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Other Countries' Space Weapons Programs

The United States is not the only country to have a space weapons or defense program. Other countries have made efforts to achieve space weapons or defense systems to further what they consider as national security objectives. This chapter seeks to chronicle the efforts made by these countries in this regard. The countries whose space weapons and defense systems receive the most coverage are Russia and the former Soviet Union, China, and European countries, focusing on those that are members of the European Union.

Russia/Soviet Union

Besides the United States, no nation has invested as much effort or as many resources in developing space weapons and defenses as the former Soviet Union and its national successor the Russian Federation. For the purposes of historical distinction, the term "Russian" is used to describe the military astronautics programs of the Russian Federation since 1991 and "Soviet" is used to describe Russian national space programs for 1991 and earlier.

Russian efforts to develop a military space program began during the concluding stages of World War II when they sought, along with the United States, to gain information about the German V-2 rocket program, which introduced the world to the military potential of rockets and guided missiles (Neufeld 1996; Bille and Lishock 2004, 23–25, 56–72, 100–114; McDougall 1997, 41–62, 237–293).

Soviet interest in German space program assets began before the Germans surrendered to the Red Army. There is vague evidence suggesting that the Soviet government had acquired recent intelligence on a German missile development program in 1935. In a July 13, 1944 letter, British prime minister Winston Churchill (1874–1965) told Soviet leader Joseph Stalin (1879–1953) of a German rocket weapon being tested in Poland and asked Stalin to instruct his advancing forces to preserve any equipment they found and allow British personnel to examine this equipment. Stalin granted this request and Soviet troops entered the German rocket test site at Blizna on August 6 and sent samples of the German's A-4 missile back to the Soviet Union for further inspection (Russian Space Web 2006(a), 1–4; Siddiqi 2003(a), 1–22).

This Soviet interest in military applications of space built on preexisting and ongoing work by Soviet scientists such as Konstantin Tsiolkovsky (1857–1935) and Sergey Korolev (1907–1966). Tsiolkovsky was a rural math teacher enthralled by the idea of human travel beyond the atmosphere. In 1895 he wrote on the possibility of an artificial satellite and discussed the basics of space flight and orbital mechanics in articles published in 1903 and 1911. In later work he reached the conclusion that it would take the power and speed of a rocket engine to boost a satellite beyond the earth's atmosphere and concluded that a combination of liquid hydrogen and liquid oxygen (LOX) would be the best way to fuel such access to space. Tsiolkovsky was supported by the Bolshevik regime, which seized power in the 1917 revolution; his writings were published by the Soviet government, and his work played a key role in motivating future Soviet research in astronautics (Bille and Lishock, 6–8; Harford 1997; Zak 2002, 62–69).

Korolev was working in a Soviet military supported research and development center during the 1930s. He survived being arrested during the Stalinist purges on a specious charge of "sabotage" and endured some time in the Gulag before ending up working for the NKVD, the Soviet secret police during World War II's later years. While working for the NKVD, Korolev designed his first long-range rockets with warheads designed to be carried 40 miles. He was involved in conducting assessments of captured German rocketry equipment and went on to play key roles in the development of the Soviet Union's ballistic missile and artificial satellite programs, which culminated in the 1957 Sputnik launch (Bille and Lishock, 56–72; Siddiqi 2003(b), 470–501).

Soviet developments in this area over the next decade underwent numerous changes and began with a July 23, 1945 government decree establishing three development bureaus that would each be responsible for creating missiles with different ranges and fuel propellants. A March 13, 1946 decree signed by Stalin distributed rocket technology responsibilities among several governmental ministries and created a special government committee on reactive technology to oversee these military astronautic efforts (Russian Space Web 2006(b), 3, 6; Siddiqi 2003(a), 23–47).

Soviet research efforts were assisted by teams of German scientists captured in the aftermath of World War II, and Soviet rocket research programs were concentrated at Kapustin Yar, which was chosen for its relative proximity to Stalingrad (Volgograd). On October 18, 1947 the first German A-4 rocket was launched at Kapustin Yar and flew for approximately 209 kilometers before landing 30 kilometers to the left of its intended target with the rocket disintegrating before crashing and not leaving a hole in the ground upon impact (Russian Space Web 2006(c), 1–2; Siddiqi 2003(a), 54–56).

