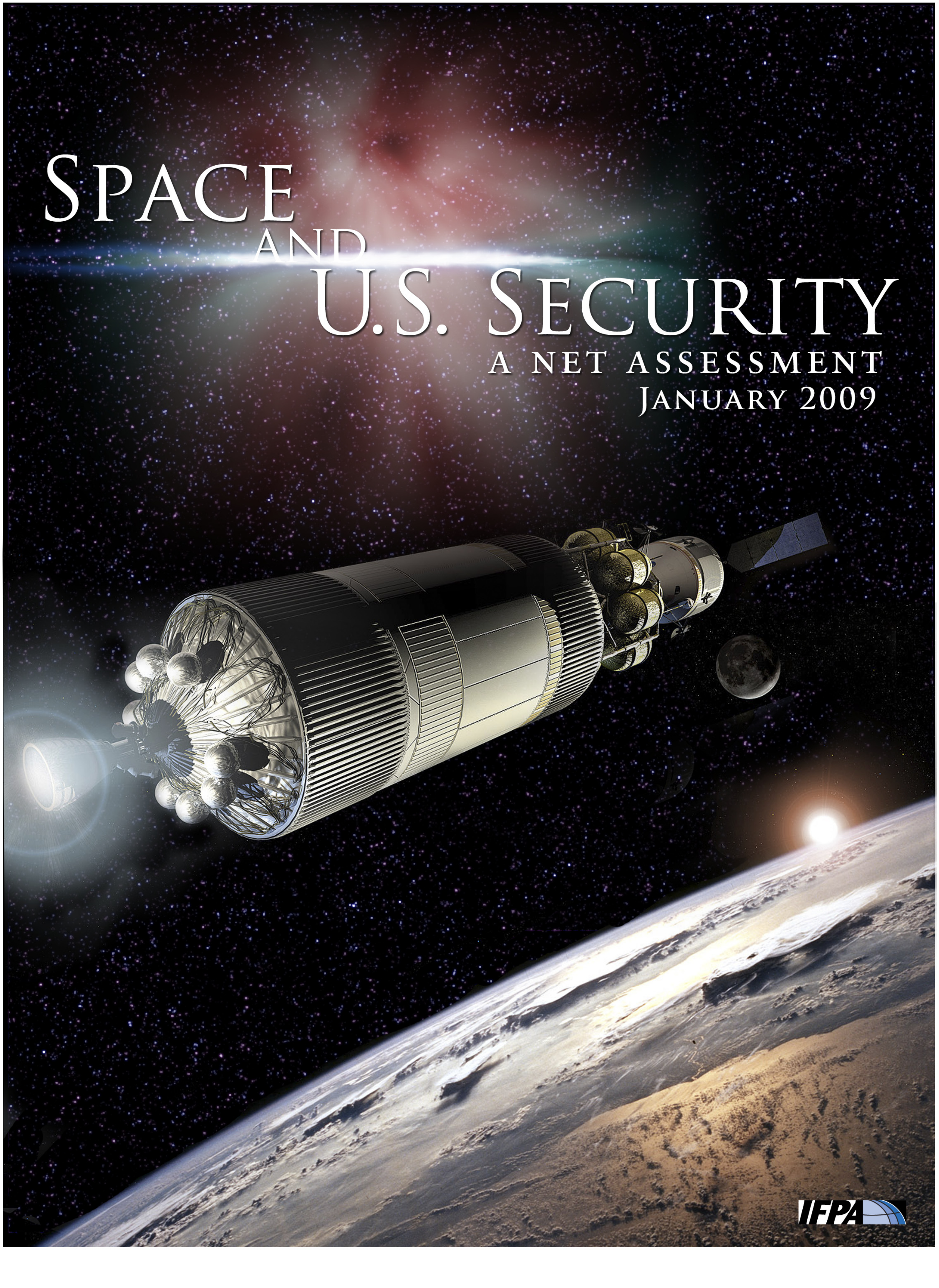
# Space and U.S. Security

## A Net Assessment

January 2009



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The purpose of the *Space and U.S. Security Net Assessment* undertaken by the Institute for Foreign Policy Analysis (IFPA) is to survey the current status of U.S. space activities and to draw comparisons with other countries that have developed space programs in recent decades. Our goal is also to project major trends into a 10-20 year timeframe to identify factors that may have important implications positively or negatively on the position of the United States relative to other nations as we move toward and into the 2020 timeframe. Because of the inherently dual-use nature of space technology and the growing role of the commercial sector, this net assessment takes a broad view of space encompassing space technologies for military uses and for commercial purposes.

This net assessment has been prepared as a contribution to the discussion about the future role of the United States as a space-faring nation. There is substantial sentiment to the effect that the United States can avoid the "weaponization" of space by restricting its future space-related national security programs, including foregoing deployment of space-based missile defense. Therefore, our net assessment includes a discussion of arguments about weapons in space. How the debate about defense in space is resolved will shape the types of space-based capabilities that the United States deploys in the years ahead. How U.S. space policy is translated into action depends vitally on levels of public understanding and support.

The *Space and U.S. Security Net Assessment* encompassed several components (more below) including extensive research into the current and evolving space programs of the United States and other nations as well as briefings and interviews with experts within and outside the U.S. government. The Institute also convened a Workshop in Washington, D.C. on December 14, 2007; prepared a paper on U.S. space policies over the past five decades; and assembled an Experts Advisory Group to focus on space policy issues specifically for this net assessment. Finally, the net assessment also drew on—and contributed to—other IFPA programmatic efforts examining the heightened importance of space in U.S. operations and security planning such as the Independent Working Group on Missile Defense, the Space Relationship, and the Twenty-first Century, and the work of Institute President Dr. Robert L. Pfaltzgraff, Jr. on the Department of State's International Security Advisory Board space study. The *Space and U.S. Security Net Assessment* can be downloaded from the Institute's website at http://www.ifpa.org.

The December 2007 *Workshop on the United States and 21st-Century Space Strategy: Vulnerabilities, Competitors, and Priorities* was divided into three sessions. The first examined the present status of the United States with regard to space programs as well as U.S. vulnerabilities in space; the second discussed what other countries such as the People's Republic of China (PRC) are doing in space and the implications for the United States; and the concluding session explored what actions the United States should take to build consensus and support to develop and implement the requisite space strategy, space policy, and space capabilities. This meeting, which was recorded and transcribed, provided the basis for numerous analytic inputs into this net assessment as well as conclusions.

Several meeting participants agreed that U.S. vulnerabilities in space must be addressed. In particular, the U.S. military establishment is not thinking seriously enough about the vulnerability of our space infrastructure to hostile actions (e.g., Chinese interdiction capabilities as evidenced by the PRC's January 2007 direct ascent anti-satellite test) even though we are increasingly dependent on space for military operations. Mitigating the problem entails increased funding of missile defense (including space-based interdiction), space control assets, situational awareness, and a robust launch and replenishment capability.

It also requires the development of a concept for space deterrence as an integral component of overall U.S. deterrence strategy and how it fits into the national security strategy of the United States. For example, a robust defense against missiles missile could furnish an antidote to nuclear proliferation making it more costly for nations to proliferate and therefore provide a basis for deterrence. At the same time, we must undertake an outreach program to help the Executive Branch, Congress, and the public understand the central role that space plays in U.S. national security.

Other issues that were discussed at the December 2007 Workshop are summarized. They included:

- The need for a space deterrence component of national security strategy for which the United States should develop a declaratory policy addressing what actions the United States would take if a nation attacks our space assets. A space declaratory policy would be an important element of space deterrence and overall U.S. deterrence strategy as part of the New Triad set forth in the January 2002 Nuclear Posture Review (NPR) and which should form a part of the forthcoming Obama Administration nuclear posture review.
- Iran's attention to ancillary capabilities that provide leap-ahead defensive and offensive capabilities. In this regard Tehran is increasingly interested in electromagnetic pulse (EMP) capabilities and converting its ballistic missiles from liquid to solid fuel. Iran's growing interest in EMP further underscores the need for the United States to develop both sea- and space-based boost phase missile defenses. Moreover, Iran's augmented economic ties with China, particularly as a major oil supplier, provide Tehran with leverage to receive advanced military technologies/systems and technical support from Beijing for both its nuclear weapon's and ballistic missile programs, including EMP capabilities.
- The requirement for enhanced international cooperation in space that nevertheless avoids treaties and other arrangements that would place onerous restrictions on the United States. The Department of Defense is actively exploring collaboration with U.S. allies and friends who have space capabilities that can improve the performance of U.S. assets and operations. Most participants agreed that a bilateral basis is the preferred approach to collaboration because a multilateral forum is cumbersome and decisions normally cannot be made quickly because of the need to reconcile the interests of multiple nations.
- There is an inadequate effort to implement the policy set forth in the National Space Policy released by the White House on August 31, 2006. Several participants pointed to the funding gap between what is called for in the space policy and actual budget requests. This is the particularly the case for space assets/infrastructure, space control and situational awareness capabilities, and missile defense.
- Finally, the space acquisition process must be reformed and streamlined in order to deploy new systems more rapidly. One key problem is the requirements process where new capabilities and requirements are frequently added to the original industry contract resulting in both substantial cost increases and deployment delays. Incorporating the best practices of commercial procurement procedures was one example set forth on how to ameliorate the space/national security acquisition problem.

Workshop participants were drawn from the Executive Branch, including the Departments of Defense and State, the National Security Council, the military services, and Congressional staff, as well as from the broader policy community. The Workshop Participant List and Agenda are in Appendix A.

In addition, the Institute drafted a paper entitled *Areas of Consensus in U.S. Space Policies from Eisenhower to Bush*, elements of which are incorporated into the net assessment. It examines the space policies and directives of the United States issued by the White House and highlights the role space has played in U.S. security over the past fifty years and its ongoing—and accelerating—importance for U.S. security planning in the early-21st century. It details their consistency, as well as the policy modifications undertaken to support U.S. interests as changes in the strategic environment occurred and space capabilities and technologies matured.

Such changes are especially evident today. In the early 21st century, given the growing proliferation of weapons of mass destruction (WMD) and ballistic missiles to nations and terrorist groups hostile to the United States, space, including space-based missile defense, will play an increasingly expanding role in U.S. security, extended deterrence, and counterproliferation planning. In the current security setting, the United States must deter multiple actors who may not adhere to traditional, Cold-War concepts of deterrence, underscoring the need to deploy multi-layered missile defense capabilities (including space-based intercept elements) to maintain a robust and credible deterrent. Together with the other portions of the New Triad outlined in the aforementioned 2002 NPR, missile defenses provide U.S. policy makers with an expanded set of tools and options that can be tailored to deter specific adversaries. President Bush took the necessary steps to make possible the unrestricted development, testing, and deployment of all types of missile defenses when he announced U.S. withdrawal from the ABM Treaty in 2001. It is now up to the new administration and Congress to develop the requisite multi-tierd missile defense architecture. The *Areas of Consensus* paper is in Appendix B.

Furthermore, on May 31, 2007 IFPA held a meeting of the *Space and U.S. Security Net Assessment* Experts Advisory Group at the Institute's Washington, D.C. office. Participants discussed project goals and the scope/structure of the net assessment; approaches to focusing key decision-makers and the general public more fully on the importance of space in U.S. security and counterproliferation planning; and examined the role of nuclear weapons in U.S. security. A meeting summary of the Experts Advisory Group is appended.

In addition, research for the net assessment both benefited from and contributed to the Independent Working Group (IWG) on Missile Defense and the International Security Advisory Board's space study. The IWG examines the critical role of space for U.S. national security in general and for missile defense in particular. IFPA published the IWG Report in July 2006 and a revised version in January 2009. The initial Report and its updated volume provide an assessment of missile defense requirements, together with opportunities to benefit from existing and new technologies, as well as from systems that modernize earlier innovations, especially space-based missile defenses. The findings of the original IWG Report have been promulgated in various public forums including in briefings, seminars, and roundtables on Capitol Hill and elsewhere. The updated Report and briefings will be made available to key officials in both the Obama administration and the incoming 111th Congress, as well as briefed in a variety of public venues. The Executive Summary of the updated IWG Report is in Appendix D. The complete Report is available for down load on IFPA's website at http://www.ifpa.org.

Lastly, as noted earlier, Dr. Pfaltzgraff is a member of the Department of State's International Security Advisory Board (ISAB). The ISAB, which meets on a regular basis in Washington, D.C., provides the Secretary of State and other senior Department officials with insights/advice on vital national security challenges encompassing topics such as WMD terrorism, proliferation, and U.S. space policy. In this capacity, Dr. Pfaltzgraff helped draft the ISAB's *Report on Space Policy*. It examines the 2006 *U.S. National Space Policy*, emerging threats from

space, the role of space in U.S. national security, the defense of satellites from threats such as the January 2007 Chinese direct-ascent anti-satellite weapon, and requirements for space-based missile defense. The Report can be downloaded on the Department of State website at http://www.state.gov/documents/organization/85263.pdf.

The United States today remains the leader in space and the most dependent of all nations on space both for its national security and its economic wellbeing.

- A close relationship between the military and commercial uses of space exists.
  - Many space-related technologies are dual-use technologies, making it difficult, if not impossible, to delineate clearly between space as an indispensable military arena and space as essential to economic wellbeing.
  - Without space the phenomenon of globalization would not be possible.
  - The private sector plays a growing and critically important role in developing and exploiting space technologies.
- An adversary seeking to attack the United States would have an incentive to destroy U.S. space-based capabilities
  - Among the questions that must be addressed is the extent to which future adversaries may be able to offset U.S. advantages in space and whether they could do so with relatively smaller investment than that of the United States.
  - Equally important is the extent to which other countries, adversaries or otherwise, will themselves become vulnerable as their dependence on space grows and what this will mean for the United States.
- It is important to set forth the major trends that will shape the relative strengths and weaknesses of the United States and its space competitors in a timeframe extending into the 2020 period.
  - The ability to identify any such trends as early as possible might enable us to take needed corrective action.

Beginning with President Eisenhower, the U.S. has maintained a long history of bipartisan continuity in official statements supporting U.S. activities in space.

- U.S. space activities generally follow a few key principles.
  - The use and benefit for all nations of space for peaceful purposes; the rejection of any claim to national sovereignty over space; cooperation with other nations in the exploitation and peaceful use of space; the right of access to and safe passage in space without hindrance; encouragement of the commercial development of space; and recognition of space as a U.S. vital interest.
  - U.S. actions remain committed to safeguarding U.S. rights, capabilities, and freedom of action in space; assuring deterrence, defense and the means to deny adversarial uses of space that would be deemed detrimental to U.S. national interests; the deployment of space systems to maintain and improve U.S. military capabilities and intelligence; and opposing legal regimes or other international restrictions limiting U.S. access to or use of space for defense.
- Space-based systems enhance early warning and strike capabilities. Space-based systems also provide critical communications and navigation support, which allows for real-time information to be collected and distributed to users in addition to making it possible to navigate conflict areas while avoiding hostile defenses.
  - The military force enhancement mission can be divided into six key areas: geodesy, meteorology, communications, navigation, early warning and attack assessment, and surveillance and reconnaissance.

   - The growing number of missions assigned to space-based surveillance and reconnaissance satellites has led the U.S. to develop a new generation of capabilities.
  - The systems that constitute space-based capabilities, such as satellites, intertwine with the civilian sector.
  - As a result, any effect on U.S. space-based capabilities carries national security implications and commercial consequences.
- Space will become even more vital to U.S. national security in the years ahead as a result of the ongoing proliferation of weapons of mass destruction (WMD). Therefore, it becomes essential that the United States develop a strategy to counter the use, threatened or actual, of such WMD if their development, deployment, and proliferation cannot be prevented. Space is vitally important in a U.S. counterproliferation strategy that meets WMD challenges.

One of the indispensable components of a comprehensive counterproliferation strategy is missile defense. Space provides the best basis for a global missile defense.

- The proliferation of ballistic missiles and weapons of mass destruction (WMD) and their possession by growing numbers of adversaries, ranging from traditional strategic competitors to terrorist organizations, pose a serious and growing threat to the United States, its civilian population and deployed military forces, and friends and allies. This threat encompasses: rogue states, strategic competitors, and terrorists.
- A global layered defense capability that includes space is necessary to counter these threats.
- Layered defenses provide multiple opportunities to destroy attacking missiles in all three phases of flight from any direction regardless of their geographic starting point.

As the leading space power, the greater dependence of the United States on space than any other nation leads inevitably both to vulnerabilities and opportunities.

- Without assured access to space, the U.S. military could not effectively conduct military operations on land, at sea, or in the air. For example, without situational awareness (SSA) provided by space-based systems, it becomes difficult to manage battlefield operations and impossible to track ballistic missiles.
- Access to space-based assets is essential for a broad range of private-sector activities. The space infrastructure originally established with governmental funding has furnished the basis for both military and commercial applications. The commercial sector is developing technologies that are utilized by the military.
  - In 2007 alone, commercial utilization of space accounted for nearly 70 percent of total global space spending.
  - Impressive commercial growth is demonstrated by the fact that in the past two years alone, governmental share of space spending has fallen by 8 percent even though the aggregate governmental spending increased by 12 percent.
  - The significance of GPS navigation services to space industry growth is difficult to overestimate. GPS provides an example of the dual-use nature of space technologies. What provides navigation on the battlefield also serves the driver in city traffic.
  - The revenue from satellite manufacturing increased by 14 percent in 2007.

    - The increased visibility of commercial utilization means that governments will have less control over who gets access to such services. Governments in turn will rely increasingly on the private sector for a broader range of space products, services and technologies.
    - The growth of the commercial space sector does not guarantee that the United States will be the greatest beneficiary. This depends on strategic choices taken by countries, including the United States, to exploit such technologies for national security purposes.
- Continued U.S. primacy in space will be determined by our ability to anticipate and cope with gaps and weaknesses that could threaten the U.S. space lead in the years ahead.
    - Launch services and equipment manufacturing are the most competitive components of commercial space.
        - As the U.S. retires the space shuttle in 2010 and awaits the arrival of the new space orbiter, the Orion, in 2015, the U.S. may have no alternative but to rely upon Russia and its Soyuz space capsule.
- Protecting U.S. interests in space depends initially on the ability to monitor the space environment to gain SSA. U.S. SSA capabilities are insufficient for the current threat environment.
    - Inadequate SSA capabilities would constitute a critical vulnerability. SSA is the foundation of offensive and defensive counterspace measures.
    - The U.S. Air Force is working to develop and deploy a new system that will improve SSA by relying on space-based sensors. The Space Based Surveillance System (SBSS) will deliver optical sensing satellites to search, detect, and track orbiting objects, particularly those in geosynchronous Earth orbit.
- Funding for U.S. space-based programs continues to prove problematic as shortfalls significantly undercut the ability of the United States to address its vulnerabilities. This point is especially true in the case of missile defense.
    - Although some systems are funded at reduced levels, other space technologies are not being pursued at all due to a total lack of funding.
- There is a major crisis in the aerospace industry. If current trends continue, the United States will not have the specialized workforce necessary to support future U.S. primacy in space.
    - According to the Aerospace Industries Association, total industry employment went from 1,120,800 in 1990 down to 637,300 in 2007. In the space sector alone, employment slipped from 168,500 to 75,200 over the same period of time. Of the employees that remained following the initial post-Cold War cuts, it is suggested that 27 percent of America's aerospace technical workforce is now eligible for retirement.

The threat to and from space is greatest to the United States since it remains more dependent than other nations on space.

- Our space systems are vulnerable to disruption or actual destruction, as well as to efforts on the part of an adversary to deny use of them. Such efforts could include interference with satellite systems, detonation of a nuclear weapon causing electromagnetic pulse (EMP) effects on space-based systems and on electronic systems on Earth affecting vitally important sectors such as financial services, transportation, communications, medical services, and food distribution. Our vulnerability in space is enhanced by the possible use of micro-satellites to attack our satellites.

- Countries such as Iran and North Korea are developing EMP-related technologies, including missiles that could launch nuclear warheads. China and Russia already possess such capabilities.
- The wider availability of these technologies in the decades ahead will make U.S. space- and ground-based assets increasingly vulnerable to EMP attack.

- The space programs of other nations are being developed for military and commercial reasons, as well as an asymmetrical means to challenge the U.S. As other nations develop space-based capabilities, their vulnerability will also increase.

Other states are engaged in programs designed to enable them to become twenty-first century space powers capable of challenging or at least competing with the United States. As noted earlier, the growing commercialization of space will create a more level playing field as additional actors gain greater access to the products and services of the commercial space sector and to the enabling technologies as well.

- At least thirty-five countries now have space research programs designed to augment existing space capabilities or lead to their first deployments in space.
- International cooperation in the development of space technologies has increased the diffusion of capabilities to new actors.
  - China is currently developing and acquiring technologies needed for space-based military purposes in order to leapfrog past the present U.S. technological dominance of space.
    - Chinese use of the U.S. GPS and the Russian GLONASS (Global Navigation Satellite System) systems provides PLA units and weapons systems with navigation and location data that can potentially be used to improve ballistic and cruise missile accuracy.
    - In the last few years, Chinese research on small mobile launch vehicles has shown an increased focus on nano-satellites which could enable China to launch satellites swiftly from mobile launchers.
    - China is also developing high-powered lasers, which could be used to "blind" satellites.
    - On January 11, 2007, China conducted a successful anti-satellite weapons test.
  - Though there are still certain areas within Russia's space programs that have not yet reached pre-1990 levels, a revived space program and new technology are helping to restore Russia's space programs to their former status.
    - Central to its space programs are Russia's military and dual-use satellites.
    - GLONASS is a formation of radio-based satellites used to provide navigation services for military and civilian purposes. The system is run jointly between Russia and India with the goal being first to achieve constant and complete coverage of Russian and Indian territory then total global coverage by 2010.
    - Russia maintains a booming commercial satellite-launching service, thanks to converted older ICBMs.
  - Iran has become almost entirely self-sufficient in its military industry and has built up one of the largest ballistic missile inventories in the Middle East.
    - Iran has one satellite in orbit and four more under various stages of development and construction.

    - Iranian efforts to complete an indigenous space launch vehicle (SLV) are thought to be near completion.
    - Iran has made great strides toward development of an indigenous space launch capability. In February 2007, it successfully carried out an initial test of a "space rocket" built in Iran; and a year later unveiled its first space center.
- The European Space Agency (ESA) is the world leader in providing commercial space launch services with more than fifty percent of the world market for launching satellites into geostationary transfer orbit (GTO).
    - Of central importance is the Aurora program, established in 2001 to plan for future exploration of the Solar System using robotic spacecraft designed to pave the way for subsequent manned exploratory missions.
    - Europe's worldwide satellite navigation system GALILEO is scheduled for deployment in 2013.
    - As prime contributor to ESA, France is pursuing several significant space-based projects.
        - France employs a new military satellite telecommunication system known as SYRACUSE-3, the purpose of which is simultaneously to link military command centers in France with several theaters of operation.
    - Germany currently allocates €846 million ($1.35 billion) of governmental funds for space-related projects.
    - Italy's Agenzia Spaziale Italiana (ASI) is the third largest contributor to ESA.
    - The United Kingdom's space budget in 2006 was £207 million ($381 million). 65 percent of which was directed towards ESA-led projects.
    - Japan has solid foundations for an effective wide-ranging space program and through existing and planned multilateral cooperative agreements and projects should gain an increasingly influential voice among the space powers of the world.
    - India has been active in space-related activities since its national space agency, the Indian Space Research Organization (ISRO), was established in June 1972 and its first national satellite was launched into orbit in April 1975.
    - India places great emphasis on attaining and maintaining an efficient and sophisticated series of satellites for television and radio broadcasting, telecommunications, and weather data.
    - India has recently added as yet another focus in its space program the ability to conduct space exploration missions to the Moon, Mars, asteroids, and the Sun as well as indigenous technology for manned spaceflight.
    - It remains to be seen whether India will eventually deploy military assets in space, although Indian military officials have announced the formation of an Aerospace Command.
    - Due to Israel's security situation in the Middle East, a very large part of Israeli space investment is directed towards defense—the Israel Space Agency (ISA) has an annual budget of around NIS 1 million ($280,000) for commercial purposes compared to a $50 million budget for the military space program.

- Foreign cooperation enables Israel to develop and conduct more sophisticated projects in space.
- Israel is and will continue to grow in the civilian and commercial spheres of space activity.
- The military sphere of Israeli space action is an area that is continuing to receive sufficient funding and will undoubtedly continue to grow in scope and sophistication.
- Israel has deployed a missile defense system, the Arrow, jointly developed with the United States. This system is being upgraded to cope with increasingly sophisticated threats.

Increasingly, space is viewed as an arena for commercial exploitation as well as a domain having military uses. Given the dual-use nature of technologies that will be available, the choices to exploit or not to take fullest advantages of such technologies for purely civilian or for their military advantages will be based on non-technological considerations.

- Given the likelihood that several states will wish to reduce or circumvent the U.S. lead in space, it follows that such entities will have a strong incentive to exploit available technologies.
- The ability to destroy or disable satellites from Earth, demonstrated by the Chinese in 2007, will eventually be available to others as a result of proliferating rocket and other technologies.

Given present trends, several important conclusions emerge from this net assessment:

- The wider availability of high-resolution imagery will lead to situations in which the United States could find itself fighting enemies with such capabilities at least at the outset of a conflict.
- Terrorists already have access to unprecedented high-resolution imagery that is available on the Internet. Together with states, and perhaps aided by states, such groups are already able to identify and gain detailed knowledge about their targets before, during, and after a military operation.
  - As a result, the ability that others will have to threaten or to inflict destruction on the United States will grow as a result of the proliferation of space technologies, products, and services, spurred by the commercial sector.
- The threat to the United States from missile proliferation will increase as more countries gain access to propulsion technologies and warhead designs.
  - Perhaps the ultimate asymmetrical strategy against the United States lies in the possibility of a nuclear detonation at an altitude between 40 and 400 kilometers designed both to disable and destroy U.S. satellites and to have devastating EMP effects against infrastructure on Earth.
  - Space represents an important arena from which to strike missiles carrying a payload intended to detonate above the Earth's surface.
- Space will become an arena in which deployed assets must be protected.
- Given the inherent problem of defining a space weapon, it would probably be impossible to design a verifiable international treaty against such a capability.
  - The capability to attack a satellite need not be deployed in space to be able to achieve its intended result, as China demonstrated with its direct-ascent ground-based strike to destroy an aging Chinese satellite.
- Present trends clearly point to a world that by 2020 will have increasing numbers of states pursuing space programs capable of challenging the United States. Under such circumstances, the United

States will have little alternative but to pursue as fully as possible space programs, both by itself and in collaborative ventures, both in the commercial and military sectors, if we are to remain in the forefront as a space faring nation.

## Introduction

Space is an arena of growing twenty-first-century importance both for the United States and for other nations. The United States today remains the leader in space and the most dependent of all nations on space both for its national security and its economic wellbeing. Specifically, the United States enjoys an overall lead in space technologies, together with the greatest number of assets in space. As a result, an adversary seeking to attack the United States would have an incentive to destroy U.S. space-based capabilities. The purpose of this net assessment is, first, to describe the nature and extent of U.S. space capabilities and dependence compared and contrasted with its competitors and, second, to set forth the major trends that will shape the relative strengths and weaknesses of the United States and its space competitors in a timeframe extending into the 2020 period. Its purpose is more descriptive than prescriptive, although if the U.S. position were to deteriorate relative to adversaries and competitors, the ability to identify any such trends as early as possible might enable us to take needed corrective action.

Our net assessment, in keeping with such exercises undertaken in the Department of Defense, is intended to set forth in comparative fashion the major trends that will enable us in the years ahead to see how well (or poorly) the United States is doing in space compared to its competitors. What are our present strengths? Will they be sustained or increasingly challenged? What are the benefits and liabilities—advantages and disadvantages—attached to major alternative courses of action for the United States? For example, what are the disadvantages, contrasted with benefits associated with international legal regimes and treaties designed to regulate the uses of space?

This net assessment does not rely on sophisticated models or methodologies. Instead, the approach is based on available information about the present, together with the delineation of major trend lines that can reasonably be expected to shape the respective space strategies and capabilities of the United States and other nations with major space programs over the next 15-20 years. Included are comparisons between evolving U.S. space programs and capabilities and those of other key countries with space programs projected into this timeframe. Among the questions to be addressed is the extent to which future adversaries may be able to offset U.S. advantages in space and whether they could do so with relatively smaller investment than that of the United States. Equally important is the extent to which other countries, adversaries or otherwise, will themselves become vulnerable as their dependence on space grows and what this will and should mean for the United States.

Last but not least, there is a close relationship between the military and commercial uses of space. It becomes difficult, if not impossible, to delineate clearly between space as an indispensable military arena and space as essential to economic wellbeing. Without space the phenomenon of globalization would not be possible. Global information and communications, including the Internet, wireless communications, data transmission, and electronic commerce, are based on space assets that have transformed how we transmit and receive the information that shapes twenty-first-century interaction. New industries have emerged as a result of space technologies. The private-sector commercialization of space is generating new products, services, and non-governmental participation. A global private-sector space industry will grow extensively in the decades ahead. Therefore, such activity and its implications for the military space sector must be factored into projections about the future for reasons that are set forth in the net assessment.

## Space and U.S. National Security

There is now a long history of bipartisan continuity in U.S. official statements about space and U.S. national security. Successive administrations, beginning with President Eisenhower, have affirmed the importance of U.S. access to and use of space. The statement contained in the latest U.S. space policy, NSPD-49, issued in 2006, bears great resemblance to what preceding administrations have stated about space:

> 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 U.S. national interests.[1]

Although the space policy statements issued by successive U.S. administrations have become more elaborate and detailed, reflecting changes in the security setting as well as a growing understanding of the utilization and potential of space, the fundamental principles have remained largely unchanged. They include:

- The use and benefit, for all nations, of space for peaceful purposes
- The rejection of any claim to national sovereignty over space
- Cooperation with other nations in the exploitation and peaceful use of space
- The right of access to and safe passage in space without hindrance
- Encouragement of the commercial development of space
- Recognition of space as a vital interest of the United States

There has been a longstanding stated commitment to: (1) safeguarding U.S. rights, capabilities, and freedom of action in space; (2) assuring deterrence, defense, and the means to deny adversarial uses of space that would be deemed detrimental to U.S. national interests; (3) the deployment of space systems to maintain and improve U.S. military capabilities and intelligence; and (4) opposition to legal regimes or other international restrictions limiting U.S. access to or use of space for defense. However, the United States is party to the Outer Space treaty of 1967, which bans the stationing of weapons of mass destruction in space or on celestial bodies such as the Moon. The Treaty also reaffirms principles that are compatible with U.S. interests in space. These include the principle that space should be accessible to all states for peaceful purposes and that space should be an arena for international cooperation. The term "peaceful purposes" contained in the Outer Space Treaty refers to "nonaggressive activities" undertaken in compliance with the inherent right of nations to provide for their self-defense and is so noted in the Treaty itself.

The general principles that have been central to U.S. space policy are based on the recognition that space is indispensable to U.S. national security in critically important areas. As the Rumsfeld Space Commission concluded in 2001, "space-related capabilities help national leaders to implement American foreign policy and, when necessary, to use military power in ways never before possible."[2] Space-based capabilities provide

1 Office of Science and Technology Policy, *U.S. National Space Policy* (Washington, DC: The White House, August 31, 2006), 1. Available on the Internet at: http://www.fas.org/irp/offdocs/nspd/space.html. Accessed February 5, 2008. This document superseded NSC-49, *National Space Policy*, dated September 14, 1996.

2 *Report of the Commission to Assess United States National Security Space Management and Organization* (January 11, 2001), 12. Available on the Internet at: http://space.au.af.mil/space_commission/index.htm. Accessed February 5, 2008.

early warning and communications that warn military forces of attacks, provide a basis for communications, allow real-time information to be collected and distributed to users, make it possible to navigate conflict areas while avoiding hostile defenses, and identify and strike targets with devastating effect.

Among space-based assets, intelligence systems are essential to U.S. security. They furnish the "national technical means" to verify arms reduction treaties, conduct photoreconnaissance, and gather information on natural or man-made disasters. As former Undersecretary of State for Arms Control and International Security Robert G. Joseph noted: "space systems, services, and capabilities are used to improve productivity in areas as diverse as farming, mining, construction, surveying, as well as in providing weather forecasting, enabling search and rescue missions, and facilitating emergency communications."[3] Without space-based intelligence, the ability of the United States to cope with crises and conduct supporting military operations would be gravely damaged. Space has become vitally important not only for national security but also for homeland security in the post-9/11 world. The assets deployed in space serve not only a variety of national security functions but also contribute vitally to economic security. Such assets, often the same satellites used by the military, are truly "dual use" capabilities in which the military and civilian sectors are intertwined. Thus the loss of such space capabilities would have simultaneous national security implications and commercial consequences.

