—an assertion that garnered renewed attention in October 2006 with reports regarding an incident (or perhaps incidents) of a US satellite being illuminated by a Chinese ground-based laser.[32] Although evidence supplied by DoD has been thin, and in some cases dubious, Chinese military writings on asymmetric warfare have long made it clear that China has been investigating the possibilities of satellite attack capabilities both as a hedge against US missile defenses and/or space weaponry and for potential offensive use against the US in any conflict. The ASAT test seems to prove this. While it is dangerous to speculate on the Chinese motivations for the ASAT test, the timing of the event could have been deliberate as a direct response to the NSP. Some analysts in the US have speculated that due to increased Chinese frustration with a lack of response by the US to diplomatic and soft-power approaches, Beijing made a determination that the only way to bring Washington to the table regarding its concerns would be through a display of hard-power strength. This strategy is not without precedent: the administration of President Jimmy Carter, made a similar calculation in taking a two-track approach of attempting to bring the Soviets to the table on an ASAT weapons ban treaty while simultaneously pursuing a US ASAT capability as a bargaining chip.[33] But in the increasingly negative US-China dynamic on military space, all eyes are now on Beijing.

Repercussion Risks

Obviously, the Chinese ASAT test raises the specter of a negative action-reaction cycle between Washington and Beijing—and on the face of it represents the worst-case scenario stemming from the misunderstandings and misperceptions fostered by the NSP and US declaratory policy on space. Dramatic near-term responses to the new US space policy by other space-faring nations seem unlikely, as other nations are instead more liable to wait to see how Washington moves to implement the policy. Given growing fiscal constraints on US spending and the change of Congressional leadership to the Democrats—both factors that could impact how much leeway the Bush administration has to invest in any new space programs or efforts—a 'watch and wait' policy would seem to make sense. That said, there remains potential for subtle reactions by others, including allies, in the short and medium term that could have negative repercussions for the US.

In Europe, several questions arise regarding future transatlantic relations in space. A fundamental issue, according to diplomats, is in regards to balancing cooperation with Russia and the US on future exploration missions. Moscow has been actively lobbying for higher levels of space cooperation with Europe, an initiative that has the direct backing of President Putin, according to European officials. Indeed, the European Space Agency and the Roskosmos on 10 March 2006 signed a pact designed to boost cooperation in a wide range of space activities from exploration to launch vehicles.[34] European officials perceive less of a commitment to civil space cooperation by the US, so they have been slow to consider US plans. Meanwhile, Europe is attempting to agree on its own European Space Policy, an effort that is expected to come to fruition in 2008. One of the questions underlying that effort is the extent to which Europe needs to establish strategic autonomy in space, including in the military arena. To the extent that the new NSP furthers the long-standing perception in Europe that the US is an unstable and even unwilling partner in space—on the civil and commercial side, as well as, the military side—European thinking may be nudged further in the direction of autonomy and overtures by Russia for cooperation may look more attractive.

Further, Europe's meager space budgets make it necessary for Europe to set limited priorities both for international cooperation and in collective/national space programs. The European Space Agency's budget for 2006-2010 was set at 8.26 billion Euros ($10.7 billion).[35] Total European spending on military space in 2006 is estimated at 1 billion Euros ($1.30 billion).[36] Indeed, the US spends six times more than Europe on space in total, and 30 times more on military space.[37] In other words, choices regarding priorities for spending are critical and often difficult. Europe will not be able to afford robust civil cooperation with both Russia and the US, especially at a time when Europe is considering how to fill the gaps in European space capabilities that are considered ever more important to military operations. Meanwhile, the Pentagon has been urging European allies to put more attention to the protection of space assets, another potential expenditure. It will behoove US officials to keep in mind that budgetary realities may force European nations and the European Space Agency to rob Peter to pay Paul, even under today's circumstances.

Already, French officials have been discussing the priorities of their space budget in view of a potentially more risky environment in the future—discussions that have taken on greater urgency in the wake of the NSP. France has the largest space budget of any European nation—1.7 billion Euros ($2.2 billion) per annum including France's contribution to the European Space Agency—but nonetheless is hard-pressed by financial constraints. For example, one diplomat explained that France would have to think hard about whether it now wants to shift funding to protection of its space assets rather than toward cooperation with NASA on Moon-Mars initiatives.

In the broader sense, the new NSP may lead to more concerted action by the international community to develop diplomatic measures designed to constrain US behavior in space, or at a minimum seek to politically embarrass and further isolate Washington. One possibility is that some nations may choose to use the Committee for the Peaceful Uses on Outer Space to "call out" the US space policy as contradicting legal norms, perhaps referring an investigation to the Legal Subcommittee. Of course, such a move would now require a similar condemnation of the Chinese. Canada is also leading a push within the Conference on Disarmament to establish an informal "discussion" group on PAROS, an effort that already has widespread support.[38]

Another possibility is that some nations, such as India and Russia, may redouble their efforts to launch an overhaul of the 1967 Outer Space Treaty (OST). In fact, the head of the Indian Space Research Organization, G. Madhavan Nair, speaking at the Indian Law Institute on 29 November 2006, said that the OST and other current space treaties have become obsolete because of issues such as increasing space debris and space weaponization. "There is a need to replace the entire set of treaties by a comprehensive space law," he said.[39] Many US space experts, including within the US government, fear that opening the OST would actually harm rather than help future security in space, given that some nations would like to rollback certain provisions such as overflight freedom for reconnaissance and Earth observation satellites. India, for example, has complained bitterly that services such as Google Earth are harming its security and New Delhi is sure to react, and likely overreact, to the Chinese ASAT test.[40]

Finally, one could logically expect Russia and China to continue to attempt to make political and economic hay by portraying the US policy as dangerously unilateralist and redoubling their attempts to forge stronger space cooperation with Europe and other nations. China is likely to use the NSP and US declaratory policy writ large to justify its ASAT test on the grounds that it is being threatened by the United States.[41]

Conclusion

Despite the "perfect storm" of negative public reaction abroad to the new US NSP, it remains unclear—and largely unpredictable—whether other space-faring powers will actively seek to respond in concrete political, economic or military ways. It could be that even the Chinese ASAT test was an attention-getting device, rather than a signal of a full-court press to militarily challenge the US—much in the way North Korea seems to use threatening activities in order to focus world attention on Pyongyang. First, questions loom about how (or even if) the new policy might result in changes in US behavior in space, in budget priorities, or in research and development of new "space-related" weaponry. This fact is likely to result in largely "wait and see" approaches by others, since (as always) the true test will be not what Washington says, but what it does. Second, it is not clear how important the issue of space will weigh in US relations with individual nations or regions, and that balance is certainly going to be different for each bilateral/regional relationship; with the Sino-US relationship obviously the most fraught. Both US allies and competitors have other economic, political and military interests vis-à-vis the US that must be considered. Third, space policies and strategies in Europe, Russia, China and India remain somewhat inchoate—torn between conflicting budgetary, political, and military priorities and approaches. Interestingly, the release of the blunt new US space policy may spur some major space-faring powers, especially among US allies, toward more coherent strategic thinking—which could be a positive thing. Finally, given that the UN institutions with responsibilities regarding space work by consensus, it is difficult to imagine those bodies taking strong collective action—though certainly they will continue to serve as political pulpits, and as venues for further isolation of the US.

At the same time, the reaction overseas—especially amongst allies—should be troubling to US officials, and not just those charged with space-related portfolios. Public opinion matters and governments (at least those in democratic countries) are obliged to take that into account. It should be obvious that the US approach to space and especially space security is not, to put it mildly, widely accepted. And to the extent that US policies and actions regarding space serve to deepen already negative views about US leadership and motivations, US 'soft power' could be further eroded. And while no nation (even China at this time) may have the economic or military clout to directly challenge the US in the exercise of space power, it is possible for others to act individually or in concert to economically and politically isolate and/or constrain US actions through both 'soft-power' and asymmetric 'hard-power' responses. Nor is it realistic to assume that the US can simply impose its will upon other space actors, given the growing importance of space activities to any given nation's development and national security. At a minimum, the current situation behooves the United States to do more to explain its views, policies, strategies and intentions regarding space, especially to allies and friendly nations; to exhibit more willingness to hear and seriously take into account the concerns of others; and to recognize that rejection of rules of behavior in space opens the way for more overtly negative behavior, as the confirmation of a Chinese ASAT test attests. Unfortunately, rather than clarifying US intentions, the new NSP only further muddied the waters.

Notes:

[1] *US National Space Policy,* fact sheet, White House, US Office of Science and Technology Policy, released October 2006, www.ostp.gov/html/US%20National%20Space%20Policy.pdf (accessed on 23 January 2007).

[2] Marc Kaufman, "Bush Sets Defense As Space Priority: US Says Shift Is Not A Step Toward Arms; Experts Say It Could Be," *The Washington Post,* 18 October 2006, A01, http://www.washingtonpost.com/wp-dyn/content/article/2006/10/17/AR2006101701484.html.

[3] Louis Friedman, "Belligerent Tone Mars Bush Administration Space Policy," *SpaceDaily.com*, 25 October 2006, http://www.spacedaily.com/reports/Belligerent_Tone_Mars_US_Administration_Space_Policy_999.html.

[4] Joan Johnson-Freese, "The New US Space Policy: A Turn Toward Militancy?" *Issues in Science and Technology*, Winter 2006, 33-36.

[5] "Jingoism Will Get US Nowhere in Global Space Affairs," *Aviation Week & Space Technology,* 30 October 2006, 58.

[6] Bronwen Maddox, "America wants it all – life, the Universe, everything," *The Times*, 19 October 2006, http://www.timesonline.co.uk/article/0,,30809-2410592,00.html.

[7] Craig Covault, "Chinese Test Anti-Satellite Weapon," *Aviation Week & Space Technology,* 17 January 2007, http://www.aviationnow.com/avnow/news/channel_space_story.jsp?id=news/CHI01177.xml, subscription only; Jeffrey Lewis, "Chinese ASAT Test?" *Armscontrolwonk.com*, 17 January 2007, http://www.armscontrolwonk.com/1359/chinese-test-asat.

[8] For a full analysis of the text, see: Theresa Hitchens, "The Bush National Space Policy: Contrasts and Contradictions," 13 October 2006, Center for Defense Information, http://www.cdi.org/program/document.cfm?DocumentID=3692&StartRow=11&ListRows=10&appendURL=&Orderby=D.DateLastUpdated&ProgramID=68&from_page=index.cfm; Michael Katz-Hyman, "The Bush National Space Policy: Freedom of Action, Not Diplomacy," 10 October 2006, The Henry L. Stimson Center, http://www.stimson.org/?SN=WS200610101122; and, Johnson-Freese.

[9] Joint Publication (JP) 3-14, *Joint Doctrine for Space Operations*, 9 August 2002, http://www.dtic.mil/doctrine/jel/new_pubs/jp3_14.pdf; Air Force Doctrine Document (AFDD) 2-2.1, *Counterspace Operations*,

2 August 2004, http://www.dtic.mil/doctrine/jel/service_pubs/afdd2_2_1.pdf; and Air Force Doctrine Document 2-2, *Space Operations*, 27 November 2006, http://www.e-publishing.af.mil.

[10] The United States has been blocking any progress, informal or formal, on UN efforts to launch discussions on Prevention of an Arms Race in Outer Space (PAROS) since the mid-1990s – discussions that have been supported for decades by the overwhelming majority of UN member states.

[11] Julien Glover, "British believe Bush is more dangerous than Kim Jong-il," *The Guardian*, 3 November 2006, http://www.guardian.co.uk/usa/story/0,,1938434,00.html.

[12] *US National Space Policy,* 1-2.

[13] *US National Space Policy,* "the United States will: preserve its rights, capabilities, and freedom of action in space, dissuade or deter others from either impeding those rights or developing capabilities intended to do so, take those actions necessary to protect its space capabilities; respond to interference; and deny, if necessary, adversaries the use of space capabilities hostile to US national interests."

[14] JP 3-14; AFDD 2-2.1.

[15] John Mohanco, deputy director for the Office of Multilateral Nuclear and Security Affairs, US Department of State, "US Statement at the Conference on Disarmament," US Mission to the United Nations in Geneva, press release, 13 June 2006, http://www.usmission.ch/Press2006/0613USstatementattheCD.htm.

[16] This author spoke with several reporters who characterized the manner of the NSP release as designed to ensure that it "fell under the radar," thus making the story all the more interesting to them.

[17] That said, the Clinton administration was widely regarded as opposed to the development of ASAT or space-based weapons, and the lack of political will for implementing a space control strategy was bemoaned by Air Force leadership at the time. For example, see: "United States Space Command Long Range Plan," April 1998, http://www.fas.org/spp/military/docops/usspac/lrp/toc.htm. The document states that in order for a robust space control strategy to be implemented, "The United States will need to develop national policies supporting space warfare, weapons development and employment, and rules of engagement…" This suggests those policies had not been developed. Further, the plan states clearly that: "At present, the notion of weapons in space is not consistent with US national policy."

[18] Rebecca Johnson, "UN First Committee Update," 30 October 2005, The Acronym Institute, http://www.acronym.org.uk/un/2005up01.htm.

[19] Ibid.

[20] Mohanco.

[21] "Russia Concerned About Space Weapons Deployment – Putin," *Moscow News*, 9 November 2006, http://www.mosnews.com/news/2006/11/09/spacewar.shtml.

[22] For a text of the document, plus a statement by Russian Ambassador Leonid A. Stotnikov explaining the initiative, Disarmament Documentation, Russia-China CD Working Paper on New Space Treaty, The Acronym Institute for Disarmament Diplomacy, June 2002, http://www.acronym.org.uk/docs/0206/doc10.htm.

[23] Rebecca Johnson, "UN First Committee 2004: PAROS discussions at the UN First Committee," The Acronym Institute for Disarmament Diplomacy, 20 October 2004, http://www.acronym.org.uk/un/2004paro.htm.

[24] "Russia warns US about weapons in space: Minister vows retaliatory steps over technology threat," *Associated Press*, 2 June 2005, http://www.msnbc.msn.com/id/8073961/.

[25] German diplomat, interview by author via e-mail, 19 December 2006.

[26] "Russia Concerned About Space Weapons Deployment – Putin."

[27] "Russian Official Says New US Space Policy Will Lead to Military Confrontation," *Moscow News*, 30 November 2006, http://www.mosnews.com/news/2006/11/30/spacecritic.shtml.

[28] At least one commentator charged that the United States not only is using China as an excuse for building space weapons, but also that China is the primary target of such weaponry: Xu Changjun, "US Builds Spaceships to Establish Hegemony in Space," *World News Journal*, 26 October 2006,http://www.china.com.cn/military/txt/2006-10/26/content_7277637.htm (translation provided by Eric Hagt, director of the World Security Institute's China Program, Washington, DC).

[29] For example, see the 30 June 2006 statement to the Conference on Disarmament by China's UN Ambassador Hu Xiaodi, http://www.china-un.ch/eng/xwdt/t201853.htm.

[30] Covault.

[31] "Annual Report to Congress: Military Power of the People's Republic of China 2006," US Department of Defense Office of Secretary of Defense, May 2006, http://www.defenselink.mil/pubs/pdfs/China%20Report%202006.pdf.

[32] Warren Ferster and Colin Clark, "NRO Confirms Chinese Laser Test Illuminated US Spacecraft," *Space News*, 2 October 2006, 10.

[33] Lt Col Peter L. Hays, USAF, "United States Military Space Into the Twenty-First Century," INSS Occasional Paper 42, September 2002, Institute for National Security Studies, US Air Force Academy, Colorado Springs, CO, 104-105.

[34] "New Space Milestone for EU and Russia," *Europa*, 14 March 2006, http://ec.europa.eu/comm/space/russia/highlights/milestone.html.

[35] Peter B. deSelding, "Ministers approve 8.26 billion euro package for ESA," *Space News*, 12 December 2005, 6.

[36] "Tracking European space policies – have we got the civil/military balance right?" New Defence Agenda, Brussels, Belgium, 18 October 2005, http://www.forum-europe.com/publication/NDA_SOD_18Oct2005.pdf.

[37] Ibid.

[38] Ambassador Paul Meyer, "The Conference on Disarmament: Getting Back to Business," *Arms Control Today 36*, no. 10, December 2006, http://www.armscontrol.org/act/2006_12/Meyer.asp.

[39] "India needs strong legal group in order to pursue space science: madhavan nair," *indlaw.com*, 30 November 2006, http://www.indlawnews.com/B1627A40CCE6442F0927336BF6133578.

[40] "India: Google Earth images to be 'masked:' Government seeks to mask certain images they say pose threat to security," *The Times of India*, 10 March 2006, http://www.asiamedia.ucla.edu/article.asp?parentid=40651 (accessed 24 January 2007).

[41] *Note bene:* In this author's view, however, the deliberate creation in peacetime of persistent space debris in a heavily used orbit not only unjustifiable, but irresponsible.

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Leveraging Space to Improve Missile Defense

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President George W. Bush's National Space Policy received a flurry of attention in the trade press in October 2006, but interest waned quickly because, in the end, the new policy is a fairly inconsequential document.[1] Truth is, policies come to life through programs and budgets. Words unsupported by money or deeds are, well, just words. That said, there was goodness in the policy's publication. It reminded us of the realities and potentialities of combat on the edge of Earth. It also caused us to once again consider ways space may be used to enhance traditional military missions.

There are three combat mission areas in particular that could benefit significantly from a more thoroughgoing exploitation of space—space control, offensive strike, and missile defense. I will focus on the latter. Adding a space-based layer of hit-to-kill interceptors to enhance the performance of the newly deployed United States ballistic missile defense system could offer numerous military and diplomatic advantages. Highly effective defenses against ballistic missiles carrying nuclear or other weapons of mass destruction would offer a great pay-off over the long-term when one takes into account threat and national vulnerability to catastrophic attack.[2]

Ballistic Missile Threat

The ballistic missile threat to the US, its deployed forces, and allies and friends was defined and analyzed comprehensively in 1998 by a respected bipartisan commission.[3] The commissioners reaffirmed that foreign governments, some of whose leaders have hostile intentions toward the US and its allies, seek ballistic missiles in order to confront tactically superior US conventional military forces or build up an inventory of terror weapons.

The US has been incrementally fielding point defenses to defend populations and military assets from short- to medium-range ballistic missiles and demonstrated the progress made with this capability in Operation Iraqi Freedom, when Patriot batteries intercepted all threatening short-range ballistic missiles launched by Iraqi forces. Until fall 2004, when the US fielded limited defensive capabilities, the country was completely vulnerable to a long-range ballistic missile strike. Without such protection the citizens were exposed to sudden attacks from above and the government exposed to foreign strategies involving coercion, intimidation, and deterrence. The summer of 2006 crisis in Lebanon, when Hezbollah forces relentlessly bombarded Israel's northern territory with more than 4,000 projectiles, illustrated that states and non-state actors are willing to use missiles and rockets to produce terror and further political aims.

The adversaries of the US are looking hard at ballistic missiles because they represent a challenging threat. An intercontinental ballistic missile (ICBM) can travel at extremely high speeds—at times more than 15,000 mph. Kinetic energy interceptors collide with targets in space thousands of miles away at closing speeds that can exceed 25,000 mph. Besides hurling very small objects through air and space at very high speeds, ballistic missiles can be launched from anywhere at any time from multiple directions, to anywhere on the globe. Adding to this challenge, we can expect adversaries to employ countermeasures to foil missile defense calculations and disrupt system operations.

With intercontinental flight times measured in minutes, ballistic missiles are the surest and fastest way to destroy a distant city or military asset. They can give a state regional or even global prestige and are a potentially significant military weapon and tool of terror, especially if those missiles are married to weapons of mass destruction. Longer-range systems would give hostile rogue states a capability to vault over the oceans to strike American cities and blackmail US leaders.

In the future, we may face adversaries unknown to us today, fight in unexpected regions, or have to defend against new types of ballistic missiles and countermeasures. The significance of this uncertainty for missile defense planners is enormous. This means that we cannot be totally focused on "who" poses the threat today because the "who" can change with a political decision or by a surprise shift in capabilities from one region to another. Similarly, a focus on the "how" does not mean we can ignore today's enemies or their present-day capabilities. On the contrary, today's ballistic missile threats continue to drive our Nation's near-term missile defense fielding and long-term development efforts. Today's threats provide "ground truth," a measure of what is possible today and, therefore, a low-end representation of what we must be prepared to defeat tomorrow. The "high end" represents ballistic missile threats that today are either unrealized or unknown but yet are possible to develop.

There has been steady interest and investment of scarce resources by some 20 to 30 countries in acquiring ballistic missiles and improving payload destructive power, warhead accuracy, and delivery range. Turnkey missile systems have been transferred from one state to another and may one day be purchased by terrorists. So why must we pay attention? Because a missile strike involving nuclear, biological, or chemical weapons could wreak catastrophic damage, far surpassing the levels of destruction, economic dislocation, and terror produced by the 11 September 2001 attacks.

The international web of trading relationships in ballistic missiles and related technologies is extensive. Short-range ballistic missile systems are plentiful and available for sale on the international black market. Equally worrisome is the heightened interest in longer-range systems. For example, North Korea is developing an improved performance intermediate-range ballistic missile that can travel about 3,200 km. North Korea also has an intense development program to produce an ICBM. The

Taepo Dong-2 ICBM may have a two-stage variant (and travel around 10,000 km) and a three-stage variant (15,000 km). The 4 July 2006 test of the Taepo Dong-2 failed moments after lift-off, demonstrating that the North Koreans have more work to do. There is every indication, however, they will continue to strive for a viable long-range strike capability in addition to producing and selling shorter-range systems that may be used to threaten its neighbors, such as Japan.

Iran also has a significant ballistic missile development program. Besides its numerous short-range systems, Iran is developing a medium-range ballistic missile (Shahab-3) based on North Korean No Dong technology. In its quest for longer reach, Iran is developing an extended range Shahab-3 (which can travel 1,300 km and threaten Israel) and a new medium-range system (which may travel 2,000 km and reach into portions of Europe). In November 2006, Iran showcased on television several ballistic missile launches, to include the Shahab-3, demonstrating for the world the importance Tehran places on its ballistic missile development program. Iran is believed to be working on intercontinental range ballistic missiles, which may be in its arsenal by 2015, that is if it does not import longer-range systems from proliferators like North Korea earlier than that.

Countries like China and Russia have done considerable work on ballistic missile and countermeasure technologies.[4] Having developed and deployed advanced ballistic missiles of all ranges and done extensive research on nuclear weapons, we are rightfully concerned, not only about the tremendous and devastating offensive potential of these foreign ballistic missile forces, but also about the willingness of these two governments to proliferate ballistic missile technologies abroad and sell their expertise to other countries.

In other words, there are significant technological and political uncertainties to weigh as we consider how to proceed with the development of US missile defenses. How China and Russia will play in the use and proliferation of ballistic missiles is no small part of this consideration. How will our adversaries fight today and tomorrow and with what capabilities? How can we technologically and operationally defend ourselves against an array of ballistic missile threats? The truth is, we cannot know for certain, so we must be ready for many contingencies.

How Space Can Help

Are we attempting the impossible? I believe highly-effective defenses against future ballistic missile threats will be a challenge to develop, but not impossible, especially if we find the political will to focus on the best ways to leverage the space environment to accomplish this mission.

With several successful hit-to-kill intercept tests in the bag and the proven combat performance of short-range land-based defenses, we have shown that we can "hit-a-bullet-with-a-bullet." We also have made great strides in component miniaturization and advances in materials, and over the past twenty years have improved performance in interceptors, sensors, and battle management. This technological progress is key to considering whether the operation of space-based interceptors is feasible, effective (as part of the overall US missile defense system), and affordable.

Yet progress in fielding the overall missile defense system has been slow. In part we can blame this on the technically challenging nature of the mission. Political disagreements over the years have also hampered progress. The Anti-Ballistic Missile Treaty of 1972 stood in the way of developing a fully integrated, layered system to defeat missiles of all ranges. This treaty forbade different basing modes for missile defense, including basing interceptors in space. After more than three decades of living within these legal constraints and living with homeland vulnerability, the United States withdrew from that treaty in June 2002 in order to strengthen homeland defense.

Today we are considering new sensor and interceptor basing modes at sea, in the air, and in space as part of a layered defense concept. The initial layered ballistic missile defense system fielded by the Bush administration will not at first be capable of addressing all missile threats. But at least something is out there in the field and available for emergency use today. The current system can address a portion of the threat spectrum, and we can enhance, augment, and upgrade that capability by building on it incrementally over time. It is better to field some capability, no matter how limited, than to have no capability at all in the face of a growing threat. The system's readiness during the July 2006 North Korea missile launches and the confidence this gave our leaders demonstrated the prudence of the "field-what-we-can-now-and-improve-it-as-we-go" approach. So how can world-circling missile defense assets improve what we have?

Flexibility

Today we have an aggressive missile defense development program to look at future basing possibilities for sensors and weapons as part of a layered defense concept. Weapons and sensors at sea, in the air, and in space would enlarge the engagement battle space and make it harder for an enemy to outflank the missile defense system. More platforms means greater flexibility and improved system robustness. Currently, the US has fixed sites at Fort Greely, Alaska and Vandenberg AFB, California for its long-range interceptors. There are also fixed sensors in Alaska, California, and the United Kingdom. These sites are optimized to defend against a limited threat posed by North Korea and Iran. But what if the threat country shifts and "out-flanks" this operational geometry?

Optimal orbits for engaging missiles from space would depend on the satellites' inclinations, which bound the orbital engagement zone between latitudes north and south of the equator at similar distances. With weapons on-orbit, missile defenders would have a capability to engage intercontinental- to medium-range ballistic missiles launched from any region within that zone. Intercepts in the boost and midcourse of that missile's flight could be possible. Essential work to demonstrate the feasibility of critical space-based interceptor functions has already been done (as part of the Brilliant Pebbles development program in the 1980s and early 1990s). The Missile Defense Agency (MDA), should it receive the support of the administration and Congress, could continue development efforts to perfect command and control of space-based assets and long-term storage of propellant, among other things.

The important point here is that, all at once, a space-based layer of weapons gives the current missile defense system a true global engagement capability. Without space, the only way to

Midcourse Space Experiment (MSX) satellite launched from Vandenberg AFB, California on 24 April 1996. The MSX satellite is used by the Missile Defense Agency to characterize ballistic missile signatures during the midcourse phase of missile flight against a variety of backgrounds.

deal with threat uncertainty is to populate the world with fixed and mobile sensors and radars (on ground and at sea). As you might imagine, the cost of doing so would be prohibitive, and would probably not be politically sustainable.

Without a space-based layer, missile defenses would continue to require numerous bilateral and multilateral agreements with our allies and friends to host various missile defense assets. And there would continue to be a risk that these assets would not be properly positioned to defend against a particular threat. Space-based interceptors introduce flexibility and a near-global coverage capability into the system, they can offer a very cost-effective and, from one perspective, politically-efficient option for dealing with an uncertain and evolving threat.

Boost Defense—"Get'em while they're hot!"

The current US approach to missile defense is to develop and field a single integrated system with defensive layers. What does it mean to have more than one layer? It means having more than just a terminal or midcourse capability against a particular threat. In the best of all worlds, a truly robust system will make available engagement opportunities in the boost, midcourse, and terminal layers.

To have multiple layers means having shot opportunities in more than one engagement phase (boost, midcourse, or terminal) against a threat, missile, or payload. To have layers is to have a capability to deal with an increased number of launched missiles and warheads. A layered defense system also makes it more difficult for the enemy to use countermeasures. Usually, a missile defense countermeasure that works well in one engagement phase will not work well or at all in another phase. And adding countermeasure capabilities comes at a price. A robust defensive system will force the enemy to consider using up valuable payload space that would otherwise be assigned to deadly munitions in order to install additional defensive countermeasures onto its offensive missile system. In one sense, the reduction in the size of the munitions payload is already a victory for the defense.

Boost phase missile defense capabilities create a defensive layer near the hostile missile's launch point. Engagement in this defensive phase of a ballistic missile's flight demands quick reaction times, high confidence decision-making, and high performance capabilities. This is the point in a ballistic missile's flight when it is traveling at slower (though accelerating) speeds and is most vulnerable. Currently, the US missile defense system does not have a boost defense layer, which requires development of high-power lasers, faster terrestrial-based kinetic energy interceptor capabilities, or space-basing of sensors and defensive weapons.