Subsequent years saw incremental increases in Soviet military astronautics skills and technology. Under Korolev's leadership and with the assistance of their captured German slave labor force, the Soviets launched their version of the German A-4, which they called the R-1, from Kapustin Yar on October 18, 1948. This missile reached its target area nearly 288 kilometers from the launch site (Russian Space Web 2006(d), 1–2).

Russian aeronautical engineer Sergey Pavlovich Korolev. *(Bettmann/Corbis)*

Lessons learned from this initial launch were applied to the successor R-2 missile and included improvements such as making the upper position fuel tank part of the rocket's external structure. The R-2 was launched from Kapustin Yar on September 21, 1949 signifying significant improvement in Soviet ballistic missile knowledge and expertise while also indicating maturation in the nascent Soviet aerospace industry (Russian Space Web 2006(e), 1–2; Siddiqi 2003(a), 73).

Korolev became the chief developer of Soviet long-range ballistic missiles on April 26, 1950, and the R-1 was officially incorporated into the Red Army's arsenal on November 25, 1950, and the R-2 became part of the Red Army's weapons stockpile on November 27, 1951 (Russian Space Web 2006(f), 2). Further development in the Soviet's ballistic missile arsenal involved the R-5 missile, which was first launched on March 15, 1953 and received formal Soviet government approval to proceed with production on April 10, 1954. The R-5's significance is that it represented the first Soviet rocket capable of flying over 1,000 kilometers and that it was capable of carrying a nuclear warhead. This missile's flight control system included aerodynamic and gas rudders, which prevented it from rolling on its main axis after launch. A U.S. CIA assessment at this time could not confirm nor deny Soviet guided missile production (Russian Space Web 2006(g), 1–2; Bluth 1992; Cochran, Norris, and Bukharin 1995; Bolonkin 1991; U.S. Central Intelligence Agency 1954).

This growth in Soviet missile flight range exceeding 1,000 kilometers meant that the Kapustin Yar facility would no longer work due to its proximity to population centers on the Volga River. Consequently, the Soviet military began looking for a new missile range flight test site. A key requirement for this new test range was the desire of missile program scientists to deploy a series of guidance antennas that would have unobstructed views of the missile during its flight. Korolev directed his associates to search various regions in the Soviet Union and rejected the area adjacent to Kapustin Yar and the Stavropol Region west of the Caspian Sea due to their proximity to population centers, countries such as Iran, and mountains (Russian Space Web 2006(h), 1).

On March 17, 1954, the Soviet Minister's Council issued a decree directing several government agencies including the Ministry of Defense and Ministry of Aviation Industry to search for a long-range missile test site and report their findings by March 1, 1955. Following several months of investigation, the Soviet commission decided to select the remote Central Asian village of Tyuratam in what is now Kazakhstan to build their missile test range. Key factors in selecting Tyuratam were the area's geographic isolation and proximity to railroads connected to other areas of the Soviet Union.

Tyuratam is an isolated and desolate region whose summer climate can include dust storms and temperatures up to 122°F and winter snowstorms and temperatures as low –13°F. The commission presented its recommendations to the government on February 4, 1955, and the Politburo agreed soon after this, issuing a formal decree authorizing construction at Tyuratam on February 12, 1955. Work soon began on making this site, which would become known as the Baikonaur Cosmodrome, the center of Soviet missile testing and space launches in the years to come (Russian Space Web 2006(h), 2–6; Siddiqi 2003(a), 135–138).

On June 21, 1956, the Red Army incorporated the nuclear tipped R-5 missile into its arsenal. With a range of nearly 1,200 kilometers, this became the first "strategic" ballistic missile in the Soviet arsenal although later arms control classification would place it in the Intermediate Range Ballistic Missile (IRBM) category. R-5 development began in 1952, and the ultimate result was a single-stage missile with a height of 20 meters, which was shaped like a cylinder instead of a cigar. The R-5 was powered by a single engine that used a 92% mix of alcohol with water as fuel and LOX as an oxidizer while yielding thrust of 43.8 tons. This missile's flight control system consisted of aerodynamic and gas rudders, which prevented the missile from rolling on its main axis during flight (Russian Space Web 2006(g), 1–2; Siddiqi 2003(a), 99–101).