The importance of this net assessment is heightened by the fact that space will become even more vital to U.S. national security in the years ahead as a result of the ongoing proliferation of weapons of mass destruction (WMD) and the growing dependence of the United States on space-based assets for commercial and defense purposes. Although the United States is undertaking major counterproliferation efforts to prevent countries such as Iran and North Korea from becoming nuclear weapons states and exporting associated technologies, the prospects for success may not be promising. States and other actors determined to acquire WMD have often not been dissuaded by diplomatic initiatives from the United States or other countries or by international organizations. Therefore, it becomes essential that the United States develop a strategy to *counter the use*, threatened or actual, of such WMD if their development, deployment, and proliferation cannot be prevented. If nonproliferation proves to be impossible, then counterproliferation becomes essential. If we fail to dissuade *acquisition* of WMD, it becomes necessary to deter *use*. This leads to the need for a counterproliferation strategy. One of the principal components of a comprehensive counterproliferation strategy is missile defense. Space provides the best basis for a global missile defense. A counterproliferation strategy that includes space requires not only continued U.S. access to space but also a more prominent place for space in U.S. national security planning. Yet discussion about space-based defenses with interceptors deployed in space confronts substantial sentiment to the effect that the "weaponization" of space can be prevented if the United States foregoes space-based missile defense and otherwise restricts future space-related national security programs.

## The Space Debate

In fact the debate about space, including whether it is already weaponized or whether space can somehow be sanctuarized, in many ways resembles historic debates about human terrestrial relationships. Can humans transcend their power urges and instincts to engage instead in cooperative behavior? Will earthly competition inevitably be expanded into space? There is little, if any, evidence to support the proposition that human behavior in space would differ substantially from that on Earth. Historically, established patterns of human

3 Robert G. Joseph, "Remarks on the President's National Space Policy: Assuring America's Vital Interests," delivered at the Center for Space and Defense Forum, Colorado Springs, CO, January 11, 2007. Available on the Internet at: http://www.state.gov/t/us/rm/78679.htm. Accessed February 25, 2008.

behavior have been carried from one environment into another. Conceivably, the substitution of space cooperation in place of space competition awaits a comparable human transformation here on Earth.

Our theories of international relations offer conflicting perspectives about this debate. Realist theorists have suggested that human behavior in space is essentially unchanging and unchangeable because it will be an extension of such activity on Earth. Humans will carry into space the power urges and calculations, as well as perceptions of national interest and competition that shape their behavior in earthly situations. However, liberal theorists usually hold that it is possible to transform human behavior from competitive instincts to cooperation here on Earth. Therefore, such changes are also possible in space. Space can be separated from Earth-bound conflicts. At the very least, space can be regulated by international organizations and by legal regimes that set space apart, or sanctuarize space, from the competition and conflict that exist on Earth.

One important aspect of the debate about space and its weaponization focuses on whether missile defense interceptors should be placed in space as part of a comprehensive counterproliferation strategy. Those who oppose the use of space for missile defense often base their arguments essentially on variations of four contentions that are more broadly applied to opposition to the militarization or weaponization of space: (1) that space should not become an arena for international strategic competition and that such trends can be halted or even reversed by timely U.S. action that makes the United States a shining example to be emulated by others; (2) that others will follow an American lead against international space competition—in other words, U.S. self denial will be reciprocated by others; (3) that because some space-based weapons such as lasers could be used to attack targets in the atmosphere, at sea, and on the ground, they should be banned and that placing such weapons in space will only spark an arms race in space detrimental to U.S. interests since the United States is presently the dominant power with the most commercial and national security assets, including notably satellites, deployed in space and therefore has the most to lose; and (4) that the development of international regimes and treaties can effectively govern the uses of space for peaceful purposes, while preventing weaponization. Therefore, it is argued that the United States should take the lead in promoting such agreements.

Juxtaposed are those who advocate the use of space for a variety of uses, including missile defense. Access to space is considered to be essential to the United States both for commercial activity and for military purposes. Such advocates base their arguments also on generally four points taken together or in some combination of variations: (1) that space has already become an arena for international strategic competition and that the United States, because of its global position, must not cede space control to others because if we do not maintain U.S. space supremacy, other states will fill the resulting political vacuum and in any event there is an accelerating space race in which U.S. dominance is increasingly subject to challenge by others seeking their own dominance; (2) that the United States was not the first nation to enter space because the World War II German V2 rocket was a ballistic missile passing through the edges of space during its trajectory and, furthermore, it was the Soviet Union, not the United States, that launched *Sputnik*, the first Earth-orbiting satellite, in 1957; (3) that ground- or air-based systems can already be used to attack and destroy space assets as well as targets on Earth; and (4) that international treaties and regimes not backed by incentives, disincentives, and sanctions are not likely to be enforceable. Last but not least, the proponents of space-based missile defense contend that because ballistic missiles traverse space during part of their trajectory it is appropriate that they should be attacked and destroyed from space and in space. Consequently, it is argued that a defense deployed in space against offensive ballistic missiles traveling through space does not constitute the weaponization of space.

## The Evolving Space Environment

Even as this debate has unfolded, space has become both militarized and weaponized, notwithstanding the contentions and efforts of the opponents. Space has been "militarized" for several decades because space has been used for military purposes such as the transiting of ballistic missiles which inevitably fly part of their trajectory through space. It has been argued that because the United States has the most to lose, given its dominant position and resulting vulnerabilities in space, we should take the lead in developing new international legal regimes. The treaty-based approach that is favored by such advocates would ban certain types of weapons in space, notably anti-satellite systems. Thereby we could avoid a costly arms race in space. Even as it presses forward with its own space program, as discussed later in this net assessment, China has put forward various iterations of a draft treaty on the "prevention of the placement of weapons in outer space and the threat or use of force against outer space objects"[4] There are similar Russian efforts, alone and sometimes in direct cooperation with China, to limit space weaponization, directed principally at the United States.

The banning of weapons in space would not necessarily reduce the vulnerability of space-based capabilities, as China demonstrated in its January 11, 2007 destruction of a disabled Chinese satellite with a direct ascent missile launched from China. Because such a launch from the ground can be highly effective in destroying an object in space, verification of compliance in such a treaty would be difficult, and probably impossible. If the United States were to sign such a treaty, its intended effect would be to prevent the United States from deploying space-based missile defense. This is the apparent Chinese goal. The 2008 Annual Report to Congress, *Military Power of the People's Republic of China,* refers to legal warfare as the "use of international and domestic laws to gain international support and manage possible political repercussions of China's military actions" (p. 19). The purpose of such warfare is to shape international opinion and otherwise affect the mindset of those whom China is attempting to influence.

Therefore, this net assessment includes a comparison between China's own space policy and its priorities, compared and contrasted with what it urges on the United States. China is enhancing its own space capabilities while at the same time attempting to shape U.S. strategies and policies. Before discussing the space programs of other nations, including China, we turn next to a survey of current U.S. strengths and weaknesses in space.

## Present U.S. Space Strengths

As the leading space power, the greater dependence of the United States on space than any other nation leads inevitably both to vulnerabilities and opportunities. The U.S. position in space is the result of numerous strengths developed over more than five decades. They fall into two broad, overlapping categories: (1) military force enhancement; and (2) commercial utilization of space. We turn first to military force enhancement, setting forth in brief fashion the major technologies on which the United States has become increasingly dependent in recent decades, together with systems that are currently projected to be deployed in the next several years. Because of the dual-use nature of these technologies, it is not easy to separate them from the commercial sector. Therefore, the failure of the United States to remain in the forefront of space technologies would have both military and commercial implications. Advances in the military or civilian sectors will overlap, intersect, and reinforce each other. Consequently, the development in the United States of a dynamic innovative private-sector space industry will be indispensable to future U.S. space leadership. Nevertheless, the ability of the U.S. military both to contribute to, and benefit from, such a space technology base will depend

4 Conference on Disarmament, United Nations, February 12, 2008, CCO/1836. Available on the Internet at: http://daccessdds.un.org/doc/UNDOC/GEN/G08/602/34/PDF/G0860234.pdf?OpenElement. Accessed February 25, 2008.

on its focus and priorities. The availability of technologies does not lead inevitably to their exploitation. We may fail to move forward to exploit technological opportunities and breakthroughs. Such choices may be based on political or other considerations, whether well founded or the product of mistaken assumptions about what competitors or adversaries will or will not do.

## Military Force Enhancement

Space is militarily indispensable to the United States. As discussed below, the U.S. military relies on a broad range of space technologies not only to deter and dissuade enemies but also to fight and win the nation's wars. As Peter L. Hays has pointed out, military force enhancement "refers to all military space activities that help to increase the warfighting effectiveness of terrestrial forces and is sometimes referred to as 'space support to the warfighter.'"[5] Without assured access to space, the U.S. military could not effectively conduct military operations on land, at sea, or in the air. For example, space situational awareness is essential to our ability to distinguish a foreign space launch from a missile launch. At the present time there are eight nations capable of launching spacecraft and others who are developing such technology. Without space situational awareness it becomes impossible to anticipate threats such as those from ballistic missiles which travel part of their trajectory in space. There are more than 17,000 man-made objects that orbit the Earth, together with other objects such as asteroids and comets. All could inflict substantial and possibly catastrophic damage—man-made or natural—on the Earth. Although this is not the focus of this net assessment, it is necessary to note that, however remote, the threat to life on Earth would be potentially overwhelming from an asteroid or comet.[6] Our military commands require not only space situational awareness, but also battle space awareness that is based on assets in space. This includes land-, air-, and sea-borne Command, Control, Communications, intelligence and reconnaissance. Satellite communications capabilities provide the essential interconnectivity both for battlefield operations and for emergency responders at the state and local levels. There is an indispensable link provided by space assets between international and domestic security. The critical military force enhancement mission can be divided into six key areas that are described and summarized below, based on open-source information:

**Geodesy.** Since 1972, the United States has successfully operated the Landsat Earth observation satellite program, which provides an uninterrupted picture of the Earth's surface. Landsat program satellites in polar low-Earth orbit (LEO) collect spectral information from the Earth's surface. Over the years a historical archive unmatched in quality, detail, and coverage has been created.[7] Current Landsat programs will be augmented by the Landsat Data Continuity Mission in July 2011.[8] Data are acquired systematically for a global archive with approximately one quarter of the Earth's landmass being imaged every 16 days. The latest new image can be compared to previous images in order to observe changes that may have taken place.[9] This capability makes an important contribution to battlefield situational awareness for the military planner.

5 Peter L. Hays, *United States Military Space: Into the Twenty-First Century* (Maxwell AFB, AL: Air University Press, 2002), 5.

6 See Gregg Easterbrook, "The Sky Is Falling," *The Atlantic,* June 2008, pp. 74-78; 80-84.

7 "Landsat Then and Now," NASA/Goddard Spaceflight Center. Available on the Internet at: http://landsat.gsfc.nasa.gov/about/. Accessed May 12, 2008.

8 "Landsat Data Continuity Mission," NASA Fact Sheet. Available on the Internet at: http://ldcm.gsfc.nasa.gov/about.html. Accessed May 12, 2008.

9 "Landsat 7 Program History," NASA/Goddard Spaceflight Center. Available on the Internet at: http://landsat.gsfc.nasa.gov/about/landsat7.html. Accessed May 12, 2008.

**Meteorology.** The Defense Meteorological Support Program (DMSP), originally known as the Defense System Applications Program (DSAP) and the Defense Acquisition and Processing Program (DAPP), monitor the Earth's meteorological, oceanographic, and solar-geophysical environment in support of military operations.[10] Information gathered from DMSP satellites is used for general weather predictions and severe weather warnings, with obvious advantages both for the military and civilian communities. Data can be transmitted in real time to users on a world-wide basis, and can be stored using onboard recorders for subsequent transmission and processing. Of particular utility to the military is the use of DMSP data to save surveillance satellite observation time and resources when targets are obscured by cloud cover.[11] From its inception in 1965, more than 35 DMSP satellites have been launched, encompassing 6 satellite variants of increasing sophistication. From polar LEO, the DMSP satellites are operated in pairs to provide daily coverage of the entire surface of the Earth, with higher latitudes receiving twice daily coverage.[12]

In the mid-1990's, an effort was made to increase the capabilities of U.S. national meteorological assets in space, while reducing cost. This resulted in the establishment of the National Polar-Orbiting Operation Environment Satellite System (NPOESS). In keeping with the dual-use nature of this technology, this system merges the DMSP assets of the Department of Defense with the Department of Commerce's (DOC) parallel polar program, the Polar-Orbiting Environmental Satellite (POES), which currently operates five satellites in two pairs with one backup.[13] In order to enhance the interoperability of the two systems, the NPOESS Preparatory Project (NPP) is currently developing a new generation of sensors that will link DOD and DOC assets. These systems include an Advanced Technology Microwave Sounder (AMTS), a Cross-track Infrared Sounder (CrIS), an Ozone Mapping and Profiler Suite (OMPS), and a Visible/Infrared Imager radiometer Suite (VIIRS). The current NPOESS mandate extends to the year 2018.[14]

**Communications.** U.S. military forces are supported by a wide array of communications assets in space. The Defense Satellite Communications System (DSCS) Phase III, operated by Air Force Space Command, includes nine satellites in geostationary orbit (GSO) at an altitude of more than 22,000 miles. Each of these satellites uses super high frequency transponder channels capable of providing secure voice and high rate data communications. The U.S. Navy is continually updating its primary space-based communications systems to provide airborne, ship-based, submarine, and ground forces.[15] A new generation system, the Mobile User Objective System (MUOS), is under development to be completed in 2010. MUOS is designed to provide state-of-the-art mobile technology with simultaneous voice, data, and video services for increasingly mobile warfighters.[16]

10 "Defense Meteorological Support Program [DMSP]," GlobalSecurity.org. Available on the Internet at: http://www.globalsecurity.org/space/systems/dmsp.htm. Accessed May 13, 2008.

11 "Defense Meteorological Support Program (DMSP)," NASA/JPL Mission and Spacecraft Library. Available on the Internet at: http://msl.jpl.nasa.gov/Programs/dmsp.html. Accessed May 13, 2008.

12 Ibid.

13 "NPOESS-Background," National Oceanic and Atmospheric Administration. Available on the Internet at: http://www.ipo.noaa.gov/About/backgroundTXT.html. Accessed May 13, 2008.

14 "NPOESS Program Description," National Oceanic and Atmospheric Administration. Available on the Internet at: http://www.ipo.noaa.gov/About/prog_descriptTXT.html. Accessed May 13, 2008.

15 "Ultra High Frequency Follow-On (UFO)," Federation of American Scientists Fact Sheet. Available on the Internet at: http://www.fas.org/spp/military/program/com/ufo.htm. Accessed May 13, 2008.

16 "LockMart Team Completes Design Review Phase of Mobile User Objective System for Navy," *Space Daily* (April 5, 2007). Available on the Internet at: http://www.spacewar.com/reports/LockMart_Team_Completes_Design_Review_Phase_Of_Mobile_User_Objective_System_For_Navy_999.html.

**Milstar represents yet another advanced space-based military communications system.** It consists of satellites in geosynchronous orbit. The first satellite was launched in February 1994, and the last in this series in April 2003. *Milstar* provides interoperable communications among the military services. Each *Milstar* satellite has a space-based switchboard that directs traffic from terminal to terminal anywhere on the Earth. Because the satellite processes communications signals with other *Milstar* satellites through crosslinks, the need for ground-controlled switching is reduced.[17]

> The Global Broadcast System (GBS) provides still another military communications capability. Commonly referred to as "DirecTV for warfighters," the system utilizes a network of ground based transmit suites, broadcast satellite payloads and receiver suites. The network furnishes critical intelligence, weather, and other information to widely dispersed terminals. This satellite-based system can transmit critical intelligence images as well as 24-hour cable television news. Data can be sent to small 18-inch antennas that can be configured for fixed, portable, or sea-based platforms.[18]

**Navigation.** Currently, the United States military operates the world's only fully functioning Global Navigation Satellite System (GNSS). Officially known as the NAVSTAR Global Positioning System, but more commonly referred to simply as GPS, this constellation of 31 satellites in semi-synchronous medium-Earth orbit, provides continuous navigation and timing information to military and civilian users worldwide. GPS satellites orbit the Earth every 12 hours while sending out continuous navigation signals. Military users are able to access an encrypted signal that provides the most accurate navigation and timing information, while slightly less accurate data are freely available to civilian users.[19] GPS capabilities are essential to nearly all U.S military operations and almost every type of weapon system, including aircraft, spacecraft, vehicles, and ships. GPS-guided weaponry enables the military to conduct strikes with unprecedented precision, reducing both the number of weapons needed to attack a target and the threat to civilian populations.[20]

The first GPS satellite was launched in 1978, with the GPS system achieving full operational capacity in April 1995. The system has been updated with replacement satellites. New-generation GPS *Block* III systems are currently under development. In addition to upgrades for the civil sector, *Block* III is scheduled for launch in 2014. Eventually, the Air Force plans to acquire 32 *Block* III satellites.

**Early Warning and Attack Assessment.** During the Cold War, as the Soviet Union built its ICBM capability, the United States recognized the need to deploy a space-based early warning system that could detect missile launches. The U.S. military undertook a number of projects, beginning in 1957 with Subsystem G and MIDAS, that culminated in the launch of the Defense Support Program (DSP).[21] Since their first deployment in the early 1970s, DSP satellites have provided the United States with an uninterrupted early warning capability in geostationary orbit with sensitive infrared sensors to detect heat from missile and booster plumes against the Earth's background.

17 "MILSTAR Satellite Communications System," U.S. Air Force Fact Sheet. Available on the Internet at: http://www.af.mil/factsheets/factsheet.asp?id=118. Accessed May 13, 2008.

18 "Global Broadcast Service," Federation of American Scientists Fact Sheet. Available on the Internet at: http://www.fas.org/spp/military/program/com/gbs.htm. Accessed May 13, 2008.

19 "Global Positioning System," U.S. Air Force Fact Sheet. Available on the Internet at: http://www.losangeles.af.mil/library/factsheets/factsheet.asp?id=5325. Accessed May 16, 2008.

20 Ibid.

21 Jeffrey Richelson, ed., "Space-Based Early Warning: From Midas to DSP to SBIRS," *National Security Archive Electronic Briefing Book No. 235* (November 9, 2007). Available on the Internet at: http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB235/index.htm. Accessed May 16, 2008.

Augmented by ground stations and sensors on National Reconnaissance Organization (NRO) spy satellites, DSP satellites detect strategic and tactical missile launches. DSP capabilities helped identify shorter-range offensive and surface-to-air missiles during regional conflicts such as the Gulf War in 1991.

The Space-Based Infrared System (SBIRS) will provide the follow-on to DSP.[22] Initially, SBIRS was to consist of two segments: SBIRS-High and SBIRS-Low (in reference to highly-elliptical orbit and low-Earth orbit, respectively). However, SBIRS-Low was subsequently placed under the purview of the Missile Defense Agency (MDA) and renamed the Space Tracking and Surveillance System (STSS). Thus the nomenclature for SBIRS-High reverted simply to SBIRS.

As currently conceived, SBIRS will consist of at least three geosynchronous orbit (GEO) satellites and four infrared sensor payloads on highly-elliptical orbiting (HEO) satellites fielded by the NRO.[23] SBIRS GEO satellites, designed to have a 12-year life, will weigh approximately 10,000 pounds at launch. In addition to secure communications links and anti-spoof GPS modules, GEO satellites will be equipped with infrared sensors capable of continuously monitoring a selected area while also scanning a wider geographical space.[24] The first GEO satellite is currently undergoing testing for an anticipated launch in late 2009.[25] The first HEO payload was placed into orbit aboard an NRO satellite in June 2007, and successfully completed testing in November of that year. In addition to the continued use of DSP and SBIRS assets, the STSS will serve as an integral part of the ballistic missile defense system being deployed by the United States. This capability will allow ballistic missile defense interceptors to engage enemy missiles earlier in flight. Therefore, it makes possible additional intercept opportunities.

**Surveillance and Reconnaissance.** Space-based surveillance and reconnaissance capabilities were first developed during the Cold War to provide access to areas of the Soviet Union that otherwise would have been totally inaccessible to U.S. intelligence. Although manned missions using aircraft such as the U-2 provided valuable intelligence on Soviet military forces, these missions became increasingly dangerous as Soviet air defense capabilities were upgraded. In response, the United States realized the need for advanced, space-based systems capable of identifying small objects from space.[26] Unlike manned platforms, space-based assets offered the benefit of global coverage, near invulnerability, and sustained operations over a continuous period of time. Beginning with deployments in the late 1950s and early 1960s, the U.S. has pioneered increasingly sophisticated space-based surveillance and reconnaissance systems for over fifty years.

As satellite capabilities have evolved, so too has the role of these advanced systems. In addition to monitoring foreign military forces, such satellites have played a crucial role in verifying arms control agreements. Since the Cold War, the role of satellites in verifying treaties has expanded to include supporting nuclear nonproliferation efforts. With the arrival of precision-guided munitions, reconnaissance satellites have become "the key to post-Cold War defense tactics that rely on highly selective targeting to destroy selected targets with minimal collateral damage."[27]

22 Ibid.

23 "USAF Decides to Buy Third SBIRS High from Lockheed," *Space News* (27 June 2007).

24 "Space-Based Infrared Systems Wing," U.S. Air Force Fact Sheet. Available on the Internet at: http://www.losangeles.af.mil/library/factsheets/factsheet.asp?id=5514. Accessed May 14, 2007.

25 "Lockheed Martin Achieves Key Milestone on New Missile Warning Satellite," Lockheed Martin Co. Press Release (30 April 2008).

26 Richard A. Best, "Intelligence, Surveillance, and Reconnaissance (ISR) Programs: Issues for Congress," *CRS Report for Congress* (February 22, 2005): 24. Available on the Internet at: http://www.fas.org/sgp/crs/intel/RL32508.pdf. Accessed June 2, 2008.

27 Best, "Intelligence, Surveillance, and Reconnaissance (ISR) Programs: Issues for Congress."

Despite the shroud of secrecy, some general facts are known about the broad elements of U.S. surveillance and reconnaissance satellites. In particular, the systems function primarily in support of two types of missions: imagery intelligence (IMINT) and other, non-visual intelligence information, including signals intelligence (SIGINT), electronic signals intelligence (ELINT) and measurement and signature intelligence (MASINT). Within the realm of IMINT, two types of systems are employed: (1) those that collect images using visible and thermal (infrared) light; and (2) those that use radar to image the Earth's surface. Regarding non-visual intelligence, numerous configurations are utilized to intercept valuable information including enemy voice communications and data transmissions.

Within these broad mission areas, the U.S. currently deploys a number of advanced systems. For IMINT collection, the Keyhole series KH-12 (commonly referred to as the Improved Crystal or Advanced KH-11) is the latest and most sophisticated iteration in a series of satellites that have provided imagery for a number of years. Building on technologies contained in the KH-11 used during the 1990-91 Gulf War, the KH-12 is much heavier—weighing nearly 30,000lbs and costing in excess of $1 billion excluding launch costs. Other U.S. surveillance capabilities are summarized in Table 1.

Table 1: Current U.S. Space-Based Surveillance and Reconnaissance Systems[28]

| System | Function | Last Reported Launch |
|---|---|---|
| Keyhole (KH) | IMINT | October 5, 2001<br>USA 161 (2001-044A) |
| Naval Ocean Surveillance System (3rd Generation) | Ocean Surveillance/Tracking | February 3, 2005<br>USA 181 (2005-004A) |
| MENTOR (Advanced ORION) | SIGINT | September 9, 2003<br>USA 171 (2003-041A) |
| MERCURY (Advanced VORTEX) | SIGINT/ELINT | April 24, 1996<br>USA 118 (1996-026A), later attempt on August 12, 1998 failed during launch |
| LACROSSE/ONYX | IMINT/Synthetic Aperture Radar | April 30, 2005<br>USA 182 (2005-016A) |
| Satellite Data System (SDS) 3rd Generation | Data transmission between intelligence satellites | December 10, 2007<br>USA 198 (2007-060A) |

The growing number of missions assigned to space-based surveillance and reconnaissance satellites has led the United States to develop a new generation of capabilities. Dubbed BASIC for Broad Area Space-based Imagery Collector, the new system would be launched by 2011 at an estimated cost of $2-4 billion. Although the program is currently in its very early stages, development options include an entirely new photo imagery satellite or a derivative of a commercial imagery satellite, buying a commercial satellite or leasing existing commercial satellite capacity.[29]

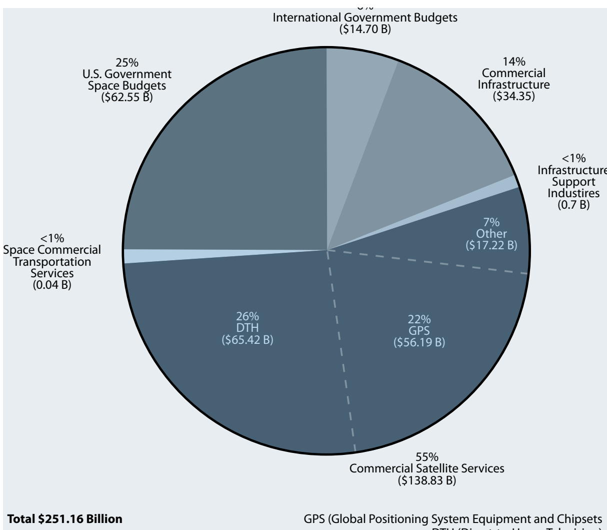
28 For launch data, see *NASA National Space Science Data Center (NSSDC)*. Available on the Internet at: http://nssdc.gsfc.nasa.gov/nmc/spacecraftSearch.do. See also: Craig Covault, "Titan Explosion Destroys Secret 'Mercury' SIGINT," *Aviation Week & Space* Technology (August 17, 1998): 28; Charles P. Vick, "LACROSSE/ONYX," *GlobalSecurity.org* (April 26, 2007). Available on the Internet at: http://www.globalsecurity.org/space/systems/lacrosse.htm. Accessed June 4, 2008.

29 Flaherty, Anne and Pamela Hess, "U.S. Plans New Multibillion-Dollar Spy Satellite Program to be Launched by 2011," Associated Press (November 30, 2007). Available on the Internet at: http://www.globalsecurity.org/org/news/2007/071130-spy-sat-program.htm. Accessed June 4, 2008.

## Commercial Utilization of Space

Space has become an essential part of daily life. This includes satellites that transmit television images, provide weather forecasting data, emergency response, the infrastructure for the Internet, the mapping of the Earth's surface, and global positioning information. Space technologies are transforming the process by which we conduct business and undertake research. The net result is greater productivity with important implications for economic growth, prosperity, and innovation. Access to space-based assets is essential for a broad range of private-sector activities, which will increase both in scope and intensity as a result of the emergence of technologies including smaller satellites and cheaper boosters, miniaturization, and greater economies of scale. The space infrastructure originally established with governmental funding has furnished the basis for both military and commercial applications. In the years ahead, the commercial sector is likely to provide innovative impetus that spills over into the military arena.

### Figure 1: Global Space Activity 2007[30]




By the mid 1990s, global commercial revenues from space resulting from the rapid expansion of consumer services such as telecommunications and television were greater than the aggregate of government spending on space. In 2007 alone, spending on commercial space infrastructure, infrastructure support industries, and commercial satellite services (including direct-to-home television and GPS) totaled approximately $174 B, accounting for nearly 70 percent of total global space spending (see Figure 1). Alongside increased commercial spending on space, government space budgets have accounted for a steadily decreasing share of global space spending. In the past two years alone, the governmental share of global space spending has slipped by 8 percent, from 39 percent of global space spending in 2005 to 31 percent in 2007. Over the same period of time, aggregate government spending on space actually *increased* by $8.25 B. The fact that government's share of space spending *decreased* 8 percent in spite of a 12 percent boost in spending further underscores the impressive growth of the commercial space sector.[31] This means that governments will have less control over access to such services as high resolution imagery of the Earth's surface, which can be used for civilian or for military purposes. Growing commercialization of space will make such access more widely available as commercial investment in space technologies increases relative to that of governments.

Governments in turn will rely increasingly on the private sector for a broader range of space products, services, and technologies. While government-sponsored innovation provided the initial catalyst, especially during the Cold War, the private sector will play a growing role in the development of space technologies that have potential military applications in the years ahead. Dual-use space technologies will spin off from the commercial to the military sector in unprecedented ways. This includes areas such as communications and

30 *The Space Report 2008* (Colorado Springs, CO: The Space Foundation, 2008).

31 *The Space Report 2008* (Colorado Springs, CO: The Space Foundation, 2008). Executive Summary and selected data available on the Internet at: http://www.thespacereport.org/content/overview/activity.php . Accessed June 6, 2008.

imaging satellites and new launch vehicles as well as telecommunications, the broader availability of imagery, and GPS technologies, products, and services. The private sector will develop new products such as satellites and at the same time offer services such as we see today with telecommunications and imagery. In some cases government programs will produce infrastructure such as satellites and GPS, with the private sector then benefiting from such capabilities. Likewise, the government, including the U.S. military, will contract with the private sector to lease communications and other capabilities. For example, the U.S. military recently contracted with Paradigm Secure Communications, based in the United Kingdom, in an effort to augment the capabilities of the Defense Satellite Communications System (DSCS). The deal, worth up to $48 million over three years, will provide the military with X-band communications using Paradigm's fleet of Skynet satellites. Currently, the U.S. military receives about 80 percent of its satellite communications capacity from commercial providers.[32]

Of course, such basic trends—the growth in a commercial space sector—do not guarantee that the United States will be the greatest beneficiary. This obviously depends on strategic choices taken by the United States to exploit such technologies for military purposes. Others bent on benefiting from space technologies will increasingly have access to a global commercial space sector from which they are likely to be capable of spinning off technologies for military purposes if they choose to do so.

**Satellite Services.** Within the commercial space industry, the satellite services sector includes the use of satellites to deliver television, telephony, radio, data communications, remote sensing data, and government services.[33] Through these technologies, the commercial space industry is delivering services that are changing the way people go about their daily lives, driven primarily by the use of communications and positioning satellites.[34]

Statistically, according to *The Space Report 2008*, satellite services comprise both the largest and fastest growing sector of the global commercial space industry. In 2007, satellite services accounted for 55 percent of global space activity, totaling $138.83 billion, an increase of 20 percent over 2006. Two specific technologies are driving robust growth in the satellite services sector: direct-to-home (DTH) television service and Global Positioning System (GPS) equipment and chipsets, accounting for $65.42 billion and $56.19 billion, respectively in 2007. In particular, the significance of GPS navigation services to space industry growth is difficult to overestimate. Indeed, this particular sector of the commercial space industry is so dynamic that some industry representatives refer to satellite positioning data as the "fifth utility," comparing its importance to vital essentials like water, gas, electricity, and phone service.[35]

Additionally, the use of remote sensing data—primarily satellite imagery—is a growing sector of the commercial satellite services market. According to a 2007 survey by the Futron Corporation, "revenue for global commercial satellite remote sensing increased approximately 16 percent from 2005 to 2006." This growth is driven largely by new and continuing military and intelligence imagery contracts. Expanded

32 Turner Brinton, "U.K.'s Skynet Satcom Firm Breaks Into U.S. Military Market," *Defense News* (June 9, 2008): 38.

33 Hays, *United States Military Space: Into the Twenty-First Century*, 15.

34 *The Space Report 2008* (Colorado Springs, CO: The Space Foundation, 2008).

35 Ibid. In September 2008 a privately financed, small 364-pound rocket launched into orbit by Space Exploration Technologies, based in California. The company has a commercial orbital transportation service contract than may total as much as $100 million. This illustrates the growing importance of the private sector in the global space industry. John Schwartz, "Private Company Launches it Rocket into Orbit," *New York Times,* September 29, 2008, p. A18. A video of the launch may be viewed on the company's website, spacex.com

applications for satellite remote sensing data, such as online mapping services, has contributed to growth in this sector. [36]

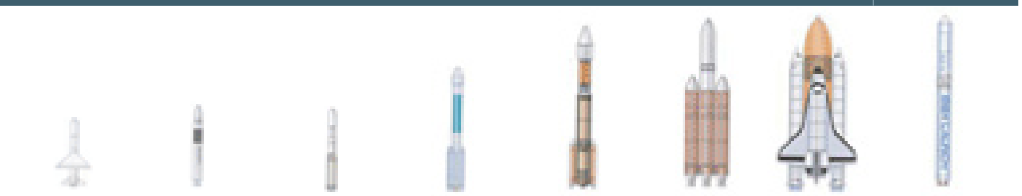
**Satellite Manufacturing.** In 2006, global satellite manufacturing revenues were estimated at $12 billion, of which, the United States accounted for $5 billion.[37] According to the *Space Report 2008*, satellite manufacturing revenue increased 14 percent in 2007, to an estimated $13.64 billion. This remarkable growth was spurred by a 26 percent increase in revenue for government payloads, to $11.41 billion.[38]

## Gaps in U.S. Space Capabilities

Continued U.S. primacy in space will be determined by our ability to anticipate and cope with gaps and weaknesses that could threaten the U.S. space lead in the years ahead. Among the areas of deficiency, we turn first to launch systems.