The MDA is putting in place the requisite command, control, battle management, and communication infrastructure, and is developing and demonstrating the technologies needed to operate an Airborne Laser (ABL), which uses directed energy to cause weakness and instability in the airframe of a ballistic missile. The ABL would be capable of engaging ballistic missiles of all ranges. Also in development is a high acceleration kinetic energy booster that, when mated with an exo-atmospheric kill vehicle, could be based on land or at sea and would be effective against longer-range ballistic missiles.

The disadvantage of these terrestrial options is that they must be in position to be effective. Technological marvel that it is, the ABL is limited logistically—it must be in the air (along with in-flight escort defenses) during missile boosting and within range of the threat launch site to be operationally effective. A transportable high-acceleration land- or sea-based interceptor would also require positioning within range of the missile launch (along with adequate sensor coverage for detection, tracking, and discrimination).

What this means is that launches out of the deep interiors of some countries might circumvent the terrestrial boost-phase defenses under development. Even if the ABL could operate along enemy borders, in other words, it may not be effective against threat missiles launched a thousand miles away. Missiles

YAL-1 Airborne Laser (ABL) in flight.

launched from far away and away from the positions occupied by the kinetic energy interceptors also could evade the early defenses, although midcourse defenses may be able to engage them (hence the value of a layered defense system). These terrestrial capabilities would be welcome additions to the system, but the question is, can we do better?

The ability to stage ballistic missile launches far away from their border areas makes it challenging for the defense for several reasons. Sensors can help discriminate and track the ballistic missile and payload and cue the missile defense system for possible engagement. To the degree we can place radars closer to the threat launch site, we are better off. The closer we are, the earlier we can look at the launching missile and the better and more accurate the information provided to the system will be. Launches out of deep interiors may keep that information away from missile defenders.

One way to overcome this disadvantage is to place advanced sensors in space. The country already leverages Earth's orbits to detect and warn of missile launches worldwide. The missile defense system will continue to leverage the Air Force non-imaging infrared Defense Support Program (which has been around since the mid-1960s) and the follow-on space-based infrared system–high satellites for threat detection and early warning.

There are other sensing functions that can be optimally executed from space. Beginning in 2007, the US will experiment for several years with Space Tracking and Surveillance System (STSS) satellites. Space-based sensors would have a global footprint, improve situational awareness, and help shorten the track detection timeline and improve track accuracy, which means improving performance for all elements of the system (space-based and terrestrial). These satellites will also provide faster cues to other radars and weapons elements of the system and provide better information on threat missiles, including position, velocity, and acceleration estimates. Until the STSS satellites are launched and operational, though, we will be limited to terrestrial tracking sensors with their attendant drawbacks.

A space-based interceptor layer would help take away the geographical advantage held by the offense, since space-based assets would be on-call 24/7 and would have near-global access to launch points. Missile defense operations from space not only would allow the system to address a very large set of possible threat launch points around the globe, but they would also allow the US to engage ballistic missiles launched from deep within enemy interiors.

Robustness and Synergy

We must recognize that improving the performance of the ballistic missile defense system means adding mobility (flexibility to meet unforeseen threats or to defend against a known adversary), layers (to increase engagement redundancy), and inventory (more interceptors or shots in the system to deal with larger raid sizes). Space-based interceptors can make a significant contribution in each of these areas. While interceptor platforms will travel in a relatively "fixed" orbit, the movement of even a constellation as small as 100 interceptor platforms (with, for example, four interceptors per platform) will act like a mobile defense asset and be ready to engage at multiple points around the world at a time.

Because the missile defense system has more than one layer, it will have multiple elements working together synergistically, sharing information, sharing existing sensors, communicating as a single system worldwide. Even a small constellation of space-based interceptor platforms leveraging existing terrestrial sensors and the extensive command, control, battle management, and communication network would allow the entire system to work more efficiently. As mentioned above, a capability to strike in boost and midcourse from space would thin out the number of attacking payloads, and thereby increase the probability of engagement for other midcourse and terminal defenses and improve overall system synergy.

Ironically, when one considers the emotional and at times hyperbolic debate over deploying weapons in space, much of the missile defense battle involving ground-based or sea-based interceptors already takes place in space.[5] The exoatmospheric kill vehicle (EKV) mated to booster stacks are designed to collide with the target in low Earth orbit. The EKV is a "space weapon"—it just spends most of its time on the ground. The attacker, therefore, has an ability to preposition before the defender can get to the point where he must engage. The currently deployed terrestrial-based interceptors, in other words, are not in the most optimal position to do battle with high-speed offensive missiles and payloads in the midcourse phase of the missile's flight. By surrendering this fundamental positional advantage, we are fighting a space war with our bellies in the mud. Why not pre-position assets in space, where we know the battle is going to take place?

The on-call, persistent defensive capabilities made available by space-based assets would improve missile defense response times, expand areas of engagement, provide better information on offensive missile events, and generally improve the worldwide integration of the system. The improved flexibility space offers would allow the US to better defend against emerging threats. This would allow it to improve crisis response times and enable US military forces to be more agile and protected on the battlefield. The US would be in a better position to defend its interests and more readily able to meet the defense commitments of its allies and friends. The confidence of the leadership would also improve, and the leadership, in turn, would have greater freedom of action to defend US interests and populations from a wider range of missile threats.

Will there ever be a time when we will need the powerful capabilities discussed above? Robust missile defenses, at a minimum, could further the defensive goals of dissuading our allies from investing in ballistic missile programs and deterring aggressive missile behavior. Yet there are instances imaginable too when we would want to have the strongest, most reliable, most effective defenses possible.

What if, for example, a hostile country decided that the best military option it had available, an option that would inflict maximum damage on the US, would be to launch and then detonate a nuclear weapon several hundred kilometers above the US? Although nobody would die, not immediately at least, and no buildings would be destroyed, the resulting explosion would send out an invisible electro-magnetic pulse that would disable or destroy the electrical, financial, communications, and transportation infrastructures of part or all of the country. The impact on the economy and the health and safety of citizens would be felt worldwide. According to a recent report by a congressionally chartered commission to look at the electromagnetic pulse threat, "a regional or national recovery would be long and difficult and would seriously degrade the safety and overall viability of our Nation."[6] Indeed, our vulnerability might invite such an attack.

The stakes, in fact, are that high, and the possible threat posed by a nuclear-tipped ballistic missile is that chilling. A robust missile defense system may be the only recourse we have to defend ourselves against such a threat.

Now who is in favor of having the most efficient, most effective missile defenses in place? And if most of us favor strengthening defenses to improve our ability to kill long-range missiles early enough in their trajectory (that is, from boost phase to early midcourse phase), why would we not be in favor of a vigorous program to develop and deploy interceptors that provide on-call, worldwide reach, and a boost phase layer within the currently deployed ballistic missile defense system? Why, in other words, would we not want to investigate more fully the performance possibilities of space-based interceptors?

Military Space and Politics

The Bush administration's commitment to deploying a ballistic missile defense system ended a decades-old and bitter partisan battle and inaugurated a new defense era. There is a limited system now in place to defend the US homeland, its allies, and its deployed troops against ballistic missile attack. There also are plans in place to improve the system incrementally to address current and emerging threats. Yet at the moment, those plans shy away from a full-fledge investigation of the space option.

Policy makers in favor of the space option have not done the political spadework required to push it forward. The current administration has not been willing to take it on, despite the heady language in the 2006 National Space Policy. Congress also has a few space proponents, but the groundswell of support required to authorize and fund this approach will be impossible to build on Capitol Hill without leadership from the administration.

Other reasons: domestic and international political correctness movement against "weapons in space" has gained momentum since the inauguration of President George W. Bush. There is a vigorous arms control lobby that views space as the last regulation frontier as well as "think tanks" and other advocacy organizations that are generously funded to oppose military programs that would lead to "weaponizing space." Without question, the arms control faithful look to leverage what they can from the political correctness crowd. And, in the end, the adversaries of the United States no doubt seek to exploit ideas and political inroads constructed by arms control and political correctness.

It all comes down to one question—how effective do we want to be against an evolving ballistic missile threat? If you can agree that American cities face a serious, potentially catastrophic threat in the future (whether that threat be from a nuclear strike or an electromagnetic pulse event), the answer ought to be that we should make our missile defense system as effective as possible. And to do that, we must be prepared to march confidently along the high ground surrounding Earth.

Notes:

[1] *US National Space Policy,* fact sheet, White House, US Office of Science and Technology Policy, released October 2006, www.ostp.gov/html/US%20National%20Space%20Policy.pdf (accessed on 23 January 2007). Space policy since President Eisenhower has been remarkably consistent with respect to national goals in space, with each iteration respecting the need to use force in space to defend US freedom of action. The real differences among the various administrations may be found in the budget submissions and justifications for defense space activities. As I argued in 2001 in Steven Lambakis, *On the Edge of Earth: The Future of American Space Power* (Lexington, KY: University Press of Kentucky, 2001), 207, "Fragmentary spending on military space programs, a decentralized defense space organization, and the unbalanced rhetoric of public officials on military space matters indicate that this country is deeply divided on this subject, the tough words in the National Space Policy notwithstanding."

[2] General James Cartwright, Commander US Strategic Command, before the Strategic Forces Subcommittee of the Senate Armed Services Committee, testimony, 7 April 2005, "If the nation needs it (missile defense), we have a thin line. We have an emergency capability. But the focus needs to be on increasing the depth of the sensors, the command and control and the weapons and realistic operational testing."

[3] Donald Rumsfeld, et al., *Executive Summary of the Report of the Commission To Assess The Ballistic Missile Threat To The United States*, 15 July 1998, http://www.house.gov/hasc/testimony/105thcongress/BMThreat.htm; "Ballistic and Cruise Missile Threat," National Air and Space Intelligence Center, NAIC-1031-0985-03, August 2003, 9; "The Iranian Ballistic Missile and WMD Threat to the United States Through 2015" NIO Robert Walpole, 21 September 2000.

[4] "Current and Project National Security Threats to the United States," Testimony of Director, Defense Intelligence Agency, Vice Admiral Lowell E. Jacoby before the Senate Select Committee on Intelligence, 17 March 2005, 11; "Annual Report on the Military Power of the People's Republic of China 2005," Department of Defense Report to Congress, 28 (China Annual Report); "Proliferation: Threat and Response," Office of the Secretary of Defense, January 2001, 17.

[5] I have addressed these criticisms in Steven Lambakis, "Space Weapons: Refuting the Critics," *Policy Review*, February/March 2001, no. 105, 41-51, and Steven Lambakis, "Space Cops: Reviving Space Arms Control," *Astropolitics 1*, no. 2 (Autumn 2003): 75-83.

[6] Dr. John Foster, Jr., et al., *Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack*, vol 1: Executive Report, report to Congress, 2004, 1, http://www.globalsecurity.org/wmd/library/congress/2004_r/04-07-22emp.pdf (accessed 24 January 2007); see also Curt Weldon and Roscoe Bartlett, "Counter the Mega-Threat: EMP Attack," in Frank Gaffney, et al., *War Footing: 10 Steps America Must Take to Prevail in the War for the Free World* (Annapolis, MD: Naval Institute Press, 2006), 00-112.

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Space Policy

How Can the Space Medium Be Further Exploited to Counter Terrorism?

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America's *Air Force Vision 2020* challenged US Air Force Airmen to integrate air, space and information operations.[1] *New World Vistas, Spacecast 2020* laid the groundwork for future thinking on the value of space power.[2] Space power evolved in a dramatic fashion very similar to what air power went through in the 20th century. Where that evolution will lead is a question of enormous impact.

Following the Soviet Union's 1957 Sputnik launch, US space operations progressed from the first space launch, the Explorer 1 satellite, through the Apollo Moon landing, to the successful space shuttle missions. Today, the strength of the US space program gives the US an edge over any potential foe.

Although the United States enjoys certain space advantages over other space fairing nations, it must continue to design, develop and even deploy new space capabilities to further exploit the medium of space. In particular, this continued exploitation of space will enable the US to more effectively fight terrorism.

There are numerous definitions of the word "terrorism." A working definition of terrorism is needed to describe how space applies to countering terrorism. It would also be of use in analyzing the nature of terrorism and its differences with conventional warfare, as well as the application of space power in the current Global War on Terrorism (GWOT). For example, how can the US leverage space to interrupt terrorism or even prevent terrorism? Can space assets be used to interrupt a terrorist financial network? Can information operations and information warfare applications from space be used to identify terrorism cells, terrorist targets, plans, and so forth?

With this in mind, how can present and, more importantly, future space capabilities be used to combat terrorism? Further discussions of conducting counter terrorism operations in and from space will be analyzed by showing how some of the US Air Force's distinctive capabilities are related to space power and how these capabilities could augment counter terrorism operations.

Finally, what is the future of US space power? What does the US need to do to prepare for the eventuality of space combat? Space is a unique medium to operate through in order to infiltrate transnational terrorism. Using space applications to interfere with states that sponsor terrorism is becoming ever more part of the today's political and military landscape. How will space power and future warfighting in, from, and through space enhance global strike operations and maintain the ultimate high ground?

Terrorism and How Space Applies to Counter Terrorism

Nature of Terrorism and the Differences with Conventional Warfare

Terrorists and terrorist cells seek to defeat us at our own game, asymmetrical warfare. Using asymmetrical attacks, they have used air warfare (9/11 airplane attacks on the US), land warfare (fighting in the hills of Afghanistan and streets of Iraq) and sea warfare (attack on the USS Cole). Space is the next logical medium for terrorists to act in unless the US prepares for this eventuality and remains vigilant. Using a space layer for offensive or defensive actions would help protect the United States and its allies against asymmetric threats designed to exploit coverage and engagement gaps in our defenses.

With this in mind, what is terrorism, what is the process(es) of terrorism. Can space be used to interrupt terrorism or terrorist activities? In other words how can the US leverage its current/future space systems to deter, deny, disrupt, degrade, or destroy terrorist networks?

There is no universally accepted definition of terrorism. Even within the US government there are different definitions among the interagencies. Foreign governments, the United Nations, the European Union, North Atlantic Treaty Organization, and so forth have different definitions of terrorism. This situation has muddied the waters with respect to combating terrorism. Internationally acclaimed counter terrorism expert Dr. Boaz Ganor stated that "most effective definitions of terrorism include three factors: its essence (violence or threat of violence), its targets (civilians or non-combatants), and its aim (to gain or maintain some form of political power by instilling fear and forcing political or social change).[3] A helpful work-

"Our safety as a nation may depend upon our achieving 'space superiority.' Several decades from now the important battles may not be sea battles or air battles, but space battles …"
~ General Bernard A. Schriever

ing definition of terrorism, which will be adopted in this article, is: "the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." [4]

Space power and the fight against the Global War on Terrorism

Although the primary focus of this article is to assess how space can/should be used to fight terrorism, it is also important to understand how terrorists use space for their own benefit. The 2006 National Security Strategy states that the DoD is tasked to answer the disruptive challenges from state and non-state actors who employ technologies and capabilities that include cyber and space operations or directed energy weapons in new ways to counter military advantages the United States currently enjoy.[5]

Up to now, space capabilities have allowed the US military to fight and win the nation's battles on its own terms. Advanced, space-based satellites enable reliable precision weapons, highly accurate air/surface navigation, swift and secure worldwide communication, timely intelligence-surveillance-reconnaissance data, and so forth. But these highly technical systems are not without their vulnerabilities. If adversaries were to take advantage of this strength and attack US space capabilities, all the modern sophisticated weapons systems and tactics could fail.

For most, the realization comes when the capability is lost, such as the Galaxy IV satellite disruption in May 1998. The failure of that one satellite left about 80-90 percent of the 45 million pager customers in the US without service for two to four days and over 5,400 of Chevron's 7,700 gas stations without pay-at the-pump capability.[6] The satellite suffered an error in its onboard control system, the backup switch also failed, and the $250 million satellite rotated out of position, completely disrupting communications. Company officials labeled it a "one-time random event."[7]

Could this have been a terrorist event? Most analysts claim that the failure was caused by solar activity (what space operators call a "single event upset") but the true source of the disruption may never be known. This incident was definitely one of the biggest satellite telecommunications outages in recent years.

Although international terrorists would hardly be able to reach space directly by current conventional means due to a lack of territory, capability, and infrastructure (unless they team up with a rogue state[s]), they could wreak havoc on space assets by destroying ground stations. Cyber-terrorists could also infiltrate command and control nodes, communication nodes, computer networks, and so forth. They could exploit a nation's own critical infrastructure and facilities to inflict damage upon that nation itself. For example, a satellite telecommunications ground station could be knocked out, a satellite imagery downlink station could be targeted or worst case a satellite in orbit could be destroyed. Such threats create a crucial need for tight security and protection of domestic and international cyber networks.

The key is to not allow the terrorists to get to the point that they could inflict severe and catastrophic destruction on the space segment(s). International terrorism will not be defeated from space, but space assets can contribute substantially to its containment. So how can the US employ space power to battle terrorism?

In response to the terrorist threat, the Air Force is developing and deploying terrestrial and space-based assets to counter the terrorist threats of the future. One of the concepts being addressed by the Air Force and other agencies is aggressively employing intelligence, surveillance, and reconnaissance assets in this fight. Intelligence is critical to being successful in this effort. As was witnessed in Operation Iraqi Freedom, "space-based collection systems, although indispensable, still experienced 'severe limitations in collecting signal intelligence and imagery'."[8]

Another concept in this fight against terrorism is conventional-warhead or conventional ballistic missiles (CBM). "The proposed capability, called 'prompt global strike' is needed to address threats—such as terrorist groups and underground weapons stocks and military facilities—that have proliferated and for which nuclear weapons are 'not appropriate' because they are too powerful and inflict high civilian casualties."[9] The CBM concept continues to gain momentum. The Pentagon has asked Congress for $500 million "to create a new force of conventionally armed, long-range missiles capable of striking anywhere in the world within an hour after an order is given."[10] Currently, the CBM concept calls for this type of weapon system to fall under the strategic control of United States Strategic Command (USSTRATCOM).

Another possible option is deploying a small space vehicle that could disperse weapons while traveling at 20 times the speed of sound.[11] These types of hypervelocity weapons are not meant to be "offensive" ***in*** space. Their intent is to strike targets on the ground, in the air, on the seas, and so forth.

Another critical aspect of terrorism is financing. Current and future space-based assets and technology could be used to hamper the terrorist's capabilities to move and spend funds. The key is surveillance and tracking. For example, using signals intelligence (SIGINT) satellites, space systems provide the platforms for surveillance and tracking. Such space-based assets could be combined with traditional terrestrial-based activities such as money tracking and asset freezing to disrupt terrorist financial activities. Current initiatives such as the Financial Action Task Force and the Interagency Terrorist Financing Working Group are two groups that are working toward this effort.

Electronic banking relies on satellite technology; electrons that flow through space can be tracked and even targeted for potential criminal activity. Using information operations or information warfare tactics and techniques to monitor electronic financial transactions can severely impact terrorist financing transactions.

Another resource frequently used by terrorist organizations is the Internet. Here again, communications and financial transactions move at the speed of light. Current SIGINT platforms, together with traditional communications intelligence sources and methods, could be employed in an offensive or defensive fashion to disrupt such activities.

As demonstrated, those involved in the GWOT will constantly have to remain one step ahead of the terrorists. Technology drives this effort but also represents a vulnerability. Conducting counter terrorism operations from space and with space-based assets is a logical step, one that will become even more compelling in the future.

Space and Terrorism: Using One to Combat the Other

Space-based assets have given the Nation's military leaders the luxury of trading the military principle of mass for speed and accuracy. In October, 2005 former Air Force Space Command Commander, General Lance W. Lord, retired, highlighted this point:

> "The capabilities and effects we provide from and through space are an enormous advantage to our American and coalition forces. We are able to find targets more quickly and use precision attack to maximize our combat effects on the battlefield, which shortens the "kill chain," while at the same time reducing collateral damage to civilian lives and property. When you integrate space into our military operations on the ground, in the air or on the sea, you significantly increase combat effectiveness while decreasing the number of American and coalition troops you put in harm's way. Thanks to space, our forces are able to move faster and fight smarter and more precisely. Those are keys to success in any war, but particularly in the type of unconventional counterinsurgency operations we're conducting in Afghanistan, Iraq and around the world in the Global War on Terrorism."[12]

One example of using current fielded space-based technology in concert with fielded ground-based systems to counter terrorism is the defense advanced global positioning system receiver (DAGR), shown below. Army ground units currently use the DAGRs to track insurgents and enemy activity.[13]

Figure 1. DAGR in the field.

If you compare space operations to air operations, one can readily see the similar advantages Airmen have had for years—transparency, precision, persistence, and mobility. Space combat, as politically incorrect as it may sound, is on the horizon or above it. If forces are not or cannot be deployed in an area of interest due to poor visibility or terrain, a capability to strike from space might provide some strategic and tactical regional options.[14] This strike capability would help solve the potential problem of getting into areas of denied access to strike targets deep within a heavily defended region, in addition to supporting the US Air Force's distinctive capabilities of global reach and global attack.

To further examine the prospect that space will become a battlefield in the future and how using space can counter terrorism, one must examine how a number of the US Air Force's distinctive capabilities relate to space power and their use in countering terrorism.

The United States Air Force's Distinctive Capabilities and Their Relation to Space Power

The US Air Force's Distinctive Capabilities are the enablers to what Airmen around the Air Force do on a daily basis. Four of the six distinctive capabilities are related to space power and the future of our role in conflict and countering terrorism, whether the battleground is air, land, sea, or space-based.

- **Precision Engagement and Global Attack**
  1. Space maneuver vehicles (SMV)[15]
  2. Space operation vehicles (SOV)[16]
  3. Common aero vehicles (CAV)[17]
- **Rapid Global Mobility**
  1. Military space plane (MSP)
  2. Near-space platforms
- **Agile Combat Support**
  1. Reusable single-stage-to-orbit launch vehicles (RLV)
  2. SMVs or SOVs
  3. On-orbit space depot

Modifying or enhancing each of these capabilities in space is the next step. These competencies will provide the Joint Force commander more weapons to conduct joint/multinational operations.

Precision Engagement as defined in Air Force Doctrine Document (AFDD) 1 "is the ability to command, control, and employ forces to cause specific strategic, operational, or tactical effects."[18] **Global Attack** is "the ability of the Air Force to attack rapidly and persistently with a wide range of munitions anywhere on the globe at any time."[19] These two "missions" can and will be conducted from space in the future.

To do so, the US needs new platforms. SMVs, SOVs, and CAVs are possible future space vehicles that the DoD, led by the US Air Force and major defense contractors, is evaluating, and for which it is seeking funding.[20]

The US Air Force already employs precision munitions and conducts wargames with global attack capabilities from

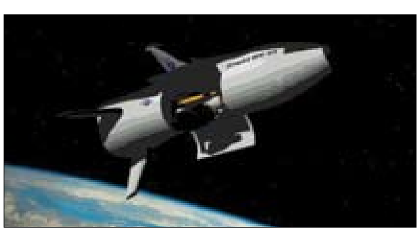

Figure 2. Artist depiction of a SMV.

Figure 3. Artist depiction of a SOV.

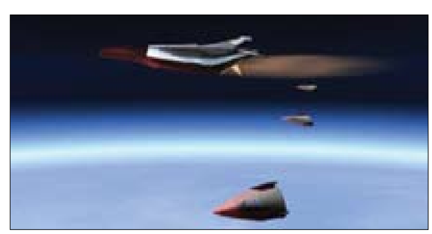

Figure 4. Artist depiction of a CAV.

and through space. In fact, "The combination of space-based navigational and timing services with precise weapons guidance is making the promise of air power's precision strike an aerospace power reality."[21] The Chief of Staff, US Air Force's (CSAF's) Title X, US Code wargame, Global Engagement, has showcased several types of space capabilities including tungsten rods (fragmentary penetrators) launched from space at speeds up to Mach 17 and CAVs that will deliver these precision weapons anywhere on the globe in less than 60 minutes. To use an example of speed and precision, consider the raid on Abu Musab Al-Zarqawi's safe house. A US Air Force F-16 used a laser guided bomb and a global positioning system (GPS)-aided precision guided munition to destroy the safe house. If you staged tungsten rods or CAVs on-orbit for potential future targeting, the timelines of a precision strike could be reduced even more, thereby further denying a terrorist safe passage and/or cover. Transporting or delivering these new weapons leads into the rapid global mobility mission area.

> *The combination of space-based navigational and timing services with precise weapons guidance is making the promise of air power's precision strike an aerospace power reality.*
>
> ~ Department of the Air Force, US Government White Paper, 2000

Rapid Global Mobility as defined in AFDD 1 "refers to the timely movement, positioning, and sustainment of military forces and capabilities through air and space, across the range of military operations."[22] Prior to the decision to cancel the X-33 program, there were several MSP concepts on the drawing board:

> A military space plane architecture has many compelling advantages … global access from either the continental United States or the world's oceans without overflight constraints, reduced risk of lost crew (from traditional piloted aircraft) or reduced dependence on a dwindling number of increasingly unwelcome overseas bases (making forward staging/basing harder and harder).[23]

Another concept with momentum is exploiting "near-space," which is the atmosphere between 65,000 and 325,000 feet.[24] For example, Raytheon Corporation is working on concepts involving short duration (hours or less), medium duration (hours to weeks), and long duration (weeks to months) type space platforms. Such platforms include unmanned aerial vehicles, airships, steerable balloons, and static balloons.[25] Why would the US want to go back to the past? The answer is persistence over the battlefield. Near-space offers persistence and is a key enabler when combined with low, medium and geosynchronous orbit platforms. "With our current space capabilities, it's not that the information isn't available; it's just that relevant battlespace awareness doesn't always reach our forces … with near-space, we believe we can provide persistence, payload and deterrence."[26]

These near-space platforms also are quickly recoverable, can be developed/launched more quickly and, once again, provide another asset to the Joint Force commander. Imagine a near-space platform high over the mountains of Afghanistan tracking terrorist squads that are continuously on the move. This type of surveillance could be of significant value if traditional overhead reconnaissance assets are either out of line of sight or not currently over the battlefield. Additionally, ground forces and air forces may not be in the proper positions at all times so near-instantaneous queuing from a near-space platform could be the key discriminator in a strike mission.

Finally, **Agile Combat Support**, is defined in AFDD 1 as "how the Air Force supports the forces we deploy forward … and the need to provide highly responsive force support."[27] Once again, drawing from Global Engagement and other wargames, such as Air University's former Tandem Challenge wargame and the joint land, air, and sea simulation, the Air Force is wargaming with fully reusable single-stage-to-orbit space launch vehicles (e.g., VentureStar), space maneuvering, and space operations vehicles that could put "bombs on target."

A VentureStar vehicle could possibly ferry troops and logistics from the CONUS to anywhere on the globe. With this in mind, future combat support could include, "support missions enabled by military space planes for satellite deployment and rapid constellation replenishment, to force enhancement missions like theater, space and global reconnaissance."[28] Reusable Launch Vehicles (RLVs) could become a tremendous asset to our warfighting arsenal. Once again, using the mountainous Afghanistan terrain as an example, troop resupply is a dangerous and complicated endeavor. But, a VentureStar type space vehicle or transport that could get supplies, additional troops, and so forth into theater or into denied or hard-to-reach areas would enhance the joint warfighter's ability to track down and capture terrorists and other types of enemy forces.

Agile combat support could also involve an on-orbit space depot that provides logistical support for continuous space force reconstitution missions. Additionally, the strike mission may be accomplished against surface, air, or space targets. Strikes from space may also enable attacks on targets which would otherwise be beyond the reach of air, land, and sea forces, thus enabling Precision Engagement/Global Attack missions to be executed quicker and more effectively.[29]

Precision Engagement, Global Attack, Rapid Global Mobility, and Agile Combat Support are significant capabilities that the US Air Force currently provides to the warfighter. Enhancing these competencies and moving deeper into the realm of space warfare will further complement the existing arsenal in the fight against terrorism.