Soviet missile and military striking power increased exponentially with the August 21, 1957 launch of the R-7 missile. With a range of 8,500–8,800 kilometers, the R-7 was the first Soviet ICBM. The R-7 had a two-stage rocket, weighed 280 tons when full, and was capable of carrying a single 3–5 megaton nuclear warhead. As a weapon the R-7 reached obsolescence quickly, but descendants of its launch capability are still in use launching Russian manned spacecraft into orbit (Russian Space Web 2006(i), 1–2; Siddiqi 2003(a), 135–143).

These initial Soviet accomplishments in space were only of interest to observers in relevant scientific disciplines and military and intelligence fields and had limited public impact. This obscurity would be eliminated by the October 4, 1957 launch of the world's first artificial satellite Sputnik as part of the International Geophysical Year from July 1957–December 1958. Sputnik's launch, while primarily being a boost for Soviet propaganda, also created acute concern in the United States about its space efforts and the possible national security implications Sputnik's launch might have on U.S. national security policies. It also transformed the U.S. educational system, which began placing increased emphasis on science and technology training as it sought to rise to meet the perceived Soviet technological challenge presented by Sputnik (U.S. National Academies 2005, 1; Launius, Logsdon, and Smith 2000; MacInnis 2003; Siddiqi 2003(a); Portree 1998; NASA History Office 2007; Killian 1977; U.S. Central Intelligence Agency 1958, 2–6).

One assessment of Soviet military space policy describes the impact of Sputnik and other early Soviet space accomplishments as follows:

> The Soviet leadership under Khrushchev certainly recognized the potential of the space programme as a focus of national unity and pride. It was presented as peaceful in nature and as conductive to the promotion of peace.
>
> Soviet achievements in space were also used as diplomatic tools in relations with neutral and Third World countries, and Soviet astronauts were frequently sent on tours to promote the image of the Soviet Union. Obviously the space programme was useful as a propaganda tool not only abroad, but also at home. Achievements in space which demonstrated Soviet missile capability bolstered Khrushchev's arguments for reliance on the strategic missile as the major factor in Soviet security (Bluth 1992, 221).

This growth in Soviet military space accomplishments also saw the Soviet government seek to share this technology with ideologically compatible nations. On December 6, 1957, the Soviets decided to provide China with the production license for the predecessor R-2 missile, whose development began in 1949 and had a range of 600 kilometers in what can be viewed as an early instance of weapons of mass destruction proliferation (Russian Space Web 2006(e), 1).

A key post-Sputnik development in Soviet military space policy was the December 17, 1959 Soviet government decree establishing the Strategic Missile Forces, which gave this organization control of all ballistic missiles within the Soviet Union. Headed by Marshall Mitrofan Nedelin (1902–1960), who would be killed during an October 24, 1960 explosion of a missile at Baikonaur, the Strategic Missile Forces were also responsible for handling launching, tracking, and communications operations for Soviet spacecraft and ensuring

Soviet premier Nikita Khrushchev (center) and cosmonauts Valentina Tereshkova and Lt. Colonel Valery Bykovsky, acknowledge cheers of crowds during welcoming celebrations from atop Lenin's Mausoleum in Red Square on June 22, 1963. *(Bettmann/Corbis)*

that the Soviet military and Ministry of Defense would be the preeminent drivers of Soviet space policy for several decades (Siddiqi 2003(a), 211–212, 256–258).

These expanded Soviet military space responsibilities were financed by an augmented Soviet military budget, which increased an estimated 40% between 1957–1962. Some of this budget was allocated for a partially deployed ABM system near Leningrad, which was abandoned in 1962 although another ABM system called Galosh would eventually be deployed near Moscow (Mathers 1998, 38–40).

This military preeminence in the Soviet space program was described in an early 21st century assessment. This appraisal contended that the military was and remains the focus of Soviet space power. It went on to assert that the rockets launching Sputnik and Yuri Gagarin were ICBM derived and that the Soviet space program was politically motivated with its purpose being to display Soviet power to the world (Mowthorpe 2002, 25).