**Launch Services/Equipment Manufacturing.** Launch is understandably the most competitive component of commercial space. This is due in no small part to the wide variety of launch vehicle suppliers, many of which are state sponsored or otherwise subsidized by the numerous states that offer commercial launch services (see Table 2, 3, 4).[39]

Table 2: U.S. and FAA Licensed Launch Vehicle Performance in 2007[40]



| | United States | | | | | | | Sea Launch |
|---|---|---|---|---|---|---|---|---|
| Vehicle | Pegasus XL | Falcon 1 | Minotaur | Delta II | Atlas V | Delta IV | Shuttle | Zenit-3SL |
| 2007 Total Launches | 1 | 1 | 1 | 8 | 4 | 1 | 3 | 1 |
| 2007 Licensed Launches | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 |
| Launch Reliability (2007) | 1/1–100% | 0/1–0% | 1/1–100% | 8/8–100% | 4/4–100% | 1/1–100% | 3/3–100% | 0/1–0% |
| Launch Reliability (Last 10 years) | 14/14 100% | 0/2 0% | 7/7 100% | 69/69 100% | 12/12 100% | 8/8 100% | 32/32 100% | 22/24 92% |
| Year of First Launch | 1994 | 2006 | 1999 | 1990 | 2002 | 2002 | 1981 | 1999 |
| Active Launch Sites | CCAFS Kwajalein VAFB, WFF | Kwajalein | VAFB, WFF | CCAFS, VAFB | CCAFS, VAFB | CCAFS, VAFB | KSC | Odyssey Pacific Ocean Platform |
| LEO kg (lbs) | 443 (977) | 454 (1,000) | 640 (1,410) | 6,100 (13,440) | 20,520 (45,240) | 23,040 (50,750) | 23,435 (51,557) | 15,246 (33.541) |
| GTO kg (lbs) | — | — | — | 2,170 (4,790) | 8,670 (19,110) | 13,130 (28,920) | 5,663 (12,459) | 6,100 (13,440) |

36 *State of the Satellite Industry Report* (Futron/SIA, June 2007). Available on the Internet at: http://www.futron.com/pdf/resource_center/reports/SIA_2006_Indicators.pdf. Accessed June 13, 2008.

37 Ibid.

38 *The Space Report 2008* (Colorado Springs, CO: The Space Foundation, 2008).

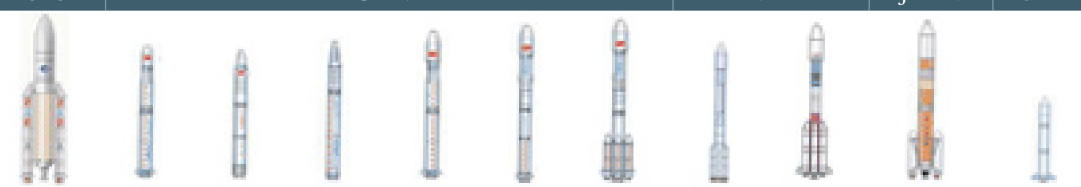
39 Hays, *United States Military Space: Into the Twenty-First Century*, 17.

40 *The Space Report 2008*.

## Table 3: Russian Launch Vehicle Performance in 2007[41]

| | Russia | | | | | | |
|---|---|---|---|---|---|---|---|
| Vehicle | Kosmos 3M | Molniya | Dnepr | Soyuz | Zerit 2M | Proton K | Proton M |
| 2007 Total Launches | 3 | 1 | 3 | 11 | 1 | 2 | 5 |
| Launch Reliability 2007 | 3/3-100% | 1/1-100% | 3/3-100% | 11/11-100% | 1/1-100% | 2/2-100% | 4/5-80% |
| Launch Reliabilty (Last 10 Years) | 9/9<br>100% | 14/15<br>93% | 9/10<br>90% | 93/94<br>99% | 1/1<br>100% | 54/57<br>95% | 18/20<br>90% |
| Year of First Launch | 2004 | 1960 | 1999 | 1963 | 2007 | 1967 | 2000 |
| Active Launch Sites | Plesetsk | Plesetsk | Baikonur,<br>Dombarovskiy | Baikonur,<br>Plesetsk | Baikonur | Baikonur | Baikonur |
| LEO kg (lbs) | 1,350<br>(2,970) | 1,800<br>(3,960) | 3,700<br>(8,150) | 6,708<br>(14,758) | 13,740<br>(30,360) | 19,760<br>(43,570) | 21,000<br>(46,305) |
| GTO kg (lbs) | — | — | — | 1,350<br>(2,975) | — | 4,430<br>(9,770) | 5,500<br>(12,125) |

## Table 4: European, Chinese, Indian, Japanese, and Israeli Launch Vehicle Performance in 2007[42]

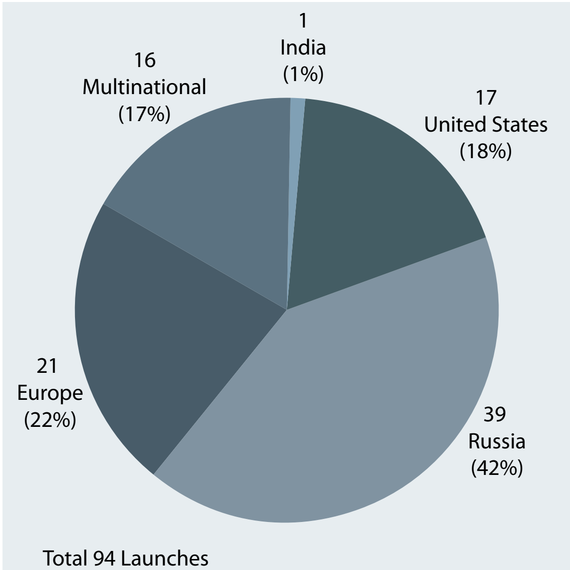


| | Europe | China | | | | | | India | | Japan | Israel |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vehicle | Ariane 5 | Long March 4B | Long March 2C | Long March 2D | Long March 4C | Long March 3A | Long March 3B | PSLV | GSLV | H-IIA | Shavit I |
| Country Region | Europe | China | China | China | China | China | China | India | India | Japan | Israel |
| 2007 Total Launches | 6 | 1 | 1 | 1 | 1 | 4 | 2 | 2 | 1 | 2 | 1 |
| Launch Reliability 2007 | 6/6<br>100% | 1/1<br>100% | 1/1<br>100% | 1/1<br>100% | 1/1<br>100% | 4/4<br>100% | 2/2<br>100% | 2/2<br>100% | 1/1<br>100% | 2/2<br>100% | 1/1<br>100% |
| Launch Reliabilty (Last 10 Years) | 33/34<br>97% | 11/11<br>100% | 13/13<br>100% | 5/5<br>100% | 1/1<br>100% | 12/12<br>100% | 6/6<br>100% | 7/7<br>100% | 3/5<br>60% | 12/13<br>92% | 2/4<br>50% |
| Year of First Launch | 1996 | 1999 | 1975 | 1992 | 2007 | 1994 | 1996 | 1993 | 2001 | 2001 | 1988 |
| Active Launch Sites | Kourou | Taiyuan | Jiuquan<br>Taiyuan<br>Xichang | Jiuquan | Taiyuan | Taiyuan<br>Xichang | Xichang | Satish Dhawan | Satish Dhawan | Tanegashima | Palmachim |
| LEO kg (lbs) | 17,250<br>(37,950) | 2,800<br>(6,170) | 3,200<br>(7,048) | 3,500<br>(7,700) | 4,200<br>(9,250) | 6,000<br>(13,225) | 13,562<br>(29,900) | 3,700<br>(8,150) | 5,000<br>(11,000) | 11,730<br>(25,860) | 225<br>(496) |
| GTO kg (lbs) | 10,500<br>(23,127) | — | 1,000<br>(2,203) | 1,250<br>(2,750) | 1,500<br>(3,300) | 2,600<br>(5,700) | 4,491<br>(9,900) | 800<br>(1,760) | 2,500<br>(5,500) | 5,800<br>(12,800) | — |

41 *The Space Report 2008*.

42 *The Space Report 2008*.

### Figure 2: Commercial Orbital Launches and Market Share by Country, 2003-2007[43]




According to Futron, in 2006, worldwide launch industry revenue decreased by 10 percent from 2005. However, this downward slump in revenue was most likely the result of the retirement of the higher-priced Titan 4B launchers. Additionally, the U.S. share of global launch industry revenue continued to decline, with U.S. providers taking 37 percent of launch revenue in 2006, compared with 50 percent in 2005 and a high of 66 percent in 2003. In terms of the number of commercial launches by U.S. providers, the U.S. accounted for 44 percent of the 41 commercial launches in 2006. [44] For an idea of where the United States stands relative to other nations or multinational groups over the 2003-2007 period, see Figure 2, to the left.

Currently, the sole U.S. platform for manned space flight is the Space Transport System (STS), commonly referred to as the Space Shuttle. First launched in 1981, the shuttle fleet presently includes 3 orbiters: *Discovery*, *Atlantis*, and *Endeavor*. In 2010, the National Aeronautics and Space Administration (NASA) plans to end the shuttle program and retire the entire fleet of orbiters. The follow-on to the Space Shuttle, named *Orion*, is not slated to launch until 2015. During the interim time between the retirement of the Space Shuttle and the launch of *Orion*, the United States will be entirely dependent on Russian manufactured *Soyuz* space capsules, many of which will begin to be launched from the European Space Agency's Soyuz launch facility in French Guiana.[45] In this net assessment, we note that there will be a gap in the U.S. space program unless *Soyuz* proves to be a satisfactory interim capability and Russia continues to cooperate with the United States in the space program. Moreover, as far as unmanned re-supplying of the International Space Station (ISS) is concerned, the 2010 retirement of the Space Shuttle will also cause a reduction in U.S. participation. Until *Orion* becomes operational, the ISS will depend upon the comparatively small Russian Progress[46] and the large European Automated Transfer Vehicle (ATV[47]) for all re-supply missions.

Despite a forty-year history of success, the continued reliability and safety of *Soyuz* has been called into question by recent failures during capsule recovery. The *Soyuz* mission made an emergency landing on April 19, 2008, nearly 300 miles from the initial landing site in Kazakhstan. In an accident that that may have been the result of failure of a bolt connecting the *Soyuz* capsule and an equipment module, causing it to disconnect improperly, astronauts were forced to endure a very steep and rough ballistic landing. This followed a similar ballistic landing in October 2007.[48]

43 *The Space Report 2008*.

44 *State of the Satellite Industry Report*, 17.

45 Based on a February 15, 2006 major agreement between Jean-Yves Le Gall, Chief Executive Officer of Arianespace, and Anatoly Perminov, Director General of Roscosmos ("Arianespace and Roscosmos Sign Contract for Soyuz Operations at Guiana Space Center," *Space Daily*, February 15, 2006).

46 With a cargo carrying capacity of 2,350kg and a docking lifetime of 6 months.

47 With a cargo carrying capacity of 8,000kg and a docking lifetime of 6 months.

48 Marc Kaufman, "Perilous Landings by Soyuz Worry NASA," *Washington Post* (May 12, 2008): A07.

Two factors are likely to contribute to emerging problems with the *Soyuz* capsule and associated systems. First, the Russian company that makes the capsules has historically produced only four or five single-use *Soyuz* capsules a year. This will need to be increased to nine or ten a year to make up for the planned 2010 retirement of the U.S. space shuttle fleet. According to James Oberg, a former NASA mission control specialist, "We're asking a lot of the Russians—a doubling of their *Soyuz* production—and we may well be overstraining their capacity." Compounding the strain on *Soyuz* capsule manufacturing is a shortage of qualified aerospace workers in Russia since the collapse of the Soviet Union. Currently, the United States has a $719 million contract with Russia for crew and payload transport services from 2007-2011 and is in the process of negotiating a second, long-term contract.[49] We turn now to other gaps in space capabilities that are likely to confront the United States in the years ahead.

## Missile Defense

The proliferation of ballistic missiles and weapons of mass destruction (WMD) and their possession by growing numbers of adversaries, ranging from traditional strategic competitors to terrorist organizations, pose a serious and growing threat to the United States, its civilian population and deployed military forces, and friends and allies. This threat encompasses:

- States such as North Korea and Iran which are working hard to acquire (or already possess) WMD and the means to deliver them;
- Strategic competitors, Russia and China, which are extending the sophistication of their strategic arsenals in terms of warhead accuracy, countermeasures, and delivery systems;
- Terrorist groups, which are making concerted efforts to obtain WMD that would enable them to conduct chemical, biological, radiological, or nuclear attacks; and

Threats are increasing at a pace that may not give the United States the luxury of lengthy timelines to develop and deploy a missile defense against them. A global layered defense capability is necessary to counter these threats. Near-term options exist for developing viable space-based defenses within the next decade resulting in a comprehensive, global layered missile defense system. This option would complement the system currently being deployed but afford superior coverage at less cost than expanding the number of GMD sites beyond those already planned in the United States and in Europe. Layered defenses provide multiple opportunities to destroy attacking missiles in all three phases of flight from any direction regardless of their geographic starting point. Furthermore, a layered defense makes the countermeasures available to the offensive systems much less effective than would be the case if interdiction was only possible in one (or two) phase(s) of the missile's flight. Boost phase intercepts, most efficiently conducted by components deployed in space, are particularly desirable because a missile is most vulnerable during this segment since it is relatively slow moving, presents a readily identifiable target (bright rocket plume), and has not released any of its warheads or countermeasures which would complicate interception in subsequent phases. Boost phase interception has the added advantage that the missile's payload may, depending on how early interdiction occurs, fall back on the attacking nation. This situation could deter the launching state if it is confronted with the likelihood of serious damage to its own territory. In addition, depending on the number of assets deployed, a space-based boost-phase defense could always be on station on a world-wide basis, unfettered by sovereignty issues of overflight and operations on another nation's territory.

49 Ibid.

There are essentially two basic approaches to space-based missile defense. The first is kinetic energy systems; the second is directed energy weapons.

## Space-Based Kinetic Energy Missile Defense

A space-based kinetic energy system is designed to hit a ballistic missile in its boost phase, when the warhead(s) has not yet separated from the missile and is most vulnerable, as well as in the midcourse and high-terminal phases. Kinetic kill vehicles would be placed in low-Earth orbit, where they would remain until a hostile missile launch was detected. For intercepts in the boost or terminal phases, a kinetic kill vehicle would accelerate out of orbit toward the missile which would be destroyed by direct impact. Midcourse intercepts would occur in space.

Over a decade ago, the United States had developed technology for light-weight propulsion units, sensors, computers, and other components of an advanced kill vehicle. This concept, *Brilliant Pebbles*, consisted of a constellation of about 1000 satellites that combined its own early-warning and tracking capability with high maneuverability to engage attacking ballistic missiles in all phases of their flight trajectory. Each pebble was designed to identify the nature of the attack, which might include up to 200 ballistic missiles; and since it knew its own location and that of all other pebbles, each could calculate an optimum attack strategy from its own perspective and execute an intercept maneuver, while simultaneously informing the other pebbles of its action. This operational concept survived numerous scientific and engineering peer reviews in the 1989-90 time period, including by some groups that were hostile to the idea of missile defense in general, and space-based defenses in particular. Still, because of persistent policy preferences, the opposition eventually gained the upper hand politically, and the program which had been formally approved by the Pentagon's acquisition authorities was curtailed by Congress in 1991 and 1992 and then cancelled by the Clinton administration, which opposed space-based missile defense and sought to preserve intact the ABM Treaty.[50] Thus, in a very real sense, political decisions overrode technological feasibility.

Although there has been no formal program to develop the key technologies further, major advances in the commercial, civil and other defense sectors over the past decade will now permit even lighter mass, lower cost, and higher performance space-based interceptors than would have been achieved by the 1990-era *Brilliant Pebbles* technology base. Thus, lighter weight and smarter components can now give to a kinetic energy interceptor greater acceleration/velocity making possible boost-phase intercept of even short- and medium-range ballistic missiles. If the necessary investments are made to upgrade *Brilliant Pebbles*-type technology for the twenty-first century, boost-phase intercept from space will also be feasible against high acceleration ICBMs that would have exceeded the capabilities of the 1990 *Brilliant Pebbles*.[51]

## Space-Based Directed-Energy (Laser) Missile Defense

Directed-energy defenses hold the potential in the longer-term to provide a boost-phase missile defense capability. The 1991-92 GPALS system included a follow-on space-based laser (SBL) layer after the *Brilliant Pebbles* deployment with capabilities that would complement it in two ways: (1) lasers operating at the speed-of-light to assure the earliest possible boost-phase intercept capability, maximizing the likelihood that the

50 See the record of this program as recorded by the Missile Defense Agency's Historian, Donald R. Baucom, "The Rise and Fall of Brilliant Pebbles," *International Flight Symposium*, October 23, 2001. This piece was subsequently published in the *Journal of Social, Political and Economic Studies*, Volume 29, no. 2, (September 2004): 145-190.

51 See Gregory H. Canavan, *Missile Defense for the 21st Century*, Heritage Foundation Paper, 2003, particularly 96-111.

debris remaining after the intercept would fall back on the launcher's territory; and (2) while lasers would not be effective in destroying nuclear warheads in space, they would be capable of the active discrimination of warheads from decoys thus enabling intercept by *Brilliant Pebbles* or other midcourse defense systems.

The SBL platform would intercept ballistic missiles by focusing and maintaining a high-powered laser on the missile while its rockets are burning and it is vulnerable to even a small perturbation that could ignite the rocket fuel and destroy the missile. A missile that is struck early in its boost phase could dispense its deadly payload over the country of launch, thus creating in itself a possible deterrent to launching missiles against the United States and its forward deployed forces. (Countries contemplating the use of missile-delivered weapons of mass destruction would have to consider the possibility that the payload would fall within their own borders). If the missile were engaged near the end of its boost phase, it still might fly a ballistic trajectory, but one that would fall short of its intended target. And as noted above, SBLs could perform an active discrimination mission, aiding SBIs and other midcourse-capable defenses in intercepting the attacking missile before it re-enters the Earth's atmosphere.

Given that of all possible basing modes, space-based defenses offer the widest coverage and largest number of intercept opportunities, and the fact that little if anything has been done to take advantage of space defense technologies that were mature more than fifteen years ago, a new initiative is required to bring that technology and its potential up to date. A streamlined technology-limited development program based on the *Brilliant Pebbles* program could be designed to demonstrate within three years the feasibility of a constellation of space-based interceptors to intercept ballistic missiles in all phases of flight—boost, midcourse, and terminal.

## Space Situational Awareness

Protecting U.S. interests in space depends initially on the ability to monitor the space environment to gain space situational awareness. For this purpose, the U.S. maintains a database that identifies the more than over 10,000 mostly man-made objects now orbiting the Earth. Air Force Space Command tracks these objects in order to prevent collisions between spacecraft and to highlight any that could pose a threat.[52]

However, U.S. SSA capabilities are insufficient for the current threat environment. Currently, the Air Force tracks space objects by means of ground based telescopes and radars comprising the Ground-based Electro-Optical Deep Space Surveillance (GEODSS) system. However, these sensors are inadequate at best. While offering good resolution on objects in low-Earth orbit, the system is far less useful for imaging objects in geosynchronous orbit. It is also limited by weather conditions.[53] In particular, airmen on the ground can only collect data on satellites using the GEODSS at night when the sun is reflecting on the targeted satellite.[54]

The implications of poor SSA are widespread. This is primarily due to the fact that situational awareness forms the foundation of offensive and defensive counterspace measures. Indeed, without the ability to effectively monitor activity in the space environment, there is little hope of protecting vital national space assets from attack.

Currently, the U.S. Air Force is working to develop and deploy a new system that will drastically improve U.S. situational awareness by relying on space-based sensors instead of inherently limited ground based telescopes

52 John A. Tirpak, "Security the Space Arena: Air Force Plans Call for Defensive and Offensive Systems to Protect Vital U.S. Spacecraft," *Air Force Magazine* (July 2004): 31.

53 Ibid.

54 Michael Hoffman, "Air Force to Launch Space Based Surveillance System," *Defense News* (April 10, 2008). Available on the Internet at: http://www.defensenews.com/osd_story.php?sh=VSDR&i=3474508. Accessed June 13, 2008.

and radars. Named the Space Based Surveillance System (SBSS), the program will deliver optical sensing satellites to search, detect, and track orbiting objects, particularly those in geosynchronous Earth orbit.[55] The Air Force plans to have an operational SBSS constellation by 2014.[56]

**Funding Gaps.** Though significant effort has been made to study current deficiencies in missile defense and space situational awareness, the lack of funding significantly undercuts the ability of the United States to address these weaknesses—particularly missile defense. When Congressional funding is reduced, systems are developed on a much reduced scale, over a longer period of time, and often with fewer capabilities. When funding is nonexistent, technological opportunities that might help address U.S. weaknesses in space are not pursued. In these instances, short-term political preference often takes precedence over strategic necessity, technical feasibility, and long-term thinking.

In Fiscal Year 2008, funding for a key missile defense system was reduced significantly. Formerly known as SBIRS-Low, MDA's Space Tracking and Surveillance System (STSS) was appropriated $233.1 million, compared to $322 million in FY 2007—a reduction of $88.9 million, or 28 percent.[57] Congress cut missile defense funding for FY 2008 to $8.7 billion, some $700 million below FY 2007 funding levels.[58] The cuts were deepest in long-term, advanced development projects, a number of which are space-based, such as STSS.[59]

Although some systems are being funded at reduced levels, other space technologies are not being pursued at all due to a total lack of funding. In FY 2008, funding for development of a Space Test Bed to explore the potential for space-based missile defenses (much of the technology for which was pioneered during the late-1980s) was denied entirely, although the modest $10 million request amounts to far less than one percent of MDA's budget.[60] Instead, we have limited ourselves to an even more modest $5 million appropriation for an independent study of the option of space-based interceptors in the continuing resolution that contains the DoD appropriation for FY 2009. In point of fact, as already discussed, the United States had solved crucially important technology problems associated with space-based interceptors nearly a generation ago in the *Brilliant Pebbles* system.

To underscore the importance of pursuing even very limited exploration of space-based missile defense systems, MDA Director LTG Henry Obering stated before the Senate Armed Services Committee in April 2008 that:

> I believe the performance of the BMD system could be greatly enhanced someday by an integrated, space-based interceptor layer. Space systems could provide on-demand, near

55 "Space Based Space Surveillance," *Global Security*. Available on the Internet at: http://www.globalsecurity.org/space/systems/sbss.htm. Accessed June13, 2008. See also "Report of the Committee on Armed Services, U.S. House of Representatives, on H.R.5658—The Duncan-Hunter National Defense Authorization Act for Fiscal Year 2009," (Washington, DC: Government Printing Office, 2008): 212. Available on the Internet at: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_reports&docid=f:hr652.110.pdf. Accessed June 16, 2008.

56 Jeremy Singer, "U.S. Air Force Mulls Second Space-Surveillance Satellite," *Space News* (May 23, 2007). Available on the Internet at: http://www.space.com/spacenews/archive07/sbssmess_0521.html. Accessed Jun 13, 2008.

57 "National Security Space FY 2008 Budget: Overview and Assessment," *Policy Outlook* (The George C. Marshall Institute, November 2007): 3. Available on the Internet at: http://www.marshall.org/pdf/materials/566.pdf. Accessed May 15, 2008.

58 "Historical Funding for MDA FY85-08," Missile Defense Agency. Available on the Internet at: http://www.mda.mil/mdalink/pdf/histfunds.pdf. Accessed May 15, 2008.

59 John W. Douglass, "Missile Defense Cuts Don't Add Up in a Threatening World," *Space News* (November 19, 2007). Available on the Internet at: http://www.aia-aerospace.org/aianews/op_detail.cfm?Content_ID=591. Accessed May 6, 2008.

60 "National Security Space FY 2008 Budget: Overview and Assessment," 3.

> global access to ballistic missile threats, minimizing limitations imposed by geography, absence of strategic warning, and the politics of international basing rights. I would like to begin concept analysis and preparation for small-scale experiments. These experiments would provide real data to answer a number of technical questions and help the leadership make a more informed decision about adding this capability.[61]

Indeed, space-based systems, such as STSS and the Space Test Bed, have the unique ability to offset, detect, deter, and destroy threats and the flexibility more quickly to address challenges as they arise.

However, regardless of the possible strategic advantages of space-based missile defense, the prospects for funding even a modest investment in the Space Test Bed in FY 2009 are not favorable. The outlook for increased STSS funding is equally discouraging. In May 2008, the National Defense Authorization Act for Fiscal Year 2009 once again eliminated the $10 million requested for the Space Test Bed program, noting strongly that "the committee does not support the deployment of space-based interceptors."[62] Furthermore, despite a significantly lowered request of $242 million for STSS, the House of Representatives has thus far authorized only $217.4 million, a further program reduction of $25 million.[63] In no uncertain terms, regardless of the future utility of the Space Test Bed or STSS, "the committee has re-prioritized resources away from systems designed to address longer-term threats and focused them instead on closing existing capability gaps against short- and medium-range threats."[64]

The effect of such funding decisions missile defense and national security space systems is significant. According to the MDA Director, General Obering, MDA has had to "restructure some development activities and cancel others as a result of reductions in the FY 2008 budget. Reductions in funding for [MDA] programs will result in some schedule delays."[65] In addition to schedule delays for STSS, two promising possibilities will not be pursued at all unless Congress changes direction on the Space Test Bed: (1) twenty-first century upgrades to 1980s-era *Brilliant Pebbles* technology that would enhance both the effectiveness and fiscal feasibility of space-based kinetic energy interceptors; and (2) development of space-based directed energy lasers that were originally intended to augment GPALS capabilities.

In order to provide for the future security of the United States and its allies against emerging threats, Congress must work to ensure that near term capabilities are not funded at the expense of long-term development projects. Indeed, the greatest danger in MDA's current budget is that it increasingly strains the Agency's overall mission to develop a balanced program between current and future missile threats. Future spending is directed toward near-term fielding. To do this within budget constraints, MDA is sacrificing options for

61 LTG Henry A. Obering, "Missile Defense Program and Fiscal Year 2009 Budget," Testimony Before the Senate Armed Services Committee, Subcommittee on Strategic Forces (April 1, 2008). Available on the Internet at: http://www.mda.mil/mdalink/pdf/spring_08.pdf. Accessed June 16, 2008.

62 "Report of the Committee on Armed Services, U.S. House of Representatives, on H.R.5658—The Duncan-Hunter National Defense Authorization Act for Fiscal Year 2009," 258.

63 See "Report of the Committee on Armed Services, U.S. House of Representatives, on H.R.5658—The Duncan-Hunter National Defense Authorization Act for Fiscal Year 2009," (Washington, DC: Government Printing Office, 2008): 242, 263. Available on the Internet at: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_reports&docid=f:hr652.110.pdf. Accessed June 16, 2008.

64 "Report of the Committee on Armed Services," 255.

65 Obering, "Missile Defense Program and Fiscal Year 2009 Budget."

the future. Further cuts will only heighten this imbalance, with serious implications for our future security.[66] Barring a long-term approach to funding, the potential for space-based assets to detect, deter, and destroy missile threats will be wasted entirely and unnecessarily.[67]

**Future Workforce Development.** If current trends continue, the United States will not have the specialized workforce necessary to support future U.S. primacy in space. Indeed, there is a major crisis in the aerospace industry, both in terms of sustaining the current workforce and developing the workforce of the future.

With the reductions in defense spending that followed the end of the Cold War, the United States lost over 600,000 scientific and technical aerospace jobs.[68] According to the Aerospace Industries Association, total industry employment went from 1,120,800 in 1990 down to 637,300 in 2007. In the space sector alone, employment slipped from 168,500 to 75,200 over the same period of time.[69] Of the employees that remained following the initial post-Cold War cuts, it is suggested that 27 percent of America's aerospace technical workforce is now eligible for retirement. This is simply the continuation of a wave of retirements that began some time ago[70] The Aerospace Industries Association contends that nearly 60 percent of the U.S.-aerospace workforce was at least 45 years old in 2007. What is significant is that because many began their careers relatively young, a large number will be eligible for retirement in the next decade. Clearly, the workforce that supported U.S. space primacy during and immediately following the Cold War will need to be replenished with the infusion of new talent.

The ability of the United States to fill the void left by retirements is in question. Currently, the portion of those workers 34 or younger has declined from 32 percent in 1992 to 16 percent in 2003. About 70,000 students each year receive undergraduate degrees in engineering in the United States. Subtracting the 15,000 degrees in non-space related engineering fields (civil, automotive, mining and transportation engineers) about 55,000 graduates are qualified for aerospace work. Of those, approximately 20 percent are international students who are expected to return home upon graduation. That leaves about 44,000 graduates per year for *all* American companies, not only aerospace firms. Given that a single leading aerospace company expects to hire 50,000 engineers in the next five years, the challenge of replenishing the aerospace workforce becomes a challenge. It is compounded by the fact that fewer students are earning degrees in math and science—from undergraduate to doctorate—while at the same time, there is an ongoing shortage of math and science teachers. [71]

66 "Missile Defense in the Fiscal Year 2008 Budget Request—Issues and Background," *Policy Outlook* (The George C. Marshall Institute, February 2007): 9. Available on the Internet at: http://www.marshall.org/pdf/materials/502.pdf. Accessed May 15, 2008.

67 John W. Douglass, "Missile Defense Cuts Don't Add Up in a Threatening World," *Space News* (November 19, 2007). Available on the Internet at: http://www.aia-aerospace.org/aianews/op_detail.cfm?Content_ID=591. Accessed May 6, 2008.

68 *Final Report of the Commission on the Future of the United States Aerospace Industry*, XV. Available on the Internet at: http://www.ita.doc.gov/td/aerospace/aerospacecommission/AeroCommissionFinalReport.pdf. Accessed May 16, 2008.

69 "Total Employment Annual - Calendar Years 1990 to 2008," Aerospace Industries Association. Available on the Internet at: http://www.aia-aerospace.org/stats/aero_stats/stat12.pdf. Accessed June 3, 2008.

70 "Election 2008 Issues: Keeping America Strong - Aerospace Workforce Renewal," Aerospace Industries Association. Available on the Internet at: http://www.aia-aerospace.org/pdf/08issues_4-workforce.pdf. Accessed May 15, 2008.

71 Ibid. See also: "Revitalization of the Aerospace Workforce," Aerospace Industries Association. Available on the Internet at: http://www.aia-aerospace.org/issues/subject/employment_facts.cfm. Accessed May 15, 2008.

## U.S. Space Vulnerabilities: Assessing Risk

In addition to shortfalls in our future space workforce, it is possible to survey U.S. vulnerabilities in space by reference to the risk of attack and the consequences of the destruction of specific space-based assets. Risk may be assessed by determining the availability of capabilities in the hands of adversaries of the United States that could mount such an attack. The incentive to destroy U.S. space-based capabilities would be enhanced by the impact of the devastating consequences that their destruction would bring upon the United States—leading in a worst-case situation to a "world without the United States" to which the Iranian leader Ahmadinejad has referred. An attack would be mounted against space systems themselves or against their ground-based infrastructure. Anti-satellite attacks could be staged from the ground or from space. Treaty-based efforts to prevent the development and deployment of such capabilities, even if they were to prove feasible, would probably be inadequate in themselves for reasons already discussed. For example, the definition of a space weapon is difficult in itself because satellites can be attacked from Earth or from space, making verification perhaps impossible.

Because it is more dependent than any other nation on space, the threat to and from space is greatest to the United States. Space systems such as those deployed by the United States have various vulnerabilities. They include strikes that could be mounted against ground stations, launch systems, or orbiting satellites. Our space systems are vulnerable to disruption or actual destruction, as well as to efforts on the part of an adversary to deny use of them. Such efforts could include interference with satellite systems, detonation of a nuclear weapon in space causing electromagnetic pulse (EMP) effects, or use of micro-satellites to attack our satellites. Just as control of the seas has been essential to the right of innocent passage for commerce, the ability of the United States to maintain assured access to space will depend on space control. The already extensive importance of space for commercial and military purposes, as well as its prospective role in missile defense reinforces the case that the United States must maintain control of space in the twenty-first century.

Among the areas of U.S. space vulnerability is electromagnetic pulse (EMP) attack. As pointed out elsewhere in this net assessment and to quote from the EMP Commission Report, "Ubiquitous Earth-orbiting satellites are a mainstay of modern critical national infrastructures. Satellites provide Earth observations, communications, navigation, weather information, and other capabilities."[72] Other countries such as Iran and North Korea are developing EMP-related technologies, including missiles that could launch nuclear warheads. China and Russia already possess such capabilities. The wider availability of these technologies in the decades ahead will make U.S. space- and ground-based assets increasingly vulnerable to EMP attack. U.S. space systems in low-Earth orbits are especially susceptible to nuclear detonations at high altitudes and therefore to EMP attack. In addition, EMP could have devastating consequences for the control systems and ground infrastructure of space systems. The nuclear weapons effects on satellites could be the collateral consequences of an EMP attack mounted principally against other targets, or an EMP attack could be carried out with U.S. low-Earth orbit space systems as their primary target. Thus the cascading effects of an EMP attack would extend to a spectrum of electronic systems on Earth as well as the space capabilities that are vital to such infrastructures, including for example the communications systems on which nearly all Americans depend in their daily lives, whether for commercial or individual purposes such as cell phones and television.

72 *Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack: Critical National Infrastructures,* p. 159.