Currently, the US does not have "active offensive" weapons on-orbit. Some would argue that our ICBMs could act as an offensive counterspace weapon (OCS, defensive counterspace known as DCS) since they travel from/through space. As mentioned earlier, some current experts advocate a conventional

ICBM capability. This type of weapon could be used to strike a ground target, a moving target in the air or on the ground, or eventually, even a space-based target. All involve a change in philosophy, renewed political will, and further legal analysis.

Legal Analysis of Space Warfare

Is there a political will to pursue space combat power? Many Americans generally agree that space should not be weaponized or even militarized. Some would argue that we have already militarized space by using GPS satellites for precision-guided munitions and space-based imagery for targeting and battle damage assessment. The critical piece will be if we cross the threshold with space-based weapons, either offensive or defensive in nature. The political will is also often tied to the legal questions pertaining to space warfare.

Is "the law" standing in the way of what the US wants to do? Furthermore, what international treaties/agreements and doctrine in relation to space combat are applicable? "Space law is of relatively recent vintage, with the Soviet launch of Sputnik I in 1957 ushering in the 'Space Age'."[30] To begin, the question of what is space law must be answered followed by what are the international treaties that apply to space operations/space combat and how are the "laws" interpreted with respect to national space policies, DoD and specifically Air Force space policies (since the Air Force is the executive agent for space)? One must only turn to the Office for Outer Space Affairs in the United Nations Office in Vienna, Austria for some clear definitions:

> Space law can be described as the body of law applicable to and governing space-related activities. The term "space law" is most often associated with the rules, principles and standards of international law appearing in the five international treaties and five sets of principles governing outer space which have been elaborated under the auspices of the United Nations Organization. However, space law also includes international agreements, treaties, conventions, rules and regulations of international organizations (e.g., the International Telecommunications Union), national laws, rules and regulations, executive and administrative orders, and judicial decisions.[31]

There are five international treaties that have become the basis for space law over the years: the informal customary names of these treaties are the "Outer Space Treaty," the "Rescue Agreement," the "Liability Convention," the "Registration Convention," and the "Moon Agreement."[32] Although the UN charter requires all UN member nations to settle disputes peacefully, the organization does allow states to act individually or collectively in self-defense. It is this provision that most space control proponents stand by with respect to offensive/defensive counterspace and space superiority systems.

Through the years, our domestic/national space policies progressed from promoting space for scientific purposes through the controversial Space Defense Initiative of the Reagan administration to the 1996 Clinton administration policy that is being updated by the Bush administration. This new national space policy, "is expected to give a green light to the already articulated by DoD and US Air Force strategy to fight 'in, from, and through space,' turning upside down some 40 years of US policy and practice that put a priority on the peaceful uses of space."[33] It is in step with the current Bush administration's policy of "preempting" aggressors before they can inflict harm against the US or coalition forces.

Counterspace opponents claim space law and treaties prevent tomorrow's counterspace missions. AFDD 1 defines counterspace as "those kinetic and nonkinetic operations conducted to maintain a desired degree of space superiority by the destruction, degradation, or disruption of enemy space capability."[34] They include both OCS and DCS missions.

The US already possesses active and passive counterspace capabilities. For example, attacking a satellite ground station with airpower or a satellite communications link with a communications jammer is an OCS capability. USSTRATCOM performs passive space protection missions with the Laser Clearinghouse program and with USSTRATCOM's Space Control Center collision avoidance analysis.[35]

Additionally, recent press reports indicate that the Bush administration is considering further enhancement of its ground based-laser capability. "The largely secret project, parts of which have been made public through Air Force budget documents … is part of a wide-ranging effort to develop space weapons, both defensive and offensive. No treaty or law forbids such work."[36] The nexus for this type of arms research dates back to the 1996 presidential directive which "allows for 'countering, if necessary, space systems and services used for hostile purposes'."[37] Suffice it to say, there are no direct limitations to conducting counter-terrorist operations from space. Research and development will continue in order to keep the asymmetrical advantage on the side of the US and its allies.

Recommendations: The Way Ahead

The US has a military advantage on the ground, on/under the sea, and in the air. It also clearly enjoys certain space advantages over other space fairing nations. As the value of space power grows over the course of the next twenty years, the US advantage in space will also grow. With this in mind, four recommendations can be offered:

Prepare for Space Combat

In a speech given in February 1957, the late General Bernard A. Schriever, USAF, retired, clearly gave his vision on the

"The new policy is expected to give a green light to the already articulated by DoD and US Air Force strategy to fight "in, from and through space," turning upside down some 40 years of US policy and practice that put a priority on the peaceful uses of space.

~ Ms. Theresa Hitchens

future of space and space superiority. He said, "Our safety as a nation may depend upon our achieving 'space superiority.' Several decades from now the important battles may not be sea battles or air battles, but space battles …"[38] We are at that point now, but we must prepare for the eventuality of actual space combat, especially if the US and its coalition partners are to be successful in this GWOT. "In future wars, it is inevitable that space operations will move from concept to practice."[39]

Enhance the US Air Force's Distinctive Capabilities

The US has mastered manned space flight, a new class of EELVs has completed their maiden voyages, and our satellite systems are becoming more and more technical. It is with this vision that we must look towards the future and further consider enhancing the US Air Force's distinctive capabilities (precision engagement, global attack, rapid global mobility, and agile combat support). "The quickening pace of war will place the emphasis on rapid, precision, target-specific strike to achieve desired effects and to minimize collateral damage."[40] Moreover, fighting terrorism has forced the US and other allies to change the way wars/campaigns are waged.

Continue Investing in Space Technology

The US must remain persistent in its efforts towards maintaining space supremacy by continuing to invest in space technology and programs ensuring that advocacy remains strong and supported. Using law as an excuse to prevent technology development and system deployment should not be a hurdle. "Space law and the law of international armed conflict do not dramatically limit military operations to, from, and within space."[41]

Producing new technology and new capabilities will further enhance the combat power of a joint/multinational force. Technological advances in space operations in this global campaign against an asymmetrical enemy are paramount to victory.

Exploit the Medium of Space

Exploiting the space medium should continue to be the aim of the US Air Force's space supremacy vision. Effects from space have been critical in the current counter terrorism campaigns and staying ahead of the enemy is vital. Developing and employing the space "tools" of the future will enhance the ability of joint and multinational/coalition forces to hunt, capture and defeat the terrorist threat. Space continues to provide the medium for the US and allies to stay ahead of the terrorist's ability to wage their type of warfare but this asymmetrical advantage could very easily be taken away if not properly protected.

Conclusion

For a variety of reasons that include, speed, maneuver, flexibility, and longevity in space, the time has come to increase our presence in space and to develop the capabilities that will ensure our success in space operations continues.

In this article, space power was examined through an analysis of how space operations are relevant to counter terrorism by describing the unique aspects of space power and the military and technological advantage that space provides. Using a working definition of terrorism, the focus shifted to describing how space applies to countering terrorism in today's fight and in future conflicts. Additionally, using space to combat terrorism was analyzed. Finally, an opinion on what is the future of US space power along with four recommendations for the national policy makers and military leaders was proposed.

Preparing to conduct military operations in space may prevent a *Space Pearl Harbor*. Former CSAF, General Ronald R. Fogleman, retired, said, "The Air Force must change its mindset … space will become its own warfighting medium."[42] Who will step forward to lead the charge to this new medium, to achieving space supremacy? The next Billy Mitchell or Guilio Douhet of space is out there somewhere carrying that space torch which must remain lit so that the path to space power can remain bright. Space warfare is on the horizon.

Notes:

1 Office of the Secretary of the Air Force and Chief of Staff, United States Air Force, *America's Air Force Vision 2020* (Washington, DC: Department of the Air Force, 2000), 4.

2 *Spacecast 2020*. In 1993, The Chief of Staff, US Air Force (CSAF) directed Air University to complete a study to identify capabilities for the year 2020 and beyond and to explore new technologies and how these new capabilities could best be exploited to support and preserve the security of the United States. The study, focused almost primarily on space power, began in 1993 and was presented to the CSAF in June 1994 was called *New World Vistas, SPACECAST 2020*. The most compelling finding of *SPACECAST 2020* was that "global presence through robust space operations is critical to the security of our Nation."

3 College of International Security Studies, "Program on Terrorism and Security Studies: Syllabus Book, Core Curriculum," George C. Marshall European Center for Security Studies, 2006, 4.

4 College of International Security Studies, "Glossary of Terms," 3d ed., handout, George C. Marshall European Center for Security Studies, 2002, 21.

5 *The National Security Strategy of the United States of America*, The White House, 16 March 2006, 44, http://www.whitehouse.gov/nsc/nss/2006/ (accessed 30 March 2006).

6 Major Charles H. Cynamon, USAF, *Protecting Commercial Space Systems: A Critical National Security Issue* (Maxwell AFB, AL: Air University, 1999), 9, http://www.au.af.mil/au/awc/awcgate/acsc/99-035.pdf (accessed 25 September 2006).

7 Daniel N. Baker and Michael J. Carlowicz, "ISTP and Beyond: A Solar System Telescope and Cosmic Microscope," Goddard Space Flight Center, http://pwg.gsfc.nasa.gov/istp/outreach/beyond.html (accessed 20 20 April 2006).

8 William B. Danskine, "Aggressive ISR in the War on Terrorism," *Air and Space Power Journal* 19, no. 2 (Summer 05) http://www.airpower.maxwell.af.mil/airchronicles/apj/apj05/sum05/danskine.html (accessed 15 March 2006).

9 Anne Scott Tyson, "Pentagon Seeks to Fund New Force Of Conventional-Warhead Missiles," *Washington Post*, 8 March 2006, http://www.washingtonpost.com/wp-dyn/content/article/2006/03/07/AR2006030701546.html (accessed 3 April 2006).

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11 Bryan Bender, "Pentagon Eyeing Weapons in Space," *Boston Globe*, 14 March 2006, http://www.boston.com/news/nation/articles/2006/03/14/pentagon_eyeing_weapons_in_space/ (accessed 15 March 2006).

12 Harrison Donnelly, "Space Warfighter," *Military Aerospace Technology* 4, no. 3 (20 October 2005) http://www.military-aerospace-technology.com/article.cfm?DocID=1207 (accessed 25 April 2006).

13 "GPS Enables Army to Track Insurgents," *Satellite Flyer*, 9 March 2006, 9, http://www.csmng.com/images/satelliteflyer/satelliteflyer_2006-03-09.pdf (accessed 25 September 2006). Previously, maps, compasses, and basic GPS were used to find, fix, locate, target enemies. Now this

hand-held device weighing less than a pound is giving US ground forces another ace in the hole. The DAGR is equipped with better anti-jamming technology known as the Selective Availability Anti-Spoofing Module that makes it much more difficult for enemy forces to jam signals or transmit false information.

[14]Lt Col Michael R. Mantz, USAF, "The NEW SWORD A Theory of Space Combat Power," ARI Research Report No. AU-ARI-94-6 (Maxwell AFB, AL, May 1995), 2.

[15]Image courtesy of: http://www.fas.org/spp/military/program/launch/x-40-smv.gif (accessed 25 September 2006).

[16]Image courtesy of: http://www.afrlhorizons.com/Briefs/Sept02/VA0210.html (accessed 25 September 2006).

[17]Image courtesy of: http://www.andrews-space.com/thumb/phpThumb.php?src=../images/pages/ecav-hcv.jpg&w=500 (accessed 25 September 2006).

[18]Air Force Doctrine Document (AFDD 1), *Air Force Basic Doctrine*, 17 November 2003, 80.

[19]Ibid, 79.

[20]The Space Maneuver Vehicle (SMV) is a small, very powerful, space vehicle and capable of staying in orbit for up to one year. The Space Operations Vehicles (SOV) is designed for vertical takeoff and single stage to orbit operations carrying satellites all the way to orbit. Once an SOV is launched from one of the three bases it performs its mission and then lands at its home base or one of the two other bases. The SOV could be used to launch microsatellites and CAVs. The Common Aero Vehicle (CAV) is designed for expendable suborbital flight with the ability to re-enter and disperse its payload in the atmosphere with high accuracy. CAVs are unmanned maneuverable spacecraft that would travel at five times the speed of sound and could carry 1,000 lbs. of munitions, intelligence sensors or other payloads. Among the system's strengths is that commanders could order a CAV not to release its payload if they decided not to follow through with an attack. Walter Pincus, "Pentagon Has Far-Reaching Defense Spacecraft in Works," *WashingtonPost.com*, 16 March 2005, http://www.washingtonpost.com/ac2/wp-dyn/A38272-2005Mar15?language=printer (accessed 25 September 2006).

[21]Department of the Air Force, *The Aerospace Force: Defending America in the 21st Century*, US Government White Paper (Washington, DC: Department of the Air Force, 2000), 13.

[22]AFDD-1, 80.

[23]Lt Col Jess Sponable, "Military Space Plane Needed," *Space News*, 18 December 2000, 29.

[24]In space travel lexicon, the space medium officially begins at 264,000 feet or the altitude where the astronaut designator is awarded.

[25]Frank Prautzsch, Raytheon Corp., "Future Initiatives in Near and Responsive Space for the Warfighter" (presentation at the MilSpace 2006 conference, Brussels, Belgium, 8 March 2006).

[26]Lt Col Ed Herlik, "Developing the Near Frontier," interview with TSgt Jennifer Thibault, *Military Aerospace Technology*, 20 October 2005, http://www.military-aerospace-technology.com/print_article.cfm?DocID=1210 (accessed 25 April 2006).

[27]AFDD, 81.

[28]Sponable, 29.

[29]Major Michael A. Rampino, *Concepts of Operations for a Reusable Launch Vehicle* (Maxwell AFB AL: Thesis, School of Advanced Airpower Studies, Air University, September 1997), 21.

[30]Michael N. Schmitt, "Military Space Operations and International Law," e-mail to the author, 25 August 2005.

[31]"International Space Law: Space Law Frequently Asked Questions," United Nations Office for Outer Space Affairs, http://www.unoosa.org/oosa/en/FAQ/splawfaq.html (accessed 20 January 2006).

[32]The formal names of these five treaties are: Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies; Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space; Convention on International Liability for Damage Causes by Space Objects; Convention on Registration of Objects Launched into Outer Space; and Agreement Governing the Activities of States on the Moon and Other Celestial Bodies; United Nations Office for Outer Space Affairs, http://www.unoosa.org/oosa/en/SpaceLaw/treaties.html (accessed 25 September 2006).

[33]Theresa Hitchens, "Update on US Military Space Policy and Strategy," (Center for Defense Information speech, 18 July 2005) http://www.cdi.org/friendlyversion/printversion.cfm?documentID=3064 (accessed 15 March 2006).

[34]AFDD-1, 42.

[35]"Air Force Lab Evaluating Satellites Vulnerability To Lasers," *Space Daily*, 12 July 2000, Kirtland AFB, http://www.spacedaily.com/news/laser-00i.html (accessed June 25, 2006). Any Department of Defense agency wanting to fire a laser above the horizon must first get permission from US Space Command's [dated article, now the request goes through USSTRATCOM] Laser Clearing House, which uses the center's information on satellite vulnerabilities to help determine if there are any satellites in the laser's path that should be avoided.

[36]William J. Broad, "Administration Researches Laser Weapon," *New York Times*, 3 May 2006, http://www.nytimes.com/2006/05/03/washington/03laser.html?ex=1304308800&en=d3975f5fa334c2ec&ei=5088&partner=rssnyt&emc=rss (accessed 3 May 2006).

[37]Ibid.

[38]Rampino, 43.

[39]Schmitt, 22.

[40]Peter L. Hays et al., *Space Power for a New Millennium: Space and US National Security* (New York: The McGraw-Hill Companies, Inc., 2000), 211.

[41]Schmitt, 22.

[42]General Ronald R. Fogleman, "Aerospace Power" (lecture, Aerospace Power Breakfast Symposium, Washington, DC, 1 February 2001).

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Global Positioning System International Challenges and Opportunities in the 21st Century

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The Navstar Global Positioning System (GPS) is a truly international system with civilian users in every nation on Earth. In addition, the United States armed forces and 46 allied nations have global access to GPS military signals. Since 1983, the US Air Force has continually provided civilian GPS signals worldwide without interruption. Through accurate positioning, navigation, and timing (PNT), GPS has both propelled international commerce and enabled revolutionary changes in modern warfare.

Today, GPS sets the worldwide standard for Global Navigation Satellite Systems (GNSS). The GPS Wing at Los Angeles AFB, California continues to sustain and modernize the GPS constellation as depicted by the most recent 17 November 2006 launch of the 3rd modernized IIR-M satellite in figure 1.

GPS has manifold civil applications ranging from automobile navigation, aircraft guidance, emergency location, tsunami and earthquake monitoring, and business transaction authentication, to land surveying. GPS military uses span the gamut of navigation and timing functions from aviation and rescue to targeting. As other nations deploy GNSS and GPS seeks to better serve the US and the world, international cooperation in support of GPS has become more important.

GPS threats and opportunities have never been greater, and cooperation is needed to counter threats and to pursue opportunities. The radio frequency spectrum is finite and crowded, making it a scarce resource increasingly sought by competing systems and services. While it can be mutually beneficial for GPS to share spectrum with other systems in carefully controlled ways, misguided attempts by other GNSS or non-GNSS systems to share GPS spectrum could be detrimental to GPS and other GNSS. Conversely, deliberate cooperation with other GNSS developers and operators results in improved civil receiver performance, providing more capable and robust service to all GNSS users.

Figure 1. GPS launch of modernized satellite Block IIR-16(M) on 17 November 2006.

Recognizing the unique technical and programmatic expertise available at the GPS Wing, the US Department of State has repeatedly turned to the GPS Wing for technical leadership in support of international GNSS activities. Since the GPS Wing mission is to "[a]cquire and sustain survivable, effective, and affordable [GPS] services for our customers," these international efforts are an inherent part of the GPS Wing's work.[1]

Successfully accomplishing this mission while meeting national space policy goals requires the extensive international exchanges summarized in this article. The following section describes the background and context of the GPS Wing's international work. In section two, work to ensure compatibility is described, followed by section three, an overview of efforts to enhance performance and interoperability. GPS Wing involvement in aviation standards and international military user equipment are summarized in sections four and five, respectively. Challenges and opportunities for the future are then identified.

Background

GPS is a continuous, space-based, all-weather PNT system. GPS satellites transmit radio signals that GPS receivers use to determine extremely accurate three-dimensional position and velocity information together with a precise common time reference. Although the nominal constellation consists of 24 medium Earth orbiting satellites, the constellation has grown to as many as 30 operational satellites in recent years. Each satellite circles the Earth at an altitude of 20,200 km (10,900 nm) with an orbital period of approximately 12 hours, in six orbital planes. Satellites currently transmit military and civilian navigation signals on each of two different L-band frequencies, L1 (1575.42 MHz) and L2 (1227.6 MHz). A third L-band frequency, L5 (1176.45 MHz), will also be used for civil signals starting later in this decade.

GPS is used worldwide for civilian as well as military purposes. US policy is to provide GPS civilian signals free of direct user fees to all users, along with openly providing the technical information needed to develop civilian GPS receivers and PNT services based on GPS. The US and its allies also share GPS military capabilities, jointly benefiting from the system's high accuracy, reliability, worldwide availability, and passive stand-alone operations.

There is increasing international interest in GPS augmentations and in the establishment of independent GNSS. For instance, the US, the European Union, China, India, Japan, and other nations are fielding Satellite-Based Augmentation Systems (SBAS) that provide greater accuracy and integrity to users who receive SBAS signals while continuing to receive the necessary GPS signals as well. SBAS signals use the same frequencies as GPS signals and, therefore, must be designed to be compatible and interoperable with GPS signals. In addition, the Russian Federation is repopulating its Global Navigation Satellite System (GLONASS), the European Union is developing Galileo, China is considering its own GNSS called Compass, and Japan is developing a regional augmentation system called the

Quasi-Zenith Satellite System (QZSS). By deliberate engagement with other GNSS, the US and the world can benefit from collaboration between GPS and these other systems.

Developing and modifying space systems takes many years, and users expect continued interoperability and compatibility with already-fielded receivers. Consequently, decisions made today will not take effect until the next decade, and will persist thereafter. Clearly, a consistent, long-term vision is needed in the international development and coordination of GNSS.

... decisions made today will not take effect until the next decade, and will persist thereafter. Clearly, a consistent, long-term vision is needed in the international development and coordination of Global Navigation Satellite Systems.

In recognition of increasing global use of GPS, and growing international interest in developing additional satellite navigation systems, the White House released a National Space-Based PNT Policy in December 2004.[2] This policy establishes guidance for space-based PNT programs, augmentations, and activities for US national and homeland security, civil, scientific, and commercial purposes. The policy update was timed perfectly to help guide the US's international cooperation in satellite navigation. The policy directive identifies two overarching goals that guide these international efforts:

- Remain the pre-eminent military space-based PNT service;
- Remain an essential component of international PNT services.[3]

In response to this guidance, the GPS Wing proactively works with our allies and other GNSS providers in the design and acquisition of GPS as the lead component of today's GNSS architecture. In turn, the GPS Wing engages in diverse international activities including International Telecommunication Union (ITU) spectrum meetings, GNSS working groups for signal compatibility, the North Atlantic Treaty Organization (NATO) and other allied GPS user equipment forums. Each activity seeks to provide uncompromised and enhanced GPS service. Leading these activities is important since they underpin successful GPS modernization, helping to ensure continuing and pre-eminent GPS service for all users.

Compatibility

In the context of satellite navigation, compatibility is the ability of multiple systems to be used either independently or collectively without unacceptable mutual interference. For theater-specific military operations, the US also seeks to preserve US navigation warfare (Navwar) operations. Navwar protects GPS operations for the US and our allies, while simultaneously preventing the hostile use of GNSS and preserving peaceful civilian uses of GNSS outside the area of operations.

Achieving GNSS compatibility is particularly challenging because GNSS signals have low power, wide-area coverage, and overlapping frequencies. The satellites transmit each signal with only tens of watts of power, more than 20,000 km above the Earth's surface. This power is dispersed over a region larger than the Earth, resulting in received signal powers typically less than a femtowatt—orders of magnitude lower than the thermal noise power in a receiver. Since many of these signals are received at each point on Earth, and many signals have overlapping frequencies, it's vitally important that the signals do not interfere. The unique signal characteristics make GNSS compatibility assessments very different from compatibility assessments for geostationary satellite communications, requiring significant technical sophistication.

Successful GNSS compatibility requires early international engagement in parallel with the development of GPS constituent components, including ground control, satellites, and receivers. For example, as initial space-vehicle (SV) signal design efforts commence, signal center frequencies, bandwidths, and power levels are defined, and the GPS Wing takes action to secure international authorizations for SV signal transmissions.

Obtaining necessary frequency spectrum is the critical first step in GPS development. According to US law and Department of Defense (DoD) Directive 4650.1, systems must have proper domestic and international authorizations to broadcast signals.[4] Proper authorization not only assures the GPS right to broadcast, but it also provides the basis for legal actions to protect against interference to GPS. To ensure GPS mission success, the GPS Wing has acquired radio frequency spectrum authorizations through appropriate ITU filings. Subsequently, the GPS Wing actively works in the ITU and other forums to protect GPS spectrum.

The GPS Wing works to protect GPS spectrum from two potential external types of interference: GNSS and other radio services. Should the GPS Wing fail to achieve adequate protection, changes to GPS programs could be required, with detrimental effects on GPS modernization schedules and GPS programmatic costs.

The GPS Wing protects spectrum in the global arena at the ITU World Radiocommunication Conference in which representatives of all nations of the world meet to review and revise ITU spectrum regulations. The ITU regulations constitute an international treaty that governs the use of radio frequency spectrum. Therefore, it's essential that the GPS Wing cooperate with ITU members to develop spectrum regulations favorable for GPS and GNSS operations.

The GPS Wing also works diligently to prevent interference from other GNSS signals. The GPS Wing participates in multiple international forums to sort through compatibility issues between GPS and other systems. The goal is to identify and resolve the natural tensions between sharing and protecting radio-frequency spectrum, and then complete the technical and legal steps required for optimal GPS service.

An example of this effort is the collaboration between the US and the European community that took place between 2002 and 2004. The GPS Wing (then called the GPS Joint Program Office) played a critical role in working with the European community to ensure that Galileo signal designs have adequate frequency separation from the modernized GPS military signal called "M-code." This long and sometimes challenging bilateral effort led to a mutually satisfactory solution that was documented in an agreement signed by then-US Secretary of State Colin Powell, European Commission Vice-President Loyola de Palacio, and the Irish Foreign Minister Brian Cowen. Technical aspects of the GPS-Galileo Agreement involved (1) balancing the performance and radio frequency compatibility of all signals, (2) achieving interoperability of civil signals, and (3) protecting US and allied capabilities of maintaining assured M-code PNT service while denying hostile use of PNT services. These three objectives were met by the GPS-Galileo Agreement of 26 June 2004. Figure 2 depicts the resulting baseline signal spectra defined in the GPS-Galileo Agreement.

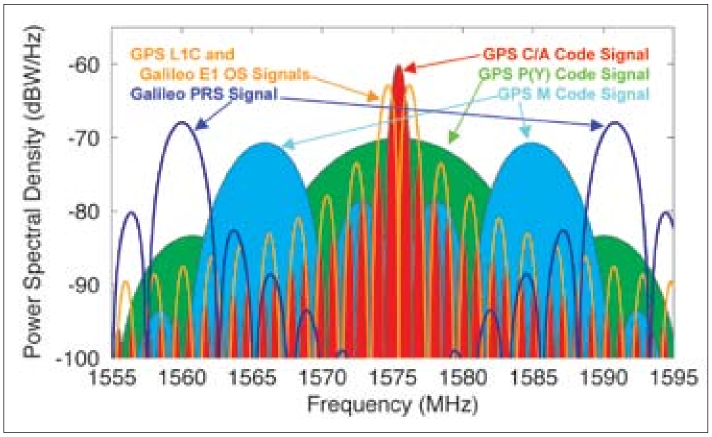

Figure 2. GPS and Galileo Signal Spectra in the Upper L1 band (1555-1595 MHz).

Note that the GPS M-code and the Galileo Public Regulated Service signals are spectrally separated from civilian signals. In addition, the GPS L1C and Galileo E1 Open Service signals share the same spectrum for enhanced interoperability while being spectrally separated from GPS Coarse Acquisition (L1 C/A) code for improved radio frequency compatibility.

Finally, GPS must prevent interference from systems other than GNSS. The very low received power levels of GNSS signals makes these signals vulnerable to interference from other systems, whose received power levels may be orders of magnitude higher. The continuing worldwide growth in radio frequency devices, combined with the limited availability of radio frequency spectrum, means that new radio frequency systems and services are always looking for spectrum—including spectrum currently used for GNSS.

As an example of how these conflicting interests are resolved, it is illustrative to review the ultrawideband (UWB) controversy. In 2001, developers of UWB, a new technology for personal communications and sensing, petitioned the Federal Communications Commission and international bodies for permission to radiate signals in the GPS frequency bands. Because of its transmission characteristics and power levels, UWB presented a significant interference threat to GPS service. In order to protect GPS and all GNSS, the GPS Wing conducted its own interference tests of proposed UWB operations. The results of the tests reflected that UWB operations would exceed acceptable GPS thresholds. These tests, combined with other information from GPS Wing technical experts, served as the foundation for regulations established to limit interference from UWB. Had this assessment process not been followed, GPS could have experienced detrimental interference that would have unacceptably degraded its performance.[5]

Performance and Interoperability

Since GNSS performance improves with more satellites in view, civil users benefit when their receivers can use signals from multiple GNSS constellations. Receivers with a limited view of the sky (due to blockage from buildings and trees) will still be able to receive signals from a sufficient number of satellites, and thus obtain position and time. Receivers with a better view of the sky will take advantage of the redundant signals to obtain improved accuracy and better integrity. Highly interoperable signals allow lower cost receivers to take advantage of the multiple constellations.

In the context of satellite navigation, the US has defined interoperability as the ability of civil US and foreign space-based PNT services that, when used together, provide better capabilities at the user level than would be achieved by relying solely on one service or signal. The GPS Wing works actively with experts from other GNSS systems to design civil signals for improved interoperability. The goal is to cooperatively design satellite systems that not only transmit compatible signals, but also deliver enhanced performance via signal interoperability.