Further illustration of the military's ongoing centrality in Soviet space policy is illustrated by the September 30, 1963 Ministry of Defense deployment of an ICBM missile site near Plesetsk, located near the community of Mirny about 400 miles northeast of St. Petersburg, to shorten the time and distance required to launch missiles to North America. Besides being used for missile launches, the Plesetsk site was also a center for intelligence satellite launches for at least three decades (Russian Space Web 2006(j), 1–4; Siddiqi 2003(a), 72; Federation of American Scientists n.d.(a), 1).

Additional Soviet military space developments during 1963 included the November 1 launch of the Polet 1 satellite, which was the first satellite to maneuver in space by changing orbits, an essential capability for performing antisatellite operations (Siddiqi 2003(a), 72). Just over a month later on December 19, the Zenit reconnaissance satellite, which had been under development since 1958, was launched giving the Soviets the ability to monitor other nations' military activities from space and a counterpart to the United States' Corona satellite reconnaissance program (Siddiqi 2003(a), 250; Gorin 1998, 157–170).

The evolving organizational structure of the Soviet military space program was reflected in the October 1964 creation of the Central Directorate of Space Assets (TSUKOS) within the Ministry of Defense. TSUKOS was separated from the Strategic Missile Forces Chief Directorate of Reactive Armaments and now reported directly to the Strategic Missile Forces commander-in-chief. This reorganization now made TSUKOS the primary client for all Soviet space program assets giving it the authority to approve relevant program specifications. TSUKOS was now given authority over two component organizations: the Center for Leading the Development and Production of Space Armament Assets, which served as a research and development facility, and the Center of the Command Measurement Complex, which was responsible for overseeing the space program's national tracking, communications, and flight control stations (Siddiqi 2003(a), 380).

This same 1963–1964 time period also saw two commands established within the Soviet military dealing with space warfare and defense programs. The PRO command was given responsibility for detecting, intercepting, and destroying enemy ballistic missiles, while the PKO command was responsible for antispace defense including destroying enemy space weapons and assets (Federation of American Scientists n.d.(b), 1). The October 27, 1967 launch of a Tsyklon–2 rocket capable of carrying antisatellite weapons from Baikonaur is evidence of Soviet intent to deploy such weaponry (Russian Space Web 2006(k), 6).

This willingness to assert national military power in space was also being reflected in Soviet military doctrinal statements. A recent analysis of the 1968 *Soviet Military Strategy* makes the following appraisals of Soviet military space policy. It maintained that this policy sought to create space weapons systems to enhance overall military combat effectiveness; to prevent other countries from using space; and for developing strategic offensive systems for space war fighters. Soviet space policy objectives also encompassed protecting tactical and strategic strike capabilities; preventing hostile space use for military, political or economic gain; and giving the Soviets unrestricted access to space assets. Such assessment went on to maintain that the Soviets made extensive use of photoreconnaissance satellites for surveillance; early warning; support for troop deployment and targeting; intelligence gathering; strike assessment; and targeting U.S. and North Atlantic Treaty Organization (NATO) supply lines, communication links, and space systems (Mowthorpe 2002, 27; U.S. Defense Intelligence Agency 1984).

Soviet military space doctrinal thought during this 1960's chronological timeframe also consisted of diverse strands of opinion on the efficacy and feasibility of ballistic missile defenses. Individuals representing the viewpoints of personnel in the Strategic Missile Forces and naval submarines viewed wars involving missile defenses as being ones in which their service branches would be the principal participants, and they estimated that such wars would be relatively short in duration. In contrast to these perspectives, there were those who argued that future wars would be more protracted and involve the increased integration and involvement of all levels of Soviet strategic defense planning and cooperation such as antiaircraft, antimissile, and civil defense programs. Such debates characterized Soviet military and political planning on space warfare and defense issues during the 1960s and beyond (Mathers 1998, 44–55).

During the 1960s and 1970s, the Soviets made extensive efforts to develop ASAT with some recognition of these efforts occurring as early as 1962. Between 1968 and 1982 an ASAT was tested 20 times in space. During each test, a dedicated target vehicle was launched into low earth orbit by rockets from Baikonur and Plesetsk. The intercepting ASAT was launched from these sites and attempted to reach the intended target after either one or two revolutions around the earth. The interceptor weighed 1,400 kilograms and had a diameter of 1.8 meters and length of 4.2 meters, while the intended target was a 650-kilogram polyhedron with a 1.4-meter diameter (Federation of American Scientists n.d.(c), 1; U.S. Central Intelligence Agency 1962, 4).