The electromagnetic pulse effects of even a single nuclear weapon exploded at high altitude above or near the United States would disrupt the electrical power systems, electronics and information systems on which we vitally depend, producing catastrophic damage from which recovery would be protracted, painful, and potentially impossible. Space systems could be vulnerable to EMP effects resulting from one or more nuclear detonations at altitudes between 40 and 400 kilometers.[73] Satellites in low-Earth orbit are considered to be especially at risk from the collateral radiation effects resulting from an EMP attack. Low-Earth orbit is usually delineated within an altitude that begins at about 140 kilometers and extends several hundred kilometers. Therefore, there is a convergence between the LEO and the altitude region in which EMP effects would be directly felt on orbiting satellites. Commercial satellites are vitally important to support such governmental services as weather forecasting and communications, emergency response services, and military operations. The destruction or disabling of such satellites would have possibly catastrophic implications for homeland security and for the U.S. military as well as the overall economy and society. Because the United States is most dependent of all nations on space, it is the most vulnerable. The space programs of other nations are being developed for several reasons, including the military and commercial importance attached to space, but also in some cases as asymmetrical means to be able to challenge the U.S. in crisis situations by threatening U.S. space-based assets. By the same token, as other nations develop space-based capabilities, their vulnerability also will increase. Therefore, we turn next to a brief survey of what others are doing in space.

## Other Space Programs

Other states are engaged in programs designed to enable them to become twenty-first-century space powers capable of challenging or at least competing with the United States. As noted earlier, the growing commercialization of space will create a more level playing field as additional actors gain greater access to the products and services of the commercial space sector and to the enabling technologies as well. Thus we consider military competitors as well as commercial competitors in this net assessment. Because space technologies are generally dual-use systems, with for example commercial satellites used also for military communications, there is an intertwining of space capabilities. Equally important, however, is the fact that technologically advanced allies of the United States will also have available space technologies that make them U.S. commercial competitors. Increasingly, space technologies will be more widely available both to friendly and hostile actors alike. At least thirty-five countries now have space research programs designed to augment existing space capabilities or lead to their first deployments in space. For example:

- The countries of the European Union (EU) have entered into a collaborative agreement with the European Space Agency to build a *Galileo* satellite navigation network that—with possible participation from China and other countries—will far outclass the U.S. global positioning system (GPS). *Galileo* is scheduled for deployment by 2013. The EU is developing a highly competitive commercial space industry that includes both satellites and launchers.
- With the help of the Russian military, Iran has placed in orbit the first of several satellites, which could provide Iran with strategic intelligence.
- Several Asia-Pacific countries are developing important space programs. They include India, South Korea, China, and Japan.

73 See the "Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse Attack, Volume 1: Executive Report," 2004, http://www.empcommission.org/index.php.

- India has developed satellites and launch vehicles for uses ranging from navigation to reconnaissance, together with a space manufacturing base. Its satellites provide communications services and meteorological payloads. India has cooperative space programs with Israel, Russia, and the United States among other such programs. India also recently announced plans to develop "space applications for military purposes."[74]
- Both China and Japan launched Moon orbiters in 2007, while China demonstrated the ability in January 2007 to destroy an aging Chinese satellite by a missile launched from the ground. This signals China's efforts to offset U.S. space advantages by holding at risk satellite capabilities deemed vital by our military in a crisis over Taiwan.

- The data collected from space-based imagery can be downloaded and easily acquired by a host of actors, including terrorists, creating an expanding information base previously not available in some cases even to governments.

As these examples suggest, knowledge about space systems, including the means to counter them, is becoming more widely available on a global basis. International cooperation in the development of space technologies has increased the diffusion of capabilities to new actors. The commercial space sector, already discussed in this net assessment, includes many international programs designed to pool resources and expand markets. Within alliances such as NATO, militaries cooperate in space-related capabilities such as communications and sharing intelligence gained from space-based assets. Globalization, dependent on space, is based on expanding international cooperative arrangements for the development and utilization of space technologies. Therefore, the ability to disrupt U.S. space systems is growing. Whether or not the United States moves forward in space, other countries will do so, as discussed in the next section of this net assessment. Our focus is on the space programs of China, Russia, Iran, the European Union and several of its key members with space programs, Japan, India, and Israel. In each case specific programs and technologies are set forth in an effort to indicate both the focus and extent of such efforts.

## China

China is developing or acquiring technologies for space-based military purposes in order to leapfrog the present U.S. technological dominance of space. This includes microsatellites (weighing less than 100 kilograms) for remote sensing and for networks of electro-optical and radar satellites, and it has shown interest in electronic/signals intelligence reconnaissance satellites.[75] China hopes to have in excess of 100 satellites in orbit by 2010, and to have launched an additional 100 satellites by 2020. In another example of its burgeoning space capabilities, China launched its first manned spacecraft into orbit in its *Shenzhou*-3 missions in October 2003 and a second manned flight in October 2005.[76] With the October 2003 mission, China became the third country (after the United States and Russia) to complete a successful manned space mission. In September 2008, furthermore, China conducted its first space walk with the launch of the *Shenzhou*-7 spacecraft mission. This included not only a spacewalk by a Chinese astronaut, but also a companion satellite. China demonstrated the ability to release one satellite from another satellite. Its purpose was said to be to photograph the *Shenzhou*-7 and study another orbital module left in space during the mission.[77] China hopes to conduct additional space walks together with docking missions with a space module and eventually to make a Moon landing by 2010,

74 "China, India Hasten Arms Race In Space," *Washington Times*, June 25, 2008.

75 Ibid, 35.

76 "Report: China Hopes to Launch Second Manned Space Mission in October,"The Associated Press, July 15, 2005.

77 Sara Sargent, "Analysis: China Space Launch Raises Fears," *Space Daily* October 3, 2008.

and to have a full space station by 2020.[78] Even as it attempts to restrict U.S. efforts through, for example, "legal warfare" described above, Beijing pursues a strategy designed to make China a twenty-first-century space power.

In addition to the ground-based missile intercept of a Chinese satellite in January 2007, China is reported to be conducting research for other anti-satellite weapons, such as a ground-based laser capable of damaging and destroying satellites.[79] Such a capability could paralyze U.S. civilian and military space systems that are crucially important for a variety of commercial and national security purposes. Again, to highlight the apparent Chinese focus on asymmetric capabilities to hold at risk U.S. space-based assets, the loss of U.S. space-based satellites would have a dramatic effect on communications, whether for civilian or for military purposes. Wireless telephones, pagers, and electronic mail would be disrupted. In addition, satellites that provide automated reconnaissance and mapping, aid weather prediction, track fleet and troop movements, give accurate positions of U.S. and enemy forces, and guide missiles and pilotless planes to their targets during military operations would have their services curtailed or terminated.

China's earlier manned space flight in October 2003 demonstrated dramatic technological advancements in the country's space program. It showed that China has developed an extensive array of space capabilities ranging from satellite design and manufacture to launch services and on-orbit operations.[80] China builds satellites on its own, and is engaged in international commercial and scientific collaboration with Brazil, Russia, and other European countries.[81] China has a robust commercial satellite launch industry capable of placing payloads into geosynchronous and polar orbits.[82] Its space program is also notable for the ability to move technology and personnel between the civilian and military sectors.[83]

Clearly, a great deal of the data and technology now being used in commercial space systems can also be applied to military systems. For example, an imaging satellite, whether civilian or military, requires the same basic technical capabilities for collecting data, and a rocket launcher delivering a civilian satellite to space is largely identical in terms of rocket science and guidance technology to a ballistic missile delivering a nuclear warhead. China almost certainly exploits commercial high-resolution imagery for intelligence purposes, supported by signals intelligence satellites (SIGINT), many of which carry both civilian and military signals. Satellite signals enable mobile communications while being harder to intercept or locate compared to radio communications. Although satellite programs will enhance military communications, they will not provide access to military-specific technologies such as jamming resistance and spread-spectrum transmission.[84]

China currently uses the U.S. global-positioning system (GPS) and the Russian GLONASS system and will participate in the *Galileo* European satellite navigation system. These satellites provide PLA units and weapons systems with "navigation and location data that can potentially be used to improve ballistic and cruise

78 "Annual Report on the Military Power of the People's Republic of China," U.S. Department of Defense, 2005, www.defenselink.mil/news/Jul2005/d20050719china.pdf, 36.

79 Ibid, 36.

80 Phillip Saunders et al, "China's Space Capabilities and the Strategic Logic of Anti-Satellite Weapons," July 22, 2002.

81 Ibid.

82 J. Johnson-Freese and A. Erickson, "The Emerging China-EU Space Partnership: A Geotechnological Balancer," *Space Policy* No. 22 (2006): 12-22.

83 Phillip Saunders, "China's Future in Space: Implications for U.S. Security," AdAstra, The National Space Society (NSS), September 20, 2005.

84 Ibid.

missile accuracy and to convert 'dumb bombs' into precision-guided munitions."[85] The Chinese are seeking to improve the robustness of their space capabilities, drawing where possible on indigenous sources, but where necessary obtaining designs and technologies now abroad.

For example, the *Long March* rocket family, China's indigenously developed launch vehicle group, includes twelve different versions capable of placing satellites into low-Earth (LEO), geo-stationary (GEO), and sun-synchronous orbits.[86] China used the upgraded *Long March*-2F rocket with improved guidance and control systems, engines, and computer systems to launch its first man into space in October 2003.[87] China is also experimenting with heavy-lift space launch vehicles. In September 2003 China successfully tested its first four-stage solid-fuel launch vehicle, *Kaituozhe*-1 (KT-1), capable of placing microsatellites in orbit.[88] China has also made great progress in reusable vehicle technology for its manned space "Project 921" program initiated in 1992.[89] The *Shenzhou*-6 was designed to place two astronauts (taikonauts) into orbit for several days, marking a significant improvement upon the single person placed in orbit for 21 hours in the first manned mission.[90]

China's civilian and military space programs provide many of the capabilities, such as on-orbit maneuvering, mission management, and high-powered laser technology, that would be needed to support an ASAT program.[91] Small satellites represent another dual-use technology with possible ASAT applications.[92] Miniature satellites potentially allow for "lower-cost access to space, enhanced maneuverability, and increased ability to launch-on-demand."[93] Such factors can be advantageous, particularly in communications and meteorological applications.[94] China may also be developing jammers, which could be used against Global Positioning System (GPS) receivers.[95] In the last few years, Chinese research on small mobile launch vehicles has shown an increased focus on nano-satellites which could enable China to launch satellites swiftly from mobile launchers.[96]

The Chinese have an indigenous microsatellite program that is advanced and sophisticated. The reduced weight, and thus lower launch cost, makes small satellites and microsatellites an attractive means for increasing China's space capabilities. China has successfully launched into orbit the small *Haiyang* surveillance satellites, and at least three microsatellites. A number of reports claim that China has developed and tested an advanced anti-satellite system, described as a "parasitic microsatellite," that is, a small satellite that attaches itself to a larger satellite to disrupt or destroy that larger satellite on command.[97]

85 Ibid.

86 "White Paper Hails China's Achievements in Space Program," *Xinhua*, November 22, 2000, FBIS Document CPP20001122000026.

87 Leonard David, "Shenzhou Secrets: China Prepares for First Human Spaceflight," http://www.space.com/businesstechnology/technology/shenzhou_tech_030924.html, September 24, 2003.

88 "China Successfully Test Fires Its First Four-Stage Solid-Fuel Launch Vehicle," *Xinhua*, September 24, 2003, FBIS Document CPP20030924000048.

89 Leonard David, "Shenzhou Secrets: China Prepares for First Human Spaceflight, " http://www.space.com/businesstechnology/technology/shenzhou_tech_030924.html.

90 "AFP: PRC Launches Second Manned Space Mission," *Hong Kong AFP*, October 12, 2005.

91 Phillip Saunders et al, "China's Space Capabilities and the Strategic Logic of Anti-Satellite Weapons," July 22, 2002.

92 Ibid.

93 Ibid.

94 Ibid.

95 Craig Covault, "Chinese Test Anti-Satellite Weapon," *Aviation Week and Space Technology*, January 17, 2007.

96 Phillip Saunders et al, "China's Space Capabilities and the Strategic Logic of Anti-Satellite Weapons," July 22, 2002.

97 U.S. Department of Defense, Annual Report on the Military Power of the People's Republic of China, 2003 and 2004.

High-powered lasers have also been a high priority for development in China.[98] In 2006, China reportedly fired high-power lasers at U.S. spy satellites flying over its territory, an act described by experts as a test of the Chinese ability to blind the spacecraft.[99] The targeted satellites appear to have been U.S. military imaging satellites, which are quite vulnerable to such illumination, as even relatively low-power laser light could interfere with, or potentially damage, their sensitive detectors.[100] One possible explanation could be that China is developing laser weapons intended to disrupt satellites, and therefore has tested them against U.S. satellites. Ground-based laser technology provides a more likely alternative to space-based technologies due to lower relative costs and superior control capabilities.[101] However, ground-based lasers would require significant advances in adaptive optics, together with large fixed power sources that would be visible and vulnerable to attack.[102]

On January 11, 2007, China conducted a successful anti-satellite weapons test that was widely publicized by the United States. A kinetic kill vehicle, launched from the Xichang Space Center by a medium-range ballistic missile, destroyed an inactive Chinese meteorological satellite at an altitude of approximately 500 miles.[103] Dubbed the SC-19 by American intelligence, the Chinese anti-satellite weapon is fired from a mobile launcher and consists of a solid-fuel medium-range missile carrying an interceptor that is designed to crash into satellites.[104] The Chinese ASAT test has dramatically increased orbiting debris, as well as the threat to low-orbiting American imaging satellites.

Although China has made remarkable progress in its space program, it still lags behind developed countries.[105] The key to narrowing that gap, according to the PRC, lies in increasing the country's capacity for innovation, which the 2006 White Paper strongly emphasizes.[106] Among the core principles of development for China's space program are upholding independent innovation and a policy of self-reliance, leapfrogging development, as well as actively engaging in international space exchanges and cooperation.[107] China has already formed useful partnerships with other countries and organizations, and is using joint ventures to improve its own capabilities.

The PRC has set development targets for its space program in the next five years, which include building a "coordinated and complete national satellite remote-sensing application system," setting up a "relatively complete satellite telecommunications and broadcasting system," and establishing a satellite navigation and positioning system to better meet the needs of the people. Additionally, for the first time, China has ranked the importance of various space projects, including applied satellites, manned space flights, deep-space exploration,

98 Phillip Saunders et al, "China's Space Capabilities and the Strategic Logic of Anti-Satellite Weapons," July 22, 2002.

99 The term "blinding" refers to causing permanent damage to an imaging satellite's detector.

100 Muradian, V., "China Attempted to Blind U.S. Satellites with Laser," *Defense News*, September 22, 2006.

101 Col David J. Thompson, USAF, "China's Military Space Program: Strategic Threat, Regional Power, or National Defense," *China in Space: Civilian and Military Developments*, August 2001.

102 Phillip Saunders et al, "China's Space Capabilities and the Strategic Logic of Anti-Satellite Weapons," July 22, 2002.

103 "Debris from China's Kinetic Energy ASAT Test," *Global Security*, March 23, 2007.

104 M. Gordon, "U.S. Knew of China's Missile Test, but Kept Silent," *New York Times*, April 23, 2007.

105 Wu Chunsi, "Development Goals of China's Space Program," www.wsichina.org/attach/cs2_9.pdf.

106 White Paper, "China's Space Activities in 2006," Information Office of the State Council of the People's Republic of China, Beijing, October 2006, www.fas.org/spp/guide/china/wp2006.pdf.

107 Ibid.

and space science. Applied satellites and satellite applications rank at the top of the agenda for China's space program. In sum, the PRC plans to make a substantial investment in space in the years ahead.[108]

## Russia

On October 4, 1957, the Soviet Union launched the world's first satellite to orbit the Earth, the *Sputnik*. The result was a space race that galvanized the U.S. program, with the United States becoming the leader in space technologies. In 1969 the United States landed the first man on the Moon. For the several Cold War decades after 1957 the Soviet Union remained the leading U.S. competitor in space. With the collapse of the Union of Soviet Socialist Republics (USSR) in December 1991 there came a period of administrative chaos within the newly formed Russian Federation. This was especially the case within the remaining military establishment and its various research and development centers. Russia finds itself in a different state of affairs today. The focus has moved away from recovery in the years following the collapse of the Soviet Union and toward efforts to build twenty-first-century capabilities that will return Russia to the forefront of space technologies. Though there are still certain areas within Russia's space programs that still have not reached pre-1990 levels, a revived space program and new technology are helping to restore Russia's space programs to their former status.

Central to its space programs are Russia's military and dual-use satellites. They include: (1) navigation (known as the Global Navigation Satellite System (GLONASS) series); 2) early warning; (3) communications; and (4) intelligence/ reconnaissance. Russia remains today a major provider of commercial launch services. Russia and the United States have worked together in the International Space Station. As already noted, the United States will be dependent for several years on the Russian *Soyez* launch capability when the Shuttle is retired in 2010.

Russia's navigation satellites fall under the name GLONASS (Global Navigation Satellite System), which represents a formation of radio-based satellites used to provide navigation services for military and civilian purposes. Russia is investing heavily in GLONASS, which will reach operational status in the 2010-2012 time-frame. The GLONASS project began in 1976 and the launching of GLONASS satellites started in 1982.[109] In 1995 the GLONASS navigation system became fully operational with a constellation of twenty-four satellites in three orbital planes. The collapse of the Russian economy in the late 1990s led to extensive disrepair until President Vladimir Putin announced on August 20, 2001 that the GLONASS system would be fully restored by 2009.[110] After three years of the restoration and recovery project, it was announced that the GLONASS system would become a joint project between Russia and India (more specifically with the Indian Space Research Organization or ISRO[111]) with the goal being to achieve constant and complete coverage of Russian and Indian Territory by 2008 and total global coverage by 2010.[112] Under the terms of the agreement signed in 2004, India would supply rockets for an unspecified number of launches and would also fund a portion of the project.[113]

108 Ibid.

109 "Glonass Summary," *Space & Tech*, available at: http://www.spaceandtech.com/spacedata/constellations/glonass_consum.shtml.

110 "Russia Challenges the U.S. Monopoly on Satellite Navigation," Andrews E. Kramer, *The New York Times*, April 4, 2007, available at: http://www.nytimes.com/2007/04/04/business/worldbusiness/04gps.html?_r=1&oref=slogin.

111 For more information on the Indian Space Research Organization refer to its website at: http://www.isro.org/.

112 "Russian Space Agency Plans Cooperation With India," *MosNews*, January 12, 2004.

113 "India to Launch 2 Russian GLONASS Satellites," *MosNews,* June 27, 2005.

During the Cold War, the Soviet Union had embarked on a number of ambitious space weapon projects, largely focused on Anti Satellite (ASAT) systems. The most notable examples of these attempts include the technically "still existing" Co-Orbital ASAT system,[114] the short-lived and now inactive Almaz Military Space Station,[115] and the failed *Polyus* (also known as *Skif*-D) orbital weapons platform.[116] However, as the Cold War ended, Soviet efforts in space weaponry decreased and after the USSR's dissolution, much of what had previously been space weapon research programs and complexes became derelict and poorly maintained.

Even as its overall space program underwent reductions, Russia maintained certain important capabilities. They include the *Soyuz*-FG SLV, which is probably the most advanced of Russia's currently active space launchers. Extremely popular in Russia's commercial space activities, it is currently the principal SLV used to travel to and from the International Space Station (ISS). It is often used to lift military payloads into space—most recently it has carried both *Persona* and *Kobalt*-M optical reconnaissance satellites into orbit. The most recent upgraded version of the *Soyuz* launcher, known as the *Soyuz*-2, is powered entirely by environmentally clean booster fuels.

On the civilian side, Russia's international space projects are increasing at a rapid pace. During the Cold War, the USSR's space program was heavily military-based and entirely focused on matching or surpassing U.S. capabilities in space. There was no international commercial satellite-launching service as currently exists. Today, Russia's space launch program is dramatically different from the Cold War era. In 2006, 40 percent of the world's space launches were conducted by Russian space launch vehicles (SLVs), while 28 percent were carried out by the U.S., nine percent each by China and Japan, and eight percent by Europe.[117] This dominant trend has been the norm for many years now.[118] Russia has signed cooperation agreements with nineteen other countries such as Argentina, Brazil, China, the European Space Agency, India, Sweden, and the United States. Russia has also entered into a substantial number of multilateral launch ventures.

114 The Russian Co-Orbital ASAT system, though technically confirmed as "active," is generally agreed to be "not inactive"—essentially, it has never been declared dissolved or closed as a project but has never been maintained and is thus in a dire working state. The system's primary function was to fire a ground-based conventionally armed missile towards an enemy satellite when it passes above the ground site. The interceptor missile is then designed to maneuver itself near to the target satellite before "diving" towards it, detonating, and destroying the target satellite with shrapnel from the explosion.

115 The Almaz program was composed of a plan to place a series of military space modules in orbit above Earth in order to eventually produce a complete military space station capable of military-quality reconnaissance and of attacking and defending against enemy systems. Three Almaz modules were launched, *Salyut*-2, *Salyut*-3 and *Salyut*-5. *Salyut*-2 was launched on April 3, 1973 but a never confirmed accident meant it failed to reach operational status. *Salyut*-3 was launched on June 25, 1974 and was subsequently used to successfully test the station's onboard *Nudelmann* NR-30 30mm aircraft cannon against a target (Soviet) satellite. *Salyut*-3 was de-orbited in January 1975 and was replaced by *Salyut*-5, which successfully entered orbit on June 22, 1976. There was a planned *Salyut*-6 that carried 2 unguided missiles but it was never launched due to a lack of sufficient funds.

116 The *Polyus* or *Skif*-D orbital weapons platform was designed to rival the planned United States' "Star Wars" system. It was launched but it failed to remain in orbit due to a faulty inertial guidance sensor. The entire system would have housed a significant number of nuclear space mines and a respective launcher, a self-defense cannon and a sensor-blinding laser. It was also thought to have been built in an "optically black shroud" in order to be near invisible to enemy radar systems. The system was launched and reached orbit on May 15, 1987, but its faulty inertial insertion engines caused it to re-orbit back to Earth and into the Pacific Ocean. It is likely that if it had succeeded in placing itself permanently into orbit, the Cold War may well have ended rather differently.

117 "Up to 28 Spacecraft To Be Launched AS Part of 2007 Space Program," *Agenstvo Voyennkh Novostey,* Wednesday, January 10, 2007.

118 For example, in 2005, Russia carried out 24 space launches—the U.S. carried out 12. In 2004, Russia carried out 23 launches—the U.S. made 16 (source: Ibid.).

A booming commercial satellite-launching service, thanks to converted older ICBMs, has also added to Russia's prime role in the development of and launching to the International Space Station (ISS), both of which have provided Russia's space programs with a significant amount of extra income that is often transferred to the military space programs run by the Russian space Forces (the VKS). These funds are also funneled through to research and development institutions where new and advanced technology will benefit Russia and its space program. In 2007 Russia accounted for about 38 percent of space launches.

## Iran

Despite more than two decades of international sanctions and virtual diplomatic isolation, Iran has managed to become almost entirely self-sufficient in its military industry and has built up one of the largest ballistic missile inventories in the Middle East[119] and the second largest in the Third World (behind North Korea[120]). Iran also has one satellite in orbit (*Sina*-1, launched onboard the Russian *Kosmos*-3M rocket in October 2005) and four more under various stages of development and construction. Iranian efforts to complete an indigenous space launch vehicle (SLV) are thought to be near completion as illustrated by the February 2007 launching of a "sounding rocket" 33 miles into orbit[121] before falling back to Earth by parachute. This suggests that Iran will eventually have the ability to produce both its own satellites for civilian and military purposes and its own SLVs. Therefore, in order to prepare for the future, one must address the question of whether Iran would use such capabilities as a defensive deterrent or an offensive threat.

The first direct mention in Iran of a space program came in 1998 when the (then) Defense Minister Admiral Ali Shamkani announced that Iran's next ballistic missile, to be called the *Shahab*-4, would be capable of lifting payloads into orbit.[122] Along with this proclamation came the televised image of a model future Iranian SLV, dubbed at the time, IRIS. Despite the sudden focus on Iran's future in space, the governmental infrastructure for a national space program did not begin to appear until April 2003 when the Iranian Space Agency (ISA) was created "to do research, design and implementation in the field of space technology, remote sensing and development of national and international space technology and communication networks."[123] The President of the ISA is a deputy from the Ministry of Information and Communication Technology.[124] In conjunction with developing a workable space infrastructure in Iran, the Iranian Space Council (ISC, also referred to as the Supreme Aerospace Council) was established in February 2005 "in order to peacefully use space technology and science above atmosphere space to develop the culture, technology science and finance of the country."

This effort is closely linked to Iran's growing interest in space. In October 2005, Iran became the first space nation in the Muslim world when it launched a surveillance satellite on a Russian rocket from Russia's missile

119 This point has been used in many government and NGO studies on the Iranian ballistic missile program and by senior U.S. government officials in testimonies, for example: John R. Bolton, "Iran's Continuing Pursuit of Weapons of Mass Destruction," *Testimony Before the House International Relations Committee Subcommittee on the Middle East and South Asia,* June 24, 2004, available at: http://www.state.gov/t/us/rm/33909.htm & *Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions,* July 1 through December 31, 2003, November 2004.

120 This has also been used by various people and organizations, for example: Iran Profile; Missile Overview, *The Nuclear Threat Initiative,* updated November 2006, available at: http://www.nti.org/e_research/profiles/Iran/Missile/index.html.

121 The rocket was judged by both Iranian scientists and later by western experts to have reached an altitude of 93 miles (150km)—space is generally agreed to begin at an altitude of 60 miles, thus implying that the missile had traveled 33 miles into space.

122 "Iran Remains on Cusp of Entering Satellite Club," Alon Ben David, *Jane's Defence Weekly*, October 5, 2005.

123 *Iran Space Agency Website*, available at: http://www.isa.ir/en/ .

124 Ibid.

base at Plesetsk.[125] Since then, Iran has made great strides toward development of an indigenous space launch capability. In February 2007, it successfully carried out an initial test of a "space rocket" built in Iran;[126] and a year later unveiled its first space center, with Tehran claiming that it had now "joined the world's top 11 countries possessing space technology to build satellites and launch rockets into space."[127] These advances, experts say, have the ability to amplify and expand Iran's ballistic missile program, since a space launch vehicle (SLV) is similar in technology and function to the booster on an intercontinental ballistic missile.

Concern has recently grown regarding the pace of Iran's space technology development, catalyzed by the February 2007 launching of a "sounding rocket" 33 miles into orbit. Beyond the *Sina*-1), Iran may also have at least 4 other multilateral satellite projects in various stages of development.

Finally, the *Small Multi-mission Satellite (SMMS)* is a wide-scoped multilateral satellite project based on a Memorandum of Understanding (MOU) signed in April 1998 between China, the Republic of Korea, Iran, Mongolia, Pakistan, and Thailand—Bangladesh joined the program in 1999.[128] Iranian experts are thought to be playing a major part in the design and manufacture of the $44 million (of which Iran has paid $6.5 million[129]) remote-sensing satellite weighing approximately 470kg. Due to the fact that China is the principal leader of the SMMS project, the system is thought to be based on a Chinese satellite.[130] With the final agreement signed in September 2001, Iran and Pakistan are both expected to benefit from a semi-autonomous space-imaging capability[131] thanks to the two charge-coupled device cameras each capable of a 30 meter resolution and a hyperspectral imager.[132] It was agreed that the SMMS would be launched onboard a Chinese SLV[133] but this has yet to take place with the most recently revised launch date put as 2006.[134]

As part of its ballistic missile program, Iran is developing a rocket capable of launching sophisticated satellites into orbit. In 1998, when then Defense Minister Admiral Shamkani first mentioned an Iranian space program, such a capable SLV was shown in model form. Dubbed IRIS, it appeared to be a three-stage, constant diameter SLV based largely on the existing Iranian *Shahab*-3 and the North Korean *No-dong* intermediate-range ballistic missiles.[135] This IRIS SLV, over time, began to morph into what Iran had previously called the *Shahab*-4, a seemingly dual-use missile for both space and military purposes. Since that time Iran seems to have abandoned

125 "First Iranian Satellite Launched," *BBC* (London), October 27, 2005, <http://news.bbc.co.uk/2/hi/middle_east/4381436.stm>.

126 "Iran: 'Space Rocket' Launch For Educational Purposes," *Associated Press*, February 26, 2007, <http://www.foxnews.com/story/0,2933,254623,00.html>.

127 Ali Akbar Dareini, "Iran Unveils Space Center, Launches Rocket," *Associated Press*, February 4, 2008, <http://www.msnbc.msn.com/id/22995937/>.

128 "Iran in SMMS Project," *Iran Daily,* October 4, 2004.

129 Ibid.

130 "SMMS (Small Multi-Mission Satellite)," *GlobalSecurity.org,* http://www.globalsecurity.org/space/world/china/smms.htm.

131 Ibid.

132 "U.S. Snubs China at Space Congress," Craig Covault, *Aviation Week & Space Technology*, October 19, 2002 quoted in: "Iran: Launch Capabilities," Center for Nonproliferation Studies (CNS) available at: http://cns.miis.edu/research/space/iran/mil.htm.

133 "Iran's Efforts to Conquer Space," Yiftah S. Shapir, *Strategic Assessment, Jaffee Center for Strategic Studies, Tel Aviv University,* November 2005.

134 Comments made by Iran's Deputy Minister of Communications and Information Technology quoted in: "Iran to Build Satellite in Cooperation with China," *Mehr News Agency,* November 16, 2005.

135 Alon Ben David, "Iran Remains on Cusp of Entering Satellite Club," *Jane's Defence Weekly*, October 5, 2005.

its *Shahab*-4 program and a future Iranian SLV is now expected to be an advanced, multiple-staged derivative of the *Shahab*-3.

## European Space Activity

For the last thirty years within Europe, space development and innovation have been directed largely under the auspices of the European Space Agency (ESA). However, security-related development has been highly amorphous in nature as there has been no distinct and unified body through which *all* European countries could or indeed would work. Nevertheless, several organizations manage European multinational space projects including the European Space Agency (ESA), the European Union (EU), the European Commission (EC), the North Atlantic Treaty Organization (NATO), the European Union Satellite Centre (EUSC), and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). Some of ESA's new-generation Earth observation, communication and navigation satellites have military as well as commercial applications. In addition to multilateral space programs, individual European nations, through their respective space "centers" and various domestic military bodies, are developing defense-related space assets, the most significant of which are from the four principal contributors to ESA—France, Germany, Italy, and the United Kingdom.[136]

Although European investment in space is comparatively small compared to that of the U.S., there is state-of-the-art technology that rivals, and on a few occasions, even outclasses its respective U.S. competition. In the years ahead ESA's ever-expanding commercial services will compete with the U.S. space program. In essence, the European space sector is divided organizationally into two segments, according to its primary civilian or military purpose. In sharp contrast to nationally focused military space programs, multilateral European space efforts are for peaceful purposes. Exclusively military projects tend to be largely national efforts, although again space technologies are inherently dual use.

## The European Space Agency (ESA)

ESA's budget for fiscal year 2007 was €2.975 billion[137] ($4.02 billion), based on financial contributions from member states. The official purpose of ESA is:

> …to provide for, and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems.[138]

Through its subsidiary launch company Arianespace, ESA is the world leader in providing commercial space launch services with more than fifty percent of the world market for launching satellites into geostationary transfer orbit (GTO).[139] With total sales in 2007 of €919 million[140] ($1.24 billion) and the consistent use and

136 Theresa Hitchens & Thomas Valasek, "The Security Dimension of European Collective Efforts in Space," *SIPRI Yearbook 2006: Armaments, Disarmament and International Security*. Available online at: http://yearbook2006.sipri.org/files/yb06ch11.pdf..

137 "How Big is ESA's Budget?" ESA website, available online at: http://www.esa.int/SPECIALS/About_ESA/SEMW16ARR1F_0.html.

138 ESA's Purpose, excerpt from: "Article II, Purpose, Convention of establishment of a European Space Agency," SP-1271(E), 2003, available online at: http://www.esa.int/SPECIALS/About_ESA/SEMSN26LARE_0.html.

139 "Arianespace: About Arianespace," available online at: http://www.arianespace.com/site/about/about_index.html.

140 "Arianespace Today," available online at: http://www.arianespace.com/about-us/Arianespace_Annual_Report_2007.pdf, p.28.

supply of heavy, medium, and light payload launchers (*Ariane* 5, *Soyuz* and *Vega* respectively), Arianespace is a major part of the ESA program. The *Ariane* 5 heavy payload launcher is ESA's primary launch vehicle. With thirty-eight successful launches since 1997 it has proved to be a highly reliable launcher.[141] Among its international cooperation agreements, ESA is working with the Russian State space agency Roscosmos to use the *Soyuz* medium payload launcher to begin launching satellites into orbit from the ESA spaceport in French Guiana.[142]

Another new light payload launcher, the Vega (*Vettore Europeo di Generazione Avanzata)*, began active service for ESA in late 2008 as a part of a series of three launchers that will provide ESA with a complete range satellite-launched rockets.[143] Because ESA's launch site is virtually on the Equator and thus allows heavier payloads to be launched into orbit, ESA will soon be in a prime position to offer efficient and reliable complete space launch service. ESA's new expendable unmanned Automated Transfer Vehicle (ATV), after the scheduled retirement of the U.S. Space Shuttle in 2010, will become an option for International Space Station (ISS) re-supply, in addition to the Russian *Soyuz*. The ATV is designed to provide the ISS with various supplies and boost it into higher orbit over an extended period of six months. The primary contractor for the ATV is EADS Astrium Space Transportation, which plans to produce five ATV's, the first of which, known as *Jules Verne*, was launched on March 9, 2008, from the ESA spaceport in French Guiana.[144] The *Jules Verne* ATV will remain in support of the International Space Station. A unique characteristic of the ATV is its fully automatic rendezvous capability that uses GPS and a star tracker to position itself within 249 meters of the station and then uses videometer and telegoniometer data for its final approach and docking procedures.[145] The ATV is the first spacecraft to have this capability.