Sometimes enhanced performance arises from the creative collaborative efforts of bilateral working groups. An example of such an accomplishment is the joint development of the Multiplexed Binary Offset Carrier (MBOC) spreading modulation for the GPS L1C signal and the Galileo Open Service signal in the L1 frequency band (centered at 1575.42 MHz). Although the 2004 GPS-Galileo Agreement defined a baseline spreading modulation, it also allowed for optimization of this baseline signal structure. In winter 2006, a group of European and US experts met to develop an optimized signal structure, yielding MBOC. The GPS-Galileo Working Group on Interoperability and Compatibility, whose co-chair for the US is the GPS Wing chief engineer, recommended that GPS and Galileo adopt MBOC, which will ultimately provide better overall performance while retaining frequency separation from military signals.

Interoperability is also promoted by maximizing the commonality of civil signal designs used in different systems. GNSS receivers of common signals (having similar technical characteristics) can be smaller, use less power, and cost less, allowing them to provide better performance and proliferate throughout the marketplace. Since the GPS Wing is a key participant in signal design and maintains interface control documents on all GPS signals, it serves as the US lead for bilateral efforts with other countries on GNSS interoperability.

A recent example involves GPS and Japan's QZSS. During

2005 and 2006, experts from Japan and the US worked to share information and explore opportunities for inter-system compatibility. As a result of these joint efforts, QZSS plans to provide signals that are common with existing and future modernized GPS signals. Consequently, receivers using these interoperable signals can be developed with the lowest cost while providing the best possible performance.

Through multiple bilateral efforts led by the GPS Wing, the US has now achieved a high degree of interoperability between GPS, Galileo, SBAS, and QZSS. Discussions with Russia are also ongoing concerning the possibility of enhanced interoperability between GPS and GLONASS. Should a mutually acceptable solution be found, the GPS Wing will be successful in enhancing performance and interoperability of civil signals on three global systems and one regional system. Users worldwide will benefit as foreign GNSS essentially double or triple the number of "GPS-like" signals and satellites that will be available to civilian GNSS users worldwide.

Aviation Navigation Standards

While the Federal Aviation Administration works with other civil aviation authorities on navigation standards for civilian aircraft, the GPS Wing is the US lead for efforts involving GPS military aviation navigation standards. GPS Wing goals in developing GPS air navigation standards are twofold: (1) to ensure the safe and efficient co-existence of civil and military air navigation activities within the same domestic and international airspace and (2) to ensure that aviation standards and policy are consistent with the military needs of the US and its allies.

GPS navigation standards are developed around two fundamental GPS services: the standard positioning service (SPS) and the precise positioning service (PPS). The SPS is open to all users, while the PPS is an encrypted service allowing access to authorized (primarily military) users. In support of these services, the DoD develops standards defining the level of GPS performance that the federal government commits to provide to civil GPS users.[6] On behalf of the DoD, the GPS Wing is responsible for performance and certification standards affecting military operations. These standards also affect GPS procurement, since they are used by recognized aviation authorities and equipment manufacturers to design GPS receivers for flight safety purposes. At times, receiver design influences required satellite signal power, which, in turn, influences satellite design. Thus, the GPS Wing mitigates programmatic risks by working with aviation and receiver manufacturer personnel to provide adequate signals and standards governing the use of those signals.

Individual nations participate in international forums such as the International Civil Aviation Organization (ICAO) and NATO to collectively develop recommended practices relating to these performance and certification standards. Since such guidelines influence national regulations, ICAO and NATO can ultimately affect seamless military operations and the design of GPS satellites.

In military aviation, the GPS Wing led the development of GPS PPS performance standards. The benefits of these new GPS PPS standards can be measured in lower cost of military aircraft navigation systems, streamlined overall airworthiness certification, and a decreased workload on air traffic controllers. Air navigation standards work conducted by the GPS Wing in NATO now allows US and allied military aircraft to seamlessly transit international airspace.

Working with NATO Nations and Other Allies

In addition to generating air navigation standards, the GPS Wing also works with 25 NATO nations and over 20 other allied nations to standardize and promote the use of GPS for military operations. In particular, the GPS Wing is responsible for GPS foreign military sales (FMS), the joint development of future military user equipment, standardization agreements, and tests and evaluation of Navwar operations. Furthermore, every six months, the GPS Wing supports a NATO navigation subcommittee (S/C 8), where allies meet to discuss specific GPS issues, including navigation standards, dissemination of cryptographic keys, equipment interoperability, Navwar operations, and other common navigation issues.

In furtherance of this effort, the GPS Wing collaborates and interfaces with international military partners as they integrate GPS into their land, sea, space and air forces' structures. In 2006, the GPS Wing delivered to allies roughly $50 million of FMS equipment. The GPS Wing's efforts to assist in standardization of GPS receivers across allied forces support such equipment sales. In doing so, Navwar capabilities are enhanced in coalition warfare, including synchronized troop movements, jamming environments, and weapon delivery. Looking to the future, the GPS Wing anticipates enlisting additional allied co-

Figure 3. The A400M will be employed by seven NATO nations on inter- and intra-theater air transport tasks. It will have the ability to employ either national or common GPS cryptonets for seamless Navwar operations.

Figure 4. (left) A bundle with the new GPS-guided Joint Precision Airdrop System (JPADS) attached to the top drops out of a C-130 Hercules on 31 August 2006. This drop was the first ever JPADS drop in a combat zone in Afghanistan (photo by US Army Sgt. Michael J. Taylor). (right) JPADS in flight carrying 10,000-pound payload dropped from a C-130 at 25,000 feet over Yuma Proving Grounds, Arizona.

operation in the development of technology demonstrators and system prototypes in areas such as GPS secure receivers, anti-jamming equipment, and joint trials and exercises.

Summary and Look to the Future

The GPS Wing's international efforts summarized in this article are essential for GPS program success. The relationships, approaches, and agreements formed in each international interaction are carefully constructed to support each other. Even more important are the benefits that accrue across different activities. For example, the involvement of US allies in the use of military GPS provides international support for ongoing GPS Wing efforts in compatibility, and worldwide civilian use of GPS provides support for enhanced performance and interoperability with other GNSS.

The future of GPS Wing international activities offer continued opportunities and challenges. Domestic and international spectrum filings are required for the GPS III program to secure radio frequency spectrum for navigation, uplink, and downlink signals. Several important new activities involving compatibility with other GNSS are also on the horizon, building on the continuing work with current GNSS partners to protect military GPS capabilities. While designing and protecting GPS signals, the GPS Wing will also work towards M-code protection by establishing proper aviation standards and coordination with NATO and other allies.

As the GPS Wing continues to acquire modernized space segments, control segments, and military user equipment, its international activities complement these acquisition activities to provide the best possible satellite navigation capabilities for the US and the entire world.

Notes:

[1] Navstar Global Positioning System Joint Program Office (SMC/GP), mission statement, http://gps.losangeles.af.mil/jpo (accessed 9 January 2007).

[2] Fact Sheet, *US Space-Based Positioning, Navigation, and Timing Policy* (15 December 2004).

[3] Ibid., III.

[4] Department of Defense Directive 4650.1, *Policy for Management and Use of the Electromagnetic Spectrum,* 8 June 2004.

[5] National Telecommunications and Information Administration, *Assessment of Compatibility Between Ultrawideband (UWB) Systems and Global Positioning System (GPS) Receivers,* iii, xx (NTIA Special Publication 01-45, 2001).

[6] Assistant Secretary of Defense for Command, Control, Communications, and Intelligence, *Global Positioning System Standard Positioning Service Performance Standard,* October 2001.

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The Moon is a Land without Sovereignty: Will it be a Business-Friendly Environment?

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Article II of the 1967 Outer Space Treaty (OST) states that, *"Outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."*[1] There is a simplistic misinterpretation that these few words mean that space is "free for all" and that no nation and no person can own anything in space. Some people argue that without the ability to own property in space commercial, firms will not invest and develop space businesses. Currently, the primary thrust of this argument centers on the ownership of real property on the Moon and the ability to use lunar resources for profit-making activities. National Aeronautics and Space Administration's (NASA's) recent invitation to both domestic and foreign entities to develop commercial opportunities on its planned lunar base and settlement about 15 years hence has further stimulated discussion of this issue.

A full discussion of property rights in space is complex and beyond the scope of this short article. However, the ownership of real estate on the Moon is neither a necessary nor a sufficient condition for investing in a lunar business with the ability to receive a fair return on that investment. Even terrestrially, profitable businesses often do not own the land or the buildings they occupy. They use different types of legal contracts including: leased property, condominium ownership agreements, cooperatives, and other risk-sharing agreements that businesses find perfectly suitable for profit-making activities. Property ownership is an option, but not a necessity. In short, ways can be found by the various governments involved in lunar activities to encourage business investments when, and if, companies identify potentially profitable activities.

The most important concern for private businesses in space activities is not property rights. It is the ability for a company to make a rate of return on a new investment that is greater than the return it can get from other investments. The length of time to realize that return is also very important. A typical business plan forecasts returns over a relatively short period (usually five years, but it can sometimes be slightly longer). A space activity that may not materialize for 20 years is well beyond any real business plan that most companies would consider today. Far more important business risks than property rights would have to be overcome to provide incentives for companies to put today's cash into a future lunar enterprise.[2] For space commercial investments, governments should deal with current problems, not the hypothetical (and solvable) legal issues that will not have true definitions and meaning for at least another generation.

The issue of sovereignty is more directly concerned with having a government or intergovernmental organization guarantee the protection of the right of that business to use the land or resources and not to encounter competing claims on the land from others.

Property rights and national sovereignty exist in a limited form in space today. Anything launched into space is owned by the nation or individual (including companies) that launches it and they are financially responsible for damage to other objects, whether in space or on Earth.[3] Nations have agreed to recognize sovereignty over some space equipment and facilities, such as the International Space Station (ISS) where the governing multilateral agreement specifically allows the nation owning a module to assert elements of sovereignty over that portion of the ISS.[4] Also, intellectual property rights on the ISS are allocated through special provisions of the Space Station Agreement.[5] The United States space policy considers satellites owned by the US as part of its sovereign domain.[6] Taking and using resources from the Moon is not specifically prohibited by the OST, although certain considerations such as limits to environmental damage have to be adhered to.[7] Use of the spectrum and orbital positions are granted through the International Telecommunications Union. Although these are not traditional property rights, they do reserve very limited bands of the spectrum for exclusive use by governments or businesses, albeit for a limited time.

Outer space is regulated and controlled by treaties, governmental legislation and policy, and through common practice. There are many types of property and many types of property rights in space just as there are many types of property and property rights terrestrially. In fact, in capitalist nations property rights are essential for the smooth operating of a profit-motivated private economy. The same conditions are expected to apply to space activities, at least by the major capitalist nations planning space exploration, and exploitation.

The myth that ownership is prohibited in space has led to misunderstandings about the potential for commercial use of space resources and to a call for the negotiation of new treaties. This is unwarranted and would likely result in many years of more rather than fewer rules and regulations being in limbo because:

- The treaties in place, although not perfect, provide a foundation for space activities that have become customary international law and establish basic principles of behavior that are accepted by all space-faring nations.
- Renegotiating the treaties could put all current provisions on the table for discussion and create more commercial (and political) uncertainty rather than less.[8] This would have a negative effect on business investment decisions because of increased perceived (and possibly real) risk.
- Commercial proposals for using lunar resources are currently only "powerpoint businesses." No private lunar

activities that threaten resources or environmental damage are imminent. None of the business proposals can establish a business case that has attracted both sufficient investment funds and has demonstrated the potential to make a profit.[9] Negotiating rules or specific changes now to accommodate a theoretical future business could jeopardize a truly valid business opportunity.

- Most of the governmental and private sector attention is on the Moon. A prerequisite is for research and development programs that will prove or disprove the value of lunar resources for sustaining human life on the Moon and/or discovering new and valuable uses for lunar resources. At least in the near future, these activities will be carried out by government(s) or private partnerships with governments; any commercial participation will necessarily be heavily influenced and regulated by the respective governments.

The present series of the five space treaties are not perfect.[10] The OST has been ratified or signed by 64 percent of the member nations of the United Nations (UN); the other treaties have been signed by many fewer nations with the Moon Treaty ratified by only 12 of the 192 nations. The language of the treaties and definition of key words is not entirely consistent, either among the five treaties or in the translations among the various official languages of the UN. Many key terms, such as space object, launching state, and "exploitation, exploration, and use" are defined so loosely in the treaties that they are still subject to international negotiations, which have failed to provide definitive interpretations. For example, the Registration Convention does not provide for the transfer of ownership in the event of a sale, bankruptcy, lease, or other business transaction.[11] And that convention leaves the interpretation of what a space object is and the timing of the actual registration with the UN up to the reporting State.

The enforcement of the provisions of the treaties is weak. It is left to negotiations between aggrieved parties and, if that fails, the formation of a UN Commission to make recommendations to the affected nations. This can become a lengthy and uncertain path for a possible commercial dispute. The International Court of Justice does have final authority within the present construct of legal appeals.

The focus of the currently debated issues is primarily with the right of a nation or its citizens to claim physical property and resources on the Moon and to use that property for political, security, or commercial gains. The treaties clearly prohibit a declaration of sovereignty over the lunar territory; they do not prohibit the use of that property. But the treaties do limit use. Limitations include military operations and environmental damage. Another provision that can interfere with commercial operations is the requirement of a right of others to travel through the property as well as visit the facility.[12]

As the US prepares for its return to the Moon, NASA has identified parts of the lunar South Pole for establishing a base of operations. What were mainly far-future questions about land and resource ownership on the Moon are beginning to become real questions that need answers. At present, most of those issues are more relevant to government programs rather than commercial questions. With the invitation from the US for other nations eventually to develop commercial enterprises on this territory, additional questions that the current treaties are unable to resolve are raised. Specifically,

- Are there plans for the exploration, exploitation, or use of the Moon? Does it matter which one of the objectives is claimed by the nations or enterprises?
- Will the US "claim" the property itself and use some type of system to defend the property?
  - Since any equipment put on the Moon is owned by the nation that built and launched it, is defending property the equivalent of defending the territory on which it is placed?
- Is such a "claim" a declaration of sovereignty?
- Will lunar resources be owned by the user? Are rights similar to those of some nations on the Earth where the owner of the property also owns everything beneath and above the property? If so, how far down or up might the rights apply?
- What does the phrase "province of all mankind" in the Moon Treaty mean? What are the positions and roles of nations that do not have the technology to access the Moon?
- If other states claim the right to use parts of the Moon, can companies wishing to use that territory "forum shop" for jurisdictions with lenient laws?
- What will the status of intellectual property developed on the Moon be?
- Will provisions, regulations, and negotiated agreements concerning the Moon also be applicable to other celestial bodies such as asteroids? Will they be applied to other aspects of space such as orbital paths?
- Finally, there is an assumption by NASA and by the US government that the US will be the first nation to return to the Moon. It is important to remember that other nations also have plans and the potential to establish bases on the Moon. If another nation is first, what legal claims and perhaps precedents will they establish? What might be the US policy on sovereignty and property rights towards someone else getting to the South Pole of the Moon and putting equipment there first? How might this change the tenor of international negotiations?

Answers to these questions will be important for commercial activity to develop in space. The fact remains that commercial business for profit on the Moon is at least 15, if not many more years ahead. Trying to establish specific rules for some type of activity that is yet undefined is pointless. History has shown that when a profit potential truly exists, and real capital is invested by private firms to earn that profit, governments make every effort to find ways to make it work.

A case in point is the Aérospatiale-BAC Concorde supersonic transport (SST). The technology for the SST existed well before the commercial plane was built. It took about 15 years of development before the Concorde was tested and ready for commercial passengers. In order to get landing rights in the United States it technically had to conform to the Federal Aviation Regulations (FARs) that govern all commercial planes. The Concorde was not in compliance. The US Department of Transportation (DOT) negotiated waivers to those FARS and imposed special rules that permitted the Concorde to fly and land in the US for 25 years. In spite of the fact that it did not prove to be a profitable airplane, governments found ways to accommodate the new technology and allow the companies to operate commercially.

Another example is human sub-orbital flight. Actual business operations are still in the future, but with the success of SpaceShipOne (built by Scaled Composites, LLC) winning the X-prize, the potential was proven. In the United States, Congress passed a bill requiring the DOT and Federal Aviation Administration (FAA) to propose rules to encourage this activity and to provide sufficient regulations to protect the public.[13] In December 2006, these rules were finalized and published by the FAA.[14] Whether or not the companies planning to offer the flights publicly succeed or not, the legal and regulatory system responded in a timely fashion.

Finally, returning to the issue of the ownership of property rights, it has been proven many times that governments find ways of guaranteeing the ability for companies to make profits, even if the ownership of land itself is not permitted. In the former Soviet Union, all real property was owned by the government. Western companies that saw profit opportunities in the large potential market within the Soviet Union needed assurance that their investments and property located within the Soviet Union would be protected. The solution was a special government organization within the Soviet Union that provided guarantees to those companies similar to property rights in a western society.

It is likely that some form of inter-governmental accommodation will be found for private space activities at the proper time and with the proper limitations. The most important incentive for a commercial enterprise is the assurance that a fair rate of return can be made on a capital investment. That assurance can be accommodated through many avenues that may *or may not* involve the actual ownership of the land and resources. It will be up to future negotiations on specific business projects to find the appropriate means to provide those incentives, but only when a real, not a hypothetical problem, exists.

Between the flexibility of the OST and the many precedents in the history of terrestrial business activities, it is clear that solutions can be found to not only permit, but also provide incentives for private business to exist on the Moon and in other outer space ventures.

Notes:

[1] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1967), Article II, 18 UST 2410, 2413 (1969).

[2] For example, reducing the up-front cost of launching payloads into space and/or reducing the risks of launch failures.

[3] Outer Space Treaty (OST), and the Liability Convention, Article VII (see note 10, below).

[4] Agreement Among the Government of Canada, the Governments of Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States Concerning Cooperation on the Civil International Space Station (1998), http://www.nasa.gov/offices/ogc/international/Intnl_subst_areas_text.html.

[5] Space Station Intergovernmental Agreement.

[6] *US National Space Policy,* fact sheet, White House, US Office of Science and Technology Policy, released October 2006, www.ostp.gov/html/US%20National%20Space%20Policy.pdf (accessed on 23 January 2007).

[7] OST, see note 1.

[8] For example, the provisions of the Law of the Seas Treaty that call for equitable sharing of both profits and technology associated with mining of the sea bed was found unacceptable to the United States. A compromise was found with the New York Agreement of 1994 which set up an international Administration which grants permits for mining the sea bed and acts in "commercially... ways." (Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, http://www.un.org/depts/los/convention_agreements/texts/unclos/closindxAgree.htm. It is interesting to note that this compromise was not needed until it was shown that there were resources in the sea bed that had true commercial potential and companies were in position with the technological capability to actually get those resources profitably. A similar commercial showing on the Moon or other celestial bodies has yet to be found.

[9] Where profits may be indicated in these proposals, they are based on either a time frame that is well beyond normal business plans (i.e., greater than 10 years), and/or require very significant government subsidies. None of these proposals can stand alone as competitive commercial investment opportunities.

[10] Apart from the OST, these include: the Liability Convention (cited in note 1); Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (1968), 19 UST 7570 (1969); the Convention on Registration of Objects Launched into Outer Space (1975), 28 UST 695 (1978); and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1979), 1363 UN Treaty Ser 3 (1984).

[11] Registration Convention, see note 10. But it should be noted that a clear definition of what are military operations, what is environmental damage, and what types of passage and/or rules for "visitation" does not exist. When disputes arise over these issues in the future, either negotiation between the parties involved and/or a lengthy legal battle and judicial interpretation may occur. Alternatively, the parties with the potential to use the Moon may be able to negotiate specific contractual agreements before a problem occurs. Whether such contractual agreements will or could become customary international law is, of course, unknown at present.

[12] The Moon Treaty goes further than the OST in prohibiting any military bases on the Moon (Article 3). Article 4 states that: "The exploration and use of the Moon shall be the province of all mankind and shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development. Due regard shall be paid to the interests of present and future generations as well as to the need to promote higher standards of living and conditions of economic and social progress and development in accordance with the Charter of the United Nations." This is interpreted by some to mean that technology and profits have to be shared by all nations and is one of the major reasons that the Moon Treaty has not been ratified by very many nations (including the United States).

[13] US Congress, HR5382, Public Law 108–492—Dec. 23, 2004 Commercial Space Launch Amendment Act of 2004.

[14] Human Space Flight Requirements for Crew and Space Flight Participants: Final Rule (pdf)-211, http://www.faa.gov/about/office_org/headquarters_offices/ast/human_space_flight_reqs/.

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Call to Action: A Space Diplomacy Offensive

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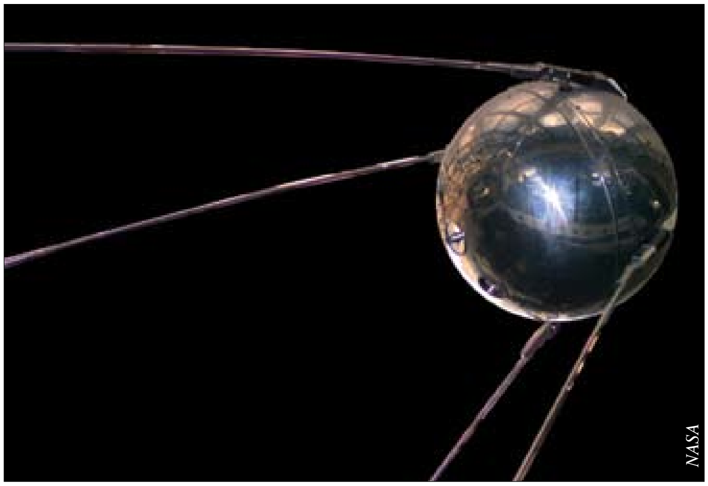
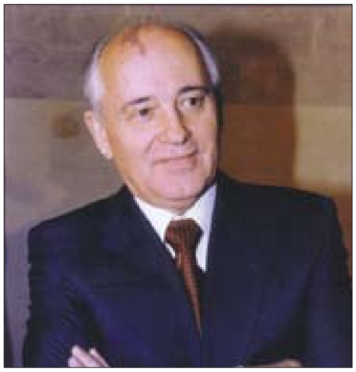
The debate over the "militarization" of space began in the Cold War propaganda battles of the early 1960s. Though the technologies of peacekeeping and warfighting have evolved through several generations since then, this anachronistic rhetoric—and associated institutions and norms—persist and now constrain our pursuit of national security. Our military has become increasingly dependent on reliable access to space-based assets, and so it is only natural and prudent to seek some forms of "space control" and "space superiority." However, achieving space control unilaterally could unnecessarily provoke potential adversaries, provide others the opportunity to label the United States as the international space "bad guy" and make it more difficult to leverage the increasingly international space industries and civil programs. Conversely, a proactive diplomatic campaign to revamp associated international agreements could loosen policy constraints, influence other actors' behavior and enhance the US' international standing.

It is ironic that an arena characterized by cutting edge technologies remains trapped in a rusty, rhetorical cage dating from the mid-1950s. Two of the first salvos in the space race were actually humanistic propaganda: In July 1955, the Americans and Soviets both announced their intentions to launch research satellites as a part of the International Geophysical Year. Later, in the late 1950s, official Soviet legal experts repeatedly declared that the "freedom of the seas" applied to space, and that reconnaissance satellites have free right of passage since, they argued, it is the Earth that rotates underneath them. Then, in early 1959 the Soviets changed policy, declaring that reconnaissance satellites were illegal and subject to "reprisals and retaliation."[1] The Soviets had decided to leverage their closed system by projecting peaceful intentions while publicly berating the US for "militarizing" space. Meantime, the US openly brandished its intelligence to deflect Soviet bluster, such as during the Cuban Missile and 1961 Berlin Wall crises.[2]



The Sputnik 1 spacecraft was the first artificial satellite successfully placed in orbit around the Earth and was launched from Baikonur Cosmodrome at Tyuratam in Kazakhstan, then part of the former Soviet Union. The Russian word "Sputnik" means "companion" ("satellite" in the astronomical sense).

The Soviet propaganda was a thin sham: For instance, the Soviets introduced a resolution banning space-based reconnaissance and other space militarization to the United Nations Committee on the Peaceful Uses of Outer Space on 7 June 1962—less than seven weeks after they launched their first spy satellite. For good measure, they launched at least five more spy satellites over the next 10 months, before introducing a second such resolution intended to embarrass the US.[3]



Mikhail Sergeyevich Gorbachyev, general secretary of the Communist Party of the Soviet Union, 11 March 1985 – 25 December 1991.

The Soviets continued to exploit their closed system and dual standards to claim the moral high ground in space through 1991. For examples, fast forward to 1987, when Mikhail Gorbachev lectured Secretary of State George Shultz for five hours during Strategic Arms Reduction Treaty negotiations about what he called the "root problem," namely the United States' insistence on placing "offensive arms in space," or to 1988, when, addressing the United Nations General Assembly, Mikhail Gorbachev assumed the mantle as the global diplomat leading the world into nuclear and space "de-militarization."[4]

The Soviet approach may have been a cynical sham, but it has had lasting impact. For decades the bulk of the world's legal and diplomatic space experts focused on how to institutionalize the "use of outer space for peaceful purposes" in the "common interest of all mankind."[5] These international experts formed an influential international community of individuals, ideas and international agreements that have sought to advance "peaceful" uses of space—and ban the "militarization" of space. Beyond dividing spectrum, registering spacecraft, and assigning liability, the major thrust of international space law has been to proscribe military uses of space.[6] Along the way, the politics of consensus has tolerated vague definitions of what constitutes "militarization" and "offensive" space weapons.[7] The Anti-Ballistic Missile Treaty (ABMT) further proscribed military uses of space.

As a result, US legislators and other policymakers have limited US military space spending qualitatively. Even seriously and publicly debating the need to defend space-based assets has been largely taboo. Only in the last 24 years have we seriously begun seeking space and other assets to defeat incoming offensive missiles, and that has involved rancorous, partisan, and healthy debate. Defeating incoming missiles is, at least in principle, a desirable goal. So too, is providing our fighting forces the space situational awareness upon which they depend. Though our intentions in securing space control may be to preserve the peace, reasonable parties will be able to consider such activities potentially more offensive and destabilizing than missile defense. Though technologies' purposes are not always simple, it is clear that norms have constrained policies, and policies have constrained programs for decades. Technologies, the nature of our military and geopolitics have shifted considerably over that period, but the norms and policies remain relatively static. Almost 50 years ago, the two super- and space-powers tacitly agreed to tolerate each other's spy satellites as providing a bulwark of stability in an information-starved, fragile peace hovering on the edge of mutual-assured destruction. Today these satellites provide many more essential and advanced functions, and yet they are more vulnerable to increasingly sophisticated and diffused technologies.

The result is that though we are now more dependent than ever on space assets for monitoring, targeting, communications, positioning, and other functions, we are ill-equipped to defend this infrastructure. Only recently US political and military leaders have begun publicly describing the importance of controlling space, even though it has been nearly 16 years since space assets proved themselves enormous force multipliers in the first Gulf War.[8] Even the watershed August 2006 National Space Policy (NSP) opens by paying homage to legacy principles ("The US is committed to the exploration and use of outer space by all nations for peaceful purposes, and for the benefit of all humanity") before asserting the right to space control:

> The United States considers space capabilities—including the ground and space segments and supporting links—vital to its national interests. Consistent with this policy, the United States will: preserve its rights, capabilities, and freedom of action in space; dissuade or deter others from either impeding those rights or developing capabilities intended to do so; take those actions necessary to protect its space capabilities; respond to interference; and deny, if necessary, adversaries the use of space capabilities hostile to US national interests.

Now that one administration has explicitly acknowledged that we will assert space control in order to defend our national interests, what should we do about our rusty cage of international law, expectations, and norms? In short, "So what?" On the one hand, it is tempting to do nothing. In fact, short of placing nuclear weapons in space, existing treaties do little to constrain our research and deployment. We could just abandon our (weak) confines and focus on the many challenges at hand. Moreover, many of our space control and counterspace measures are, will, and should remain classified.