Launch opportunities occurred as the target satellite's orbital plane passed over Baikonur twice a day, but only one daily launch opportunity actually existed to prevent possible launches toward China, which would have caused considerable problems for Soviet testers and policymakers. The time between launch and target intercept was 90–200 minutes after launch. Once the target was within range, the ASAT was maneuvered into desired attack position and a conventional warhead was exploded to destroy the target (Federation of American Scientists n.d.(c), 1).

Five of the initial seven ASAT tests between 1968–1971 were judged successful with tests being conducted at altitudes ranging from 230 to 1,000 kilometers above the earth's surface. Thirteen more tests were conducted between 1976–1982 in efforts to achieve a faster intercept profile and evaluate a new acquisition sensor. Two of these subsequent tests attempted to reach the target in one revolution around the earth but were unsuccessful, while two of this series of attacks achieved success adhering to the two revolution standard. In addition, some missions during this latter time frame are believed to have employed optical or infrared scanners for target acquisition instead of a radar seeking scanner and are believed to have failed in their missions (Federation of American Scientists n.d.(c), 1).

These Soviet military space efforts had, by the early 1980s, produced a significant infrastructure of programs in areas such as meteorology, communications, navigation, reconnaissance, surveillance, targeting, and antisatellite missions. In June 1981 a mobile command center of the Strategic Missile Forces began operational patrols, and in November 1981 the Main Directorate of Space Assets was transferred from the Strategic Missile Forces to report directly to the Ministry of Defense. A 1983 U.S. Defense Department as-

Launch of Soyuz T-6, June 24, 1982. *(Roger Ressmeyer/Corbis)*

sessment of Soviet military space programs contended that the Soviets could launch the initial prototype of a space-based laser ASAT system in the late 1980s or early 1990s and that space-based ABM systems could be tested in the 1990s but would not become operational until the next century (U.S. Department of Defense 1983, 65, 68; Russian Space Web 2006(k), 8).

This report went on to emphasize that the then existing Soviet space launch rate was four to five times larger than the United States' then current space rate, that the Soviet payload weight placed into orbit was 10 times greater than the United States, and that future Soviet space deployments would expand their military global command, control, and communications capabilities and potential to communicate with ground, sea, and air armed force components (U.S. Department of Defense 1983, 69).

A later edition of a regular Defense Department report on Soviet military capabilities during the 1980s reiterated the importance of Soviet military space operations by emphasizing the presence of the Krasnoyarsk ballistic missile radar system. This facility, located 3,700 kilometers from Moscow and 750 kilometers from the Mongolian border, violated the 1972 ABM Treaty between the United States and Soviet Union because it exceeded treaty provisions allowing the Soviets to build an ABM facility only in the Moscow area and because it was not located on the Soviet Union's periphery and pointed outward, which the ABM Treaty required for early warning radars. Additional Soviet ABM Treaty violations involved developing components giving them the ability to construct individual mobile ABM sites within months instead of the period of several years normally required to construct ABM systems (U.S. Department of Defense 1986, 41, 45).