Although with retirement of the U.S. Shuttle the ATV will assume a prominent resupply position, only four more ATVs are planned for construction until 2013.[146] Therefore, EADS Astrium and ESA have launched a series of studies into potential variations of the current ATV design to allow for further efficiency and a capacity to return cargo to Earth. Because the ATV is based on state-of-the-art technology, it clearly demonstrates the ESA potential in space.

Space exploration represents yet another emerging focus for ESA. Of central importance is its Aurora program, established in 2001 to plan for future exploration of the Solar System using robotic spacecraft designed to pave the way for subsequent manned exploratory missions. Thus far, the Moon, Mars, and various asteroids and comets seem the most likely preliminary targets for ESA's Aurora missions. The purpose will be to learn more about the Solar System, to stimulate the acquisition of new technology and to search for life beyond Earth.[147] International cooperation plays a major part in Aurora, especially with considerable input from

141 "Ariane 5 Generic, ESA Launch Vehicles," available online at: http://www.esa.int/SPECIALS/Launchers_Access_to_Space/SEM9UD67ESD_0.html.

142 "Soyuz; Launch Vehicles," available online at: http://www.esa.int/esaMI/Launchers_Access_to_Space/SEMQ5P57ESD_0.html.

143 "Vega, ESA Launch Vehicles," available online at: http://www.esa.int/SPECIALS/Launchers_Access_to_Space/ASEKMU0TCNC_2.html.

144 "Europe launches its first re-supply ship—Jules Verne ATV—to the ISS, Jules Verne ATV," Available online at: http://www.esa.int/esaMI/ATV/SEMDYOK26DF_0.html.

145 "Jules Verne ATV - roadmap of campaign until docking, Spacecraft Operations," available online at: http://www.esa.int/esaMI/Operations/SEMSFJM5NDF_0.html.

146 "European Cargo Ship Begins Maiden Space Voyage," Space.com. Available online at: http://www.space.com/missionlaunches/080308-atv-first-launch-day.html.

147 "Aurora's Origins," ESA Website. Available online at: http://www.esa.int/SPECIALS/Aurora/SEMZOS39ZAD_2.html

Canadian industry and academia. Roughly the first decade of Aurora is planned to focus on the establishment of robotic exploration missions, especially the ExoMars mission.

As the first mission of the Aurora program, ExoMars is planned for launch in November 2013 and arrival on Mars in September 2014. The Descent Module (DM) of the ExoMars mission will transport a 210kg mobile Rover (itself carrying a drill, a sample separation and distribution system (SPDS) and the 16.5kg Pasteur Payload with remote sensing and various analytical instruments) and the 8.5kg package of Humboldt instruments.[148] ESA plans to demonstrate a number of significant capabilities with ExoMars. These include: (1) an entry, descent, and landing of a "large" payload onto the surface of Mars; (2) to demonstrate the surface mobility of the ExoMars Rover over a distance of several kilometers on Mars; (3) the ability to gain access to sub-surface Mars , including the collection of samples from depths of two meters; and (4) to demonstrate to prepare and distribute samples immediately after collection on Mars for scientific analysis.[149]

Many more projects are planned over the long term as part of Aurora. A manned mission to the Moon is projected for 2024 and a manned mission to Mars is scheduled for the 2030-2033 timeframe. Other projects may include LAPLACE (deploying three orbiting platforms in Jupiter's magnetosphere) and TANDEM (to explore Titan and Enceladus, two of Saturn's satellites).

The long-anticipated GALILEO system, now scheduled to be deployed in 2013, is a joint project initiated between the EU and ESA. GALILEO will be Europe's worldwide satellite navigation system. It is a truly international venture with financial, industrial and scientific participation from China,[150] Israel,[151] Ukraine,[152] India,[153] Morocco,[154] Saudi Arabia,[155] and South Korea.[156] The entire €3.4 billion ($4.6 billion) system will eventually

148 "Europe Returns to Mars: The ESA ExoMars Mission," Available online at: http://esamultimedia.esa.int/docs/ESA_ExoMars_Mission_Information_Sheet_rev01Feb08.pdf

149 Ibid.

150 China became involved in GALILEO in September 2003 when it agreed to invest €230 million ($366 million) in the development of the system. ("China Joins EU's Satellite Network," BBC News, Friday September 19, 2003. Available online at: http://news.bbc.co.uk/2/hi/business/3121682.stm.)

151 Israel agreed to cooperate and lend assistance towards the GALILEO project in March 2004. ("EU and Israel reach agreement on GALILEO. Under EU auspices, cooperation between Israel and the Palestinian Authority is also taking off," Press Release, Brussels, March 17, 2004. Available online at: http://www.galileoic.org/la/files/EU%20and%20Israel%20reach%20agreement%20on%20GALILEO.%20Under%20EU%20auspices,%20cooperation%20between%20Israel%20and%20the%20Palestinian%20Authority%20is%20also%20taking%20off.PDF.

152 The Ukraine agreed to cooperate with GALILEO on June 16, 2005. ("EU, Ukraine Initial Galileo Agreement," *Space Daily*, available online at: http://www.spacedaily.com/news/gps-euro-05l.html.)

153 India agreed to assist in the development of GALILEO, as well as to establish a regional augmentation system based on the existing EGNOS one on September 7, 2005. ("India Signs Agreement to Take Part in Europe's Galileo Satellite Project," Forbes.com; Available online at: http://www.forbes.com/business/feeds/afx/2005/09/07/afx2209740.html.)

154 Morocco agreed to cooperate industrially and scientifically with the development of GALILEO on November 8, 2005. ("EU Signs Partnership with Morocco on Satellite Navigation System Galileo," Forbes.com; Available online at: http://www.forbes.com/business/feeds/afx/2005/09/07/afx2209740.html.)

155 "EU Launches 1st Galileo Program Satellite," CBS News, December 28, 2005; Available online at: http://www.cbsnews.com/stories/2005/12/28/ap/tech/mainD8EP4A6G5.shtml.

156 "EU, South Korea Seal Galileo Agreement," *People's Daily Online*, January 13, 2006. Available online at: http://english.people.com.cn/200601/13/eng20060113_235115.html.

consist of thirty satellites.[157] Two satellites for GALILEO have been launched into orbit so far: GIOVE-A was launched on December 28, 2005 and GIOVE-B on April 27, 2008. According to ESA, five more GALILEO satellites, including GIOVE-A2, are due to be launched by the end of 2009 in order to reach the In-Orbit Validation (IOV) phase, after which the remaining satellites will be launched to reach the Full Operational Capability (FOC) phase by 2013.[158] Although GALILEO has been developed as a civilian-controlled system, its high level of accuracy and coverage will confer military applications. This was confirmed on July 10, 2008 by the European Parliament when it voted in favor (502 votes versus 83) of GALILEO being open for military purposes.[159] Because it provides a basis for users in many sectors, such as transport, including vehicle location, route searching, speed control, and guidance systems, as well as border control and search and rescue systems, its dual-use implications, both civilian and military, should be obvious.[160]

## France and Space

Individual NATO-European countries also have developed national space programs that benefit from, and contribute to, broader European programs. For example, France employs a new and sophisticated military satellite telecommunication system known as SYRACUSE-3. Although CNES played a part in the planning stages, the general management of the SYRACUSE system is carried out by the French Ministry of Defense (MOD) and the French Delegation for Armament (DGA).[161] The essential purpose of the SYRACUSE-3 system is simultaneously to link (via multiple radio frequencies and secure mobile and fixed terminals) military command centers in France with several theaters of operation.[162] The 3725kg satellite design is based upon the Spacebus 4000 B3 commercial platform and has nuclear hardening to French and NATO specifications.[163] Thus far, two satellites have been launched from the Kourou spaceport in French Guiana as part of the system; SYR3A in October 2005[164] and SYR3B in August 2006.[165] A third satellite, SYR3C, is planned to be part of the system. Subsequent to multilateral agreement between the Defense Ministries of France, Italy, and the United Kingdom, SYRACUSE-3 has become (along with Italy's SICRAL and the UK's SKYNET satellites) part of a wider military satellite communications network available to their armed forces and more broadly to NATO.[166]

157 "What is Galileo?" The Future: GALILEO; ESA Website. Available online at: http://www.esa.int/esaNA/GGGMX650NDC_galileo_0.html.

158 Ibid.

159 "European Parliament Approves Military Use of Galileo Satellite," *Deutsche Welle*, July 10, 2008. Available online at: http://www.dw-world.de/dw/article/0,2144,3474226,00.html.

160 "Galileo Leads the Race Against Russia's Glonass," *RIA Novosti* (Russian News & Information Agency), July 10, 2008. Available online at: http://en.rian.ru/analysis/20080710/113714563.html.

161 "Customer Application Note; Military Satcom Operations on Syracuse 3," *Alcatel Space*, available online at: http://www1.alcatel-lucent.com/com/en/appcontent/apl/C0605-Syracuse3-EN_tcm172-910111635.pdf.

162 Ibid.

163 Ibid.

164 Ibid.

165 "Successful Launch of Ariane 5 ECA Flight 172—SYRACUSE 3B and JCSAT-10 Satellites Placed in Orbit," CNES Press Release, August 11, 2006, available online at: http://www.cnes.fr/automne_modules_files/comm/public/r516_PR057-2006_-_Successful_launch_of_Ariane_5ECA_Flight_172.pdf.

166 "The Strategic Value of Space; A European Perspective," Dr. Serge Plattard, Secretary General of the European Space Policy Institute (ESPI), January 31, 2007. Available online at: http://www.ndc.nato.int/news/sc109/D1/esrin/plattard.pdf.

France plans to launch two 120kg SPIRALE satellites in order to conduct a "missile-warning experiment" from space.[167] The two satellites will each be equipped with infrared sensors that will be able to detect the specific infrared signature of a fired missile and relay the data, in X-band format, down to military-controlled ground stations, where, it is hoped in the future, a successful missile interception can be controlled.[168] Thus, French President Nicolas Sarkozy has announced that France should begin designing one or more large-scale radars, similar in nature to the U.S. Pave Paws, in order to play a significant part in a future French missile defense system.[169]

As prime contributor to ESA and thus the leading European space power in current terms, France is pursuing several significant sophisticated space-based projects. The June 2008 *White Paper on Defence and National Security* emphasized the importance of space-based military systems. If current projects and policy direction are indicative, France will continue to press forward as a major European space power. We turn next to a brief survey of German space efforts.

## Germany and Space

Germany's space program is controlled principally by its national aerospace agency, Deutsches Zentrum fur Luft-und Raumfahrt e. V. (DLR). Germany currently allocates €846 million[170] ($1.35 billion) for governmental funds to space. Its officially stated purpose is to "promote and support Germany's strategic goals in the European programs of ESA and the EU by purposefully equipping Germany's industry and scientific institutions for competition within the EU as well as for their tasks within the ESA framework."[171]

In one of the areas of focus, Earth observation satellites, Germany has developed the SAR-Lupe (Synthetic Aperture Radar-Lupe (magnifying glass)) reconnaissance system that will consist of five identical 770kg X-band radar satellites.[172] The system, which is nearing operational status, will be capable of providing continuous image data independent of weather conditions.[173] Four of the planned five satellites were launched into orbit thus far (SAR-Lupe-1 on December 19, 2006,[174] SAR-Lupe-2 on July 2, 2007,[175] SAR-Lupe-3 on November

167 "French Missile Warning Demo to Fly in Highly Elliptical Orbit," *Space News*, October 11, 2004. Available online at: http://www.space.com/spacenews/archive04/orbitarch_100404.html.

168 Ibid.

169 "French Military Space Policy, More of the Same,"Taylor Dinerman, *The Space Review,* July 7, 2008. Available online at: http://www.thespacereview.com/article/1164/1.

170 "DLR at a Glance," DLR website, available online at: http://www.dlr.de/en/desktopdefault.aspx/tabid-636/1065_read-1465/.

171 "The Space Agency; Tasks," DLR website; Space Agency website, available online at: http://www.dlr.de/rd/en/desktopdefault.aspx/tabid-2099/3053_read-4706/.

172 "SAR-Lupe: The Innovative Program for Satellite-based Radar Reconnaissance," OHB System; SAR-Lupe Brochure; available online at: http://www.ohb-system.de/gb/pdf/sar-lupe-broschure.pdf.

173 Ibid.

174 "SAR-Lupe-1," NASA Space Science Data Center; available online at: http://nssdc.gsfc.nasa.gov/nmc/masterCatalog.do?sc=2006-060A.

175 "SAR-Lupe-2," NASA Space Science Data Center; available online at: http://nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=2007-030A.

1, 2007[176] and SAR-Lupe-4 on March 27, 2008;[177] all onboard *Cosmos*-3M SLVs from Plesetsk Cosmodrome in Russia) and the fifth, SAR-Lupe-5, in July 2008. According to a treaty signed in 2002 between the Ministers of Defense of France and Germany, the SAR-Lupe and HELIOS reconnaissance systems will form a comprehensive radar-optical satellite constellation for use by France, Germany, Belgium, Greece, Italy, and Spain.[178]

A sophisticated militarily-secure telecommunications satellite system for use by the German military is also nearing completion. The system will consist of two satellites, to be built by EADS Astrium, and to be launched into a geostationary orbit by Arianespace from French Guiana by the end of 2009.[179] According to Astrium, the operational system will allow "data transmission (voice, fax, data, video and multimedia applications anywhere within and outside Germany[180]) between vehicles, ships, aircraft, as well as fixed and mobile terminals and is specifically tailored to the increasing out-of-area missions of the Bundeswehr"[181] (German Armed Forces).

## Italy and Space

Italian space efforts are coordinated by its national space agency, Agenzia Spaziale Italiana (ASI), which had a 2007 budget of €743 million ($978 million[182]). ASI is the third largest contributor to ESA and works in collaboration with ESA, NASA and many national space agencies, including Roscosmos (Russia), CSA (Canada), JAXA (Japan) and ISRO (India).[183] ASI has a number of stated aims in space, including scientific missions (especially in astronomy and cosmology), space exploration (to Mars, Jupiter, Saturn, and in the future to Venus and comets), Earth observation ("to prevent environmental disasters, ensure rapid intervention in crisis-stricken areas and measure the effects of climate change") and to exploit the economic opportunities in space, especially through telecommunications and satellite navigation.[184] Again, much like France and Germany, Italian space-based activity is carried out principally under ESA, although Italy has a number of projects that are clearly dual-use or purely military in their application.

One example of the dual-use category is the COSMO-SkyMed (Constellation of small Satellites for the Mediterranean basin Observation). This is designed to provide a dual-use global-coverage, remote-sensing Earth observation system funded jointly by the Italian Ministries of Research and of Defense and administered by ASI. The system currently consists of two SAR (synthetic aperture radar) satellites (COSMO-1

176 "SAR-Lupe-3," NASA Space Science Data Center; available online at: http://nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=2007-053A.

177 "German Earth-Observing Radar Satellite Launched," *Spaceflight Now*; available online at: http://www.spaceflightnow.com/news/n0803/27sarlupe4/.

178 "SAR-Lupe," *Bundesamt fur Wehrtechnik und Beschaffung;* available online at: http://www.bwb.org/01DB022000000001/vwContentByKey/W26FTE79283INFOEN.

179 "Dedicated secure satellite communications for the Bundeswehr," EADS Astrium, available online at: http://www.astrium.eads.net/families/a-safer-world/securecoms/satcombw.

180 "SATCOMBw," Deagel.com; available online at: http://www.deagel.com/C3ISTAR-Satellites/SATCOMBw_a000210001.aspx.

181 "SATCOMBw: Satellite Communications for the German Armed Forces," EADS Astrium, May 10, 2004; available online at: http://www.planet-aerospace.com/800/en/pressdb/archiv/2004/2004/en_20040510_ila_sp_services_SATCOMBw.html.

182 "Looking Up: The Weekly Edition," SIFUA Foundation Inc., available online at: http://www.sifua.org/newsletter/pdf/V1_W2_lookingup.pdf.

183 "Bilateral Relationships," ASI website, available online at: http://www.asi.it/SiteEN/ContentSite.aspx?Area=Rapporti+Bilaterali.

184 "Italian Space Agency; Introduction," ASI website, available online at: http://www.asi.it/SiteEN/ContentSite.aspx?Area=L'agenzia.

launched on June 8, 2007 and COSMO-2 launched on December 9, 2007[185]) but will eventually be completed with the addition of two more satellites, the COSMO-3 and the COSMO-4. The system is designed for both civilian and military applications on an around-the-clock basis and independent of weather conditions—specifically for all aspects of defense-related observation as well as seismic hazard analysis, environmental disaster monitoring and agricultural mapping.[186] The COSMO-SkyMed system, once fully operational, will work in tandem with France's PLEIADES system to form the ORFEO (Optical and Radar Federated Earth Observation) program.[187]

For militarily secure telecommunications, the Italian Armed Forces use the SICRAL (Sistema Italiana de Communicazione Riservente Allarmi) system. Thus far, one satellite, SICRAL-1 (launched on February 7, 2001 onboard an *Ariane*-4 SLV from French Guiana[188]), is in orbit and two more satellites, SICRAL-1B and SICRAL-2 are planned for launch in 2008 and 2011 respectively.[189] The system can operate simultaneously on a number of frequency bands—SHF, EHF and UHF[190]—and has reportedly been used in humanitarian aid and other foreign-based missions. The SICRAL system, combined with the French SYRACUSE-3 and the British SKYNET systems, forms NATO's secure SATCOM Post-2000 system.[191]

The Italian space program is still considerably focused within the ESA realm of activities but nevertheless has a number of small collaborative efforts with NASA.[192] In this sense, it is a step behind France and Germany. Regarding the dual-use and military sphere of space activity, Italy has recently begun to assert its relative potential strength in the fields of Earth observation/reconnaissance and military telecommunications satellites.

## The United Kingdom and Space

The British National Space Centre (BNSC) coordinates British activities in space with other government offices including the Ministry of Defense (MoD) and the Department of Trade and Industry (DTI). The 2006 UK space budget was £207 million ($381 million) of which approximately 65 percent was directed towards ESA-led projects including Cassini-Huygens (a NASA-ESA robotic mission exploring Saturn and its moons), ENVISAT and GALILEO.[193] In its 2008-2012 space strategy BNSC outlines several objectives: (1) to help develop the future economy; (2) tostrengthen innovation; manage our changing planet; engage in space exploration; (3) to develop skills for a high-technology future; and (4) to build national and international

185 "Worldwide Launch Log," *Spaceflight Now*, available online at: http://spaceflightnow.com/tracking/launchlog.html.

186 "Constellation of Small Satellites for Mediterranean basin Observation (COSMO) SkyMed 1 & 2," SpaceHab Press Release June 7, 2007, available online at: http://www.spacehab.com/news/2007/07_06_07.htm.

187 "Pleiades: Dual Optical System for Metric Resolution Observations," CNES website, available online at: http://smsc.cnes.fr/PLEIADES/.

188 "SICRAL," Deagel.com; available online at: http://www.deagel.com/C3ISTAR-Satellites/Sicral_a000214001.aspx.

189 Ibid.

190 "Sicral-1; Summary," Space and Tech Database, available online at: http://www.spaceandtech.com/spacedata/logs/2001/2001-005a_sicral-1_sumpub.shtml.

191 "NATO Selects France, Italy, and UK Satellite Communications Solution," Deagel.com; available online at: http://www.deagel.com/news/NATO-Selects-France-Italy-and-UK-Satellite-Communications-Solution_n000000260.aspx.

192 For example, ASI is involved with NASA in LAGEOS (Laser Geodynamics Satellites), the Multi-Purpose Logistics Module (MPLM), the Swift Gamma-Ray Burst Mission, the Mars Reconnaissance Orbiter and the Harmony ISS Module with NASA.

193 "How We Are Funded," BNSC website, available online at: http://www.bnsc.gov.uk/content.aspx?nid=5551.

partnerships.[194] British military space projects are most often funded jointly between the BNSC and the MoD. Some 65 percent of the UK space budget goes towards ESA projects, with remaining funds used to finance military or dual-use ventures.

TOPSAT is a unique and cutting-edge micro-Earth observation satellite that began operations in December 2005. The £14 million ($25 million) satellite weighs only 120kg but carries an optical camera capable of delivering panchromatic images with a high spatial resolution and simultaneous multi-spectral images.[195] TOPSAT thus offers state-of-the-art resolution.[196] In disaster situations, TOPSAT is ideal because images can be relayed immediately to ground stations. The MoD and BNSC have discussed the possibility of deploying three or four TOPSATs in orbit around the world in order to provide an extremely cost-efficient worldwide Earth observation/reconnaissance satellite system.

SKYNET is a British militarily-secure strategic communications satellite project that has been in existence since the first satellite, SKYNET-1, was launched in November 1969.[197] The SKYNET system consists of three SKYNET-5 series satellites (SKYNET-5A launched in March 2007, SKYNET-5B launched in November 2007, and SKYNET-5C launched in June 2008[198]). Each has a mass of 4,700kg and is equipped with the most advanced military communications equipment. They also have the ability to cancel out any jamming signal and to resist high-powered laser satellite disruption.[199] The series-5 satellites allow for instant voice, data, and text communication between naval, air, and land forces with mobile and fixed stations deployed anywhere in the world. SKYNET, along with France's SYRACUSE-3 and Italy's SICRAL telecommunications satellites, is part of NATO's SATCOM Post-2000 system. The entire SKYNET-5 system has a lifetime extending at least to 2018, by which time the principal contractors, Paradigm and EADS Astrium, will have designed and began deploying a new and updated series of satellites.[200]

## Japan and Space

Japanese activity in space is led principally by the "Japan Aerospace Exploration Agency" (JAXA), which was formed on October 1, 2003 through the merging of three previously existing national space organizations—the Institute for Space and Astronautical Science (ISAS), the National Aerospace Laboratory of Japan (NAL), and the National Space Development Agency of Japan (NASDA). The essential objective of JAXA is to conduct research and development leading to the production and launching of satellites and other objects into space. JAXA's current budget is around 250 billion yen ($2.5 billion)[201] and is

194 "UK Civil Space Strategy: 2008-2012 and Beyond," BNSC (British National Space Centre); available online at: http://www.bnsc.gov.uk/assets/channels/about/UKCSS0812.pdf.

195 "TopSat," QinetiQ website, available online at: http://www.qinetiq.com/home/defence/defence_solutions/space/topsat.html.

196 Ibid.

197 "1960 to 1969; SKYNET-1," Small Satellite Home Page; available online at: http://centaur.sstl.co.uk/SSHP/mini/mini60s.html.

198 "SKYNET 5A, 5B, 5C," Gunter's Space Page, available online at: http://space.skyrocket.de/index_frame.htm?http://www.skyrocket.de/space/doc_sdat/skynet-5.htm.

199 "UK Set For Military Space Launch," BBC News, November 9, 2007; available online at: http://news.bbc.co.uk/2/hi/science/nature/7079876.stm.

200 "SKYNET 5," EADS Astrium website, available online at: http://www.eadsdsuk.com/index.php?id=153.

201 Ichiro Taniguchi, "Industrialization of Space Development and Utilization in Japan," JAXA website; available online at: http://www.jaxa.jp/article/interview/vol31/index_e.html.

largely devoted to peaceful scientific projects. However, the Japanese government enacted a new law (”the Basic Space Bill”) on May 21, 2008 that effectively allows for a “non-aggressive” (defensive) military use of space.[202] Nevertheless, Japan has solid foundations for an effective wide-ranging space program and through existing and planned multilateral cooperative agreements and projects, should gain an increasingly influential voice among the space powers of the world.

Due to Japan’s post-World War II constitution, Japanese development in space has been principally related to peaceful purposes. A great focus has been placed upon research about specific planets and stars as well as issues such as climate change. Before 2003, moreover, Japan had been entirely reliant on imaging data supplied by U.S. reconnaissance satellites. Japan’s first satellites were launched into orbit in March 2003. Known simply as “Information Gathering Satellites” (IGS), the systems had to be classed as civilian satellites and operated by the civilian Cabinet Satellite Intelligence Center.[203] Since the 2008 Basic Space Bill came into effect, the Special Defense Forces (SDF) have acquired new power to operate their own satellites in support of defensive military operations, including missile defense.[204] It is expected therefore that Japan will focus on establishing an advanced space-based reconnaissance capability to monitor regional threats, notably China and North Korea. JAXA specifies several key areas in which it is engaged in space-based activity, including Earth observation satellites; communication, positioning and engineering test satellites; astronomical observation satellites; lunar and planetary exploration spacecraft; and the International Space Station and the launch vehicles.[205]

Japan’s primary space launch vehicle (SLV) is the H-IIA large-scale rocket capable of lifting a maximum of 11,730kg into low-Earth orbit (LEO) and 5,000kg into a geostationary transfer orbit (GTO).[206] The H-IIA was first launched on August 21, 2001 when it successfully placed the LRE satellite into GTO,[207] and its first flight beyond an Earth orbit in September 2007 when it took the SELENE Moon mission into space.[208] The H-IIA has had some fourteen launches, thirteen of which have successfully placed payloads into orbit.[209]

Japan is developing the H-IIB, a new upgraded version of the H-IIA SLV. Scheduled for its first operational flight in 2009,[210] the H-IIB will be a two-stage rocket fueled entirely using an environmentally friendly combination of liquid oxygen and liquid hydrogen.[211] The H-IIB is not only being designed as an upgrade from previous launchers but also to launch cargo transport missions to the ISS and to the Moon, more specifically

202 “Japan to Allow Military Use of Space,” *The Guardian*, May 21, 2008; available online at: http://www.guardian.co.uk/world/2008/may/21/japan/print.

203 Setsuko Aoki, “Challenges for Japan’s Space Strategy,” AJISS (The Association of Japanese Institutes of Strategic Studies) *Commentary*, June 26, 2008.

204 Ibid.

205 “Japan Aerospace Exploration Agency; Missions,” available online at: http://www.jaxa.jp/projects/index_e.html.

206 “H-2A,” *Astronautix*, available online at: http://www.astronautix.com/lvs/h2a.htm.

207 “Development Works of the H-IIA Rocket Engine in Mitsubishi Heavy Industries, Nagoya Guidance and Propulsion System (MHI-MEIYU),” Special Report available online at: http://satcom.nict.go.jp/English/english1011/specialrp2.pdf.

208 “Launch Result of the KAGUYA (SELENE) by the H-IIA Launch Vehicle No. 13 (H-IIA F13),” JAXA Press Release, September 14, 2007; available online at: http://www.jaxa.jp/press/2007/09/20070914_h2a-f13_e.html.

209 A list of all complete and planned global space launch missions is available online at: http://spaceflightnow.com/tracking/launchlog.html.

210 It will carry the H-II Transfer Vehicle (HTV) to the International Space Station (ISS) (“Japan in Space; H-II Transfer Vehicle,” *WorldSpaceFlight*; available online at: http://www.worldspaceflight.com/japan/htv.htm.)

211 “H-IIB Launch Vehicle; Opening the Door to Future Space Mission,” Japan Aerospace Exploration Agency (JAXA), available online at: http://www.jaxa.jp/projects/rockets/h2b/index_e.html?print=true&css=.

to carry Japan's developing H-II Transfer Vehicle (HTV). It will also have a significantly improved payload carrying capacity of 8,000kg to GTO and at least 16,500kg to LEO,[212] which will certainly contribute to Japan's long-term goal of competing successfully in the global commercial space launch market. Japan also has a longer-term SLV development project underway known simply as the "Advanced Solid Rocket" that will enable Japan to launch greater payloads more cheaply.[213]

Japan is one of many international contributors to the ISS in the areas of research and physical contributions to the station—equipment and astronauts. Thus far, Japan has contributed only a small number of astronauts to the ISS effort but will no doubt begin to supply more with the introduction of the 98 billion yen[214] ($950 million) Japanese "KIBO" experiment module to the station, scheduled for completion in 2009.[215] Thus far, two of three "pieces" of KIBO (Experiment Logistics Module Pressurized Section (ELM-PS) and (Japanese Experiment Module Pressurized Module (JEM-PM)) have been launched and connected to the ISS onboard space shuttle missions STS-123 and STS-124.[216] The entire system, once complete, will provide advanced facilities in which to conduct long-term microgravity experiments as well as observations of the Earth and other astronomical objects.[217]

JAXA is also developing the 14 billion yen[218] ($136 million) unmanned H-II Transfer Vehicle (HTV) to provide supplies to the ISS. The HTV is designed to deliver a maximum of 6,000kg of goods to the ISS and then to return to Earth and burn-up during re-entry into the atmosphere.[219] Once in operation, JAXA plans to conduct HTV flights to re-supply the ISS.[220] With the imminent 2010 retirement of the U.S. Space Shuttle, the HTV will become, along with the European Space Agency's (ESA) Automated Transfer Vehicle (ATV) and the Russian Progress spacecraft, a primary deliverer of supplies to the ISS. In fact, NASA is reported to have begun talks with JAXA over the possible purchase of HTVs so that the United States will still be able to fulfill its obligations to the station program.[221]

Japan has a number of operational Earth observation satellite projects in various stages of development. Most are multilateral ventures with other partners, especially the United States. As described below, there are two systems that could have military reconnaissance applications:

212 "H-IIB Launch Vehicle," JAXA Brochure; available online at: http://www.jaxa.jp/pr/brochure/pdf/01/rocket05.pdf.

213 "Advanced Solid Rocket; Lowering the Hurdles to Space," Japan Aerospace Exploration Agency (JAXA), available online at: http://www.jaxa.jp/projects/rockets/solid/index_e.html?print=true&css=.

214 "Twenty Years On, Japan's 'Hope' Lab To Blast Into Space," *Space Travel - Exploration and Tourism*; available online at: http://www.space-travel.com/reports/Twenty_years_on_Japans_Hope_lab_to_blast_into_space_999.html.

215 "KIBO; Japan's First Facility for Manned Space Activities—Japanese Experiment Module 'KIBO,'" Japan Aerospace Exploration Agency (JAXA), available online at: http://www.jaxa.jp/projects/iss_human/jem/index_e.html?print=true&css=.

216 STS-123—The Station Goes Global (STS-123 Press Kit)," NASA; available online at: http://www.nasa.gov/pdf/215905main_sts123_press_kit_b.pdf.

217 "KIBO; Japan's First Facility for Manned Space Activities—Japanese Experiment Module 'KIBO,'" Japan Aerospace Exploration Agency (JAXA), available online at: http://www.jaxa.jp/projects/iss_human/jem/index_e.html?print=true&css=.

218 "NASA Eyes Purchasing Japan's HTV Spacecraft," *Daily Yomiuri Online*; available online at: http://www.yomiuri.co.jp/dy/features/science/20080720TDY01305.htm

219 "H-II Transfer Vehicle (HTV)—Key Space Transfer Vehiclestrong," Japan Aerospace Exploration Agency (JAXA); available online at: http://www.jaxa.jp/projects/rockets/htv/index_e.html?print=true&css=.

220 "HTV: H-II Transfer Vehicle," JAXA Brochure; available online at: http://www.jaxa.jp/pr/brochure/pdf/01/rocket03.pdf.

221 "NASA Eyes Purchasing Japan's HTV Spacecraft," *Daily Yomiuri Online*; available online at: http://www.yomiuri.co.jp/dy/features/science/20080720TDY01305.htm.

Advanced Land Observing Satellite (ALOS) - Also referred to as "Daichi," this is a state-of-the-art 4,000kg remote-sensing satellite capable of providing Earth imagery at a resolution of eight feet (2.5m) and over an area twenty miles in black and white.[222] Due to the Phased Array L-band Synthetic Aperture Radar (PALSAR), ALOS will also be capable of providing quality data in three dimensions day and night and independent of weather conditions.[223] Other specialist equipment onboard the system will also allow for sensing vegetation and plant types on the Earth's surface (the Advanced Visible and Near Infrared Radiometer-2 (AVNIR-2[224]). The principal stated purpose of ALOS is to provide data "to contribute to the fields of mapping, precise regional land coverage observation, disaster monitoring and resource surveying,"[225] but also could be adapted for military reconnaissance purposes.