However, allowing the cage to rust unreformed would harm our national interests. First, the shift reflected by the recent NSP is far from institutionalized in US policy and could be reversed by future administrations.

Second, one of our nation's greatest strengths is that we strive, debate and occasionally fail very publicly. The world is well aware that we are pursuing space superiority. Because we are building on our clear leadership in this arena, ironically we risk undermining ourselves by provoking potential adversaries into countermeasures in order to advance what they perceive as their own security. A prime example is China's recent kinetic destruction of its own satellite; other possibilities include a nuclear explosion in space and ground-based lasers. Moreover, our pursuit of space superiority makes us vulnerable to damaging propaganda. As the geopolitical poles continue to shift and civilizations clash, the global competition for hearts and minds is heating up again. Whether we are competing for influence with a nascent superpower, regional theocracy, or anti-American rogue, we should dismantle the Cold War framework which makes it all too easy to accuse the US of cosmic warmongering while pursuing technologies that can deny the use of space. We also need to consider other nations' security calculations and think long-term, since it will take years to realign global space norms.

Third, in the meantime, we need to prevent a scenario where national governments attempt to prevent our access to elements of the increasingly international space industries and civil programs. Today many large aerospace companies are trans-national, and most civil space spending is on programs dependent on global cooperation. In a world of international dependencies, the US needs to be seen as the global space thought and technology leader, so that the country can guide and leverage research and development wherever it is done.

Conversely, a proactive diplomatic campaign to revamp associated international agreements could loosen policy constraints, influence other actors' behavior and enhance the US image. By proudly asserting our right to space superiority, we can more effectively catch up to the sciences of maritime and air superiority. These fields have benefited from decades and centuries of debate, research, and investment, while space superiority discourse has been relatively muted. Geopolitics and technologies have changed dramatically since we helped craft our own Cold War "cage." A world of bipolar clarity has been replaced by a plethora of complex relationships, and space technology has diffused to several space powers, as well as to a global industry that sometimes out-innovates even the largest militaries. For instance, the US ability to influence commercial space imagery providers is changing war planning.

These and other changes provide us the opportunity to take a fresh look at which elements of space are conducive to international cooperation; which we want to influence; and which we want to keep out of international discourse or regulation. To offer just one hypothetical, we may choose to provide some space-based services as a common good to improve transparency and retard competitive technologies, thereby adapting the global positioning system model. For example, we may want to establish and promote a multilateral treaty to require more detailed advanced notice on launches, and then publish our own observations to signatories regardless of whether the launching party provided advanced data. Though we already have many such agreements in place, establishing a treaty system open to all would create incentives for participation—and make it that much easier to punish outliers. It could also evolve to promoting a common view that space-based observation and verification comprise a universal, undeniable good, so that those who do deny access can be internationally condemned. There are other precedents for applicable multilateral institutions, including North Atlantic Treaty Organization, the Nuclear Non-Proliferation Treaty, and the Comprehensive Test Ban Treaty. This is just one possibility. The point is that, rather than secretly or shyly pursuing secure use of space, we can proudly assert that important elements of our space-based infrastructure benefit global security by, for instance, preventing accidental wars, surprise attacks, and monitoring nuclear proliferation.

Space has always included both competition and cooperation. This will not change. There will be other areas that are not conducive to international cooperation. For example, beginning in the early 2000s, the US went to great lengths to explain its intentions with regard to the ABMT to Russia, China, and other nations. Though our ultimate course depended little on their desires, we explained in remarkable detail our plans, goals, and technologies, in large part to prevent an over-reaction. While we should be clear that we will defend our right to space superiority, we should also make it exceedingly clear—especially to potential adversaries—that we are not seeking a unilateral **offensive** advantage. Otherwise we will risk an over-reaction in the forms of anti-US alliances, new military spending races, and even pre-emptive attacks. Here, too, nuclear and maritime sciences offer useful precedents, including international signaling and practices; joint exercises and exchanges; and search and rescue operations and norms. Just as we have complex communication protocols in place to establish intent and prevent accidental nuclear or naval escalations, we may prefer a future in which we can confront potentially hostile space forces with iterative options short of offensive engagement. Such a system will require careful planning and a series of bi- and/or multi-lateral protocols.

This article does not presume to design the norms and institutions that will govern future military activities in space. Instead, it merely proposes that now is the time for the US to proactively augment military pursuit of space control with a "greenfield" redesign of international space institutions and norms based on five assertions:

1. US national security is dependent on the ability to use space, and to deny others the use of space. This dependency will continue to grow with time.
2. Existing space law, institutions, and norms are anachronistic, yet continue to hamper US planning.
3. It is in the United States' best interest to proactively recast this legacy framework.
4. Pursuing space superiority without this complementary diplomatic offensive would put us at a disadvantage in the competition for global hearts and minds, and could impair our ability to access global space talent and technologies.
5. Instead, by asserting our right to space control while considering certain limits on our behaviors, we will loosen policy constraints, advance the science of space superiority, establish beneficial international codes of conduct, mitigate counter-reactions, and influence others' behavior.

This diplomatic and ideational offensive will take years and require coordination across many branches of the government, as well as allies, academia, and industry, to be successful. It is no surprise that institutions, ideas, and norms change more slowly than technologies, geopolitics, and militaries. Their persistence is a truism that dates back to the dawn of politics, and they provide a bulwark (however imperfect) against radical affronts to humankind. Changing large, shared bodies of knowledge and values requires persistent activity by leaders with acknowledged expertise in the relevant domain. It would be wise and timely for our Nation's space leadership to recognize the fact that we have an opportunity to consciously, carefully, and proactively drive change in the global institutions, laws, and ideas that are constraining our increasingly important pursuit of space security.

Notes:

[1] G. P. Zadoroshnyi, "Iskustvenii Sputnik Zemli I Mezhdunarodnoe Pravo," ("Artificial Satellites and International Law") *Sovetskaia Rossiia,* 17 October 1959; A. Kislov and S. Krilov, "State Sovereignty in Air Space," *International Affairs* (Moscow) no. 3, (March 1956): 35-44; William H. Schauer, *The Politics of Space: A Comparison of the Soviet and American Space Programs* (Holmes and Meier: 1976), 245.

[2] In August 1961 Khrushchev demanded that the Western powers sign a peace treaty with East Germany by year-end, and began construction of the Berlin Wall. However, Kennedy rejected the ultimatum, armed with knowledge supported by six reconnaissance satellites that the US possessed an ICBM advantage.

[3] Matthew J. Von Bencke, *The Politics of Space* (Westview: 1997), 45.

[4] George Shultz, *Turmoil and Triumph* (Scribner: 1995), 997; Don Oberdorfer, *The Turn* (Touchstone: 1992), 248-49.

[5] Preamble of the United Nations Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, October 1967.

[6] See the Treaty Banning Nuclear Weapon Tests in the Atmosphere, Outer Space and Under Water (1963); Treaty on Principles Governing the Activities in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (1967); Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1979).

[7] Maj Gen William L. Shelton, USAF said during a November 2006 presentation at the Strategic Space and Defense 2006 conference, "I believe the English language failed us a little here, with 'space superiority.' We talk about 'air superiority' and everybody [understands]," *Aviation Week and Space Technology,* 6 November 2006, 54.

[8] For example, General Kevin P. Chilton, ASFPC commander, recently said he wants much better capabilities to "identify what's up there, understand its mission and, ultimately, determine its intent." *Aviation Week and Space Technology,* 9 October 2006, 72.

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To Get There, Go There

Dr. Robert L. Butterworth
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While in charge of the United States Space Command in the early 1990s, General Charles A. Horner, USAF, retired, persistently criticized Air Force launch operations. Getting the country's national security satellites into space has been an Air Force responsibility exclusively since the mid-1960s, when the director of the National Reconnaissance Office, Alexander Flax, put an end to the Central Intelligence Agency's plans to go its own way, but as commander in chief, Space Command (the US still had "CINCs" then), General Horner saw little military merit in the way the mission was performed. Unlike fighters and bombers, national security satellites were not launched on command. Indeed, they were rarely launched on schedule: one Titan IV in particular was on the pad so long that General Horner threatened to paint a building number on it.

General Horner seemed to have in mind that a field commander should be able to call up a new satellite just as he could an air strike, and some even joked that if the payload were late, he would launch without it. Hearing his complaints, space cognoscenti would roll their eyes and try to explain that the goal was a functioning satellite in orbit, that most delays resulted from the payload, and that in nearly every case, timeliness was not particularly important. Nor would timely launch alone serve to meet a commander's urgent needs: once in space, the satellite might need adjustments to its orbit, time for out-gassing, and system tests and checks. Besides, even if a reliable and prompt on-demand launch capability were available, what would it launch? What satellite would a commander need that would justify such a capability?

A Contested Medium

But perhaps General Horner was just a bit ahead of his time. He had been the air component commander for the Gulf War, in which the integration of space systems into tactical military operations first became publicly evident. The US was succeeding, as Soviet military analysts wrote, in creating a "space-based reconnaissance strike complex": space systems acquiring targets and passing fire control solutions to platforms delivering weapons of precise lethality to destroy the targets in near-real time.[1] Soviet analysts credited this capability with bringing about a revolution in military affairs. Some years later, Chinese analysts, taking a somewhat broader view, talked about the US as having moved from mechanized to "informationalized" warfare.[2]

This revolution provided America's adversaries compelling military reasons to develop anti-satellite weapons; US satellites designed for reconnaissance in a benign environment are now tactical military targets. They were probably targeted by Soviet systems during the Cold War as well, but their significance was far more strategic than tactical. Soviet attacks against them could not have materially aided Soviet armored thrusts into Germany, although they may have been one of the triggers that started the war. Today, the loss of those satellites would likely degrade American tactical evolutions directly and immediately, slowing operations until alternative collection could be established and requiring larger forces to substitute for the precision enabled by space systems.

While the incentive to attack US satellites is strong, the capability is costly. Lesser means are required for lesser goals, of course: Interfering with some operations of some of these satellites might serve the purposes of an adversary in less conventional, lower intensity conflicts. Jamming communications links or nuisance attacks on ground facilities and information networks, for example, are relatively low-cost efforts that could impose limited additional costs on US operations.

An attacker would need to accomplish substantially more in higher intensity scenarios involving large conventional force movements. To materially degrade US capabilities in these settings would require denying critical space services, and doing so in time to confound the tactical evolution of US forces would require attacking the satellites in space.

The objective need not be to defeat the US; indeed, the space attacks might really be intended to forestall such hostilities. Such could be the calculation, for example, of a country whose local military superiority would allow it to achieve its objectives if the US plans for reinforcing the area were disrupted. If the aggressor could secure his objectives before the US became fully engaged, he might then sue for peace, expecting that the US would acquiesce in a *fait accompli* rather than escalate to a full-scale conventional war. A critical element in delaying and degrading a prompt response from the US would be eliminating promptly the tactically central components of the US eyes and ears in space. The most appealing military option for doing so currently are direct-ascent technologies; in the future, perhaps directed energy weapons and space mines will also prove attractive. But it is true now, as it will be later, that no joint force commander can simply assume that "space works."

These developments create a new context that challenges legacy thinking about national security space. US military today depends heavily on space systems, and those systems can be attacked by an adversary who has good military reasons to do so. US planners now confront the need to ensure the delivery of those militarily essential services that come from space systems operating in a militarily contested medium. Until recently the strategic context left plans for space defense with little programmatic support beyond funding for research and limited technology exploration. Money spent on satellite protection was money lost to collection for intelligence, surveillance, and reconnaissance (ISR). Intelligence and defense program managers alike saw the contest in the budget arena as between protection and capability. But the strategic context is different now: in contested space, there will be no capability without protection. In that sense, the US for the first time is challenged to devise a truly military space architecture.

Ground Effects

This change is felt most acutely by military planners, although it certainly affects the intelligence community as well. It was only about 15 years ago that space-based ISR services began to be integrated into joint tactical operations; now the military must consider how it might have to protect or substitute for them. Doing so is complicated by the difficulty of characterizing the military significance of losing certain satellites: the plumbing that links space platforms to military functions is neither widely nor clearly understood. It seems likely that many presumed substitutes, redundancies, and work-arounds will prove to have important space dependencies or to be inapplicable to the scenario at hand.

These assessments are not likely to be resolved for some time, if only because the significance of the question of military significance lies in the military budget. But it is hard to deny the conclusion drawn by Chinese analysts, that without space the US would be forced to conduct the mechanized warfare of an earlier era, instead of the "informationalized warfare" it has been planning. The point deserves particular emphasis in considerations of programs and budgets: space services and products are valued militarily because they increase the efficient lethality of US forces. Trading space support against terrestrial platforms is nearly always a false dichotomy. Like pilot training and weapons development, for example, space is an essential part of the integrated systems that define the capability of an F-22, enhancing target acquisition, bomb damage assessment, threat warning, navigation, precision attack, communications, blue force tracking, reach-back, and combat search and rescue, among other functions.

How, then, should the US proceed to preserve its advantage in military space? US planners have worried about attacks on national security satellites since the early days of Corona. One of the first concerns was to devise ways to know whether a satellite was being stalked. Then came proposals for specific measures to protect specific satellites against specific threats, nearly all of which are reconsidered from time to time as threat or policy or technology circumstances change. Some of them involve making the satellite hard to kill, by hardening components against laser or radio-frequency attacks, for example, or by actively defending it. Others would in various ways make the satellite hard to target, perhaps through orbital maneuvers, satellite design, and attacks against enemy surveillance and tracking systems. A third group of measures would prepare ready replacements for satellites lost to enemy action, storing them either in space or on the ground for rapid launch. There have also been various proposals to respond offensively. Proposals for reciprocal attacks, whereby each side would hold the other's satellites hostage, have generally been unpersuasive because space is more important to the US than to anyone else. Attacks against enemy ground sites promise to be more effective but pose complicated speculations about escalation and rules of engagement.

Earlier work on these options usually aimed to remedy particular vulnerabilities of specific space systems; in the earlier cold war context, the principal worries concerned probing and interference before shooting started. Such system-specific approaches could still be valuable for peacetime collection today, but they seem ill-suited to the new military circumstances in which adversaries find powerful incentives to attack US satellites as part of terrestrial military campaigns. Adding "armor" to specific satellites or making them harder to engage or giving them "secret service" bodyguards can work well if the specific measures prove effective against actual enemy operations. But if there is uncertainty in US knowledge of enemy plans and operations, if essential elements of the enemy's target acquisition and means of achieving desired effects are not known in critical detail, and if there is discomfort with Gaussian predictions of debris lethality, a broader approach less vulnerable to surprise would be appealing.

General Horner Redux

That thought leads back to General Horner's original argument that ground replenishment might be the dominant solution providing a capability that would mitigate a variety of threats, expected and otherwise. It could also increase tactical flexibility, providing options to surge on-orbit capacity, launch into non-standard orbits, and clandestine launch. An enemy would need some time to detect and characterize the tracks of these replacement satellites, particularly if initial attacks created debris clouds, allowing the new systems to operate freely for hours, days or much longer if the US degraded enemy space object surveillance and identification systems. Indeed, if the US coupled a ground replenishment capability with an offensive counterspace capability, any initial strike against US satellites would trigger quick regeneration establishing an overwhelming space advantage for the US. A demonstrated responsive space capability could also deter attacks on US satellites.

That last statement, about deterrence, can only be conjectural. But a ground replenishment architecture is not: Principal elements of it have been developed already. Furthest along is assured access to space. Quick response launch operations, launches from austere sites, and mobile range support and safety equipment have all been demonstrated in the past 10 years.

Work on the satellites to be launched in this way, assured functionality in space, is a bit less advanced, although militarily useful payloads have been demonstrated in several small satellite programs sponsored over the years by US agencies and foreign governments. The principal remaining difficulty seems to be not technology but requirements—deciding which sensors will be most useful to commanders in wartime. How should the capabilities offered by the multi-ton "peacetime" satellites be selected and revised to meet wartime requirements with satellites weighing a ton or less? Once decided, the replenishment satellites might well be launched frequently to allow users to stay proficient with their operations and products.

Ground replenishment of this sort is not by any means a complete architecture. Owing to the launchers' limited throwweight and the need for rapid response, it probably would work best in response to threats against satellites in low Earth orbit. But those are the threats developing most rapidly today, and ground replenishment offers to mitigate them substantially.

Most importantly, this approach embodies a critical change in thinking, compelled by the new strategic context—conceiving a truly military space architecture to support military operations when space is militarily contested.

Notes:

[1] The Soviet analysts also emphasized that the fire systems were capable of ranges far into enemy defensive depths, including homelands. For contemporary discussions, see Notra Trulock III, "General Staff Academy Theoretician on Future War, Nuclear Requirements," Center for National Security Studies, Los Alamos National Laboratory, 18 September 1991; Col V. V. Romanov and Col V. P. Chigak, "On the Use of Space Means in the Persian Gulf Region," Military Thought, March 1991, 76; Gen Lt S. Bogdanov, "Lessons of 'Desert Storm,'" *Red Star*, 17 May 1991, 2.

[2] Dean Cheng, briefing, Center for Naval Analyses, 29 September 2006.

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National Space Policy: Opportunities and Challenges in Shaping the International Space Regime

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A nation's space goals and aspirations are often reflected in statements of national policy or strategy, used as implementation guidelines for national agencies and for the application of resources. National space policies are motivated and shaped by bureaucratic compromise, domestic politics, and foreign policy goals, and are intended for multiple audiences: the national legislative body, the general public, and foreign allies, adversaries, and third parties such as the United Nations and non-governmental organizations (NGOs). National space policy can shape international security and the international space regime when it influences the behavior of other nations in their own space activities or in their exploitation of space data, information, or services provided by other states, commercial providers, or NGOs.

For the United States, national space policy is an expression of American national security, civil, commercial, and scientific interests and activities in the space environment, and includes implementation guidelines for individual space "sectors."[1] These interests rest upon the enunciation of national goals and expectations of what activities in space can best support US national security *writ large*. The topics in American national space policy that receive increased emphasis signal US intent to an international audience of friends, allies, and adversaries.

Why is national space policy important for US policy-makers and military planners developing courses of action involving international collaboration? First, planners need to assess the roles of US and international space capabilities in the context of the emerging international security environment, national policy objectives, ongoing and future coalition military operations, and future threats. Identifying the unique or niche space capabilities of other countries should be complemented with an understanding of those nations' space policies and the motivations shaping them. Those space capabilities can be employed to: collaborate with American space capabilities in "coalitions of the willing;" provide information to US adversaries about the locations, strengths, and movements of US military forces; or provide situational awareness for other governments and NGOs. Finally, policy makers and planners need to understand the broader international space "regime"—space-related international law, treaties, and customs, and United Nations and other international organizations to which the US is a party—and its implications for US space activities.

As they craft US space policy and plans, US policy-makers should first consider four key issues:

- What are the elements of US national space policy that may influence the international space regime?
- How are US national space policy, US space capabilities, and the emerging international security environment related?
- How are these asymmetric challenges and associated priorities related to the national space policy?
- Why might other countries find national space policy relevant to their security interests?
- How can the US shape the international space regime to achieve its policy objectives?

What are the elements of US national space policy that may influence the international space regime?

Addressing this issue requires examining the new US national space policy for its continuance of long-standing space principles and objectives, and for topics within the new policy that receive greater emphasis and consequently, greater international scrutiny. These topics include the role space systems play in achieving US national interests and in international space cooperation, and the US perspective on initiating new space-related treaties and agreements.

On 6 October 2006, the Bush administration released its new national space policy without fanfare.[2] The public and media focused on its defense-related aspects and not on its continuity in principles and objectives. US space policies tend to adhere to the same long-standing general principles, but specific space policy goals change in order of priority or emphasis to reflect an administration's domestic and foreign policy goals. The new national space policy holds true to this generalization, as it continues the goals and objectives of past policies, adhering to principles of access of space for peaceful purposes for all, and international space cooperation. But the new policy differs from earlier policies in several important ways that impact foreign space policies and the international space regime.

First, the new US policy declares space capabilities (including ground and space segments and supporting links) to be vital to US national interests. The "vital" nature of space systems reflects the fundamental relationship between the US government, society, financial institutions, transportation, public safety, and critical national infrastructure with the space systems supporting them. Accordingly, it contains more explicit guidance on the need to deter threats and deny the use of space capabilities to elements hostile to US national interests. The long-held US right of self-defense and the rejection of claims to sovereignty by any nation over outer space and celestial bodies are consistent with Article 51 of the United Nations Treaty and the 1967 Outer Space Treaty (OST), respectively. This has direct implications for the development of space superiority and missile defense capabilities, for example. Actual deployment and use of such capabilities remains a US policy decision.

Secondly, the new policy goes further than its predecessors by stating that the US will oppose new legal regimes that seek to prohibit or limit US space access and use. Furthermore, "proposed arms control agreements or restrictions must not impair the rights of the US to conduct research, development, testing, and operations or other activities in space for US national interests."[3] The US continues to fulfill its legal obligations regarding the OST and related space agreements and to support enforcement of treaty compliance, but to accede to a new multilateral agreement that might unduly constrain US space access and use is officially viewed as "unnecessary and counterproductive."[4] Such new or proposed legal regimes might impose "rules of the road" or "keep-out zones," or carry more restrictive language than the OST, for example.

Finally, the new policy declares that the US will pursue international space cooperation "as appropriate, and consistent with US national security interests." Cooperation will be done when considered beneficial and when space exploration and uses of space for national security, homeland security, and foreign policy objectives are advanced. Potential areas for international cooperation include space exploration, Earth observation systems, and space surveillance information as long as consistent with US national security and foreign policy interests.[5] The new policy designates the secretary of state as the US lead for conducting diplomatic activities in building understanding overseas of American national space policies and programs and encouraging the use of US space capabilities by friends and allies.

How are US national space policy, US space capabilities, and the emerging international security environment related?

Addressing this issue leads to a review of the emerging challenges facing US national security in the near and far term and the operational contributions that space capabilities would make to meeting those challenges.

Two recent national security documents provide context for connecting national space policy, space capabilities, and the external environment. These are the *National Security Strategy of the United States of America*, issued by the White House in March 2006,[6] and the *Quadrennial Defense Review (QDR) Report*,[7] released by the Department of Defense in February 2006. Both documents acknowledge the importance of maintaining the considerable advantages the US military enjoys in traditional forms of warfare. However, as illustrated in figure 1, these documents also acknowledge the emergence of asymmetric security challenges and threats that US military forces are expected to face in the future and describe the priorities needed to meet those challenges. These challenges and priorities include:

- **Irregular Challenges:** *Defeating terrorist networks* – This challenge acknowledges the rise of multi-national, multi-ethnic terrorist networks that exploit information sources to threaten the US and its allies, attempt to shape international public opinion, and undermine governments friendly to US and allied interests. While US military forces will continue to attack and defeat these global networks, defend the homeland against terrorist attacks, and counter ideological support over time, this effort requires international cooperation and collaboration as well as tailored regional strategies to defeat the global terrorist network.
- **Catastrophic Challenges:** *Preventing hostile states and non-state actors from acquiring or using weapons of mass destruction (WMD)* – Deterring use by the number of states possessing WMD, or denying access to WMD by non-state actors against populations requires non-traditional responses and international collaborative vigilance and defense. Protection of global information-related capabilities, such as spacecraft and communications networks vulnerable to electromagnetic pulse, requires cooperation on multiple levels. Preventing proliferation, and responding if counter-proliferation efforts fail, necessitates using all means of national power—diplomatic, economic, and political, as well as military.

  Defending the homeland in depth – This challenge also encompasses protecting against non-state actors who target not only government facilities, but also financial and cultural institutions, the nation's citizens, and critical infrastructures including space assets. Traditional means of deterrence may not apply as nation-states are no longer the sole possessors of catastrophic means of violence and non-state actors are not deterred by military force. Defending the homeland requires a layered, active defense strategy and partnerships with other states to deny non-state actors the ability to attack the homeland. Identifying and characterizing threats, and preventing, interdicting, and defeating them require not only intelligence and traditional military forces, but also situational awareness, missile defense, and consequence management capabilities.
- **Disruptive Challenges:** *Shaping the choices of countries at strategic crossroads* – Both major and emerging nations will make critical choices that will influence other nations' positions. The US and its allies will pursue strategies to shape those choices and to hedge against uncertainty. Elements of those strategies include seeking cooperation with countries on issues of common interest including space, reducing security vulnerabilities and bolstering capabilities

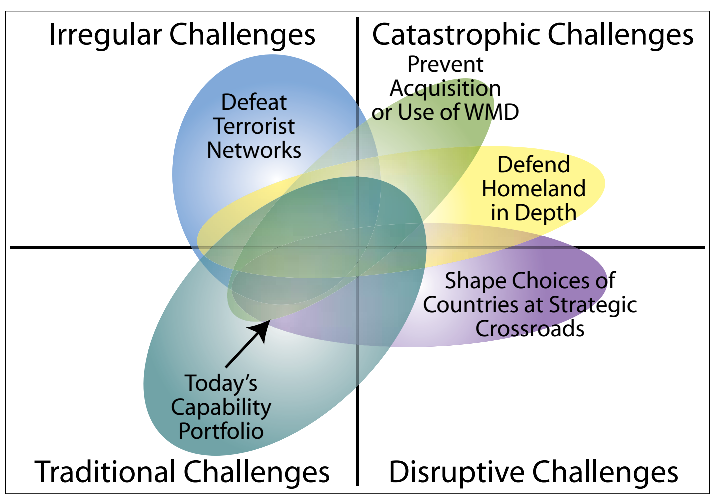

Figure 1. The Department of Defense's evolving portfolio of capabilities to meet emerging challenges.

of US partners, while deterring the rise of a hostile major power that could threaten regional and global stability.[8]

How are these asymmetric challenges and associated priorities related to the national space policy?

The new space policy includes several fundamental goals whose achievement is crucial to executing the national security strategy and meeting the challenges identified in the *QDR Report*. These fundamental space policy goals include:

- Strengthen US space leadership and ensure that space capabilities are available in time to further US national security, homeland security, and foreign policy objectives;
- Enable unhindered US operations in and through space to defend national interests there;
- Encourage international cooperation with foreign nations and/or consortia on space activities having mutual benefit, furthering the peaceful exploration and use of space, and advancing national security, homeland security, and foreign policy objectives.[9]

Just as existing military capabilities for more traditional forms of warfare are expected to meet these challenges, so must space capabilities. Space systems already provide critical force enhancement functions: missile warning and nuclear detonation detection, positioning, navigation, and timing (PNT), environmental monitoring, communications, and intelligence, surveillance, and reconnaissance (ISR). These functions support traditional military operations and provide critical information and data necessary for decision-making by national leaders and military commanders. However, in order to effectively deal with the evolving and dynamic challenges facing the US and its allies, space capabilities will be increasingly tasked with supporting more users at the strategic, operational, and tactical levels of decision-making. The strategic uncertainty and dynamic dimensions of these challenges place a premium on capabilities that can penetrate denied areas—as only space systems can—and "find, fix, track, target, engage, and assess" targets of varying sizes (from large weapon systems to individuals), speeds, and in different environments (land, sea, undersea, air, and space). That information is passed over space-based communications links (e.g., commercial satellite communications, governmental telecommunications), located precisely by global positioning systems (GPS), and fused with information from other airborne, land-based, and sea-based ISR platforms to give policy-makers and military commanders the required situational awareness and knowledge necessary for timely and effective decision-making.

In keeping with the national security strategy, the national space policy directs the secretary of defense to "develop capabilities, plans, and options to ensure freedom of action in space, and, if directed, deny such freedom of action to adversaries."[10] The director of national intelligence is directed to "ensure that timely information and data support foreign, defense, and economic policies; diplomatic activities, indications and warning; crisis management; treaty compliance verification; appropriate civil, homeland security, and law enforcement users;" and to "support military planning and satisfy operational requirements as a major intelligence mission."[11] Ensuring freedom of action in space could conceivably lead to efforts to deny terrorists and their sources of support access to satellite-based communications networks, thus depriving them sanctuary in the information domain. However, those actions are increasingly difficult for the US to accomplish unilaterally, given the plethora of internet-based information about satellite functions and orbital parameters.[12] "Tailored deterrence" capabilities—prompt global strike capabilities to defend and respond overwhelmingly to WMD attacks, along with air and missile defenses[13]—are linked in part by the national space policy's guideline to "provide space capabilities to support continuous, global strategic and tactical warning, as well as multi-layered and integrated missile defenses."[14] Space-based elements of "tailored deterrence" such as missile warning and tracking satellites can also contribute to regional and global stability by hedging against strategic uncertainty and possible failure of diplomatic initiatives and economic sanctions to deter conflict.[15]

The new policy notes that using space for national and homeland security, civil, scientific, and commercial purposes depends on maintaining reliable access to and use of radio frequency spectrum and orbital assignments. Maintaining reliable spectrum access and use entails explicitly addressing spectrum and orbital requirements prior to approving new space system acquisitions, and assuring that US and foreign space capabilities and services of interest are not affected by harmful spectrum interference.[16] A finite natural resource, radio-frequency spectrum is in increasing demand from such services as fixed, mobile, and broadcast communications, space research (e.g., radio astronomy), meteorology, global positioning, remote sensing, public safety, and other functions requiring transmission of information or data.[17] Spectrum management allocation decisions are made in the International Telecommunication Union, a United Nations organization, at World Radiocommunication Conferences (WRCs) held every few years. Ensuring that US military forces maintain access to key spectrum frequencies used by weapons systems and enablers requires concerted US diplomatic and political efforts to shape the international telecommunications community's positions prior to a WRC. Furthermore, each country maintains sovereign control over spectrum within its own territory—this can potentially lead to restrictions of spectrum access for US-led coalitions and a resulting adverse effect on the ability of the coalition to prosecute a theater war. Protecting the spectrum used by the GPS, for example, is critical for national security, civil, and safety-of-life functions, but it is also important for the innumerable multi-national PNT applications that are enabled by GPS. Preventing possible interference, whether purposeful or inadvertent, with the spectrum used by GPS and other space systems is a matter of national space policy as well as national security strategy, and, by extension, of international concern.

Finally, minimizing orbital debris is highlighted in the national space policy, again a consistent topic from past national space policies since 1989. The policy acknowledges the risks posed by orbital debris to space operations and services, and to the safety of people and property on Earth. It directs that departments and agencies follow the US government Orbital Debris Mitigation Standard Practices, and address orbital debris issues through Departments of Commerce and Transportation licensing processes. The policy states the US will take a leadership role in international fora to encourage adoption of debris minimization practices and information exchange.[18] Developing policies, procedures, and capabilities to inhibit orbital debris creation and to keep track of it in orbit have the desired correlated effects of maintaining space situational awareness, protecting vital space assets, and ultimately, conducting space control. Here as well, unilateral US actions have ramifications for foreign space policies and the international security environment.

Why might other countries find national space policy relevant to their security interests?

Not all countries will articulate a national space policy to guide their space efforts. Given most countries' limited resources (compared to those of the United States) for acquiring indigenous space capabilities, purchasing space services from commercial providers, engaging in bilateral and multi-national space projects (e.g., the International Space Station [ISS]) or organizations (e.g., the European Space Agency [ESA]), or possessing the highly skilled workforce and technological capacity required, a government may not consider it necessary to issue a broad statement of national policy to guide its space activities. For other countries with space interests, policy statements serve as evidence of their long-term goals, of perceptions of the contributions that space systems make to enhancing their national prestige and power, and of political will to make the space infrastructure organization and investment necessary to be considered a space-faring nation.

Referring again to the QDR security challenges described earlier, one can argue that these challenges are also important to other governments besides the US—that other nations also have to be concerned with trends and implications of irregular, catastrophic, and disruptive challenges as well as with more traditional regional and global challenges facing them uniquely. Consequently, the strategic choices other nations make regarding space capabilities will also be shaped by challenges to their security and by their relationships with the leading space-faring nations, including the US. A potential space peer competitor to the US may have fewer incentives to enter bilateral or cooperative space power relationships, unless those relationships are based on common shared values and expectations or are seen as means to limit US space power.[19]

Small and regional powers may hedge their options by shaping their national space policies in order to preserve, protect, and enhance their existing space capabilities and enjoy the benefits of major space power protection without becoming a threat to that protector. Alternatively, they may pursue independent courses of action, including maintaining a strong presence in the international space regime while remaining non-aligned except where their security interests mandate limited space collaboration for shared objectives. Three brief case studies of small and medium space powers follow to illustrate the range of hedging options: Australia, as a close and consistently strong US ally with limited space capabilities but with space-related geographical and political advantages; Switzerland, traditionally an international space regime proponent and participant in an independent European space power to balance US and Soviet/Russian space interests but growing closer in viewpoint to the US; and Sweden, historically nonaligned and an independent, technologically sophisticated space actor expanding its global security interests. These case studies can illuminate possible opportunities to shape the international security environment through space collaboration and shared goals.

Australia – Australia's space policy is found in the *Australian Government Space Engagement: Policy Framework and Overview,* published by the Department of Industry, Tourism and Resources.[20] This document states that "the Australian Government is engaged in space activities in support of national strategic, economic, and social outcomes."[21] Australia is a sophisticated user of space capabilities for national security, communications, broadcasting, astronomy and space science, natural resource management, navigation and timing services, and other areas.[22] Pre-eminent among these activities is the role of space in supporting Australian national security, particularly in contributing to border surveillance, anti-terrorism, and telecommunications security. The policy framework for space engagement encompasses characteristics of being user- and market-driven rather than supply-driven or technology-pushed, and emphasizes international collaboration and cooperation where Australia has competitive advantages including geographical position and political stability.[23]

> There is no strategic, economic or social reason for the Australian government to pursue self-sufficiency in space. The government secures access to the benefits of space by participating in a range of international cooperative arrangements and by purchasing products and services in the domestic and global market place. This is supported by the government's competitive industry development and science/research funding programs … This does not, however, preclude government facilitating the development of space services, such as commercial launch operations if they are commercially viable and sustainable. Nor does it preclude space hardware design and manufacture, for example in niche areas such as instrumentation, sub-systems or components. The Australian government encourages commercially viable and sustainable endeavours in the space sector.[24]

Because of these characteristics, Australian strengths lie in providing ground-segment space systems and networks, as demonstrated by the Woomera Rocket Range and the Canberra Deep Space Communications Complex. The ground-based networks and facilities provide key support to National Aeronautics and Space Administration, ESA, and the international astronomy community. Australia was a founding member of the United Nations Committee on Peaceful Uses of Outer Space in 1958, and is a signatory to many space-related international treaties, including the Missile Technology Control Regime (MTCR).[25]

Australia employs space capabilities—its own as well as those provided through international alliances and commercial relationships—in support of its national interests globally and in the Pacific region. Australia gains access to US information and technology, and therefore the relationship with the US "remains a national asset."[26] Paradoxically, while geographical location and political stability are important to becoming a trusted space partner, Australian national security policy acknowledges these same characteristics cannot protect it against rogue states armed with WMD and long-range ballistic missiles or against terrorist acts directed against Australian citizens. This situation was clearly shown by the al-Qaida-inspired terrorist attacks in Bali.[27]

Proliferation of launch vehicle technology is a national security concern, as is the protection of spectrum from interference, and both require bilateral and international collaboration, including missile defense and warning efforts with the US.[28] Spectrum protection is particularly important to Australian national security, given Australian ground-based space facilities and networks, and the transition of the Australian defense forces to a network centric orientation. Australian defense strategy and the evolution of the armed forces are laid out in a series of documents, including *Australia's National Security: A Defence Update 2003, Force 2020, Future Warfighting Concept,* and the *NCW Roadmap*.[29] *Australian Government Space Engagement* specifically addresses the importance of protecting key spectrum for data transmission to and from space from natural and intentional interference. This complements the elements of the network centric warfare concept for information sharing and connectivity among command and control, sensors, and engagement systems, and contributes to information superiority—providing the right information about adversary forces to friendly forces at the right time and in a superior manner.[30] Successful implementation of the goals and plans identified in these documents necessitates a national security-oriented space policy that addresses the enabling information systems and infrastructures, ISR, PNT, and communications. Furthermore, the US-Australian security relationship mandates a goal of interoperability and commonality among systems—and thus places a premium on shared goals of spectrum management. The Australian Department of Defence considers that "management of spectrum resources has … become an important risk mitigation strategy for Defence in both investment and operational terms."[31] Combined with its global security commitments and coalition operations in the Middle East, Southeast Asia, Africa, and elsewhere, and its relationship with the US, Australian space policy and interests remain both similar to and consistent with US national space policy and interests.

Switzerland – One country not usually considered in the forefront of space policy and activities is Switzerland, but this perception is deceptive.[32] While having no national space program, Switzerland has chosen to benefit from space assets almost entirely within the framework of European space programs and activities. Swiss space activities are consistent with the objective of preserving Swiss independence and welfare, and with the foreign policy objectives established in the new Swiss Federal Constitutional of 2000.[33]

Since 1815, Switzerland has maintained a stance of permanent armed neutrality. This has not prevented it from engaging in activities entailing limited military, political, or economic activities, including North Atlantic Treaty Organization's (NATO's) Partnership for Peace (1996) and the Euro-Atlantic Partnership Council (1997), and deploying armed troops for international peacekeeping missions under the auspices of the United Nations or the Organization for Security and Cooperation in Europe.[34] Switzerland is also an active participant in the MTCR and other export control regimes, and thus shares common interests in nonproliferation with the US. Switzerland has represented American interests in Iran since 1980, and closer economic, counter-terrorism, and other ties are evolving with the establishment of the US-Swiss Joint Economic Commission (JEC).[35] Conceivably, a closer space security relationship could develop, given Swiss diplomatic and economic strengths and shared interests in the Global War on Terrorism.

During the Cold War, Switzerland was a strong proponent of developing an independent European space capability vis-à-vis the US and the Soviet Union. However, since the 1990s, Swiss space activities have been more balanced among Swiss foreign policy, European integration policy, scientific policy, and industrial policy.[36] To do this, Switzerland has an extensive governmental space organization and a space policy governing its activities.[37] Swiss space policy demonstrates the importance and value of space systems to furthering Switzerland's national objectives and capabilities.[38] As a founding member of ESA, the Swiss government and industry are heavily involved in European space programs, including Galileo, the joint ESA-European Union (EU) venture in space-based PNT. Worth noting, however, is the absence of Swiss membership in the EU, which has led them to actively support a position of nondiscrimination against ESA member states that are not members of the EU. As a highly industrialized country, Switzerland has a strong space industrial base involving about 50 companies providing high-quality advanced technologies and capabilities to space research. According to the Swiss government, the industry generates about two times the investment made by Switzerland in ESA (122 million Swiss francs in 2003).[39]

Swiss participation in ESA and the US-led ISS program are organized by the Swiss Space Office (SSO) which serves as the head of the Swiss delegation at the European Council. The SSO also serves as the chair of the Swiss government's Interdepartmental Coordination Committee for Space Affairs, and is a part of the State Secretariat for Science and Research (SER), the administrative organization responsible for planning and implementing Swiss space policy. The SER oversees the space budget and financial contributions to ESA. Swiss space policy is determined by the Federal Council (government) with the advice of the 20-member Federal Space Affairs Commission. Swiss space policy acknowledges: (1) the importance of research, both basic and applied, and the education of scientists and researchers; (2) the importance of space activities to cutting-edge technologies and industry; (3) the role of space activities in contributing to European space efforts; and (4) the contribution of Swiss space activities to international cooperation and foreign policy goals.[40] Swiss space policy includes broad objectives in space science, Earth observation, microgravity, human spaceflight, small satellites, telecommunications, navigation, launchers, and industry and technology.[41] These activities are compatible with US space activities, and potential opportunities to engage in cooperative space projects beyond ISS could be considered by both governments.

Sweden – The Scandinavian country has long maintained a technologically advanced civil space capability, not only a strong industrial base but also a launch capability (European Space and Sounding Rocket Range, or Esrange, run by the Swedish Space Corporation [SSC] near Kiruna 200 km north of the Arctic Circle). SSC provides launch services for sounding rockets, stratospheric balloons, and ground-based instrumentation, testing, and space operations, including the establishment and promotion of "Spaceport Sweden," inaugurated on 26 January 2007, as Europe's first choice for personal suborbital spaceflight.[42]

While SSC, Esrange, and associated civil and commercial space activities represent a mature national space capability, the exploitation of space assets by the Swedish Armed Forces has lagged comparatively. Historically non-aligned in peacetime and neutral in wartime, Swedish national defense consists of a "total defence system" composed of military and civil defense. Its purpose is to defend Sweden against armed attack, assert Swedish territorial integrity, contribute to global peace and security, and strengthen Swedish society in times of severe peacetime emergencies.[43] Since 2002, Swedish national security policy has been transitioning from a strictly non-aligned and Baltic Sea-oriented focus to greater active participation in peacekeeping and combat operations overseas, including Bosnia (under the European Union Force responsible for enforcing the Dayton Accords) and Afghanistan (in the International Security Assistance Force).[44] Swedish military capabilities tend to be NATO-compatible, and Sweden looks to the US for setting standards for interoperability. Expanding global engagements by the Swedish military will likely mean greater justification for space capabilities, including PNT, satellite communications, and imagery. Furthermore, beginning in the late 1990s, the Swedish military has been transitioning to a network centric force that is adaptable, flexible, and capable of meeting a range of contingencies, necessitating greater attention to protection of information networks. Being able to execute this transition is tied to the strength of the Swedish economy, information technologies—including space-based—and industrial base. This forward-looking view of the role of Swedish armed forces in the "information and knowledge era" provides an opportunity for Sweden to engage with other similarly technologically advanced countries, particularly the US.[45] Expanding existing formal security agreements for US-Swedish military space cooperation remains to be developed.

How can the United States shape the international space regime to achieve its policy objectives?

The US possesses a huge advantage in technologically advanced space capabilities compared to most other countries and brings those advanced capabilities to bear in coalition operations. Few potential coalition partners possess a similar span and depth of space capabilities and resources. Consequently, opportunities for truly integrated coalition operations may be constrained to those countries like Australia and Sweden that possess technologies and systems on par or near-par with the US. Many of these opportunities center on common objectives and shared values, compatible technological capabilities (to support operational interoperability), and yet with a certain level of independence that can serve both the interests of the small or medium power as well as the US. For US military forces that are increasingly dependent on space capabilities, these countries may provide niche space systems that can alleviate gaps in space system development and deployment resulting from potential US acquisition or funding issues. Certainly opportunities for closer working relationships among space-faring nations can, and should, be seriously considered.

Developing a multinational space agreement beyond the OST to deal with security problems is not likely to be of great benefit to the US unless the agreement stabilizes the international security environment, protects US and allied space assets, and constrains rogue nation behavior. As a more preferable course of action, the US might identify those small and medium powers that share common interests and align with them to build basic space competencies to deal with regionally-based threats. Building space competencies will have to be tailored to specific regions, governmental structures, cultures, and levels of space-related technologies. Space powers like Switzerland and Sweden can assist because of their non-aligned, independent outlooks, their diplomatic presence in the international space regime, and their technologically advanced industrial capacities.

The language and tone of US national space policy can discourage or encourage confidence in engaging with the US in cooperative space ventures and in shaping other countries' space investments and actions. If US policy reflects and reinforces the benefits of space access for economic, commercial, and national security reasons, other countries will pursue compatible space policies and goals because they see the value to their security. If US policy is viewed as too self-serving, it can alienate other nations who will see US policy as a threat or risk to their interests. If the tone of US national space policy diverts other nations to focus on perceived US "weaponization of space," the United States may face strategic challenges alone.

Are there opportunities and challenges for national space policy to shape the international space regime? Certainly. An international space regime presupposes that national governments are able to engage in foreign relations with other governments, and not non-state actors such as terrorists with whom there is no comparable engagement or negotiation. National space policies can serve to identify common or shared interests, values, and objectives between countries with differing space capabilities, technologies, and cultures. They can help shape responses to shared security threats, whether those threats are terrorists and their global networks, rogue nations seeking to disrupt the regional status quo, or potential near-peer competitors seeking to gain military, political, or economic advantage. US national space policy can serve as a standard for foreign space policies when it influences the behavior of other nations in their own space activities, encourages them to follow US space standards and operating techniques and procedures, or shapes their exploitation of space data, information, or services in ways supporting US political, diplomatic, economic, or commercial interests. Much remains to be seen on how this new national space policy will fare in fostering greater positive collaboration and common values among those nations actively pursuing space capabilities today and in the future.

Notes:

[1] "Sectors" are defined as the national security (i.e., military, intelligence), civil, and commercial space communities.

[2] President Bush signed the space policy on 31 August 2006, but it was not publicly released until October when it was placed on the website for the Office of Science and Technology Policy (OSTP). The policy supersedes the Clinton administration's national space policy, dated 14 September 1996. *US National Space Policy*, fact sheet, White House, US Office of Science and Technology Policy, released October 2006, www.ostp.gov/html/US%20National%20Space%20Policy.pdf (accessed on 23 January 2007).

[3] Ibid., 2.

[4] Robert Joseph, under secretary of State for Arms Control and International Security, "The US National Space Policy" (speech to the Washington Roundtable on Science & Public Policy, George C. Marshall Institute, Washington, DC, 13 December 2006).

[5] *US National Space Policy,* 7.

[6] President George W. Bush, *National Security Strategy of the United States of America* (Washington, DC: The White House, 16 March 2006).

[7] Donald Rumsfeld, secretary of defense, *Quadrennial Defense Review Report* (Washington, DC: Department of Defense, 6 February 2006), hereafter cited as the *QDR Report*.

[8] *QDR Report,* 19-35.

[9] *US National Space Policy,* 2006, 2.

[10] Ibid., 4.

[11] Ibid., 4-5.

[12] Joseph.

[13] *QDR Report,* 27.

[14] *US National Space Policy,* 4.

[15] *QDR Report,* 30.

[16] Ibid., 8-9.

[17] See ITU Radiocommunication Sector (ITU-R), http://www.itu.int/ITU-R/ (accessed 2 January 2007).

[18] *US National Space Policy,* 9.

[19] For example, the emerging strategic partnership with India in space, security, non-proliferation, and other topics provides a framework for building on a relationship based on common goals and objectives. See Office of the Press Secretary, United States and India: Strategic Partnership, fact sheet, White House, 2 March 2006.

[20] Aerospace and Defence Industries Branch, *Australian Government Space Engagement: Policy Framework and Overview* (Canberra, ACT: Department of Industry, Tourism and Resources, Australian government, August 2004, updated October 2004). DITR has prime responsibility for "civil space" issues.

[21] Ibid., 2.

[22] Ibid.

[23] Ibid.

[24] Ibid., 2-3.

[25] See http://www.unoosa.org/oosa/en/COPUOS/members.html.

[26] Senator the Honorable Robert Hill, Minister for Defence, *Australia's National Security: A Defence Update 2003* (Canberra, Australia: Department of Defence, 2003), 9.

[27] Ibid., 11-12.

[28] Ibid., 17.

[29] Ibid.; Adm C. A. Barrie, RAN, chief of the Defence Force, *Force 2020* (Canberra, Australia: Department of Defence, 2002); Gen P. J. Cosgrove, AC MC, chief of the Defence Force, *Future Warfighting Concept* (Canberra, Australia: Department of Defence, 2003); Department of Defence, *NCW Roadmap 2005* (Canberra, Australia: Defence Publishing Service, 2005). Network centric warfare (NCW).

[30] Ibid., 5-7.

[31] Ibid., 31.

[32] For an interesting historical account of Switzerland's space activities, see Peter Creola, *Switzerland in Space: A Brief History,* HSR-31 (The Netherlands: European Space Agency, ESA Publications Division, March 2003). Creola is the former head of the Swiss Space Office (SSO).

[33] New Foreign Policy Report of the Federal Council, *Foreign Policy Report 2000 – Presence and Co-operation: Safeguarding Switzerland's Interests in an Integrating World*, Summary, found at: http://www.europa.admin.ch/europapol/off/ap/e/index.htm (accessed January 16, 2007).

[34] US Department of State, "Switzerland," background note, August 2006, http://www.state.gov/r/pa/ei/bgn/3431.htm.

[35] Ibid.

[36] Creola, 23.

[37] Switzerland's organizational response is a more recent development, in view of the constitutional relationship between the Cantons and the Confederation. The Confederation has the power to negotiate and adopt international treaties, whereas the creation of a national space program would have had to have been approved by the Cantons. A revision to the Swiss constitution in January 2000 gave the authority to legislate on space maters specifically to the Swiss Confederation. See Creola, 6.

[38] Quoting the Swiss Space Office (SSO) and head of the Swiss delegation to ESA, Patrick Piffaretti, "…it was our country which, 40 years ago, took the initiative in the process of cooperation which produced [ESA]. This wager has been justified on all levels: scientific, technological, industrial, and political. The space business is pure added-value. In participating in a cooperative context, our country has created opportunities for itself that it would never have had on its own." See Jean-Bernard Desfayes, "Switzerland must adapt to the new reality," *Vision* (c. 2003).

[39] See "Space Policy: Science and Industry," http://www.sbf.admin.ch/htm/international/space/science-e.html (accessed 12 January 2007); and Jean-Bernard Desfayes, "Switzerland and the new European stake in space," *Vision* (c. 2003).

[40] See "Space Policy: Guidelines and Main Objectives of the Swiss Space Policy," http://www.sbf.admin.ch/htm/international/space/space_policy-e.html (accessed 2 January 2007).

[41] Ibid.

[42] See "Press Invitation to the inauguration of Spaceport Sweden," http://www.ssc.se/esrange. Sir Richard Branson of Virgin Galactic is a partner in using Spaceport Sweden for space tourism by 2011.

[43] Government Offices of Sweden, "Total defence," http:www.sweden.gov.se/sb/d/4187 (accessed 15 January 2007).

[44] "Swedish Armed Forces," Wikipedia, http://en.wikipedia.org/wiki/Swedish_Armed_Forces (accessed 16 January 2007).

[45] Lt Gen Johan Kihl, director, Strategy, Plans, and Policy, Swedish Armed Forces, "Revolution in Military Affairs: Choices for a Small Nation," Dana J. Johnson and Ariel E. Levite, eds., *Toward Fusion of Air and Space: Surveying Developments and Assessing Choices for Small and Middle Powers,* RAND CF-177-FIAS (Santa Monica, CA: RAND, 2003), 67-81.

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Space Radar: The Quest for Joint Warfare Transformation

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Persistent, agile, and responsive is the vision for Space Radar (SR)—the first responsive and dynamically re-taskable space-based intelligence, surveillance and reconnaissance (ISR) system designed from conception for the operational warfighter, intelligence analysts, and civil users.[1] In essence, the SR system is just that—a constellation of Earth orbiting radars. However, the capability represents much more than that. It is a leading edge program, a trailblazer for transformation within the Department of Defense (DoD) and the intelligence community (IC). In 2001, Secretary of Defense Donald H. Rumsfeld challenged the military to transform—to think, organize, and operate differently with new capabilities that leverage information age technology and operating concepts to achieve and maintain an asymmetric advantage for the warfighter.[2] SR embodies the transformation concept. Air Force Space Command (AFSPC) is working in full partnership with the SR Integrated Program Office (IPO), services, US Strategic Command (USSTRATCOM), the Office of the Director of National Intelligence (ODNI), the National Geospatial-Intelligence Agency (NGA), and the National Reconnaissance Office (NRO) to develop a single SR system serving the needs of both the joint warfighting and intelligence communities. We are one nation and we intend to build one SR system to support our collective needs. So, how is SR transformational?

Since its inception the SR program has embraced the transformation concept. By design and by direction, SR is breaking down stovepipes and building bridges between the operational military and intelligence communities. The shared vision is a space system offering agility and responsiveness on a scale comparable to today's airborne ISR assets, but offering global access 24 hours a day, 365 days a year. Once operational and working in concert with transformational communications and net-centric capabilities, it is envisioned to advance and bring to fruition transformation in space support to joint operations—with the real potential to radically change the employment of air, land, and sea forces.

Space-based ISR systems—including radar satellites—are not new or novel concepts. For example, Canada has been operating their RADARSAT since November 1995. What makes our SR program different—transformational—is who it will serve, how it will be employed, and how it is being developed. Let's first review some background on the program before discussing the transformational aspects of SR.

The future joint force must be knowledge empowered so decision superiority will be essential to success in the battlespace—forces at every echelon must be able to make better, more informed decisions and implement them faster than the enemy can respond.

Requirements Basis

The need for a United States SR capability is now formally affirmed in the SR Initial Capabilities Document (ICD) approved in early 2006 by both the DoD and IC requirements process.[3] The SR ICD pulls from a multitude of requirements and capabilities documents that define broad requirements to support the future joint force. Together, the Capstone Concept for Joint Operations and associated Joint Operating and Functional Concepts, the Air Force's Transformational Flight Plan, and similar capabilities based planning guidance call for a flexible, adaptable, modular, deployable force where interoperability is the standard, and joint operations take place at the lower echelons. Linked and synchronized forces will be equipped and prepared to quickly respond to a changing and unpredictable environment. The future joint force must be knowledge empowered so decision superiority will be essential to success in the battlespace—forces at every echelon must be able to make better, more informed decisions and implement them faster than the enemy can respond.

A robust, integrated, responsive ISR architecture is necessary to support this future force operations concept. To support decision superiority the future ISR architecture must have the ability to synchronize all-source collection, processing, and data exploitation from available ISR sources.[4] The goal is unambiguous information to warfighters, intelligence analysts, and other customers—timely, actionable information on a wide range of conventional and asymmetric threats. This support will be just as critical to prevent conflict and surprise attacks as it will be to support on-going and dynamic combat operations. As threats become more unpredictable and reaction times decrease, requirements for global situational awareness also grow. SR promises to meet these ISR challenges.

SR Operations Concept

Building on the ICD, the SR user community has approved revised drafts of the SR system concept of operations (CONOPS) and SR Capability Development Document (CDD).[5] These documents state a multi-mode system is necessary to satisfy needs of diverse users. Five distinct product types, generated by multiple collection modes of operations, are detailed: SR's synthetic aperture radar (SAR), surface moving target indications (SMTI), open ocean surveillance (OOS), high resolution terrain information (HRTI), and advanced geospatial intelligence (AGI) products will be employed to provide a new space-based major force enhancement capability.[6]

SAR products have been used extensively by the DoD and IC for some time, for purposes ranging from developing intelligence preparation of the battlespace to targeting support and conducting battle damage assessment. In fact, the military may rely increasingly upon this phenomenology to complement the limited visible imagery obtained from today's sensors. The SR capability will provide a significant increase in both quantity and quality of SAR products compared to today's capabilities from airborne collectors.

SR's SMTI capabilities provide a new space-based vantage for radar tactics originally developed for airborne platforms.

Figure 1. Notional Space Radar synthetic aperture radar product.

Like existing air platforms such as the E-8C Joint Surveillance Target Attack Radar System and RQ-4A Global Hawk, SR will apply radar energy to understand the movement of vehicles on the ground. The SMTI mode will allow the user to select various sizes of search boxes, from single digits to hundreds of kilometers wide based on the mission and level of information fidelity required. SMTI will allow the user to monitor vehicle traffic patterns in most terrains, enabling the ability to discover enemy intent by understanding normal behavior and identifying changes. Users will employ SAR and SMTI interchangeably to support extremely challenging high payoff missions such as the tracking and targeting of mobile missile transporter/erector launchers. Once operational, the interleaving of these modes will result in revolutionary applications the SR user community cannot yet envision.