"Information Gathering Satellites" (IGS) - The system was first proposed in Japan in 1998 following the testing of a North Korean *Taepo-Dong* intermediate-range ballistic missile (IRBM). The first IGSs, launched in March 2003, were IGS-1A (also known as IGS Radar-1 because of its synthetic aperture radar) and the IGS-1B (also known as IGS *Optical*-1 because of its optical sensors).[226] A second pair of IGSs were launched in November 2003 but were destroyed due to a critical H-IIA failure. The IGS program was therefore set back until February 2007 when two more IGSs (IGS-4A and IGS-4B) were successfully launched into orbit. It is thought these two are currently providing major reconnaissance data to Japan. In addition, two more IGSs are scheduled for launch in the next few years—IGS-5 is expected to replace the IGS-1B optical satellite and another IGS (perhaps IGS-5B or IGS-6) will replace the IGS-1A radar satellite.[227] Furthermore, with enactment of the Basic Space Bill now complete, it is likely that a new program of Japanese military reconnaissance satellites, or perhaps an expansion of the IGS-series, will come into being.

In the sphere of science-related Earth observation satellites, Japan has five operational systems in orbit and four in development to study global climate change and the Earth's magnetosphere.

Japan launched its first satellite in 1970,[228] but until very recently has not posed any major competitive threat to the U.S. space market. Nevertheless, Japan is the fourth country to have entered space (after Russia, the U.S., and Europe); it is the third country to send spacecraft into GEO and the third country to send unmanned spacecraft to the Moon and Mars.[229] Arguably, since the formation of JAXA in 2003, Japan's space program has begun to grow at a faster pace, both in size and scope. Japan performed its highest number of

222 Stephen Clark, "Japanese Earth Observing Satellite Begins Mission," *SpaceFlightNow,* January 24, 2005; available online at: http://www.space.com/missionlaunches/sfn_060121_alos_launch.html.

223 Ibid.

224 Ibid.

225 "Advanced Land Observing Satellite 'Daichi' (ALOS) Will Be Used for Precise Land Coverage Observation," Japan Aerospace Exploration Agency (JAXA); available online at: http://www.jaxa.jp/projects/sat/alos/index_e.html?print=true&css=.

226 Christian Polak and Sylvain Belmondo, "Japan R&D Policies and Programs in the Aeronautic and Space Sectors—Possible Synergy with EU R&D," Société d'Etudes et de Recherches Industrielles et commerciales (SERIC)—a research project undertaken for the European Union—Delegation of the European Commission to Japan, Tokyo, June 2006; available online at: http://www.deljpn.ec.europa.eu/data/current/Polak_RDPoliciesProgrammesAeronauticSectors.pdf.

227 Ibid.

228 Christian Polak and Sylvain Belmondo, "Japan R&D Policies and Programs in the Aeronautic and Space Sectors—Possible Synergy with EU R&D," http://www.deljpn.ec.europa.eu/data/current/Polak_RDPoliciesProgrammesAeronauticSectors.pdf

229 Ibid.

space launches ever in 2006 (with six launches)[230] and in 2008 announced the opening up of space for Japanese defensive military purposes. As Table 5 indicates, Japan has established an ambitious projected satellite launch schedule for the next several years. In its satellite program, Japan currently is placing principal focus on Earth observation. With the adoption of the Basic Space Bill, military applications are likely to be given greater emphasis. Japan is also becoming a preeminent figure for space exploration with its unmanned missions to the Moon, Venus, Mercury, and an asteroid. Its research into and development of new and more efficient launchers and environmentally friendly fuel sources could eventually thrust Japan extensively into the commercial space launching market. Thus, as a result of the increasing sophistication and extent of its ongoing and planned missions in space, Japan is becoming an important participant in space.

**Table 5: JAXA Projected Launch Schedule[231]**

| Year | Launcher | Mission |
|---|---|---|
| FY2008 | H-IIA | Greenhouse Gases Observing Satellite (GOSAT) |
| FY2009 | | Japanese Experiment Module "KIBO" Exposed Facility |
| | H-IIB | Test launch |
| | H-IIA | Quasi Zenith Satellites System (QZSS) |
| FY2010+ | H-IIB (if operational) | Venus Climate Orbiter (PLANET-C) |
| | | HTV (H-II Transfer Vehicle) to ISS |
| | | Global Change Observation Mission—Water (GCOM-W1) |
| | | Radio-Astronomical Satellite (ASTRO-G) |
| | | Global Precipitation Measurement / Dual-frequency Precipitation Radar (GPM/DPR) |
| | | Mercury Exploration Mission (BepiColombo) |
| | | Earth, Cloud, Aerosol and Radiation Explorer / Cloud Profiling Radar (EarthCARE/CPR) |
| | | LNG Propulsion System |

## India and Space

India has been active in space-related activities since its national space agency, the Indian Space Research Organization (ISRO), was established in June 1972[232] and its first national satellite, known as *Aryabhata*, was launched into orbit onboard a Soviet *Cosmos*-3M rocket in April 1975.[233] However, the Indian space program thus far has been relatively small in comparison with those of other space countries. Nevertheless, India appears to be preparing to become a major future player in space. This judgment is based on the fact that India now has two Space Launch Vehicles (SLVs) in use. Both were specifically designed for launching India's two principal satellite systems . India also has two more systems under development for future applications.

India operates two systems of Earth observation satellites, one for remote sensing (the IRS series) and one that has just begun deployment for meteorological services (METSAT series). Prior to the 2002 launch of its first exclusively meteorological satellite, METSAT-1 (also known as KALPANA-1), India had acquired weather

230 "Futron's 2008 Space Competitiveness Index: A Comparative Analysis of How Countries Invest in and Benefit from Space Industry," Futron Corporation.

231 "Launch Schedule," Japan Aerospace Exploration Agency (JAXA); available online at: http://www.jaxa.jp/projects/in_progress_e.html.

232 "About ISRO," Indian Space Research Organization (ISRO); available online at: http://www.isro.org/about_isro.htm.

233 "ISRO Celebrates Silver Jubilee of Aryabhata Launch," Indian Space Research Organization (ISRO), April 19, 2000; available online at: http://www.isro.org/pressrelease/Apr19_2000.htm.

data both from abroad and from additional systems deployed onboard Indian satellites designed primarily for other purposes. Therefore, all but one of India's Earth observation satellites is for remote sensing and imaging for various purposes.

India places great emphasis on attaining and maintaining an efficient and sophisticated series of satellites for television and radio broadcasting, telecommunications, and weather data. The launch of the first INSAT satellite, INSAT-1B, on August 30, 1983 began India's implementation of a system of satellites that would allow such a service to become nationally available. Until recently, INSAT satellites were designed only for communications purposes, but a new generation of INSAT satellites now provides India with a variety of applications in the spheres of telecommunications, broadcasting, meteorology and emergency needs. The complete system as operational in 2008 consists of eleven satellites[234] and is the largest in the Asia-Pacific area. As ISRO is a member of the International Satellite System for Search and Rescue (COSPAS-SARSAT) program, all INSAT satellites carry sophisticated transponders to receive distress signals for search and rescue operations in South Asia and the Indian Ocean regions.

An important consequence of the expansion of the INSAT satellite series is that India is demonstrating the capability to become a leader not only in satellite technology but more importantly in launch services.

India has recently added as yet another focus in its space program the ability to conduct space exploration missions to the Moon, Mars, asteroids, and the Sun as well as indigenous technology for manned spaceflight. The Moon is the first and seemingly most important mission goal thus far in India's plans for space exploration. India's first mission to the Moon, *Chandrayaan*-1, an unmanned probe, was launched in October 2008 to place a surface observation satellite in Moon orbit for studying the lunar surface and its chemical characteristics.[235] A major goal is the production of a three-dimensional topographical map.[236] At a total estimated cost of 3.8 billion rupees ($83 million),[237] this launch makes India the sixth country to send an unmanned mission to the Moon. As part of a 2007 agreement with the Russian space agency Roskosmos, India will play a joint part in placing an unmanned rover onto the Moon's surface by 2011.[238] A manned mission to the Moon forms another goal that India hopes to achieve by 2020.[239] The India Moon probe represents part of a broader space race with China that will probably accelerate in the years ahead. "China has gone earlier, but today we are trying to catch them, catch that gap, bridge the gap," according to Bhaskar Narayan, a director at the Indian space agency.[240]

234 These are: INSAT-2E (telecommunications, meteorology, broadcasting), INSAT-3A (telecommunications, meteorology, broadcasting), INSAT-3B (communications), INSAT-3C (communications), METSAT-1 (meteorology), GSAT-2 (communications), INSAT-3E (communications), EDUSAT ("tele-education"), INSAT-4A (broadcasting), INSAT-4B (broadcasting), INSAT-4CR (television broadcasting).

235 "Olympics Best Kept Secret: Spacewalk at Nest Stadium," *MSN India News*, August 10, 2008; available online at: http://news.in.msn.com/international/article.aspx?cp-documentid=1613314.

236 "India's First Mission to the Moon; Chanrayaan-1; Announcement of Opportunity—Mission Objectives," India Space Research Organization (ISRO); available online at: http://www.isro.org/chandrayaan-1/announcement_1.htm#02.

237 "Chandrayaan-1 Lunar Orbiter," National Space Science Data Center; National Aeronautics and Space Administration (NASA); available online at: http://nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=CHANDRYN1.

238 "Russia, India Sign Joint Lunar Research Deal," *RIA Novosti*, November 12, 2007; accessed via the LexisNexis database online.

239 "India to Launch Rocket to the Moon," *National Post* (Canada), September 29, 2007; accessed via the LexisNexis database online.

240 Somini Sengupta, "India Launches Unmanned Orbiter to Moon," *New York Times,* October 22, 2008

As part of its longer term plan and perhaps in cooperation with other space powers, India has declared its desire to place a "lunar base" on the Moon's surface and then to establish "solar collectors" to generate electricity and eventually to mine the very rare and potentially extremely important helium-3 for use in future nuclear fusion power reactors on Earth.[241]

In other areas of space exploration, ISRO has announced plans to launch an Indian astronaut into space by 2014 at a total development and launch cost of approximately $2.5 to $3 billion.[242] ISRO has also stated that it is in the development stage for a mission to place a 100kg satellite, known as Aditya, in orbit over the solar corona of the Sun by 2012.[243] A Mars probe is also in the development stage with a planned 2012 launch.[244] ISRO has also claimed that planning for a mission to orbit or fly by an asteroid is proceeding or at least under construction.[245]

India's recent space-related statements point towards the threat of China in space, especially referring to its ASAT test in January 2007. It remains to be seen whether India will eventually deploy military assets in space, although Indian military officials have announced the formation of an Aerospace Command. There have also been expressions of the importance that India attaches to developing and deploying "self-defense" military space assets.[246] Ex-President Abul Pakir Jainulabdeen Abdul Kalam even declared in 2008 that India already has the capacity "to intercept and destroy any spatial object or debris in a radius of 200km … we will definitely do that if [something] endangers Indian territory."[247]

In sum, the foundations are being laid in India for a major space program. Until recently, India's space ventures had been focused on domestic development, for example, weather forecasting and telecommunications. A change is now under way that gives heightened emphasis to the military uses of space. From 2007 to 2012, India has plans to spend 80-90 billion rupees ($2-2.5 billion) on satellites,[248] India also has announced that it hopes to launch as many as 70 space missions[249] that would be used to acquire a 10 percent share of the global

241 Mark Williams, "India's Space Ambitions Soar: A Lunar Mission and a Reusable Launch Vehicle are Planned," *Technology Review*, July 30, 2007; available online at: http://www.technologyreview.com/Infotech/19115/?a=f.

242 "India to Have Manned Moon Mission Ability in Eight Years—Space Chief," BBC Monitoring South Asia, February 1, 2008; accessed via the LexisNexis database online; & "ISRO Seeks Government Approval for Manned Spaceflight Program," K. S. Jayaraman, *Space News Business Report*, November 14, 2006; available online at: http://www.space.com/spacenews/archive06/indiaastro_1113.html.

243 Divya Gandhi, "ISRO Planning to Launch Satellite to Study the Sun," *Space Daily*, January 18, 2008; available online at: http://www.spacedaily.com/reports/ISRO_Planning_To_Launch_Satellite_To_Study_The_Sun_999.html.

244 Divya Gandhi, "ISRO's Manned Mission May be Advanced," *The Hindu*, April 14, 2007; available online at: http://www.hindu.com/2007/04/14/stories/2007041400870900.htm.

245 R. Ramachandran, "ISRO Ponders Mission to Red Planet Before 2015," *The Hindu*, February 27, 2008; available online at: http://www.hindu.com/2008/02/27/stories/2008022760701400.htm.

246 Gavin Rabinowitz, "Indian Army Wants Military Space Program," *International Business Times*, June 16, 2008; available online at: http://in.ibtimes.com/services/pop_print.htm?id=5723&tb=bh.

247 "India Too Has Technology to Intercept, Destroy Rogue Satellites," *The Hindu Business Line*, February 23, 2008; available online at: http://www.thehindubusinessline.com/2008/02/23/stories/2008022351582100.htm.

248 "India Plans to Double Satellite Launches Within Five Years," *RIA Novosti*, July 27, 2007; available online at: http://www.space-travel.com/reports/India_Plans_To_Double_Satellite_Launches_Within_Five_Years_999.html.

249 "India To Undertake 70 Space Missions In Four Years: ISRO," *India Defence*, April 4, 2008; available online at: http://www.india-defence.com/reports-3793.

space launch market.[250] ISRO claims that the Indian space program is thoroughly sustainable and for every $1 invested into it, India actually gains a $2 return on its investment.[251] India already has ownership rights over one third of all remote sensing imagery with a resolution of 5 meters,[252] has governmental agreements with Israel and Russia to launch a number of their satellites with Indian SLVs[253] and has a commercial space launch body, Antrix Corp., which has established itself as a provider of efficient and reliable launches and had an income of $500 million in 2006.[254] If India succeeds in launching, deploying, and conducting all that it has planned in the years to come, it will emerge as a major space state.

## Israel and Space

Israeli space projects are conducted and run as three separate fields and by two separate national governmental organizations and a number of private companies. All science and commercial-related research developments are conducted by the Israeli Space Agency (ISA), all defense-related systems by the Ministry of Defense, and in addition to this, a number of private and state-affiliated companies produce and/or operate other civilian space systems.

Due to Israel's small geographical size and economy, the funds invested into space ventures are modest. Furthermore, as a result of Israel's security situation in the Middle East, a very large part of Israeli space investment is directed towards defense—the ISA has an annual budget of around NIS 1 million[255] ($280,000) for commercial purposes compared to a $50 million budget for the military space program.[256] This difference in investment levels clearly translates into a wide disparity in regard to both the magnitude of ventures and the extent and nature of international cooperation of and within the two programs.

The small scientific research side of Israeli action in space, ISA's contribution, has a high level of international participation. Foreign cooperation enables Israel to develop and conduct more sophisticated projects in space. Thus far, Israel has signed cooperation agreements with the U.S. (NASA), Canada, India, Germany, France, Ukraine, Russia, The Netherlands, and Brazil with two potential future deals with Chile and the Republic of Korea.[257]

250 "India Seeks to Capture 10% of World Space Launch Market," *RIA Novosti*, September 3, 2007; accessed via the LexisNexis database online.

251 "India's Growing Strides in Space," Pallava Bagla, BBC News, April 30, 2008; available online at: http://news.bbc.co.uk/2/hi/south_asia/7374714.stm.

252 Ibid.

253 Siddharth Srivastava, "India to Tap $5USb Satellite Launch Market; It Aims for 10% Share in Business; Expects Two Major Contracts Soon," *The Business Times Singapore*, February 6, 2008; accessed via the LexisNexis database online.

254 Quoted in: Jessica Guiney, "India's Space Ambitions: Headed Towards Space War?" CDI Policy Brief, May 2008; available online at: http://www.cdi.org/pdfs/GuineyIndiaSpace.pdf; from: Dr. Ashok Sharma, "India's Aerospace Command," Institute for Peace and Conflict Studies, February 14, 2007; available online at: http://www.ipcs.org/Military_articles2.jsp?action=showView&kValue=2220&keyArticle=1017&status=art%20icle&mod=a.

255 Judy Siegel, "Israel Space Agency Long on Prestige Short on Funding," *The Jerusalem Post*, January 22, 2007—accessed via the LexisNexis database online.

256 Yaakov Katz, "Eyes in the Sky. Financial Boost Needed if Israel is to Succeed in the Race to Space," *The Jerusalem Post*, June 12, 2007—accessed via the LexisNexis database online.

257 "ISA International Relations," Israel Ministry of Science Culture and Sport; available online at: http://www.most.gov.il/English/Units/Science/Israel+Space+Agency/ISA+International+Relations.htm.

ISA has two major ongoing projects in differing stages of development. First, the *Tel Aviv University Ultraviolet Explorer (TAUVEX)* will be a space telescope system that will explore and study the ultraviolet sky as part of the Indian technology demonstrator satellite GSAT-4.[258] Since the decision was made to use an Indian satellite, this has been a joint project between Tel Aviv University and the Indian Institute of Astrophysics in Bangalore and is scheduled for launch in 2009.[259]

ISA also has the *Vegetation and Environment monitoring on a New Micro-Satellite (VENUS)* project under development. This is a joint project with the French space agency—Centre Nationale d'Etudes Spatiales (CNES)—and is essentially an Earth observation satellite that will use a sophisticated superspectral sensor to monitor vegetation on the Earth's surface. The purpose behind such studies is to examine the effect of environmental and human factors on land surfaces and thus on vegetation growth. ISA is responsible for the development and construction of the spacecraft and the provision of a satellite control center for when the system launches in 2011.[260]

Israel has two major civilian state space systems in operation today, one for communication and broadcasting (AMOS) and one for the acquisition of high-resolution Earth observation imagery for commercial purposes (EROS).

The AMOS system of satellites is being developed and constructed by the major Israeli aerospace and aviation manufacturer Israel Aerospace Industries (IAI) and operated by the private company Spacecom.[261] The system currently consists of three satellites with AMOS-1 launched in May 1996 being retired while AMOS-2 was launched in December 2007 and AMOS-3 in April 2008.[262] A fourth satellite, AMOS-4, is scheduled for launch in 2012. The system as it is today provides "high-quality broadcast and communication services to Europe, the Middle East, and across the Atlantic to the United States."[263] With the addition of AMOS-3 to the system, AMOS will be capable of providing its services to 80 percent of the world's population and AMOS-4 will extend this figure by providing services exclusively to Southeast and Central Asia and Africa.[264] AMOS is thus a major series of communication and broadcasting satellites and is set to become even more significant in the near future.

The second Israeli civilian space system in operation is the EROS series of commercial imaging satellites. The system, currently made up of two satellites (EROS-A, launched on December 5, 2000 and EROS-B launched on April 25, 2006) is designed and manufactured again by IAI but owned and operated by the private Israeli company ImageSat International.[265] EROS-A was based upon the IAI design of Israel's first spy satellite *Ofeq*-3,

258 Elhanan Almoznino, "TAUVEX on GSAT-4: Observational Prospects and Constraints," Wise Observatory, Tel Aviv University; available online at: http://www.ncra.tifr.res.in/~basi/07June/352092007.PDF.

259 "About TAUVEX: TAUVEX - An Indo-Israeli Mission," TAUVEX website; available online at: http://tauvex.iiap.res.in/

260 "Vegetation and Environment monitoring on a New Micro-Satellite; Project Main Steps," VENUS webpage; available online at: http://smsc.cnes.fr/VENUS/.

261 "Spacecom Signs $365 million Deal for Construction and Launch of AMOS-4 Satellite," News Release, AMOS by Spacecom website; available online at: http://www.amos-spacecom.com/amos1/page.asp?newsid=13&type=6&lang=1&cat=68.

262 "The AMOS Satellites," AMOS by Spacecom website; available online at: http://www.amos-spacecom.com/amos1/page.asp?cat=34&type=4&lang=1.

263 "Spacecom Signs $365 million Deal for Construction and Launch of AMOS-4 Satellite," News Release, AMOS by Spacecom website; available online at: http://www.amos-spacecom.com/amos1/page.asp?newsid=13&type=6&lang=1&cat=68.

264 Ibid.

265 "About ImageSat," ImageSat International website; available online at: http://www.imagesatintl.com/default.asp?catid=%7BF41F454F-7F6B-49AA-92C4-8EF165929953%7D.

discussed below, and supplies images commercially at an optical resolution of 1.8 meters while EROS-B is a more sophisticated system and provides images with a 0.7m resolution.[266] A third satellite, EROS-C, is scheduled to join the system in 2009[267] and is expected to be able to provide a superior resolution to EROS-B. Although the EROS satellites are strictly under civilian control, it is more than possible that their images could potentially be used for defense and security purposes.[268]

Both AMOS and EROS are scheduled for further launches and thus continued growth. Israel will continue to grow in the civilian and commercial spheres of space activity. As such systems are becoming ever more sophisticated in their capabilities, their output will become greater and they will be increasingly competitive within the international Earth imagery market. In addition, a more improved version of the EROS satellite, to be known as OpSat has been placed on the international market by IAI and may become a popular commercial product.[269] Its capabilities are expected to equal that of Israel's most sophisticated spy satellite—TechSAR.

The cornerstone of Israel's space ventures is its military reconnaissance satellites known as *Ofeq*. Indeed, the first of the *Ofeq* series, *Ofeq*-1, was the very first satellite that Israel independently launched into space in September 1988. The systems are launched into orbit onboard Israel's indigenously designed and built space launch vehicle (SLV) known as *Shavit* from Israel's Palmachim launch base located on the Mediterranean coast. Again designed and manufactured by IAI, the satellites have varying capabilities but specific technical details are rarely released by the Israeli Ministry of Defense.

*Ofeq*-5, which was launched in May 2002 is said to be capable of identifying objects smaller than one meter in diameter.[270] Its main mission is to provide military and other information. *Ofeq*-7 was launched into orbit in June 2007. This system provides Israel with "a significant upgrade"[271] in intelligence capabilities. Because of Israel's security issues, especially with Iran and Syria, *Ofeq*-7 was launched into a specific orbit that gives it the ability to pass over the near region about every 90 minutes.[272]

A new and highly sophisticated Israeli reconnaissance satellite, TecSAR (also referred to as *Polaris*), was added to Israel's arsenal of intelligence gathering systems in January 2008 when it was launched into space onboard an Indian Polar Satellite Launch Vehicle (PSLV).[273] The system is the first Israeli Earth observation satellite, civilian or military, with a synthetic aperture radar (SAR) onboard which helps towards an alleged optimum

266 Barbara Opall-Rome, "ImageSat Shuffles Satellite Procurement Plan," *Space News Business Report*, June 21, 2004; available online at: http://www.space.com/spacenews/archive04/imagearch_062104.html.

267 "EROS-C," Gunter's Space Page; available online at: http://space.skyrocket.de/index_frame.htm?http://www.skyrocket.de/space/doc_sdat/eros-c.htm.

268 "Satellites," Israel Ministry of Science Culture and Sport; available online at: http://www.most.gov.il/English/Units/Science/Israel+Space+Agency/ISA+Activity/Satellites.htm.

269 Barbara Opall-Rome, "Israel Unveils Newest Spy Satellite for Export Market," *Space News Business Report*, June 13, 2005; available online at: http://www.space.com/spacenews/archive05/Israel_061305.html.

270 "Satellites," Israel Ministry of Science Culture and Sport; available online at: http://www.most.gov.il/English/Units/Science/Israel+Space+Agency/ISA+Activity/Satellites.htm.

271 Yuval Azoulay, "Ofeq-7 Satellite Lift-off is a Success," *Haartez*, June 12, 2007; available online at: http://www.haaretz.com/hasen/spages/869771.html.

272 Anthony H. Cordesman, *Peace and War: The Arab-Israeli Military Balance Enters the 21st Century* (Greenwood Publishing Group, 2002) p. 535.

273 "PSLV Successfully Launches Israeli Satellite," Indian Space Research Organization (ISRO) News Release, January 21, 2008; available online at: http://www.isro.gov.in/pressrelease/Jan21_2008.htm.

imaging resolution of 10cm.[274] This would place Israel among the very elite in the world in terms of satellite reconnaissance capability. The SAR equipment deployed on the satellite will allow Israel to observe the Earth in day or night and irrespective of any weather conditions. It is expected that TecSAR will act as the principal instrument for spying on Iran and Syria, especially with respect to suspected nuclear weapon research and development.[275]

The military sphere of Israeli space action is clearly a major focus for the Israeli defense establishment and is most certainly *the* major focus of Israeli investment into space systems. Crucially, it is an area that is continuing to receive sufficient funding and will undoubtedly continue to grow in scope and sophistication. Plans are in the making for the manufacture and launch of a new *Ofeq* satellite, *Ofeq*-8, and the development of a new model of *Ofeq* satellites, referred to as *Ofeq*-Next. As mentioned earlier, IAI's commercial release of the newest OpSat model (the OpSat-3000) for international sale is a major move for the Israeli space sector and will likely create added investment and fuel for future growth.

Israel has one SLV of its own indigenous design and manufacture known as *Shavit*. The missile, built by IAI, is based upon the design of the *Jericho* II intermediate-range ballistic missile (IRBM) and is made up of three solid-fueled stages.[276] Its first launch took place in September 1988 when it carried *Ofeq*-1, an experimental Israeli payload successfully into orbit.[277] Despite its reasonably long launch history (beginning in 1988 and ending in 2007), it is suspected that the *Shavit* SLV is due to retire as Israel announced that all future *Ofeq* and other reconnaissance satellites, like TecSAR, will be launched onboard Indian PSLVs. It is thought that the reasons behind this decision included not being willing to accept another launch failure with the *Shavit* (two of seven launches have failed) and also that the PSLV is a more cost-effective launch method (costing less than $15 million compared to *Shavit's* $15-20 million[278]).

The use of an Indian SLV to launch the TecSAR satellite in January 2008 was a significant event. The two countries had been developing closer strategic relations but this launch truly signified the extent to which the two countries have grown closer. India has become Israel's largest arms export market in the world, with 2006 sales reaching $1.5 billion.[279] With the sophisticated *Green Pine* radar system already sold to India by Israel, the *Arrow* II anti-tactical ballistic missile system a possible future export,[280] and considerable interest in Israeli *Python*-5 and *Derby* auto air missiles and the *Deblah*-2 air-launched cruise missile,[281] the two countries are truly solidifying an already strong relationship, especially when it comes to defense and strategic matters.

274 Yaakov Katz & JPost Staff, "Spy Satellite Launched from India," *Jerusalem Post*, January 21, 2008; available online at: http://www.jpost.com/servlet/Satellite?cid=1200572504264&pagename=JPost%2FJPArticle%2FShowFull.

275 Stephen Clark, "Covert Satellite for Israel Launched by Indian Rocket," *Spaceflight Now News*, January 21, 2008; available online at: http://www.spaceflightnow.com/news/n0801/21pslv/.

276 "Israel Missile Overview," Nuclear Threat Initiative (NTI) database; available online at: http://www.nti.org/e_research/profiles/Israel/Missile/index.html.

277 "Ofeq-1,-2," Astronautix database; available online at: http://www.astronautix.com/craft/ofeq12.htm.

278 Barbara Opall-Rome & K. S. Jayaraman, "Israel Chooses Indian PSLV to Launch New Spy Satellite," *Space News Business Report*, November 14, 2005; available online at: http://www.space.com/spacenews/businessmonday_051114.html.

279 Bruce Riedel, "Israel & India: New Allies," *Middle East Bulletin*, The Brookings Institution, March 21, 2008; available online at: http://www.brookings.edu/opinions/2008/0321_india_riedel.aspx.

280 "Israel Successfully Tests Arrow Theater Missile Defense," December 5, 2005, *Defense Industry Daily*; available online at: http://www.defenseindustrydaily.com/israel-successfully-tests-arrow-theater-missile-defense-01571/.

281 Ninan Koshy, "India and Israel Eye Iran," *Foreign Policy in Focus (FPIF) Commentary*, February 13, 2008; available online at: http://www.fpif.org/fpiftxt/4959.

The physical infrastructure behind the Israeli space programs is considerable and worth a brief mention. As far as industry is concerned, the principal and by far the most powerful figure is the Israel Aerospace Industries (IAI), which is "an integrated space and defense contractor with 2007 revenues of around $2.8 billion, representing 20% year-on-year increase."[282] In addition to IAI, Rafael Advanced Defense Systems Ltd. and Elbit Systems Electro-Optics ELOP Ltd. (El-Op) both play significant parts in developing Israeli satellites. With regard to the two previously mentioned satellite operators, Space-Communication Ltd. (Spacecom) and ImageSat International, Israel also finds itself in a good position with sure future expansion in the national and international commercial sectors even as Israel maintains its focus on space and national security.

## Conclusion

The commercialization of space, based on the development in the next decade of a vibrant private sector, will afford greater opportunities to larger numbers of actors. As noted, several other nations besides the United States, Russia, and China, are developing space programs that have a military dimension or at least military potential. Increasingly, space is viewed as an arena for commercial exploitation as well as a domain having military uses. Given the dual-use nature of technologies that will be available, the choices to exploit or not to take fullest advantages of such technologies for purely civilian or for their military advantages will be based on non-technological considerations. Those entities seeking purely economic gain will be able to do so. It will be equally possible to make use of space technologies for military purposes if such choices are made. For example, the situational awareness that has been a virtual U.S. monopoly will be diminished, and perhaps eliminated as others gain access to satellite imagery. Given the likelihood that several states will wish to reduce or circumvent the U.S. lead in space, it follows that such entities will have a strong incentive to exploit available technologies for this purpose. In this case their interest in weakening the United States would clearly be greater than their values against space weaponization. Stated differently, the goal of such states would be primarily to diminish the U.S. position in space. The ability to destroy or disable satellites from Earth, demonstrated by China in 2007, will eventually be available to others as a result of proliferating rocket and other technologies. Sooner or later, prospective enemies will exploit space systems to gain military advantage over the United States. Given present trends, several possibilities can be set forth in general terms:

- The wider availability of high-resolution imagery will lead to situations in which the United States could find itself fighting enemies with such capabilities at least at the outset of a conflict. However, the United States might still have the means to deprive an adversary of such capabilities, during a conflict which it would have every incentive to do in order to reestablish U.S. dominance in situational awareness. Nevertheless, the ability of a future enemy to gain for itself maximal situational awareness, together with the capacity to blunt any such U.S. advantage, will have to be calculated into U.S. space strategy and planning as well as deterrence and crisis escalation control strategies.
- Terrorists already have access to unprecedented high-resolution imagery that is readily available on the Internet and from other commercial services. Together with states, and perhaps aided by states, such groups are already able to identify and gain detailed knowledge about their targets before, during, and after a military operation. As a result, the ability that others will have to threaten or to inflict destruction on the United States will grow as a result of the proliferation of space technologies, products, and services, spurred by the commercial sector. Here it is noted that historically military forces have been developed and deployed, among other reasons, to protect investments and other commercial interests.

282 "Futron's 2008 Space Competitiveness Index," Futron Corporation (2008) p. 36.

- The threat to the United States from missile proliferation will increase as more countries gain access to propulsion technologies and warhead designs. Perhaps the ultimate asymmetrical strategy against the United States lies in the possibility of a nuclear detonation at an altitude between 40 and 400 kilometers designed both to disable and destroy U.S. satellites and to have devastating EMP effects against infrastructure on Earth, including electronics systems essential to the operation of hospitals, air traffic control, ground transportation, and food distribution, to mention only the most obvious. Space represents an important arena from which to strike missiles carrying a payload intended to detonate above the Earth's surface in the form of an EMP attack that would have devastating consequences for the United States and other countries as well that are aligned with the United States. Is this what is meant when adversaries such as Iran point to a "world without the United States"?
- Although the importance of space as an arena for terrestrial for enhancement will grow as we have seen in post-Cold War armed conflicts in the Gulf, space will become an arena in which deployed assets, such as satellites, must be protected. Given the inherent problem of identifying a space weapon, it will prove difficult, and probably impossible, to design a verifiable international treaty against such a capability. The capability to attack a satellite need not be deployed in space to be able to achieve its intended result, as China demonstrated with its direct-ascent ground-based strike to destroy an aging Chinese satellite. Given the existence of such ground-based space weaponization capabilities, it will prove increasingly difficult to ban from space missile defense systems whose purpose is to prevent missiles traversing inner space during part of their trajectory en route to targets on Earth.
- Present trends clearly point to a world that by 2020 will have increasing numbers of states pursuing space programs capable of challenging the United States. The proliferation of technologies that can (and will) be exploited for commercial purposes will also be available for military applications. This is a fundamental condition that the United States cannot change. Under such circumstances, the United States will have little alternative but to pursue as fully as possible space programs, both by itself and in collaborative ventures, both in the commercial and military sectors, if we are to remain in the forefront as a space-faring nation.

## The United States and 21st-Century Space Strategy: Vulnerabilities, Competitors, and Priorities Workshop

The Army and Navy Club
December 14, 2007

## Participant List and Agenda

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## The United States and 21st-Century Space Strategy: Vulnerabilities, Competitors, and Priorities Workshop

The Ballroom
Army and Navy Club
901 17th Street NW, Washington, D.C.
Friday, December 14, 2007

**Agenda**

8:00–9:00 CONTINENTAL BREAKFAST

9:00–10:15 AM SESSION I

### U.S. Dependence on Space: Role and Vulnerabilities

This session will examine the growing importance of space to U.S. military operations and national security. It will discuss the vulnerabilities of U.S. space assets and infrastructure and related issues as well as the electromagnetic pulse (EMP) threat.