SR operations will be integrated and synchronized with Air Operations Centers (AOCs) and service Distributed Common Ground Systems (DCGS) enabling users at the tip of the spear to utilize the system's SAR and SMTI capabilities within their timelines. The projected SR system will have sufficient capacity and agility to support multiple users at the same time. So, while it is providing data to a combined air operations center

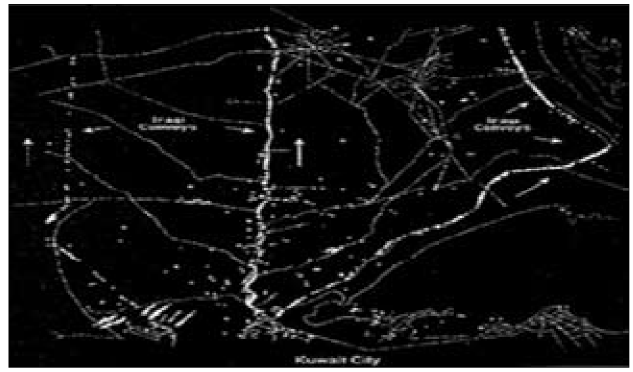

Figure 2. Notional Space Radar Surface Moving Target Indication (SMTI) product. SMTI—Monitors and tracks moving targets, fingerprints for identification and track association.

it may also support land or sea operations centers with other applications such as open ocean surveillance or mapping like functions. At the same time the system will provide critical data to analysts in the State Department, Department of Energy, and other IC members working both long- and short-range issues in support of our overall national security.

The OOS mode supports the Navy and US Northern Command by contributing to the maritime domain awareness and homeland defense missions. This mode operates much like SMTI—it detects the movement of objects, but does so over ocean vice land or littoral areas. OOS allows users to monitor ocean traffic in shipping lanes to discover changes that may indicate enemy intent. When applied in an integrated manner with other ISR assets, OOS enables the tracking of potential weapons of mass destruction shipments across the oceans.

HRTI capabilities will be operationalized to allow for military, intelligence, and civil applications to better employ this profound mapping capability. HRTI is similar to digital terrain elevation data collected during the Space Shuttle Endeavour's STS-99 mission in February 2000, though may be more detailed.[7] High resolution map making is only one highly anticipated application of HRTI data. Other applications of HRTI include detailed information on natural disasters, employment of precision guided weapons, and development of detailed ingress/egress strategies for special operations forces.

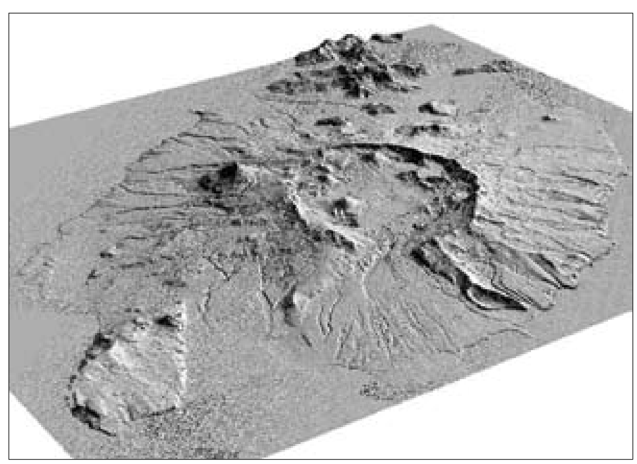

Figure 3. Example of a high resolution terrain information product.

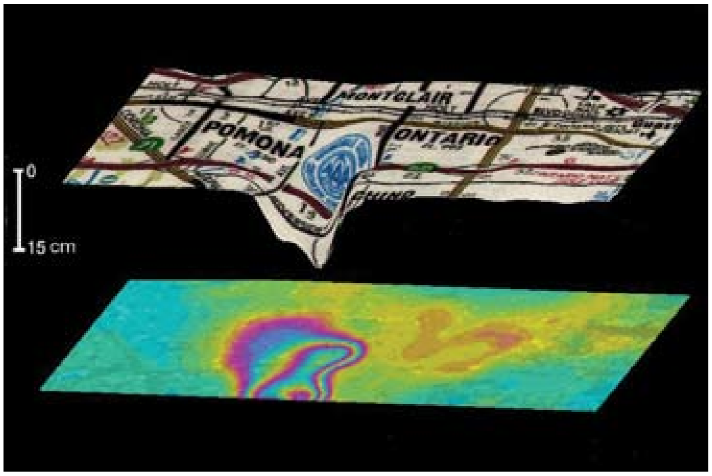

Figure 4. Notional SR advanced geospatial intelligence products.

Finally, the user community looks forward to the implementation of SR's AGI capabilities. AGI products will be derived from the same raw payload data used to develop other SR products. Users envision an operationalized AGI capability allowing them to routinely task for specific AGI applications and products. The timely exploitation and dissemination of these powerful products will support DoD and IC operations and analysis.

Timely AGI and HRTI products will contribute to near real-time situational awareness of the battlespace to aid commanders in identifying natural environmental hazards and other impacts to operations.[8] Air Force expeditionary combat support personnel will also take advantage of these products to eliminate some of the uncertainty involved with establishing contingency airfields in austere environments.

Transformational Aspects of Space Radar: Persistence, Agility, and Responsiveness

A key attribute of the future ISR architecture is increased persistence. Persistent coverage across time, over multiple theaters simultaneously, and across a wide range of the electromagnetic spectrum, will be necessary to address our information needs. Joint operating and functional concepts demand new methods for employing ISR capabilities. In keeping with these evolving concepts, SR will operate in a horizontally integrated joint architecture—combined operations with multi-service platforms feeding data to multi-service ground terminals. This network approach will yield the persistent ISR coverage our forces require. Persistence should not be defined in absolute terms—the level of persistence required depends on the mission at hand. For our purposes, persistence can be described as the integrated management of a diverse set of collection and processing capabilities operating to detect and understand the activity of interest with sufficient sensor dwell, revisit rate and quality required to expeditiously assess and predict adversary actions and deny enemy sanctuary.[9] More simply stated, revisit rate doesn't have to be continuous to understand or predict behavior. Rather, revisit just needs to be timely enough to understand the pace of activity relative to the situation. For example, monitoring activity in open ocean shipping lanes will normally require much less revisit than monitoring the movement of land vehicles across complex terrain. SR will make a critical contribution to overall ISR persistence by providing a robust constellation of low Earth orbiting radar platforms, about nine space vehicles operating in concert with each other.

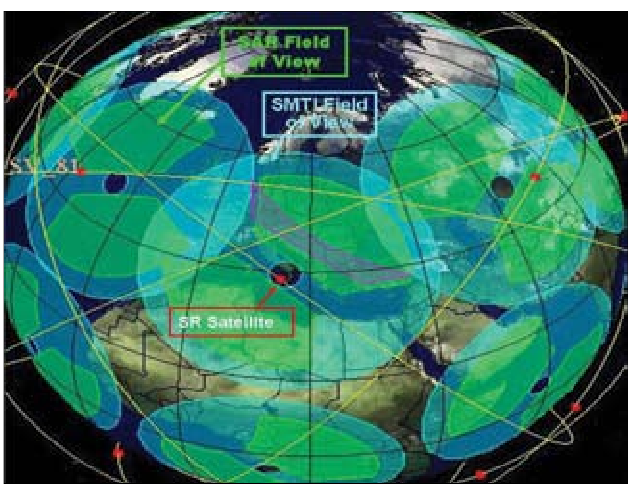

Figure 5. The constellation of SR satellites will make significant contributions toward satisfying goals for persistent ISR coverage across the globe.

At the heart of the SR capability is the satellite's electronically steered array (ESA) radar antenna (sometimes referred to as an electronically scanned array antenna). ESA technology has been successfully employed in operational fighter aircraft for over 30 years. After decades of investment and operational use, the time is right to transition this powerful technology to the space environment. ESA is a key enabler of our vision for a SR constellation with the unprecedented ability to act locally in ways/roles traditionally reserved for air assets. The ESA allows the user to focus the radar beam anywhere within its wide electronic field of regard without slewing the antenna, thus preserving precious energy and allowing the engagement and rapid retargeting of multiple targets near simultaneously across disparate geographic locations. In addition, the electronic agility of the ESA will enable the user to transition between the numerous radar modes in a seamless manner, allowing for the near simultaneous collection and integration of multiple SR products.

Figure 6. A notional SR satellite featuring the Electronically Steered Array.

Operational users across the DoD and IC have been consistent in their call for a more responsive space ISR platform—SR will be responsive to this call.[10] Meeting this vision requires an enterprise approach to the system engineering of this capability. The Air Force has teamed with NGA and NRO to mature the ground architecture in a manner that allows operators to tailor their support needs, from requests for responsive tasking through the call for timely dissemination of products. The ground segment, including the supporting communications, that will complete the overall SR system is being developed to take full advantage of the space segment's agility and flexibility. The result will be a highly responsive system of systems where rapid mode changes are not only feasible, but routine in support of user needs and the changing target environment. These responsive system capabilities will be coupled with tactics, techniques, and procedures to realize the dynamic operations described below. The net result is routine and reliable end-to-end support to time-critical operations—from near-real-time tasking to rapid product delivery—with minimal disruption to pre-planned collection.

Once operational, the persistent, agile, and responsive nature of SR will provide assured access to space-based ISR and enable mission success for the military, intelligence, and civil users it will support.

Dynamic Operations

Machine–to-machine interfaces will facilitate self-cuing within the SR system and automatic cross-cuing between other airborne and space-based ISR systems. For instance, if the SMTI mode detects vehicle movement in a particular area of high interest, the SR sensor may be automatically re-tasked to collect a SAR image of the target area. In some cases, this would occur during the same pass over the target. If this was not possible or feasible, the next SR satellite coming into view or another ISR sensor with access to the target would collect the image. Time-dominant processing will take place to get desired products to users within their timelines. At the same time, consistent with tasking and priorities, signals intelligence (SIGINT) and measurement and signature intelligence (MASINT) collection systems will automatically react to SR collected data. These 'if-then' collection strategies will be developed by users and analysts alike as part of the continuous evolution of SR employment concepts and applications.

Dynamic operations—on-the-fly changes to SR collection, processing, and exploitation operations—is a common element of SR employment concepts. Fast processing and automatic exploitation tools will be critical to fulfilling this vision. SR collection operations will produce huge volumes of data; too much data to rely solely on man-in-the-loop processes. Automatic target detection, automatic clutter cancellation applications, and data fusion applications, are just some of the tools required to assist analysts and other users separate the 'wheat' from the 'chaff.' Some SR products, such as SAR imagery and SMTI, will normally take minimal processing and exploitation time. Generating AGI products on the other hand will often entail complex processing algorithms. Even so, the objective is to generate these products and get the actionable information they reveal to users in time to take appropriate action. NGA has taken on the responsibility of developing and providing common user exploitation and analysis tools for SR and other sources of geospatial data.

Space Radar Within the National Security Enterprise

Consistent with family of system operations, SR data will not be analyzed in a vacuum. SR collection managers, operators, and data analysts will be closely tied to operations and activities of other imagery sources and those of other intelligence disciplines such as SIGINT, human intelligence, MASINT, and open source intelligence. All-source intelligence centers, like the Defense Intelligence Agency and eventually DCGS sites, will integrate SR data with other sources to provide operators the best 'picture' possible on their targets of interest.

Dissemination will be accomplished over a National Security Enterprise through both push and pull mechanisms. A mix of secure networks, broadcasts, and direct downlinks will ensure SR collected data and system information is accessible and discoverable to all who need it. SMTI and other SR data will flow into real-time battlespace awareness tools, common operating pictures, and dynamic battlefield management systems. Correlation with data from other intelligence sources and integration with operational data such as flight plans for airborne ISR platforms will occur at joint operating centers, joint intelligence centers, AOCs, DCGSs, tactical operations centers, fleet battle

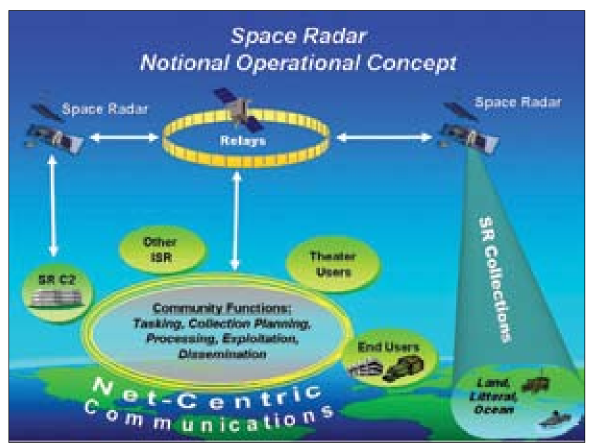

Figure 7. A notional SR operations concept.

management centers, and other operations centers. SR data and derived products will be classified at the lowest level possible to facilitate wide dissemination.

Challenges and Opportunities

SR, upon operational capability, will deliver dynamic and timely data and information to warfighters and intelligence community users. However, to achieve initial and eventually

The net result is routine and reliable end-to-end support to time-critical operations—from near-real-time tasking to rapid product delivery—with minimal disruption to pre-planned collection.

full capabilities the SR community will need to thoroughly embrace and apply the lessons learned from previous and on-going space system acquisition efforts. As such, SR development will be consistent with rigorous systems engineering and up-front technological risk reduction strategies to lower acquisition risk.

The capability users seek from SR—persistence, agility, and responsiveness—requires the acquisition community to find alternatives to mechanical age technologies with digital age technologies. Managing the associated risk will be challenging. The task is to reduce technology and integration risks in a controlled manner to achieve the goal of a timely delivery of transformational capability to the operators. For example, the SR acquisition team has made great strides by investing substantially in the development of prototype ESA transmit/receive modules over the last few years. They are confident this technology will continue to mature on schedule, and with each batch of modules produced, their confidence increases in the related cost estimates.

In many respects, SR is a pathfinder for transformation between the intelligence community and the operational military—a veritable lightning rod for national security space integration. It is the first major Air Force space program designed to satisfy the needs of both joint warfighters and intelligence community customers form the start.[11] NRO has designed, developed, and operated all other national space systems for the IC, while AFSPC has fulfilled this role for space systems designed to primarily serve the operational warfighter. Although AFSPC and NRO have been collaborating for some time, especially since release of the Space Commission report in 2001, the two space acquisition organizations follow different user requirements processes and different bodies provide requirements oversight.[12] While there has been some shared requirements oversight recently, the actual requirements development processes have remained relatively in-house efforts with NRO consulting with intelligence agencies and AFSPC consulting with the services and joint commands. The requirements process for SR is breaking this mold.

SR User Community

AFSPC is leading the way in building and operating structured user forums at the colonel (O-6) and working levels to facilitate an inclusive requirements and CONOPS development process from the ground up. Specifically, they have established requirements and concepts of operations working groups comprised of members from over 20 DoD and IC organizations to ensure user needs are comprehensive and based on capabilities and effect. These combined groups are also engaged in the analysis needed to develop specific performance parameters and demonstrate technical feasibility and affordability. While much work remains, the working groups steadily grow the relationships required to bring this capability to fruition.

As described earlier, the envisioned ISR network provides an unprecedented level of responsiveness to the user in support of time-critical scenarios. While responsiveness and agility are attributes that every operator embraces, advances in these areas have direct impact on overall system assuredness. Simply stated, one user's assured allocation is another user's loss of agility and responsiveness. The SR program is investing in the analysis and development of algorithms and automated scheduling functions to optimize tasking agility, while minimizing disruption of pre-planned collections.

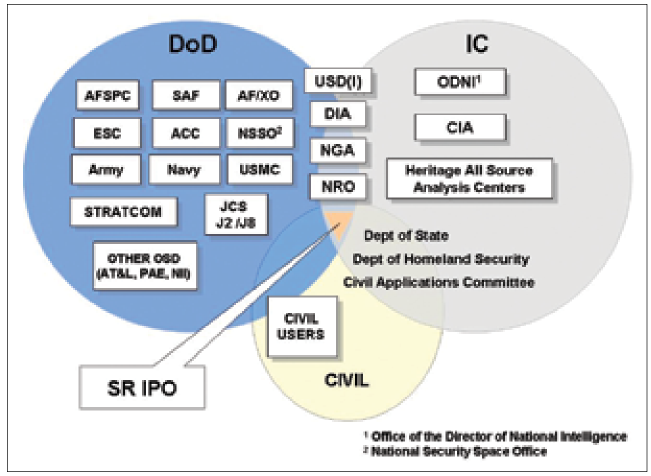

Figure 8. The SR community.

Program Status and Way Ahead

The SR program is real and growing, though it will take some time to realize an operational capability. The next major SR acquisition milestone is Key Decision Point–B (KDP-B), the approval to enter into the preliminary design phase of acquisition. This is a critical milestone since it represents formal program initiation and requires a commitment for full funding.[13] To reach this point AFSPC, NGA, and ODNI will continue to lead user efforts to solidify requirements for a SR capability and finalize the system's operations concept. This work will culminate with a CDD and CONOPS jointly approved by the DoD's Joint Requirements Oversight Council and the IC's Mission Requirements Board.

The SR IPO will use these documents to develop system level requirements, architecture products, initial designs, and high level system specifications. A Defense Space Acquisition Board will review this work for the KDP-B decision on whether or not the program is ready to enter the preliminary design phase. Currently, the SR community plans to complete all requirements for KDP-B by the end of calendar year 2008 to support an initial launch capability in the 2016 timeframe.

Full operations capability, which includes the complete constellation of satellites, is expected about six years after the first launch.

While the IPO is developing the SR satellites and associated command and control segments, others will be working to ensure users can employ the end-to-end system in a seamless and responsive manner. USSTRATCOM, AFSPC, NGA, NRO, Electronics Systems Center, and user training institutions are just a few of the organizations required to develop interfaces, systems, tactics, techniques, and procedures; and other programs to support SR operations and employment.

Over the next decade Air Force Space Command will work in concert with others in the space and intelligence, surveillance and reconnaissance (ISR) communities to develop, deliver, and operationalize an interactive Space Radar system to answer the call for transformational ISR.

Conclusions

AFSPC is committed to "develop transformational advancements in our ability to task, collect, process, exploit, and disseminate ISR fully integrated with air, ground, and naval forces."[14] The overall objective of these efforts are to help our Nation's leaders better understand the environment and avert crisis situations. Should this fail, SR will help shape the battlespace, take instigative actions, and react to developing situations.

Over the next decade AFSPC will work in concert with others in the space and ISR communities to develop, deliver, and operationalize an interactive SR system to answer the call for transformational ISR. Persistence, agility, and responsiveness will be the key performance measures for SR. The system's evolutionary capabilities and transformational path allows all to press forward with enhanced relationships between military and intelligence agencies and better ops-intel support concepts. Once operational, the system will expand our horizons on what is possible from space and help our Nation maintain an asymmetric advantage over adversaries.

In a word—SR is transformational. By working through the challenges of transformation, those making SR a reality will ensure the program's military, national, and civil users reap all the possible benefits of an integrated, agile, and responsive system. These users will take advantage of SR's inherent flexibility to drive its operations construct and mission operations. The result—data, information, products, and applications that lead to decision superiority, mission success, and, ultimately, joint warfare transformation.

Notes:

[1] Space Radar Initial Capabilities Document (U), 15 February 2006. (Secret) Information extracted is unclassified.

[2] Department of Defense, *Transformation Planning Guidance*, (Washington DC: Office of the Secretary of Defense [Force Transformation], April 2003), 1.

[3] Space Radar Initial Capabilities Document (U).

[4] Joint Chiefs of Staff, *The National Military Strategy of the United States of America: A Strategy for Today; A Vision for Tomorrow* (Washington DC: Office of the Chairman, 2004), 27-28.

[5] Space Radar System Concept of Operations (U) , Draft Rev C, 30 August 2006. (Secret) Information extracted is unclassified; Space Radar Capability Development Document (U), Draft Rev C, 30 August 2006. (Secret). Information extracted is unclassified.

[6] Space Radar Initial Capabilities Document (U).

[7] Shuttle Radar Topography Mission, NASA, Jet Propulsion Laboratory, California Institute, http://www2.jpl.nasa.gov/srtm/index.html (accessed 25 September 2006).

[8] Department of the Air Force, *The US Air Force Transformation Flight Plan* (Washington DC: HQ USAF/XPXC, Transformation Division, 2004), 55.

[9] Letitia A. Long, Deputy Undersecretary of Defense for Intelligence (Policy, Requirements and Resources) (address, US Strategic Command's ISR Transformation Government Symposium, Denver, CO, 28-30 September 2004).

[10] Space Radar Initial Capabilities Document (U).

[11] Secretary of Defense (SECDEF) and Director of Central Intelligence (DCI) Memorandum (U), 13 January 2005. (Secret) Information extracted is unclassified.

[12] *Report of the Commission to Assess United States National Security Space Management and Organization* (Washington, DC: The Commission to Assess United States National Security Space Management and Organization, Pursuant to Public Law 106-65, 11 January 2001).

[13] National Security Space Acquisition Policy, Number 03-01, Guidance for DoD Space System Acquisition Process, 27 December 2004.

[14] Air Force Space Command, *Strategic Master Plan FY06 and Beyond* (Peterson AFB, CO, 1 October 2003), 18.

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Security Forces and the Technological Edge

Maj Joseph Anthony Musacchia, Jr.
Commander, 341st Security Support Squadron
Malmstrom AFB, Montana

When one thinks of technology and Air Force Space Command (AFSPC), images of satellites, launch platforms, space radars, and a mighty intercontinental ballistic missile (ICBM) fleet lining the northern tier of the United States permeates the mind. Rarely do people visualize our Air Force security forces harnessing technology to secure these powerful aerospace platforms and weapon systems.

Our Nation's space force is truly powerful and has a proud history. On 28 February 1958, the US Air Force Ballistic Missile Division began researching and developing Minuteman solid-propellant ICBMs.[1] From this humble beginning our space capabilities have evolved and served us well. But now an emerging threat demands new and updated requirements.[2] In 1958, the technology and method of providing security for these assets were state-of-the-art. Unfortunately, as launch systems have evolved and been updated with more modern technology the methods of securing our capabilities did not … until now.

The thrust and backbone of space and nuclear physical security has always been manpower and firepower at the launch facility. This construct places our security forces in a reactionary posture. To protect the resource, our security forces Airmen establish a tight perimeter and prepare for close quarter-battle in the immediate vicinity. The tactics, manpower, and firepower requirements are compliance-driven and based on Department of Defense and AFSPC instructions. Although this method of defense worked well in the Cold War era, the strategic climate has changed. Unfortunately security forces' methods did not.

Today the threat has changed, and our security force tactics need to evolve accordingly. Under the previous leadership of Brig Gen Robert H. Holmes, security forces began a transformation designed to face the "new enemy" in the Global War on Terrorism (GWOT). This transformation is designed to alter the posture of security forces from a compliance-based force to a capability-based/operationally-focused defensive force. Air Force security forces' primary or "core" combat mission is integrated base defense and nuclear security. The strategic vision of Headquarters US Air Force is to determine capability gaps and shortfalls and then seek to close those gaps and mitigate or counteract those shortfalls. This transformation will be achieved by promoting a force protection culture and integrating technology into security forces operations.[3] This transformation is occurring throughout the Air Force and AFSPC security forces are leading the charge to ensure free and open access to space and our ability to protect our aerospace power.

SSgt William Blado and TSgt Douglas King analyze data collected by the man-portable surveillance target acquisition radar (MSTAR) during operational use at one of Malmstrom's Launch Facilities

A primary illustration of this development occurred recently in 20th Air Force, the headquarters overseeing three ICBM wings at Malmstrom AFB, Montana; Minot AFB, North Dakota; and F. E. Warren AFB, Wyoming. In 2004, Headquarters USAF procured nearly $351.7 million worth of commercial, off-the-shelf security enhancement technology for security forces use throughout the Air Force. Most of the equipment was purchased for installations with flying missions, but some of the equipment had potential applications at 20th Air Force units. AFSPC acquired two key pieces of equipment for 20th Air Force: the man-portable surveillance target acquisition radar (MSTARS) and the wide area surveillance thermal imager (WSTI). The equipment had to undergo rigorous testing prior to using it in close proximity to 20th Air Force-unique resources and components. After certification and approval, AFSPC security forces employed this technology in conjunction with current compliance-based ground security tactics to greatly enhance AFSPC security forces' capability to effectively accomplish the mission.

Why is this and other new developing technology a necessity in the heartland of America? Italian airpower theorist Guilio Douhet said long ago, "It is easier and more effective to destroy the enemy's aerial power by destroying his nest and eggs on the ground than to hunt his flying birds in the air." This same principle applies to our space capabilities. No nation can rival our capabilities in space. Therefore our impressive space capabilities are a potential target. As Douhet pointed out, disrupting this capability is easier to accomplish on the ground.

The new enemy we face in the GWOT often attempts to attack aerospace platforms on the ground using standoff attacks, as indicated by the multiple daily attacks occurring in both Iraq and Afghanistan. This is a method that has been successful throughout history. As noted by Alan Vick's book, *Snakes in the Eagle's Nest,* 78 percent of all attacks against aerospace platforms until 1992 were standoff attacks and these attacks have proven extremely difficult to counter.[4] Research by the RAND Corporation for *Project Air Force* concluded the continental United States is not necessarily a sanctuary from these attacks. Indeed, it is where the threat is greatest and where RAND's experts believe Air Force leaders need to concentrate their attention and resources.[5] The role of US ICBMs and nuclear weapons in the GWOT era is pivotal as they provide deterrence against weapons of mass destruction. The credibility of US responsive actions requires that our nuclear forces be capable of responding to any crisis, at any level.[6] But, since these weapons live in the ground until called on, their security, daily, and during periods of vulnerability, is key to their operational readiness.

As stated earlier, one of the security forces' core *combat missions* is nuclear security and a combat mission is precisely what it is. Twentieth Air Force security forces are responsible for protecting nuclear weapon systems, especially when they are at their most vulnerable state … when they are being maintained. Security forces provide optimal protection to our Airmen and assets as they secure an "open" launch facility while missile maintainers work swiftly to repair and/or upgrade systems. This mission takes place every day at many of the 500 launch facilities across the vast, isolated expanses of the northern tier of the US. These locations are geographically separated from the main support base by sometimes hundreds of miles.

Today, security forces are not confronting the enemy of the Cold War era, but one who has attacked our homeland in new and unconventional ways with the intent of inflicting terror in our Nation's population while attempting to influence our government's policies. Nothing could achieve that objective more than the loss of security of a nuclear asset or an overt attack against one of our nuclear aerospace ground platforms. To address this new enemy, AFSPC security forces use the MSTARS and WSTI technology in combination with time-proven tactics.

In the past, during missile maintenance, security forces possessed little to no standoff detection capability. Security forces were limited to what they could detect with their natural eyesight or binoculars. In perfect weather conditions, security forces had effective visibility for perhaps two miles. More often than not, effective visual detection is often hampered by rugged terrain and vegetation. Therefore, security forces could not effectively assess possible threats and engage adversaries until they were practically at the launch facility. In typical Cold War thinking, teams compensated for this limitation by forming a tight perimeter in the immediate vicinity of the resources, with as many personnel as possible, and hoped they would achieve massive and overwhelming firepower.

SrA Matthew Burke verifies directional data while setting up the man-portable surveillance target acquisition radar (MSTAR) for use within Malmstrom's missile field.

> *"Growing the intellectual properties of our space professionals that will harvest more decisive, innovative, and integrated effects on the battlefield."*
>
> ~ General Lance W. Lord, USAF, retired

Today, Airmen understand that our new enemy will use more lethal ground weapon systems. Security forces can no longer afford to wait for the enemy to attack. They have to engage the enemy before its ready. We have to disrupt and defeat the terrorist as soon as possible and as far away from the resources as possible. Increased detection distance allows security forces adequate time to assess the situation and, if warranted, mount a defense and attack away from the resource. When warned of approaching threats, security can occupy key terrain and prepare to engage.[7]

The MSTAR and WSTI make this type of defense possible. Depending on the terrain, the technology allows security forces to detect and pinpoint anyone or anything up to 25 miles away from the location of our resources, versus the two miles to which forces were previously limited. Used in combination, the equipment allows for radar location, thermal image detection, closed circuit television visual assessment, and acoustic verification of any target in close proximity to the resource. An attack can be prevented or disrupted from a distance and forces can deny the enemy its goals and objective by stopping the attack before it ever starts.

This technology provides security forces with a key principle of war, *security*, by never permitting the enemy to achieve an unexpected advantage. The "system" applies defensive fundamentals such as *aggressive defense*, by preventing enemy forces from approaching defensive positions, and taking every opportunity to disrupt the enemy's operation. While defense plans are prepared in advance, the threat we face will constantly change. It is only through the use of accurate, timely intelligence that we can modify plans to best operate in the new dynamic defensive environment that AFSPC security forces find themselves. We must not only prevail in combat at the resource; we must make every attempt to prevent combat from occurring. The MSTARS and WSTI make this possible providing a technologic advantage.

Currently, this technology is employed by security forces throughout AFSPC, particularly at Malmstrom AFB, Montana who defend a 23,500 square mile ICBM complex larger than the state of West Virginia. With the effective use of this technology to enhance AFSPC security, the security forces fulfill their strategic vision by closing the capability gap and allowing our forces to *See First … Understand First … Act First*. As stated by the former AFSPC command chief, Chief Master Sergeant Ronald G. Kriete, "We remain the best Air and Space Force in the World. But we cannot rest on our laurels".[8] We must continue to advance and develop new and creative ways to command the tactical edge. The implementation of these technological security enhancements maintains that sharp edge as well as achieves the goal of former AFSPC Commander General Lance W. Lord by, "Growing the intellectual properties of our space professionals that will harvest more decisive, innovative, and integrated effects on the battlefield."[9] The use of these innovative security techniques truly brings AFSPC security into the 21st century and provides the tactical edge necessary to deny the enemy its objective. Most importantly, it ensures our ready capability as the strategic "top cover" of our Nation's conventional forces.

Notes:

[1] Milestones in Space History - 28 February 1958, *High Frontier*, Fall 2004, 5.

[2] Lance W. Lord, "50 Years of Air Force Space and Missiles," *High Frontier*, Fall 2004, 3-5.

[3] HQ USAF/A7SF, "Security Force Transformation," briefing, September 2004.

[4] Alan Vick, *Snakes in the Eagle's Nest – A History of Ground Attacks on Air Bases* (Rand, 1995).

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[8] Ronald G. Kriete, "Developing Enlisted Space Professionals," *High Frontier*, Summer 2004, 14.

[9] Lance W. Lord, "Welcome to High Frontier," *High Frontier*, Summer 2004, 3-4.

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Major Musacchia's previous military positions include: chief, Exercise and Deployments Branch; chief, Requirements Branch; and division chief, Resources, Headquarters PACAF, Hickam AFB, Hawaii. Operations officer, 47th Security Forces Squadron, Laughlin AFB, Texas. Element leader, 39th Security Forces Squadron, Incirlik AB, Turkey. Flight leader, 319th Missile Squadron and element leader, 90th Security Forces Squadron, F.E. Warren AFB, Wyoming.

Major Musacchia is a graduate of Squadron Officer School and completed in residence the Police Administrations Course at University of Kentucky. He has been awarded the Meritorious Service Medal with one device, the Air Force Commendation Medal with one device as well as the Air Force Achievement Medal.

Launch Control Center NetLink

Capt Joseph T. Page II
Missile Combat Crew Member, 741st Missile Squadron
Capt Mark C. Bigley
Minuteman III Missile Combat Crew Commander,
741st Missile Squadron
MSgt Douglas S. Angell
NCOIC, Electronics Laboratory
Minot AFB, North Dakota

In remote corners of America, the United States Air Force is performing a vital mission: worldwide nuclear deterrence. Five hundred intercontinental ballistic missile (ICBM) launch facilities are scattered throughout five states, commanded by ICBM missile combat crew members located in underground launch control centers (LCC).[1] Affectionately known as "missileers," these crew members provide the president with 24 hour-a-day, 365 days-a-year availability of nuclear forces.

While "on alert," missileers perform a variety of tasks related to the maintenance and operation of ICBMs. Typical alert duty is a 24-hour shift; however, the duty day including transit to and from the LCC equals an average of 30 hours.[2] During an alert, 14 hours of uninterrupted operations, testing, and maintenance is common. When crew members are not otherwise occupied with daily actions, some find time to read, study for an advanced degree, improve their job knowledge or simply relax. However, at all times, crew members remain ready to immediately respond to security violations, address maintenance concerns, or to comply with higher headquarters direction.

Unlike most work centers in the Air Force, crew members pulling alert do not have access to a personal computer (PC) and the base local area network (LAN) … that is, until a 91st Space Wing senior noncommissioned officer, MSgt Doug Angell, developed the NetLink architecture. The LCC NetLink concept will deliver personal computing capability to missile combat crews in the LCC. Additionally, access to the LAN will allow crew members to change the outcome of potentially catastrophic situations and take a giant leap forward from the days of the "Cold War" to today's Global War on Terrorism.

Launch Control Center NetLink Description[3]

LCC NetLink's mission statement is:

> *To provide ICBM combat crews with full computer/network capability in the launch control center to increase mission effectiveness and training efficiency.*

The advent of LCC NetLink greatly increases the versatility of ICBM crews. The system enhances effectiveness by providing crew members access to remote-monitoring equipment, essential data programs, and training materials in their underground control center. Crews can also complete tasks that require access to a computer, such as professional military education (PME) and enlisted/officer performance reports, while on alert. Likewise, Internet access to off-duty education courses is increasing both morale and grade point averages. LCC NetLink is poised to enhance productivity while crew members perform alert duties.

NetLink Uses

The inclusion of a computer system inside the LCC will increase situational awareness for missile combat crews, while also boosting productivity. Currently, the crew's only links to the aboveground world are the weapon system console and the telephone. Remote Automated Weather System (RAWS) and Remote Visual Assessment (RVA), when connected with NetLink access, have the potential to enhance operational effectiveness. Likewise, office efficiency can be maximized and online training as well as standard Microsoft Office and Outlook programs can be accessed while crews are pulling alert.

RVA has the potential to enhance security awareness by linking a video camera at a remote launch facility (LF) to the missile alert facility (MAF). The camera can identify enemy activity at the LF for responding security forces. Current configurations of RVA use analog video equipment to broadcast information to the MAF. With NetLink, crews in the capsule will have that same sight picture. With a high-speed connection and image-processing capability, multiple views (i.e., infrared, night vision, etc.) are possible.

RAWS allows weather data fusion, through information sent from remote nodes in the missile complex. RAWS provides wind, cloud, rain, temperature, barometric pressure, and visibility information. These systems provide vital meteorological data used in direct support of flight and ground safety. This not only supports medical evacuation or security helicopter operations, but all operations including maintenance and security.

Since base weather forecasters rely on equipment located on and around an Air Force base, the immense size of the missile field sometimes precludes rapid reporting; RAWS gives the forecasters a picture of the missile complex, either as a whole or pieces at a time. By fusing this data together, the forecasters get an accurate picture of the missile field with its varied weather and geography. RAWS data is currently available online via the base network. By including RAWS data on the LCC NetLink system, combat crews can receive faster notification of developing hazardous weather fronts. Quicker notification of hazardous conditions means quicker reaction by security, maintenance and operations crews to protect equipment and personnel.

Linking LCC NetLink directly to support base network resources will enable crew members to subscribe to the same data products as other 24-hour operations centers. One such source of information is the improved maintenance management program

(IMMP). Through IMMP, crews can review maintenance schedules and task work orders for their MAF or LCC. The immediate advantage for both maintainers and operators is forewarning. As more information is available to crews, they shift from reactive to proactive leadership.

LCC NetLink enables crews to stay one step ahead of potential risks throughout the vast 8,500-mile missile complex using real-time monitoring systems.[3] Applications such as the GPS-enabled transportation control system provide tracking capability for GPS-equipped, government-owned vehicles traveling in the missile field. When coupled with programs such as GeoBase that offer three-meter resolution, ground-mapping, and geographic information system overlays, crew members effectively close any gap in physical distance and become totally integrated with activities inside their area of responsibility.

Since the LCC is an austere work environment, an alert modified with LCC NetLink offers increased office productivity. Many training materials available for missile crews are now in computer-based training format, either through HTML web pages or dynamic web presentations. During alert downtime, crew members can complete supplementary training, reference guidance and clarification traffic, and review locally produced self-study lesson plans, as well as accomplish any administrative tasking requiring rapid coordination, such as performance reports and award nominations.

PME correspondence programs for officers such as Squadron Officer School (SOS) and Air Command and Staff College (ACSC) have all "gone digital," replacing paper-based programs. Air University presents SOS courses in a completely online format. ACSC distance learning includes video presentations and interactive applications delivered via CD-ROM and through the Internet.[4] LCC NetLink provides crew members access to each PME format while on alert.

Technical Description

LCC NetLink allows personal computing in the LCC without degrading the missile crew's primary mission of performing nuclear operations. The overarching security concern in the LCC is information security, with emissions security (EMSEC), communications security, computer security, transmission security (TRANSEC), and operations security held in the highest regard.[5] Included with, but not falling under the "SECs," is nuclear surety. LCC NetLink operates well within the bounds of these nuclear surety requirements due to the use of a fiber optic keyboard, video and mouse (KVM) relay, the physical separation of the central processing unit (CPU) and policies and procedures governing the use of LCC NetLink.[6]

The LCC is engineered to mitigate EMSEC and TRANSEC risks, safeguard sensitive nuclear war plan data and ensure nuclear surety is maintained;[7] each feature is critical to the safe and secure operation of the Minuteman ICBM weapon system. The LCC NetLink program relies on an innovative application of commercial off-the-shelf hardware to operate within the LCC environment.

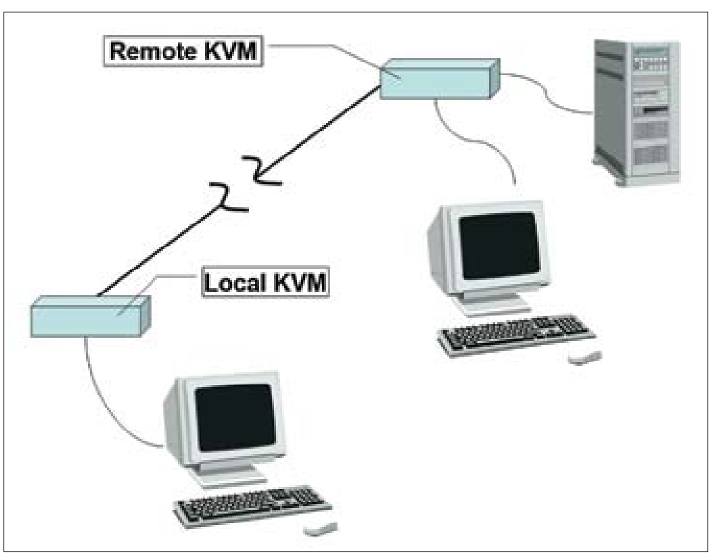


Figure 1. Simplified Launch Control Center NetLink System.

Keyboard, Video, and Mouse

A KVM system provides remote access to a PC terminal via the KVM ports. These units can be connected to the PC using a variety of methods such as a serial interface, universal serial bus, parallel, network relay, or, for LCC NetLink, fiber optic cables. The LCC NetLink application of a KVM relay system allows use of the remote video monitor as both a computer monitor and television. All equipment used in the LCC received an electromagnetic compatibility evaluation at the 526th ICBM Systems Wing at Hill AFB, Utah, with successful results.[8]

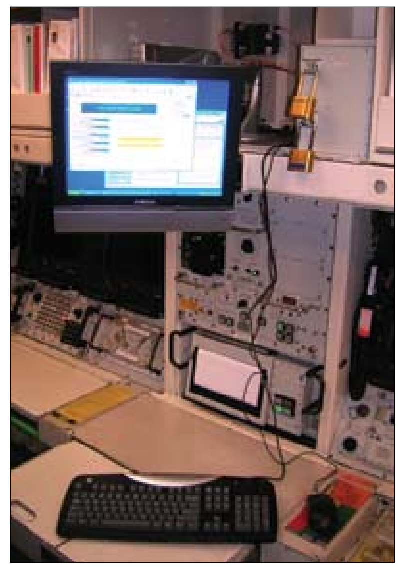


Figure 2. Launch Control Center NetLink set-up in the Launch Control Center.

Fiber Optic Link

Considered the heart of the LCC NetLink system, fiber optic technology meets strict EMSEC and TRANSEC requirements for secure area computing. A fiber optic KVM relay (in the LCC) takes signals from a remote keyboard and mouse and modulates their data across a light beam transmitted via thin glass filaments to another KVM relay (upstairs in the MAF). Once the encoded data reaches the second relay connected to the host PC, demodulation of the keyboard and mouse signals occurs. The demodulated signals then arrive at the PC in a recognizable format. The PC then transmits a video signal to the remote terminal in the LCC using the same method. In this manner, a user can interact with the computer as if they were sitting directly in front of it.

Central Processing Unit

All LCC NetLink systems will use computers certified by the

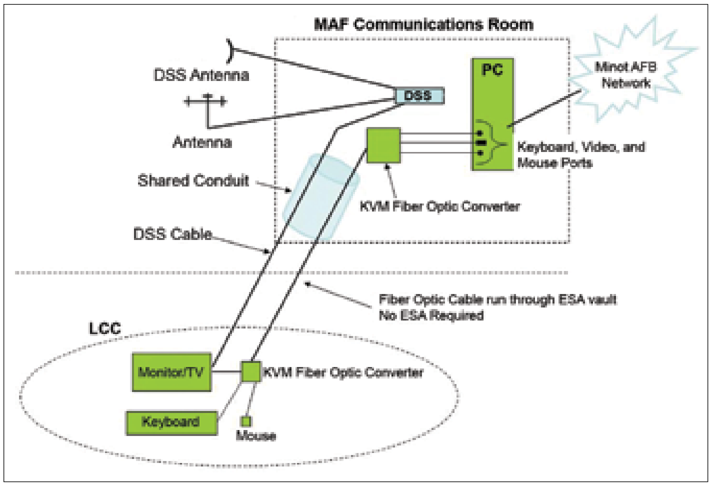


Figure 3. NetLink wiring diagram.

designated approving authority for operation on the installation's network. Certification of each LCC NetLink PC is not required, since the system does not represent a stand-alone computing platform. Computers used in conjunction with LCC NetLink fall under the same policies and must adhere to the same requirements as other computers connected to a government network. Physical security risk mitigation is possible by keeping the CPU in a secure location aboveground within the MAF. LCC NetLink also eliminates potential EMSEC and TRANSEC issues associated with secure environments by removing all access to storage devices, drive bays, and communications ports within the LCC.

Operating System

Unit client support administrators ensure each LCC NetLink PC receives the same level of service as other data-processing equipment under their control. The operating system, software applications, security patches, and all hardware are configured in accordance with local policies and should mirror the configuration of other computers on the installation's network. LCC NetLink's current configuration runs a US government-approved version of the popular Windows operating system.

Conclusion

Installation of the first LCC NetLink hardware began in May 2006 at Juliett-01 MAF/LCC located at Minot AFB, North Dakota. LCC NetLink will provide an overwhelming advantage to deployed ICBM combat crews, demonstrating a unique approach to information access in restrictive environments. In this information age, it is vital that Air Force members utilize technology to enhance the command and control capabilities of every operation.

Notes:

[1] Air Force Space Command, *AFSPC Unit Locations*, http://www.afspc.af.mil/units/ (accessed 25 September 2006). ICBM bases are located near Minot, North Dakota (Minot AFB), Cheyenne, Wyoming (F. E. Warren AFB), and Great Falls, Montana (Malmstrom AFB). Minot and Malmstrom's missile complexes reside entirely in their home states, while F. E. Warren's ICBMs and LCCs reside in three states: Colorado, Nebraska, and Wyoming.

[2] Capt J. Page, author's personal experience on missile alert at Minot AFB's Hotel Launch Control Center, 30 April 2006.

[3] MSgt D. Angell, LCC NetLink, 91MOS/MXOPE PowerPoint presentation for 91SW/CC and 91OG/CC, 8 December 2005.

[4] Air University, ACSC and SOS web sites, http://sos.maxwell.af.mil and http://acsc.maxwell.af.mil (accessed 25 September 2006).

[5] The Boeing Company, *Electromagnetic Evaluation of a LCC Crew Support Remote Computer Items (TV/Monitor, Keyboard, Mouse & Fiber Optic Extender)*, ICBM Prime Team, 25 October 2005, document contents are classified for official use only.

[6] D. Wynn, Review of the No-Impact Nuclear Certification Impact Statement (NCIS) for the Launch Control Center (LCC) NetLink Installation, memorandum for HQ AFSPC/XONO, 27 February 2006.

[7] The Nuclear Information Project, "US Changes Name of Nuclear War Plan," 21 December 2004, http://www.nukestrat.com/us/stratcom/siopname.htm (accessed 25 September 2006). Single Integrated Operational Plan, term no longer used by USSTRATCOM, but retained in historical documents and operator vocabulary.

[8] D.R. Moody, Electro-Magnetic Compatibility (EMC) Evaluation of LCC Remote Computer Items, memorandum for 526 ICBM SW/ENS and AFSPC/CEF, 25 October 2005.

Capt Joseph T. Page II (BS, Electronic Engineering Technology, NMSU, New Mexico; MS Space Studies, American Military University) is a Missile Combat Crew Member with the 741st Missile Squadron, Minot AFB, North Dakota. Captain Page attended Officer Space Prerequisite Training in 2001. After completion of Officer Space Prerequisite Training in June 2001, and ICBM Initial Qualification Training in November 2001, Captain Page joined the 741st Missile Squadron. From November 2001 to June 2003, Captain Page performed duties as a Deputy Missile Combat Crew Commander, being upgraded to his current position as Missile Combat Crew Commander in July 2003.

Capt Mark C. Bigley (BS, Biochemistry, Virginia Tech) is a Minuteman III Missile Combat Crew Senior Commander Evaluator currently assigned to the 91st Operations Group, Minot AFB, North Dakota. He is also the officer in charge for the LCC NetLink program. While on nuclear alert at the squadron command post, he is responsible to the president and CDRUSSTRATCOM for the proper launch of 50 nuclear missiles, directs missile crews and oversees $3.3 billion in critical weapon system assets. Captain Bigley earned a commission in the USAF through the Reserve Officers' Training Corps at Virginia Tech in May 2002. He is a graduate of Space 100 training at Vandenberg AFB, California, and is currently enrolled at the University of North Dakota working toward a graduate degree in space studies.

MSgt Douglas S. Angell (AS, Community College of the Air Force; Daytona Beach Community College) is the NCOIC of the Electronics Laboratory, Minot AFB, North Dakota. MSgt Angell leads technicians who maintain/calibrate Launch Facility and Launch Control Center electronic components and equipment that sustain the Minuteman III intercontinental ballistic missile system (ICBM). He is also responsible for certification of Minuteman III critical components and aerospace vehicle equipment ensuring the combat readiness of the 91st Space Wing's ICBM force. MSgt Angell has been the noncommissioned officer in charge (NCOIC) of J01 Missile Alert Facility, Technical Engineering and the assistant NCOIC of the Electro-Mechanical Team section. MSgt Angell is a graduate of the NCO academy, Airman Leadership School and a John L. Levitow award winner from the NCO preparatory course.

Book Review

Chinese Space Policy: A Study in Domestic and International Politics

Chinese Space Policy: A Study in Domestic and International Politics. By Roger Handberg and Zhen Li. New York: Routledge, 2007. Figures. Tables. Appendices. Notes. References. Index. Pp. vi, 202. $120.00 Hardback ISBN: 978-0-415-36582-6

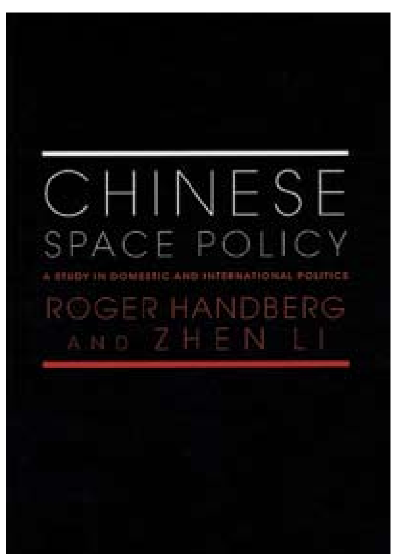
Many outside observers still find Chinese space policy enigmatic. We know China's significant space-related accomplishments: it began developing long-range missiles in 1956; its first satellite, *DFH-1*, orbited Earth in 1970; it joined a select "club" with the launch and safe return of a human in 2003; and it conducted a successful anti-satellite test in 2007. Still, the intent behind those accomplishments and the future direction of China's space program remain problematic. What are China's aspirations with respect to military space? How important to the Chinese are civil and commercial space activities? Why is China pursuing human spaceflight?

In *Chinese Space Policy*, political scientists Roger Handberg and Zhen Li shed light on such questions by analyzing the evolution of Chinese space policy through two political lenses—domestic and international. Focusing their study in this way reduces the decisional opaqueness and cultural uniqueness in Chinese space activities that Joan Johnson-Freese emphasized in *The Chinese Space Program: A Mystery Within a Maze* (1998). It circumvents the narrower technical approach found in Brian Harvey's *The Chinese Space Program: From Conception to Future Capabilities* (1998) and *China's Space Program: From Conception to Manned Spaceflight* (2004). Unlike Mark Stokes, who concentrates on the military importance of Chinese space capabilities in *China's Strategic Modernization: Implications for the United States* (1999), Handberg and Li adopt a broader perspective.

They argue one can best understand the overall course of Chinese space activity as analogous to the paths taken originally by the United States and Soviet Union/Russia. All three countries developed long-range missiles to deliver thermonuclear warheads and, subsequently, used those rockets to launch satellites. They did this initially for national security and prestige but, eventually, each perceived an important synergism between space activities and socio-economic development. Among space-faring nations, only the United States, Russia, and China have exhibited sufficient political will to invest the economic and technical resources needed for independently achieving human spaceflight. While superpower competition led the United States and Soviet Union to commit those resources during the late 1950s and the 1960s, circumstances peculiar to China caused its belated emergence as a first-rate power in space.

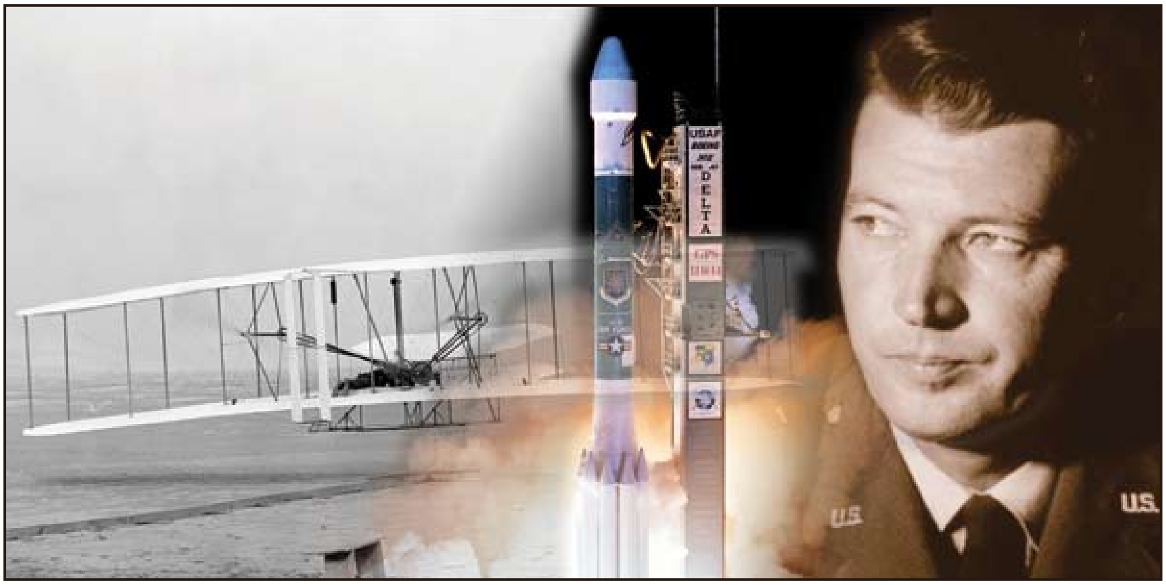
The pace of China's accomplishments in space depended both on its domestic conditions and its general role in the international system. Handberg and Li identify four distinct eras based on changing political, economic, and technical conditions. First, during 1956-66, China faced an unquestionably hostile international environment. Despite severe economic and technological constraints, a group led by Mao Zedong and his defense minister Lin Biao sought to construct a satellite for purposes of national prestige and as an internal propaganda tool to enhance their political power. The intense domestic strife of the Cultural Revolution, during which Mao sought to bolster his personal power, underlay the second era in Chinese space activity, 1966-76. Lin Biao's death in September 1971 abruptly terminated growth of the space program formerly under his patronage; the Maoists intensified their subjection of senior engineers and scientists to self criticism or imprisonment. Meanwhile, academic policies associated with the ongoing Cultural Revolution undermined the education of future scientists, engineers, and technicians inside China and severely constrained the flow of scientific and technological information from outside the country. China's space program withered.

The remaining eras, 1976-1986 and 1986-present, removed many obstacles to progress, not the least being political barriers, and brought to fruition China's space dreams. Especially after Deng Xiaoping became undisputed leader in 1978, the third era focused broadly on economic growth, with civilian space applications being related to economic development. Chinese space policy also fostered a commercial launch market and joint research and development (R&D) ventures with foreign partners to accelerate maturation of space technologies for civilian use. Given the dual-use nature of satellite systems, China recognized that as space science and technology strengthened the national economy, military capabilities also improved. Beginning in 1986 with the National High Technology Research and Development (863) Program, the fourth era included policies to enhance China's international competitiveness and to improve its high-tech R&D. A fast-growing economy and political leaders' willingness to invest more resources, both economic and technological, in the space program brought remarkable success, including *taikonauts* in orbit.



Finally, Handberg and Li use their analytical model to assess China's space future. They find China's recently demonstrated ability to keep its space-faring aspirations aligned with politically available resources both fascinating and praiseworthy. Nonetheless, the direction and success of their space program depends on how the Chinese address four issues: achieving sufficient political stability to ensure continuity in space policy; their stance toward international cooperation; transitioning from a government-dominated to a mixed program; and military space activities. For seasoned space professionals, government officials, academicians, and curious students alike, *Chinese Space Policy* offers substantial insight to that country's space-related motivations and actions.

Reviewed by Dr. Rick W. Sturdevant, deputy command historian, HQ Air Force Space Command



GENERAL BERNARD A. SCHRIEVER MEMORIAL ESSAY CONTEST

INFORMATION

In an effort to stimulate thought, discussion, and debate on the nature and employment of space power in the name and memory of a great space power pioneer, the 50th Space Wing is pleased to announce the establishment of the inaugural General Bernard A. Schriever Memorial Essay Contest.

We encourage you to reflect on today's military space challenges and take a visionary approach to determine what critical development (doctrinal, technological, or otherwise) we might witness in space power over the next 30 years, and what impact that development will have on national security matters.

Our Air Force relies on innovative ideas and critical thinking to maintain its edge. This contest serves as an opportunity to share your ideas with other space professionals.

The contest is hosted by the 50th Space Wing and sponsored by the Lance P. Sijan Chapter of the Air Force Association. It is open to all Air Force Space Command military and civilian personnel. Essays should be submitted no later than 13 April 2007.

Winners will be announced in May 2007. We will present awards to our first- through third-place winners and honorable mentions at the June 2007 Air Force Association Space Warfare Symposium. Air Force Space Command's *High Frontier* journal will publish the winning essays in its August 2007 issue.

GUIDELINES

Submissions must be original analytical and/or interpretive work not currently submitted nor previously published elsewhere. Essays are limited to 3,500 words and should be double-spaced. We encourage you to submit photographs and other supporting graphic elements along with your essay.

Please include the title of your essay in the subject line of your e-mail. In the body of the e-mail, include your name, address, telephone number, the title of your essay and a biography of 50 words or less.

Because the author's identity will not be released during the judging process, your essay cover page should include the title of your essay (as noted in the e-mail) and the total word count. Footnotes and text for supporting graphics do not count toward the overall word count. Do not include your name on the cover page.

All submissions must be dated on or before 13 April 2007. Top prize winners will be published in the *High Frontier*, the professional journal of Air Force Space Command.

ENTRIES

Submit entries and all related correspondence electronically to essay.contest@schriever.af.mil.

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