10:30–12:15 PM SESSION II

### U.S. Competitors in Space

This session examines the current status, emerging trends, and projected development of space capabilities in Russia, China, Iran, and North Korea. It will assess space policy and strategy, defense and space budgets, country perspectives of the goals of space programs, and an evaluation how each may impact U.S. utilization of space for national security and military operations. The commercial/civil space programs of Japan and India, and key EU countries, the linkages of such activities to national security and potential implications for U.S. security will also be included.

12:15–1:00 PM WORKING LUNCH

1:15–2:30 PM SESSION III

### Developing a 21st-Century U.S. Space Strategy

This concluding session is premised on the assumption that if the United States is to maintain supremacy in space and continue to conduct required military operations, it must anticipate vulnerabilities, shortcomings, and threats, and develop a base of public support for space as a vital part of national security strategy. Technological opportunities and funding gaps between what is currently being done and what is necessary will be explored. This session will discuss U.S. options including space-based missile defense.

# Areas of Consensus in U.S. Space Policies from Eisenhower to Bush

The Institute for Foreign Policy Analysis, Inc.
Cambridge, MA and Washington, D.C.

## Introduction

Beginning in 1958 with Dwight D. Eisenhower, every president has produced a U.S. space policy. Although the policies have evolved, reflecting our heightened sophistication, experience, and capabilities in space-related endeavors, the main tenets have remained extremely consistent. One tenet is the need for a strong national security space sector and the intrinsic right of self-defense to protect U.S. national interests in space. The current policy, released to the public by the Bush Administration in 2006, is the first post-9/11 appraisal of American space policy[1]. It reflects changes in the threats, challenges, and opportunities confronting the United States and its space capabilities. However, like its predecessors over the past half-century, the most recent policy directive is based on an enduring U.S. commitment to the use of space by all nations for peaceful purposes that permits defense and intelligence-related activities in support of national security.

It also reiterates longstanding and consistent U.S. policy principles such as the commitment to international cooperation and continued adherence to existing international agreements regarding the use of space. In addition, it rejects claims of sovereignty by any nation over space and any limitations on the fundamental right of the United States to use or acquire data from space, and states that the United States retains the right of free passage through and operations in space without interference.

This paper examines the space policies and directives of the United States issued by the White House over the past fifty years. It details their consistency, as well as modifications undertaken to support U.S. interests as changes in the strategic environment occurred and space capabilities and technologies matured. Such changes are especially evident today. In the early 21st century, given the growing proliferation of weapons of mass destruction (WMD) and ballistic missiles to nations and terrorist groups hostile to the United States, space, including space-based missile defense, will play an increasingly expanding role in U.S. security, extended deterrence, and counterproliferation planning.

Although there is a remarkable constancy in space policy during these five decades, ten Republican and Democratic administrations took new directions as necessary, as opportunities and technologies allowed, and as different threats emerged. For example, in 1983 the Reagan Administration, believing that deterrence based on the threat of nuclear retaliation was both immoral and increasingly less credible given the Soviet Union's growing arsenal of accurate nuclear weapons, initiated the Strategic Defense Initiative (SDI) to research missile defenses with a capability to intercept ballistic missiles in all phases of flight. President Reagan also believed that we could not sustain deterrence in Europe with a nuclear posture that was considered less than credible and with a conventional force that was regarded as inadequate. We needed to supplement our nuclear offensive forces with missile defenses to make deterrence more convincing.

President Reagan's concerns about the growing erosion of U.S. deterrence capabilities are reflected in George W. Bush's current policies, particularly the 2006 space policy directive, and the 2001 Nuclear Posture Review[2] which set forth the New Triad concept comprised of nuclear and non-nuclear forces, ballistic missile defenses, and a robust research and development (R&D) and industrial infrastructure to build and maintain

1 See National Security Presidential Directive-49 (NSPD-49), *U.S. National Space Policy*, August 31, 2006 (promulgated to the public on October 6, 2006).

2 The Bush Administration submitted the Nuclear Posture Review to Congress on December 31, 2001.

these forces. Like President Reagan, our current president believes that to be effective, U.S. deterrence policy must incorporate missile defenses into our force structure.

In today's security setting, the United States must deter multiple actors who may not adhere to traditional, Cold-War concepts of deterrence, underscoring the need to deploy multi-layered missile defense capabilities to maintain a robust and credible deterrent. Together with the other portions of the New Triad, missile defenses provide U.S. policy makers with an expanded set of tools and options that can be tailored to deter specific adversaries. President Bush took the necessary steps to make possible the unrestricted development, testing, and deployment of all types of missile defenses when he announced U.S. withdrawal from the ABM Treaty in 2001[3]. This was followed by the construction of a limited national missile defense (the Ground-based Missile Defense system) with sites in Alaska and California.

Moreover, existing U.S. space assets are a vital element of our deterrence forces utilized for intelligence, early warning, surveillance/reconnaissance, command and control, navigation/precision strike, and the integration of our missile defense systems. Consequently, given their growing vulnerability to asymmetric attack, the United States must convince adversaries that we are committed to the protection of our space-based infrastructure and that offensive actions against these assets will not undermine the endurance/resiliency of our deterrent capabilities. The growing vulnerability of U.S. space assets is an issue that successive administrations increasingly confronted over the past five decades as Soviet capabilities (and now those of several additional nations/actors) to destroy/disrupt elements of our space infrastructure developed and matured and as U.S. space capabilities assumed increasing importance for U.S. military operations. This was underscored by their escalating utilization in successive operations beginning in 1991 during Desert Storm, described as the first "space war," the Kosovo bombing campaign in 1999, and in Afghanistan and Iraq more recently.

The paper will highlight key issues, similarities and differences as well as the evolution in U.S. space policy over the past fifty years, including the national security role of space, freedom of passage and U.S. freedom of action in space, the right of self-defense, civil and commercial utilization, and arms control and legal issues/concerns. Its primary focus is the role space has played in U.S. security and its ongoing—and accelerating—importance for U.S. security planning in the early-21st century.

## U.S. Space Policy and National Security

After several years of deliberations, in August 2006 President George W. Bush signed a new national space policy to guide U.S. activities in space. Despite differences in emphasis, the policy document remains largely consistent with its predecessors. Since President Dwight D. Eisenhower promulgated the first U.S. space policy on August 18, 1958[4], every president has reaffirmed the fundamental principle of the "freedom of space." U.S. space systems are sovereign property with the right of passage through and operations in space without interference. Even more so than in the previous fifty years, the preservation of this right will be a critical policy issue for United States in the early-21st century security environment.

Today more than ever, space is a considerably more complicated operating environment with challenges to the freedom of space becoming increasingly evident. China's test of a direct ascent anti-satellite (ASAT) weapon in January 2007 and its apparent attempt to lase a U.S. reconnaissance satellite in 2006 highlight

3 The United States informed Russia of its intent to withdraw from the ABM Treaty on December 13, 2001 which became effective per the provisions in Article XV of the Treaty six months later on June 14, 2002.

4 NSC 5814 *U.S. Policy on Outer Space*, August 18, 1958.

the threat to the U.S. space infrastructure which is now integral to our conduct of military operations[5]. The dependence of U.S. combatant commanders and military forces upon the global capabilities provided by space systems has never been greater as shown by the central role of these assets in operations in Afghanistan and Iraq. The data collected, generated, and relayed by our satellite network are crucial for deterrence and warfighting. Space systems enable the maintenance of military preparedness, implement joint operational concepts, and support the planning and conduct of military operations across all levels of conflict. U.S. space systems are crucial to the superiority of our armed forces. Their disruption or loss would substantially decrease combat effectiveness and increase the risks and costs of military operations.

More troubling is the fact that the ability to put our space infrastructure at risk no longer resides solely with the major powers. Access to space and space capabilities is now more widely available than ever before. Many nations and non-state actors can develop weapons systems to impede America's right of passage through space by striking the ground segments supporting U.S. space systems, while progressively more available dual-use radio and laser technology can be employed to disrupt and blind U.S. orbiting assets. To illustrate, in the first days of Operation Iraqi Freedom, Iraq attempted to jam the U.S. Global Positioning Satellites (GPS) used for navigation, position-location and precision weapon guidance, and in 2005 Libya and Iran both disrupted international satellite transmissions[6]. Moreover, the continuing proliferation of nuclear weapon and ballistic missiles to actors hostile to the United States is increasing the threat posed by an electro-magnetic pulse or EMP attack which could disrupt or destroy our crucial space assets. As clearly demonstrated by the actions of nations cited above, adversaries understand the value of our space capabilities for warfighting and will continue to take steps to negate that capability.

## The Eisenhower Administration

The launch of *Sputnik* on 4 October 1957 produced an immediate impact on the formulation of U.S. space policy. Although the U.S. military had expressed interest in space technology as early as the mid-1940s, a viable space program failed to emerge for several reasons encompassing intense interservice rivalry; military preoccupation with the development of ballistic missiles (which limited the amount of funding available for proposed space systems); and, possibly most significantly, U.S. national security decision makers did not initially understand the strategic implications of space and satellite technology. *Sputnik* dramatically changed this. Apart from clearly demonstrating that the Soviets possessed missile technology to deliver payloads at long ranges, *Sputnik* led to an appreciation of the national security implications of space. The result was the first official U.S. government statement that space was of military significance. This statement was issued on March 26, 1958 by President Eisenhower's science advisory committee and said that the development of space technology and the maintenance of national prestige were important for the defense of the United States.

The National Aeronautics and Space Act of 1958[7] declared that the policy of the United States was to devote space activities to peaceful purposes for the benefit of all mankind. It mandated separate civilian and national security space programs and created a new agency, NASA, to direct and control all U.S. space activities except those "peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States." The Department of Defense was to be responsible for these latter activities. The Act established a mechanism for coordinating and integrating military and civilian

5 "Top Commander: Chinese Interference with US Satellites Uncertain," *Inside the Pentagon*, October 12, 2006.

6 Jeremy Singer, "War in Iraq Boosts Case for More Jam Resistant GPS," *Space News*, April 8, 2003; "Libya 'Jammed' Media Satellites," *Middle East Times*, December 5, 2005; "Iran Jams TV Channels," The *Courier Mail*, June 7, 2005.

7 Released on July 29, 1958.

research and development, encouraged significant international cooperation in space, and called for preserving the role of the United States as a leader in space technology and its application.

One month later President Eisenhower established the national security framework that would be followed for the next five decades with the release by the National Security Council of the first official space policy[8]. The directive stated that the United States "place primary emphasis on activities related to outer space necessary to maintain the overall deterrent capability of the United States and the Free World" and that superiority in space by another country "is a direct military threat to the United States." It stated that new military capabilities would occur as the technologies and uses of space grow and that no international agreements should "result in a net disadvantage to the United States by restricting its military capabilities." In other words, the Eisenhower Administration understood the need to keep the options for the utilization of space open.

Early-on, officials in the Eisenhower Administration also realized that space offered the means for "passive and active defense systems to detect and destroy enemy missiles or space vehicles." Interest in active missile defense accelerated in the mid-1950s as it became apparent that the Soviet Union was devoting extensive resources to the development of intermediate- and intercontinental ballistic missiles. In response, the Army's *Nike-Zeus* missile defense project was established in 1957 and a year later went into a full-scale development. It was eventually scaled back and later cancelled in the Kennedy Administration due to concerns regarding its technical feasibility, costs, interservice rivalries, and an emerging debate about whether or not missile defenses were destabilizing. It was believed by some key decision-makers—including Secretary of Defense Robert McNamara—that the offense could overwhelm missile defenses at a lower cost and that their deployment would lead to a continuous offense-defense arms race.

This so-called action/reaction cycle eventually culminated in the adoption of the mutual assured destruction (MAD) doctrine and the 1972 Anti-Ballistic Missile Treaty (ABM). As a result, apart from the short-lived deployment of the *Safeguard* ABM system fielded by the Nixon Administration (more below), strategic missile defense in the United States became an R&D-only endeavor for three decades until the current Bush Administration withdrew from the ABM Treaty and deployed the Ground-based Missile Defense system, together with sea-based capabilities. However, space was absent from the Bush Administration's missile defense program, despite the advances in space-based missile defense technologies developed during the Reagan and Bush 41 Administrations as discussed below.

## The Kennedy and Johnson Administrations

The Kennedy Administration, confronted by a Soviet Union that enjoyed initial success in the development and deployment of satellites, launch vehicles, and offensive ballistic missiles, pushed ahead with an aggressive space program that included the augmentation of U.S. military space capabilities, particularly long-range ballistic missiles, photo reconnaissance, communications, and navigation satellites, together with the civilian *Apollo* program to land a man on the moon and return safely by the end of the 1960s[9].

Like its predecessor and successors, the Kennedy Administration sought to maintain its options in space. For example, in National Security Decision Memorandum (NSDM) 156 on *Negotiations on Disarmament and Peaceful Uses of Outer Space* Kennedy directed the Department of State to ensure that the U.S. position in these

8 NSC 5814, *Preliminary Policy on Outer Space*, August 18, 1958.

9 President Kennedy announced this goal before a special joint session of Congress on May 25, 1961. Political factors, including the need to catch up and overtake the Soviet Union in the space race and to divert attention from the mid-April 1961 Bay of Pigs fiasco to overthrow Fidel Castro, affected Kennedy's decision and the timing of his announcement.

talks did not impede the use of photo reconnaissance satellites which were considered crucial to collecting intelligence on Soviet military activities. This was particularly important given the loss of intelligence—and the embarrassment—that ensued following the downing of a U.S. strategic reconnaissance aircraft, the U-2, by the Soviet Union and before the less vulnerable follow-on SR-71 aircraft became operational[10].

However, space systems played an important supporting role in the October 1962 Cuban missile crisis. Although they did not locate the Soviet missiles in Cuba (this was accomplished by U.S. reconnaissance aircraft), the first U.S. photo-reconnaissance satellites provided clear intelligence that the capabilities of Soviet nuclear forces were quite limited[11]. This gave the Kennedy Administration the confidence to call Premier Khrushchev's bluff during the crisis and institute a naval blockade of Soviet ships bound for Cuba.

In addition, space security efforts during the Kennedy Administration included a vigorous missile defense R&D program. Reacting to U.S. intelligence—and the public statements of Soviet officials—that the Soviet Union had successfully tested and fielded an ABM system, Kennedy directed the military to proceed rapidly with the development of missile defenses. He also gave the "highest priority" to Project Defender, a space-based ABM program that was initiated with a major study by the Advanced Research Project Agency[12]. The American concern over Soviet advances in missile defenses was so strong that President Kennedy gave this as the reason for resumption of atmospheric nuclear testing in 1962 (until the 1980s, the majority of U.S. missile defense concepts used nuclear-tipped interceptors). Finally, the Kennedy Administration also stated that attacks or interference with any space vehicle "during peacetime are inadmissible and illegal." The phrase "during peacetime" is instructive because it indicates that attacks on space assets during war or conflict are permissible, a position that further underscores the consistent U.S. principle of freedom of space passage as well as the inherent right of self-defense.

## The Nixon and Ford Administration

Shortly after coming into office, President Nixon formed a space task group (STG) to examine future U.S. space activities. The STG's September 1969 report recommended several changes for the national space program, including comprehensive cost reduction (due to the price tag of the Vietnam War and the ongoing *Apollo* program), and international cooperation in space. Regarding military programs, the group recommended that new programs be considered within the context of the threat, economic constraints, and national priorities. Such programs would only be authorized when shown to be more cost effective than other options to complete the same mission.

In addition, the Nixon Administration thoroughly reviewed the ABM *Sentinel* system the previous administration had reluctantly pursued. The size and funding of the system was not a major concern but the philosophy of its employment was. On 14 March 1969, Nixon announced that the United States would replace *Sentinel* with the *Safeguard* program. Although *Sentinel* and *Safeguard* were largely the same system, the mission of *Safeguard* was to protect U.S. ICBMs (as opposed to *Sentinel's* defense of population centers) against the growing accuracy of Soviet ICBMs. President Nixon stated that the only way to protect the American

10 On 1 May 1960, a Soviet surface-to-air missile shot down a U-2 flying carrying pilot Francis Gary Powers who failed to activate the destruct mechanism; the Soviets recovered both Powers and the aircraft. As result, President Eisenhower suspended all U-2 overflights of the Soviet Union.

11 At the time of the crisis the Soviet Union had approximately a dozen ICBMs on vulnerable surface launchers compared with over 200 U.S. ICBMs in hardened bunkers.

12 See NSAM 191, *Assignment of Highest National Priority to Project Defender*, October 1, 1962.

population was to prevent a nuclear war by keeping a viable deterrent. The first two of the six sites would be at Grand Forks Air Force Base (AFB), North Dakota, and Malmstrom AFB, Montana.

After conclusion of the 1972 ABM Treaty and its 1974 Protocol[13], work proceeded on the ABM site at Grand Forks AFB which became operational on October 1, 1975. However, Congress ordered it to shut down citing several reasons including the cost of the system (an estimated $40 billion for the planned six sites), the ABM Treaty had limited defensive systems, and the Soviet introduction of multiple independently targetable reentry vehicle (MIRVs) warheads could overwhelm the *Safeguard* system. As a consequence, the doctrine of mutual assured destruction became enshrined in U.S. deterrence policy and the United States drastically cut back on all missile defense activities and research. This course was not reversed until the SDI program was announced eight years later in 1983.

Concerned about the growing use by the Soviet Union of its space assets in direct support of its military forces, especially real-time targeting for long-range anti-ship missiles, the Ford Administration decided that the Soviets should not be allowed a "sanctuary in space for critical military supporting satellites." In a NSC document, President Ford directed the Department of Defense to develop and acquire on an accelerated basis a non-nuclear anti-satellite capability which could "selectively nullify crucial Soviet space assets[14]." Such a capability should include options for both electronic nullification expanding as far as geosynchronous orbit, and physical destruction including up to six Soviet military satellites in low-earth orbit within a one-week period. At the same time, he directed the Arms Control and Disarmament Agency to identify arms control initiatives that would restrict development of capabilities for high-altitude ASAT interceptors, raise the threshold for ASAT use, and clarify acts that constitute interference with space systems.

This policy directive marks one of the first times the issue of survivability and reconstitution was addressed in depth. President Ford stated that the United States must ensure that critical space-based assets are survivable and to the extent feasible, able to be replaced in a timely fashion to support U.S. military missions. Ford's directive was motivated by the growing dependence of the United States on space coupled with the Soviet Union's ASAT program and budding capability to disrupt/destroy U.S. space assets. The vulnerability and survivability of U.S. space assets became an issue of growing concern which was addressed more elaborately by subsequent administrations, particularly the Clinton and George W. Bush Administrations, in their space policy directives.

## The Carter Administration

The Carter Administration conducted a series of interdepartmental studies to assess U.S. space efforts. They focused on eliminating redundancy within and among the civil and national security space programs and developing a coherent recommendation for a new national space policy. The administration set forth the key principles to guide the U.S. space program on May 22, 1978 in a NSC directive[15] which highlights both the growing importance and use of space by the United States as well as the constancy in U.S. space policy that preceded the Carter Administration and continued in succeeding administrations.

13 Under the 1974 Protocol, each nation could build and operate only one ABM site to protect the national capitol or one of its ICBM fields which could contain no more the 100 launchers and no more than 100 ABM interceptors.

14 See NSDM 345, *U.S. Satellite Capabilities*, January 18, 1977.

15 See in PD/NSC-37, *National Space Policy*, May 11, 1978.

Carter's directive emphasized the right of free/safe passage and self defense in space. The directive was notable because it indicated a shift in the perception of space as a force enhancer to increase the effectiveness of land, sea, and air forces, to the importance of space systems to national survival, a recognition of the Soviet threat to those systems, and a readiness to develop an ASAT capability if a verifiable agreement to restrict such systems could not be achieved. Thus, U.S. defense planners were beginning to view space as a potential war-fighting arena.

Consequently, DOD was directed to take actions to make U.S. space systems survivable in the event of a conflict as well as develop an operational ASAT. It was also instructed to formulate plans to use civil, military, and commercial space assets in wartime or other emergencies as determined by the president (the use of commercial space for national security operations, particularly in the area of communications, is now commonplace). Finally, the directive called for the Defense Department to create an integrated attack warning, notification, verification, and contingency reaction capability for space defense. As a result of this rethinking of the traditional roles of space systems, national security space operations and war-fighting capabilities such as survivability, reliability, availability, and responsiveness, assumed higher priority in defense planning.

With regard to arms control, the directive states that the United States would continue to exercise restraint in the use of space weapons and recognized that "negotiations on the subject of space arms control were desirable." The Carter administration was especially interested in ASAT arms control and approached the Soviets on the subject in March 1977. While negotiating, the United States continued to develop its own ASAT capability. The administration believed that even the threat of an operational U.S. ASAT could be used as a bargaining chip to provide the Soviets incentive to negotiate. This method of arms negotiation and simultaneous R&D came to be called the Two-track Policy.

However, the U.S.-Soviet negotiations were unsuccessful for several reasons including the difficulty in defining what constituted an ASAT (for example, the Soviet Union claimed that the U.S. Space Shuttle developed by NASA was an ASAT system), and effectively verifying and enforcing an accord was unattainable. In addition, U.S. officials believed that the potential of a Soviet breakout from the agreement was to great a risk from which the United States could not rapidly recover.

The conclusions regarding ASAT arms control reached by the Carter Administration are even more relevant today because the number of actors with space capabilities has multiplied as has the number of on-orbit satellites[16]. Consequently, verifying what constitutes a space weapon becomes even more problematic. For example, satellites on-orbit can be maneuvered to destroy other satellites by colliding with them, launch vehicles to boost commercial/civil satellites into orbit can be modified to act as direct-ascent ASATs, and satellite ground-control facilities can be attacked by a variety of means. Thus, verifying and enforcing a "space weaponization" ban would be extremely difficult if not impossible. As indicated in U.S. space policy directives, particularly since the tenure of President Carter, administrations have recognized that a comprehensive verifiable, enforceable, and effective arms control agreement banning "space weapons" is essentially unachievable.

16 Approximately 43 nations own or operate (jointly in some cases) satellites. At present, there are about 850 active satellites on orbit.

## The Reagan Administration

On 4 July 1982, the Reagan Administration issued its first space policy[17], which affirmed the basic tenets of President Carter's policies, particularly the rights of free passage, and the principle of sovereign rights over a nation's space assets to include the right to defend those assets in space.

However, there were differences. The Reagan directive emphasized the eventual deployment of the U.S. ASAT effort as a deterrent to the use of the Soviet ASAT. The U.S. ASAT capability would deny the enemy the use of space and space assets in time of war or crisis. The directive also stated that the United States would consider treaties on weapons in space compatible with its national security interests which was somewhat less positive than Carter's assertion that such agreements were desirable (made before the "lessons learned" from its ASAT negotiations with the Soviet Union). The Reagan Administration also came to the conclusion that an ASAT accord with Moscow was essentially unverifiable.

Finally, the NSC directive introduced the basic goal of promoting and expanding the investment and involvement of the private sector in space and space-related activities as a third element of U.S. space operations, complementing the national security and civil sectors. Space assets (particularly communication systems) deployed by the commercial, private space sector have become increasingly important for national security as demonstrated by their heightened use in military operations in Afghanistan and Iraq. Reagan's space policy directive further laid the groundwork for the use of space as an arena for military operations by asserting the right of self-defense, and it opened the way for development of assets to fighting in and from space.

The single statement of national policy from this period that most influenced military space activities and that clearly reflects transition to a potential space war-fighting framework occurred on 23 March 1983. In this famous speech, President Reagan announced the Strategic Defense Initiative (SDI) calling for defensive measures to render Soviet missiles obsolete. As noted earlier, the SDI program represented a major shift away from the policy of mutual assured destruction towards a policy of strategic defense as a means of deterrence. Two days later, the Reagan Administration released an NSC policy directive ordering "an intensive effort to define a long-term research and development program aimed at an ultimate goal of eliminating the threat posed by nuclear ballistic missiles[18]." The White House established committees to study technological, political, and strategic considerations of such a system.

This document represented a significant step in the evolution of U.S. space policy. Since 1958, the U.S. had largely refrained from crossing a line from space systems designed to operate as force enhancers to establishing a war-fighting capability in space. The ASAT initiative of the Carter Administration was a response to a specific Soviet threat. However, the SDI program represented a significant augmentation of the capacity to conduct war-fighting operations in space, a departure from the traditional deterrence paradigm of mutual assured destruction relying solely on threat of offensive retaliation, and major expansion of the Defense Department's role in space.

The Reagan Administration released a second comprehensive national space policy in early 1988 that incorporated the results of a number of developments that had taken place since 1982 including the U.S. commitment in 1984 to build a space station and the space shuttle *Challenger* accident in 1986[19]. In addition, the space directive set forth in greater detail the growing importance of commercial space activities, treating

17 NSDD-42, *National Space Policy*, July 4, 1982.

18 See NSDD-85, *Eliminating the Threat from Ballistic Missiles*, March 25, 1983.

19 See NSDD-293, *National Space Policy*, January 5, 1988.

them as a near-equal to the national security and civil space sectors. In the national security sector, the directive addressed space control and force application at length, further developing the concept of war-fighting capabilities in space that as noted earlier began to emerge in the Carter Administration.

## The George H. W. Bush Administration

The George H. W. Bush Administration's *National Space Policy* set forth in NSD 30 (NSPD 1) on November 2, 1989, retained the goals and emphasis of the final Reagan Administration space policy, including U.S. leadership in space and preeminence in key areas of space crucial to achieving U.S. national security, foreign policy, scientific, technical, and economic goals. The Bush policy resulted from an interagency review to clarify, strengthen, and streamline space policy.

The principles guiding U.S. space activities reflect those of previous and future administrations including: peaceful purposes, the inherent right of self-defense, rejection of claims of sovereignty over space or celestial bodies, right of space passage, right of commercial use/exploitation of space consistent with national security interests, and international cooperation. The policy reaffirmed the organization of U.S. space activities into three complementary sectors: civil, national security and commercial which should coordinate their activities to ensure maximum information exchange and minimum duplication of effort.

Space leadership is a fundamental objective guiding U.S. space activities. While the directive states that leadership does not require preeminence in all areas of space operations it does require U.S. preeminence in those critical to achieving its space goals. These goals are to strengthen the security of the United States; to obtain scientific, technological, and economic benefits for the general population and to improve the quality of life on Earth through space-related activities; to encourage continuing United States private sector investment in space and related activities; to promote international cooperative activities, taking into account United States national security, foreign policy, scientific, and economic interests; to cooperate with other nations in maintaining the freedom of space for all activities that enhance the security and welfare of mankind; and as a long-range goal, to expand human presence and activity beyond Earth orbit into the solar system.

Although these general goals are not significantly different from those advanced by President Carter (and their heritage dates back to Eisenhower's 1958 National Aeronautics and Space Act), the major changes are the increasing detail in the policy objectives and implementation guidelines, the introduction and expansion of emphasis on commercial space activities, and a growing recognition that space, like land, sea, and air, is a potential arena for war-fighting.

With regard to national security, the directive notes that United States will conduct activities in space that contribute to security objectives by (1) deterring or, if necessary, defending against enemy attack; (2) assuring that enemy forces cannot prevent our use of space; (3) negating, if necessary, hostile space systems; and (4) enhancing operations of U.S. and allied forces. To accomplish these objectives, the Department of Defense will develop, operate, and maintain a robust space force structure capable of satisfying the mission requirements of space support, force enhancement, space control, and force application. It also emphasized the need to support the SDI program.

In this later regard, adopting the recommendations of an independent review of the SDI program and reflecting the new security environment that was emerging following the dissolution of the Soviet Union, President Bush refocused U.S. missile defense efforts with the establishment of the Global Protection Against

Limited Strikes (GPALS) program[20]. It consisted of four major components: 1000 space-based *Brilliant Pebble* interceptors, a land-based national missile defense system, a land-and-sea-based system to defend deployed U.S. forces and populations of allies, and a battle management/command and control system to integrate the other three components. The review found that Brilliant Pebbles was technically mature and ready for formal development, an assessment that was corroborated by the Defense Science Board, the JASONs, the Defense Acquisition Board, and other technical groups.

Given adequate funding and withdrawal from the ABM Treaty, it was estimated that Brilliant Pebbles could have achieved initial defensive capability in the 1996/1997 timeframe. However, Brilliant Pebbles and other key GPALS elements were subsequently emasculated through a series of actions taken by Congress and the Clinton Administration, including cancellation of Brilliant Pebbles and severe funding cuts to the remaining components of GPALS. This was driven in large measure by continuing adherence to the doctrine of mutual assured destruction and a belief that the breakup of the Soviet Union made missile defenses, particularly the space-based variety, unnecessary.

## The Clinton Administration

The Clinton Administration's space policy was released on September 19, 1996 and was the last such document issued for nearly ten years[21]. It described the goals and key tenets of U.S. space policy which included the requirement to: strengthen and maintain U.S. national security; enhance U.S. economic competitiveness and scientific and technical capabilities; encourage State, local, and private sector investment in and use of space technologies; and promote international cooperation to further U.S. domestic, national security, and foreign policies.

The principles guiding U.S. space activities reflected those of previous administrations including: peaceful purposes, pursuit of activities in space in support of its inherent right of self-defense, rejection of claims of sovereignty over space or celestial bodies, right of space passage, right of commercial use/exploitation of space consistent with national security interests, and international cooperation.

Specifically with regard to national security, the document states that the United States will conduct space activities necessary for national security; improve capability to support military operations worldwide, monitor and react to strategic military threats, and monitor arms control and non-proliferation agreements; integrate and modernize the U.S. space architecture to be able to respond to changing threats, environments, and adversaries.

The directive also notes that U.S. space activities will contribute to national security objectives by deterring and if required, defending against enemy attack, and that nations cannot prevent our own use of space. It also asserts that the United States retains the right to negate hostile space systems if necessary and to enhance the operations of U.S. and allied forces, including force application. The language on negation of hostile space systems and force application are a clear recognition by the Clinton Administration of the expanding role space assets play in the successful conduct of military operations that was demonstrated in Desert Storm and would be reaffirmed during the Kosovo campaign in 1999.

20 In the January 29, 1991 State of the Union Address, President Bush announced the GPALS program which would afford protection against as many as 200 warheads.

21 PDD/NSC 49 (PDD/NSTC 8), *National Space Policy*, September 19, 1996

To meet these objectives the United States must: maintain the capability to execute space support, force enhancement, space control, and force application; develop assured access to space, on-orbit spares, and reconstitution of vital assets; consistent with treaty obligations, develop, operate, and maintain space control capabilities to ensure freedom of action in space, and if required, deny such capabilities to adversaries. The document also states that we will "pursue a missile defense program to enhance theater missile defense capabilities, a national missile defense capability, and advanced technology program for improvements to such defenses."

Finally, the NSC document notes that the United States will consider and, as appropriate, formulate policy positions on arms control and related measures governing activities in space, and will conclude agreements only if they are equitable and effectively verifiable and enhance the security of the United States and our allies. The Arms Control and Disarmament Agency (ACDA), in coordination with DOD, the CIA, the Departments of State and Energy, and other appropriate Federal agencies, will identify arms control issues and opportunities related to space activities and examine concepts for measures that support national security objectives.

## The George W. Bush Administration

As noted earlier, the August 2006 NSPD entitled *U.S. National Space Policy* set forth President George W. Bush's key tenets and principles on space. This document includes the most elaborate discussion to date of the importance of U.S. space assets to U.S. national security stating that the United States must maintain and further develop capabilities for space support, force enhancement, space control, and force application missions[22]. In addition, it underscores the critical requirement to ensure the survivability of critical space assets, robust access to space, and that United States possesses significant reconstitution capabilities. The document also declares in unambiguous language that it will oppose any arms control or legal regime that would encumber U.S. freedom of action in space.

The document states that U.S. space programs and activities shall be guided by the following principles, the majority of which have been expounded by his predecessors throughout the space age. They include: the exploration and use of outer space by all nations for peaceful purposes which allow U.S. defense and intelligence-related activities in pursuit of national interests; claims to sovereignty over outer space or celestial bodies, and limitations on the United States to operate in and acquire data from space are rejected; international cooperation to extend the benefits of space, enhance space exploration, and to protect and promote freedom around the world; the right of space passage and operations in space without interference; purposeful interference with its space systems is an infringement on U.S. rights.

The directive also states that space capabilities, including the ground and space segments and supporting links, are vital U.S. national interests and thus 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 actions to protect its space capabilities; respond to interference; and deny, if necessary, adversaries the use of space capabilities hostile to U.S. national interests. Consequently, the United States will oppose the development of "new legal regimes or other restrictions that seek to prohibit or limit U.S. access to or use of space." Underscoring the increasing importance of commercial space assets, the directive

22 Space support includes space launch systems and facilities, and satellite control systems. Force enhancement is focused on the use of space systems to provide capabilities such as communications, navigation, early warming and attack assessment, and surveillance and reconnaissance to support military operations. Space control includes space surveillance, protection of space systems, prevention of an enemy's effective use of space, and the negation of hostile space systems. Force application refers to the use of weapons to apply military power against an adversary.

also notes that the United States government will use U.S. commercial space capabilities to the "maximum practical extent, consistent with national security."

To meet the goals of the new policy the United States must develop space professionals, improve space system development and procurement, increase and strengthen interagency partnerships, and strengthen and maintain our space-related science, technology, and industrial base.

Regarding national security uses of space the directive states that we must support and enable defense and intelligence requirements and operations during times of peace, crisis, and through all levels of conflict; develop and deploy space capabilities that sustain U.S. advantage; and ensure an operational force structure and optimized space capabilities that support national and homeland security. To implement these objectives the Secretary of Defense is instructed to: maintain capabilities to execute the space support, force enhancement, space control, and force application missions; establish specific intelligence requirements that can be met by tactical, operational, or national-level intelligence gathering capabilities; provide reliable, affordable, and timely space access as well as space capabilities to support continuous, global strategic and tactical warning; develop and deploy multi-layered and integrated missile defenses; build the capabilities to ensure freedom of action in space, and, "if necessary, deny such freedom of action to adversaries;" and conduct space situational awareness for U.S. government, commercial space capabilities and services used for national and homeland security purposes, civil space capabilities and operations, particularly human space flight activities, and, "as appropriate, commercial and foreign space entities."

## Conclusions

- There has been a remarkable continuity in U.S. space policy since the Eisenhower Administration promulgated its first NSC directive in 1958. While the directives have become more elaborate and detailed, reflecting changes in the security setting as well as a growing awareness and sophistication concerning the utilization and potential of space capabilities, the fundamental principles remain largely unchanged. These include:
    - The use and benefit, for all nations, of space for peaceful purposes.
    - The rejection of any national sovereignty over space.
    - Cooperation with other nations in the exploitation and peaceful use of space.
    - The right of access to and safe passage in space without hindrance.
    - The encouragement of commercial development of space.
    - The recognition of space as a vital interest of the United States.
- The general tenets concerning national security and space are also long-standing and consistent encompassing:
    - The United States considers space capabilities vital to its national interest and will safeguard its rights, capabilities, and freedom of action in space.
    - This requires effective deterrence, defense, and the capability to deny adversarial uses of space capabilities detrimental to U.S. national interests.
    - The United States should develop and deploy space capabilities that maintain and improve U.S. military and intelligence capabilities and national security which requires space situational awareness, survivability, and the capacity for rapid reconstitution.

  - The United States must avoid legal regimes or other international restrictions that would bar or limit U.S. access to, or use of space.
- Key differences in U.S. space policies include the emphasis on the development and deployment of missile defenses in the Reagan, Bush 41, and Bush 43 Administrations and their capacity to augment the credibility of U.S. deterrence forces.
- Today and for the foreseeable future, given growing WMD and ballistic missiles proliferation and the expanding number of space faring nations with capabilities to attack U.S. space assets, space capabilities, including space-based missile defense, will (and must) play an increasingly expanding role in the defense planning, force structure priorities, and military operations of future U.S. administrations.

# Meeting Summary of the Space and U.S. Security Net Assessment Experts Advisory Group

IFPA Washington, D.C. Office
May 31, 2007

## Introduction

On May 31, 2007 the *Space and U.S. Security Net Assessment* Experts Advisory Group held its first meeting at IFPA's Washington, D.C. office. Participants[1] addressed the goals of the Space and Missile Defense Net Assessment; discussed approaches to building a consensus among key groups, decision makers both domestic and international, and in the general public regarding the importance of space in U.S. security and counter-proliferation planning; examined the role of nuclear weapons in U.S. security; and outlined the next steps for the net assessment.

## Project Overview

Dr. Pfaltzgraff opened the meeting by setting forth the focus and goals of the *Space and U.S. Security Net Assessment*. The overall goal of the net assessment is to consider how to build consensus and greater understanding about the role of space in U.S. security. It will survey the current status of U.S. space activities and draw comparisons with other countries that have developed space programs in recent decades. It will also project major trends into a 10-20 year timeframe to identify factors that may have important implications positively or negatively on the position of the United States relative to other nations as we move toward and into the 2020 timeframe. Because of the inherently dual-use nature of space technology and the growing role of the commercial sector, the net assessment takes a broad view of space encompassing space technologies for military uses and for commercial purposes.

Dr. Pfaltzgraff added that the contending and contrasting perspectives on the utilization of space for U.S. national security purposes, particularly as they relate to the militarization and weaponization of space, require that we find common ground for the use of space for defense, civil, and commercial activities. There is substantial sentiment to the effect that the United States can avoid the "weaponization" of space by restricting its future space-related national security programs, including foregoing deployment of space-based missile defense. Therefore, the net assessment includes a discussion of arguments about weapons in space and addresses how an effective space-based defense can counter proliferation and the leverage it offers the United States. How the debate about defense in space is resolved will shape the types of space-based capabilities that the United States deploys in the years ahead. How U.S. space policy is translated into action depends vitally on levels of public understanding and support.

Finally, the net assessment will be utilized as a consensus building tool within the Executive Branch, Congress, state and local governments, key research institutions, academia, and the media, with U.S. allies, as well as at a broader public level on the critical role of space, including space-based missile defenses, in U.S. security and counterproliferation planning.

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1 Dr. David M. Abshire, President, the Richard Lounsbery Foundation, Max Angerholzer, Program Director and Secretary, the Richard Lounsbery Foundation, John Boyer, Congressional Liaison, Center for the Study of the Presidency, Dr. Robert G. Joseph, Senior Scholar, National Institute for Public Policy, Ambassador Max M. Kampelman, former Ambassador to the Conference on Security and Cooperation in Europe, Jack Kelly, Senior Staff, IFPA, Dr. Ronald F. Lehman II, Director, Center for Global Security Research, Lawrence Livermore National Laboratory (via teleconference), Dr. Robert L. Pfaltzgraff, Jr., President, IFPA, Dr. John F. Reichart, Director, Center for the Study of Weapons of Mass Destruction, National Defense University, Dr. Richard L. Wagner, Jr., Senior Staff Member, Los Alamos National Laboratory (via teleconference).

## Building a Consensus

There was a discussion of the nature of opposition to space-based missile defense. Opponents often cite the importance of establishing normative standards against the weaponization of space, suggesting that space-based missile defense would run counter to such norms. These opponents believe that the United States should take the lead in promoting regimes that will strengthen or create international norms against the weaponization of space. Contrasted is the perspective that throughout the history of conflict, the ability of states and other actors to utilize new geographical arenas, whether at sea, on land, or in the air, has led to conflict and competition based on available technologies. This has and will continue to be case with regard to space. Space is already an arena for international strategic competition, utilized for a wide-range of military activities (and, as some argue, already weaponized – more below), and consequently, the United States must not yield space control because other states will fill the resulting vacuum. In addition, international normative regimes are extremely difficult to verify and enforce.

Jeff Keuter, President of the George C. Marshall Institute and a member of the Net Assessment Experts Advisory Group, argues that space is already both militarized and weaponized.[2] As several commentators have pointed out, the "militarization of space" first occurred with the German V-2 missile attacks against targets in Southern England in the final months of World War II and with the launch of the first Soviet *Sputnik* in 1957. It is not necessary to station weapons *in* space in order to weaponize space. Such weapons can be launched into space from Earth, as in the case of China's direct ascent weapon. However, the term "militarization of space" took on new meaning in the first Gulf War with the integration of space-enabled capabilities into terrestrial weapons systems and the development of the reconnaissance strike complex. The weaponization of space is more nuanced. Although, the most frequent understanding of the phrase "weaponizing space" implies orbiting weapon systems or weapons that fire into space, as noted earlier, weapon systems already exist in space: they include space assets such as the Global Positioning System (GPS) for precision strike and surveillance/bomb damage assessment/communication satellites that are indispensable to the functioning of the U.S. reconnaissance strike complex. In addition, the Chinese view space-based systems as weapons in information-age warfare.

Moreover, China's direct ascent ASAT (tested on January 11, 2007) represents weaponization of space. An ASAT fired from either the ground or from space can be considered a space weapon because they can be launched into space. While debate on the nuances of the meaning of militarization and weaponization of space may continue, the "threat to the United States remains the same." Those who argue for establishing normative standards against the weaponization of space according to Jeff Keuter, must take account of the blurring of distinction between the militarization and weaponization of space.

A member noted that frequently when debating the weaponization and militarization of space we are dealing with the internals or the internal logic of the arguments of a particular group, not the externals or actual issues that should be addressed. Many players in these debates are "kibitzers" who do not have a real role to play in space. They are driven by ideological mindsets viewing space as a means to rein in a United States which they consider too big, arrogant, and powerful. In other words, space as such is a secondary issue. Their agenda is to restrict U.S. access to space as a tool to circumscribe U.S. power. We should ascertain the extent to which non-governmental organizations (NGOs) fall into this category. Moreover, some nations would follow the approach Canada and Norway utilized in the 1998 Landmine Convention to establish norms that would restrict the use of space by a broader community of nations. In addition, a group member noted that

2 See his May 23, 2007 Congressional testimony at http://www.marshall.org/article.php?id=528.

many Europeans favor a political regime based on the supra-national European Commission model to govern the use of space. How seriously should we regard such arguments and their proponents? How important are they in shaping debate about space and national security, and, in particular, whether or not we should deploy space-based missile defense? These are questions that will be addressed in the project.

In contrast, what is necessary is to deal with the real security issues among key players who have an actual constituency and role to play in space. We need to build on broader security concerns, understand domestic politics and economics and then enlist the support of experts who understand and can articulate/explain the actual issues, including but not limited to, verification, proliferation, and the role of space and space defenses in advancing U.S. and allied security. To be effective, allies must become actively involved in this process. In crafting a public diplomacy approach for our allies it is essential to realize that there are different communities within nations and we need to address a specific message to each of those communities. According to several participants, we need to develop a new 21st Century international security architecture that of necessity includes space. A new international security environment cannot be created without space if it is to be adequate to 21st century commercial and political-military needs.

## Proliferation Trends

Space is crucially important to efforts to counter proliferation challenges. Three key proliferation challenges were cited. The first is Iran and North Korea. If the United States and West are unsuccessful in preventing these countries from attaining a nuclear capability, significant proliferation will occur in the Middle East/Gulf, and in Northeast Asia. Egypt, Saudi Arabia, Turkey, and Iran are the potential triggers for a regional dynamic which could proliferate nuclear weapons. If any of these nations appear likely to develop and deploy nuclear weapons, they would probably all do so because none would want to be the last to acquire such a capability. In Northeast Asia, if North Korea goes nuclear, Japan may decide to develop its own nuclear weapons capability. South Korea would likely explore the nuclear option as would Taiwan.

An alternative to nuclear weapons proliferation lies in updating U.S. security guarantees. Space is crucial to such an endeavor. This is an area that should be explored as we consider 21st century security architectures. Many of those who would seek nuclear weapons have been allies or friends of the United States. Such states would want to acquire nuclear weapons if they concluded that U.S. security guarantees were no longer credible. This underscores the basic point that the nuclear proliferation cascade expected to follow a North Korean or Iranian nuclear capability includes primarily states friendly to the United States. Hence, the importance of new architectures that include security guarantees. Space-based missile defenses will be essential to such architectures.

The second challenge is how to manage the expansion of nuclear energy which will be far more widely used in the decades ahead as energy demands increase, together with environmental opposition to fossil fuels. We must reduce the risk of proliferation by restrictions on nuclear fuel enrichment to prevent/curtail clandestine weaponization. We will need to factor the importance of space into our efforts to cope with verification and other challenges of separating peaceful uses of nuclear energy from efforts to acquire nuclear weapons.

The third challenge is nuclear terrorism. The United States is highly dependent on space to combat terrorism, particularly for intelligence gathering, reconnaissance, and surveillance. Space allows the United States to penetrate easily across borders to fight terrorism. Space-based defenses would allow interception of attacks

on critical space assets with direct ascent capabilities such as those tested by China in January or electromagnetic pulse (EMP) attacks launched perhaps by terrorists.

How extensive future proliferation will be is not certain. Excessively gloomy prognostications hold their own dangers. Portraying a future that is essentially characterized by many nations with nuclear weapons may play directly into the hands of the nuclear abolitionists, who could claim that for this reason it becomes imperative to establish norms against such proliferation. In this regard, another member pointed out that President Kennedy felt there would be 20 to 25 nations with nuclear weapons by 1975. This did not prove to be true for several reasons: it was technically difficult for nations to develop nuclear weapons (this could be less the case today), and the West was creative in its policies, e.g., the United States provided extended deterrence to allies and friends and formed alliances obviating the need to develop nuclear weapons. In fact, several nations on the verge of going nuclear reversed course. These included Argentina, Brazil, South Africa, and South Korea.

## Presentation by Ambassador Max M. Kampelman

Ambassador Kampelman was invited to set forth his ideas about nuclear abolition. He is part of the Stanford Group which includes former Secretary of Defense William Perry, former Secretaries of State Henry Kissinger and George Shultz, and former Senator Sam Nunn calling for the elimination of all weapons of mass destruction. After consulting with its allies, according to Ambassador Kampelman, the United States should declare that is prepared to do away with its nuclear weapons, but only after the UN Security Council has developed and put into place an effective, ironclad verification regime to guarantee "total conformity with a universal commitment to eliminate all nuclear arms, and reaffirms the existing conventions covering chemical and biological weapons." He believes that the "Reykjavik II vision" would put the United States back on the moral high ground. The leverage for such an agreement would be provided by missile defenses.

There was discussion of the proposal put forward by President Reagan at the Reykjavik Summit with Mikael Gorbachev in October 1986. At that time Reagan proposed a transition from deterrence based on nuclear weapons to a defensive shield in which neither side would be able to destroy the other. In other words, Reagan would have substituted mutual assured survival for mutual assured destruction. The leverage for nuclear reductions and eventually the dismantling of all nuclear weapons by the United States and the Soviet Union would have come from the deployment by both sides of missile defenses. There would have been a cooperative transition with the United States sharing Strategic Defense Initiative (SDI) technologies with the Soviet Union.

Members suggested that U.S. development and deployment of space-based missile defenses could provide leverage to create a nuclear weapons free world (or move toward a significantly reduced number of nuclear weapons). One member noted that SDI and the superior technologies it was generating (both for space-based defenses as well as for conventional weaponry) was a major factor leading President Reagan to call for the elimination of U.S. and Soviet strategic nuclear weapons at the 1986 Reykjavik Summit.

## The Role of Nuclear Weapons in U.S. Security

Ambassador Kampelman's presentation led to a discussion of the role played by nuclear weapons in U.S. security. A member pointed out that we need to understand and articulate their purpose in U.S. security planning and in numerous allied countries. For example, it was noted that several nations, although not possessing nuclear weapons, fly, as part of their NATO responsibilities, dual capable aircraft. Many also rely on extended

deterrence and the nuclear security guarantee provided by the United States. This allows them to share the benefits of a nuclear weapon capability without actually possessing one. Thus, the U.S. extended nuclear deterrent minimizes proliferation. It was agreed that defining the role space plays in security guarantees is a key question that will be examined in our project and net assessment. It is crucially important as we develop 21st century security architectures.

Regarding the public diplomacy aspects of the Reykjavik II plan (and a broader plan to create a consensus for security uses of space and space defenses), we should be careful not to assert that nuclear weapons themselves are immoral. President Reagan distinguished between nuclear weapons as instrumentalities and the strategy of mutual assured destruction, which he regarded as immoral because it targeted undefended populations. We must avoid the growing tendency to delegitimize U.S. nuclear weapons at a time when others are acquiring such capabilities. After North Korea conducted a nuclear test in October 2006, the United States reaffirmed its security commitment to Japan which was greatly appreciated not only in Tokyo but in China as well. Beijing valued the U.S. action because it would lessen the perceived need of Japan to create its own nuclear weapon capability. At the same time we should deploy defenses against such weapons as a means of reducing the incentive of others to acquire them. To keep pace with emerging threats, the United States will find it necessary to deploy a layered missile defense that includes space-based interceptors.

Another member stated that it is a useful process to undertake the analysis on how to get to zero nuclear weapons. However, such an analysis can lead to unintended and negative outcomes. For example, abolition of all U.S. nuclear weapons may lead nations formerly under a U.S. nuclear umbrella to develop their own nuclear capability. Currently, there are at least thirty nations to which the United States has provided security guarantees that include extended nuclear deterrence. In addition to preventing increased proliferation, the American deterrent has proven an attractive alternative to the build-up of larger, costly conventional forces which would otherwise be required.

It was suggested that in order to broaden support for space and space-based missile defenses the United States should take "small steps" with Russia and China. Using the ABM treaty withdrawal negotiations with Russia as a template, we should meet with these nations to discuss space-based missile defenses and glean their reactions. For example, the United States and China could talk about rules of the road with regard to space operations. Such discussions could explore steps to be taken if the North Koreans launched a ballistic missile and the United States prepared to shoot it down. One participant noted that the Incidents at Sea Agreement may be instructive in this regard for developing rules of the road for a space-based regime.[3] The participant added that a key issue is keeping intelligence assets viable.

Such a "small steps" approach might also help minimize tensions on these issues within these nations and thus reduce negative reactions both on Capitol Hill and with U.S. allies to space-based missile defenses and the use of space. As noted by one participant, this is what occurred when the United States negotiated withdrawal from the ABM Treaty with Russia. After Russia was "onboard" with U.S. withdrawal it was easier for our allies and for many in Congress to accept the plan (or at least made it difficult to utilize the argument that ABM withdrawal was damaging relations with Russia and our allies). However, this approach also carries

3 In May 1972, the United States and the Soviet Union signed the Incidents at Sea Agreement. As a consequence of the rapid growth of Soviet maritime power during the 1960s, hazardous incidents at sea and in the air became a regular part of the Cold War. Eventually, both Washington and Moscow came to recognize the importance of limiting this dangerous set of interactions. The resulting set of rules and procedures helped to calm tensions in subsequent crises and may provide lessons applicable to other types of agreements.

obvious risks, as Russian opposition to the planned U.S. missile defense site in the Czech Republic and Poland, as well as Chinese objections to U.S.-Japan missile defense cooperation illustrate.

With regard to ASATs, a participant noted that many in the arms control community are of the opinion that since we cannot enforce or verify a ban on ground-based ASAT efforts such as radio frequency and countermeasures and blinding satellites by ground-based lasers, the focus should be space arms control, i.e., weapons deployed in space. The deficiencies of this approach should be obvious. As noted earlier, weapons have been launched from Earth into or through space. The Chinese direct ascent ASAT falls clearly in this category. What is a space weapon? Is it a weapon launched in space or into space? These are the types of issues that need to be fleshed out with strategies developed to build a broad-based consensus.

## Next Steps

The next steps in the project are as follows:

- Begin drafting a paper on *Areas of Consensus in U.S. Space Policies from Eisenhower to Bush*
- Continue development of the space net assessment
- Initiate planning, including possible topics and participants, for a larger Senior Level Meeting to be held in Washington, D.C.
- Continue drafting sections on the space programs, responsible organizations, and the space policy, strategy, doctrine, and budgets of other key countries with space programs.

## Executive Summary of the Independent Working Group Report on Missile Defense, the Space Relationship, and the Twenty-first Century

January 2009

Missile defense has entered a new era. With the initial missile defense deployments, the decades-long debate over whether to protect the American people from the threat of ballistic missile attack was settled—and settled unequivocally in favor of missile defense. What remains an open question is how the American missile defense system will evolve in the years ahead to take maximum advantage of technological opportunities to meet present and emerging dangers.

There is ample reason for concern. The threat environment confronting the United States in the twenty-first century differs fundamentally from that of the Cold War era. An unprecedented number of international actors have now acquired—or are seeking to acquire—ballistic missiles and weapons of mass destruction. Rogue states, chief among them North Korea and Iran, place a premium on the acquisition of nuclear, chemical, and biological weapons and the means to deliver them, and these states are moving rapidly toward that goal. Russia and China, traditional competitors of the United States, continue to expand the range and sophistication of their strategic arsenals at a time when the United States debates deep reductions in its strategic nuclear forces beyond those already made since the end of the Cold War and has no current modernization program. With a new administration, furthermore, the future development of even our limited missile defense system is in question. Furthermore, a number of asymmetric threats—including the possibility of weapons of mass destruction (WMD) acquisition by terrorist groups or the devastation of American critical infrastructure as a result of electromagnetic pulse (EMP)—now pose a direct challenge to the safety and security of the United States. Moreover, the number and sophistication of these threats are evolving at a pace that no longer allows the luxury of long lead times for the development and deployment of defenses.

In order to address these increasingly complex and multifaceted dangers, the United States must move well beyond the initial missile defense deployments of recent years to deploy a system capable of comprehensively protecting the American homeland as well as U.S. overseas forces and allies from the threat of ballistic missile attack. U.S. defenses also must be able to dissuade would-be missile possessors from costly investments in missile technologies, and to deter future adversaries from confronting the United States with WMD or ballistic missiles. America's strategic objective should be to make it impossible for any adversary to influence U.S. decision making in times of conflict through the use of ballistic missiles or WMD blackmail based on the threat to use such capabilities.

These priorities necessitate the deployment of a system capable of constant defense against a wide range of threats in all phases of flight: boost, midcourse, and terminal. A layered system—encompassing ground-based (area and theater anti-missile assets) and sea-based capabilities—can provide multiple opportunities to destroy incoming missiles in various phases of flight. A truly global capability, however, cannot be achieved without a missile defense architecture incorporating interdiction capabilities in space as one of its key operational elements. In the twenty-first century, space has replaced the seas as the ultimate frontier for commerce, technology, and national security. Space-based missile defense affords maximum opportunities for interception in boost phase before rocket boosters have released warheads and decoys or penetration aids.

The benefits of space-based defense are manifold. The deployment of a robust global missile defense that includes space-based interdiction capabilities will make more expensive, and therefore less attractive, the

foreign development of offensive ballistic missile technologies needed to overcome it. Indeed, the enduring lesson of the ABM Treaty era is that the *absence* of defenses, rather than their presence, empowers the development of offensive technologies that can threaten American security and the lives of American citizens. And access to space, as well as space control, is key to future U.S. efforts to provide disincentives to an array of actors seeking such power.

So far, however, the United States has stopped short of putting these principles into practice. Rather, the missile defense system that has been deployed so far provides extremely limited coverage. It is intended as a limited defense against a small, rogue-state threat scenario. Left unaddressed are the evolving missile arsenals of—and potential missile threats from—modernizing strategic competitors such as Russia and China as well as terrorists launching short-range missiles such as *Scuds* from off-shore vessels.

The key impediments to the development of a more robust layered system that includes space-based interdiction assets have been more political than technological. A small but vocal minority has so far succeeded in driving the debate against missile defense and especially space-based missile defense. The outcome has been that political considerations have by and large dictated technical behavior, with the goal of developing the most technologically sound and cost-effective defenses subordinated to other interests.

A symptom of this problem is the fact that, in spite of a commitment to protecting the United States from ballistic missile attack, little has been done to revive the cutting-edge technologies developed in the 1980s and early 1990s—technologies that produced the most effective, least costly ways to defend the U.S. homeland, its deployed troops, and its international partners from the threat of ballistic missile attack. The most impressive of these initiatives was *Brilliant Pebbles*. By 1992, that initiative—entailing the deployment of a constellation of small, advanced kill-vehicles in space—had developed a cheap, effective means of destroying enemy ballistic missiles in all modes of flight. Yet in the early 1990s, along with a number of other promising programs, it fell victim to a systematic eradication of space-based technologies that marked the closing years of the twentieth century and still impedes the development of the most effective missile defense today.

The current state of affairs surrounding missile defense carries profound implications for the safety and security of the United States, and its role on the world stage in the decades to come. Without the means to dissuade, deter, and defeat a growing number of strategic adversaries, the United States will be unable to maintain its status of global leadership. The creation of effective defenses against ballistic missile attack remains central to this task.

Historically, it is evident that the major geopolitical options that become available have been exploited by one nation or another. Those nations that are most successful in recognizing and acting on such options have become dominant. Others that have failed or have consciously decided not to do so are relegated to inferior political status. A salient case in point is ocean navigation and exploration. The Chinese were the first to become preeminent in this retrospectively pivotal area during the early Ming dynasty. However, domestic politics—strongly resembling missile defense politics in the United States of the past several decades—allowed this great national lead to be dissipated, with historic consequences felt until the present day, a full half millennium later. The subsequent assumption by Portugal of this leading maritime role resulted in geopolitical preeminence that was eventually lost to other powers.

In the twenty-first century, maintenance of its present lead in space may indeed be pivotal to the basic geopolitical, military, and economic status of the United States. Consolidation of the preeminent U.S. position in space akin to Britain's dominance of the oceans in the nineteenth century is not an option, but rather a

necessity, for if not the United States, some other nation, or nations, will aspire to this role, as several others already do. For the United States, space is a crucially important twenty-first century geopolitical setting that includes a global missile defense.

As American policy makers look ahead, new momentum and direction are needed in the pursuit of a truly global missile defense capability that incorporates space-based interdiction capabilities and addresses the current and emerging threats of the twenty-first century security setting.

This updated edition of the IWG Report first published in 2006 contains new information and takes account of accomplishments and challenges that have arisen in recent years. It also addresses such issues as costs and timelines, together with other topics directly related to missile defense such as the evolving threat environment. The updated report is intended as an educational tool for those who seek to understand more fully the national security implications of missile defense and the requirements for missile defense.

As the Independent Working Group prepared this report, many general and specific recommendations emerged from our research and discussions. These are summarized and prioritized here in order to answer the fundamental question that the IWG asked itself and which members of the IWG themselves have been asked many times: What should be done in light of the IWG critique and analysis contained in the report? Therefore, we provide a succinct list of recommendations whose purpose is to focus attention on missile defense requirements and provide a programmatic basis for action. The recommendations are designed to serve as an agenda that concisely sets forth what must be done, how it should be done, and who should do it if the United States is to deploy the robust, layered missile defense that will be essential for our national security in the years ahead. This report contains a detailed examination, including the background, analysis, supporting documentation, and conclusions on which our recommendations are based. It also contains a series of appendices that provide specific information about missile defense, together with detailed documentation on which our analysis, findings, and recommendations are based.

# Recommendations

## GENERAL RECOMMENDATIONS

- Make deployment of a multilayered missile defense an urgent national priority against the growing missile threat from hostile state and non-state actors to the United States, its deployed forces, and allies.
- Develop broad public recognition that this threat encompasses missiles launched against populations and infrastructures as well as nuclear detonations above the earth, resulting in an electromagnetic pulse (EMP) that could have devastating and potentially catastrophic consequences for America's society, economy, and national security.
- Build broadly based national consensus for a robust layered defense that includes sea- and space-based intercept capabilities able to defend against the growing missile threat.
- Ensure that the urgency of the missile threat is reflected in new organizational structures for a missile defense program that breaks the existing bureaucratic mold.
- Raise the national profile of missile defense by direct involvement at the presidential level and by building greater bipartisan support in the U.S. Congress.
- Reaffirm and strengthen the U.S. commitment to primacy in space.
- Recreate and sustain the scientific and technology base including the workforce needed to assure U.S primacy in space and missile defense.

## SPECIFIC RECOMMENDATIONS

### Limit Ground-based Missile Defense (GMD) Deployments

- Complete the GMD sites in Alaska and California and in Poland and the Czech Republic but do not further expand the number of ground-based sites. Instead, direct funding to sea-based and space-based missile defense in order to achieve maximum return on missile defense investment.

### Expand Sea-based Defenses

- Proceed as quickly as possible to deploy the SM-2 Block IV to defend against a ship-borne *Scud* launched off the U.S. coast.
- Accelerate deployment of the sea-based missile defense based on the U.S. Navy *Aegis* Vertical Launch System (VLS) and the Standard Missile (SM) with the current SM-3 Block 1 program to provide late-midcourse and boost-phase interception. Anticipated cost would be an additional $100 million over current funding.
- Accelerate the U.S.-Japan SM-3 Block IIA missile program to provide interdiction capabilities beyond the SM-3 Block 1. An additional $300 million over three years would push initial operating capability forward by more than a year.
- Combine and extend existing DoD and NASA test range assets to provide an East Coast test range for missile defense testing of BMD-capable *Aegis* ships currently being deployed in the Atlantic Ocean, thereby implicitly providing a limited defense against ballistic missile threats to the East Coast. The West Coast testing already provides such an inherent defense to our West Coast. This would also be an early counter to the EMP threat.

- Revive the *Brilliant Pebbles*-era light-weight Advanced Technology Kill Vehicle (ATKV) to improve the current U.S.-Japanese SM-3 Block IIA interceptor and for other applications, such as a ground-based interceptor (GBI) with multiple independently targetable kill vehicles. This would produce velocities far more advantageous for boost-phase intercepts than are achievable by other SM- 3 variants, and it would eliminate the costly plan now contemplated by the Missile Defense Agency (MDA) for a larger missile and new VLS configuration to attain a comparable capability.
- Integrate missile defense with homeland security plans to protect coastal cities and infrastructure such as key energy-producing and storage complexes.
- Equip additional U.S. vessels with the *Aegis* anti-missile system. Encourage U.S. allies equipped with *Aegis*/SM to do the same.

### Develop and Deploy Space-based Defenses

- Initiate a streamlined development program building on *Brilliant Pebbles* (and advanced technologies produced since then) for space-based interceptors for boost-phase, midcourse, and terminal-phase interdiction.
- Within three years, test a space-based missile defense system, at an anticipated cost of $3-5 billion.
- Begin operating a space testbed for space-based interceptors that would be integrated into U.S. Strategic Command's global architecture in three to five years.
- Using an event-driven procurement strategy, deploy one thousand *Brilliant Pebbles* interceptors with the goal of an initial capability within five years of a decision to move forward.

### Reaffirm the U.S. Commitment to Space

- Invest in space-based technologies to protect existing space-based assets and commercial and national security uses of space.
- Because of the centrality of space to U.S. national security, reject efforts to counter U.S. primacy in space via restrictive legal regimes.

### Strengthen Missile Defense Collaboration with Allies

- Encourage allied missile defense capabilities based on a suitable U.S.-allied division of labor, while strengthening allied participation, especially in sea-based and space-based missile defense.
- Identify allies' technologies and assets that would speed the deployment of a global layered missile defense system.
- Facilitate international missile defense technology-sharing while safeguarding cutting-edge technologies.
- Ensure maximum interoperability, flexibility, adaptability, and affordability of U.S. and allied systems.
- Educate allied decision makers and their publics about the WMD/ballistic missile threat and the role of missile defense.

### Develop New Organizational Structures for Space and Missile Defense

- Create a special task force with needed funding and political support, perhaps within the Defense Advanced Research Projects Agency (DARPA), to develop and test the space-based missile defense system. When possible, use scientists and engineers who worked on the *Brilliant Pebbles* program.

- Establish a special project initiative, again potentially within DARPA, to develop needed technologies and capabilities for U.S. space control, protec
- Assign responsibility, authority, and necessary resources to the U.S. Navy to develop, deploy, and operate the sea-based missile defense system.
- Given the inevitable technology overlaps and mission crossover applications within the proposed organizations, ensure formalized and frequent interactions and exchanges among the proposed organizational entities.
- Identify and increase the number of senators and congressmen who recognize the centrality of space to U.S. national security, including missile defense as well as the need to thwart proposed legal regimes such as the Space Preservation Act and other efforts to restrict U.S. primacy in space.
- Strengthen a congressional caucus or study group on space and missile defense to build support for U.S. space primacy, space control, and assured access as well as missile defense in general and space-based anti-missile systems in particular.
- Reorganize the National Science Foundation to revive student and faculty interest in space and defense technology.
- Because the Department of Defense's (DOD's) competence to manage innovative high technology programs has atrophied significantly, reorganize the military education system to increase the number of scientists and engineers in the uniformed military and civilian DOD workforce. This will require heightened focus on the physical sciences at our military undergraduate schools as well as incentives (pay and promotion) to military officers and civilian DOD officials to acquire advanced degrees in science and engineering.
- Create a vigorous, innovative, and sustainable science and technology workforce.
- Strengthen federal support and funding for physical science research and engineering. DOD science and technology (S&T) funding should constitute at least 3 percent of total defense spending.
- Increase funding of space security research to revive student and faculty interest in space and defense technology.
- Develop research funding solicitations and awards in missile defense-related S&T and support the missile defense component of space security research via advisory and peer groups as part of a new missile defense science and technology collegial community.
- Increase S&T in university curricula to strengthen the U.S. science, technology, and engineering base and research on missile defense and space security technologies.

## Educate the American Public

In parallel with the steps outlined above:

- Expand the educational outreach program to inform the American public, Congress and America's allies and friends about missile threats—particularly the EMP threat—and the benefits of missile defenses that must go beyond the capabilities of the current systems being fielded.
- Make clear that affordable, technologically mature sea- and space-based options are available which would supplement the current ground- and sea-based systems and provide the advantages inherent in a layered defense that ensures multiple interception opportunities and necessary protection.

- Embed missile defense as a post-9/11 homeland security priority at the local and state level.
- Strengthen state and local participation in space and missile defense education and security policy development consistent with Department of Homeland Security state-federal partnerships and the recognition of threats to the common defense.

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