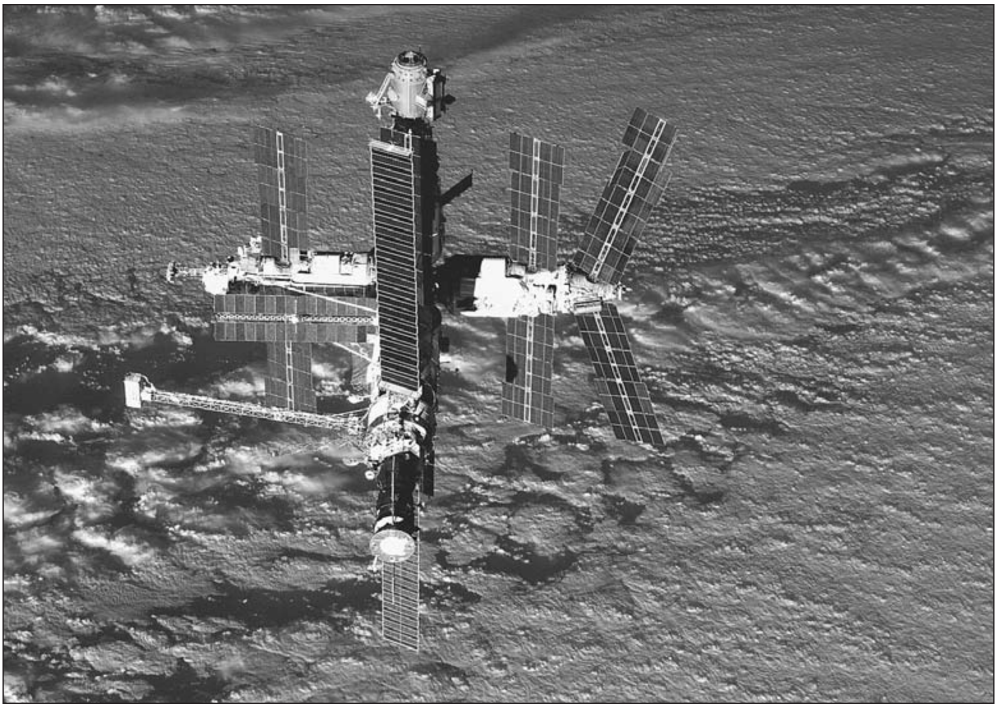
By the late 1980s, the Soviets had begun the GLONASS global navigation satellite system as their equivalent to the United States' GPS system. GLONASS had an announced fleet of 9–12 satellites with the potential ability to be upgraded from two to three dimensional reconnaissance capability and orbit 18–24 satellites. The Soviets also continued developing and deploying radar-carrying satellite systems. While designed for mapping polar formation ice, these satellites also enhanced the Soviet naval abilities to conduct operations in icebound areas by expediting northern sea route navigation and routing ships from western USSR naval yards to ports in the Pacific.

Soviet literature also indicated that military applications of remote sensing, oceanography, meteorology, and geodesy were stressed in cosmonaut activities. Possible implications of such research may have been enhancing the accuracy of directed energy weapons, repairing friendly satellites, and inspecting and disabling enemy satellites (U.S. Department of Defense 1988, 63–64).

Enhancing the ability of their satellites to conduct surveillance and targeting of adversary military forces also characterized Soviet military space operations. Their radar ocean and electronic intelligence (ELINT) ocean reconnaissance satellites were used to locate and target U.S. and allied military forces. Soviet ASAT capabilities allow them to deny or inhibit an enemy's use of vulnerable satellite systems and gave them the ability to attack and potentially destroy satellites in near-earth orbit. The Soviets also concluded 27 months of continuous manned presence in space in April 1989 through use of the Mir space station in another indication of a national commitment to maintain an ongoing presence in space (U.S. Department of Defense 1989, 54–56; Collins 1989, 129–143).

A key development in Soviet military space historical efforts was the Soviet Union's response to President Reagan's proposed ballistic missile defense system called the Strategic Defense Initiative (SDI). A 1983 CIA analysis correctly predicted that the Soviets would try to use assorted political, propaganda-related, and diplomatic means, negotiating strategies, and active measures to disrupt SDI. For example, the Soviets claimed that SDI would violate the ABM Treaty, produce threats to international security and stability, and other purported dangers (U.S. Central Intelligence Agency 1983, 1; Fitzgerald 1987; Dewolf 1989; and Simon 1990).

A 1985 CIA assessment estimated the costs of Soviet space programs at approximately $26 billion and stressed that this program's size and depth gives them the greatest potential in the competition for space and that the size of Soviet efforts compensated for the inefficiency and technological deficiencies marking many individual Soviet space programs. This appraisal went on to predict that Soviet efforts to acquire space technology would increase given heightened military-technological competition with the United States and that the Soviets had acquired and would continue to try to acquire relevant tech-



Russian space station Mir in 1996. *(NASA)*

nologies in areas such as space-based lasers, directed-energy weapons, and antimissile defense systems from U.S., Western European, and Japanese sources. Additional information sources in these fields of interest to the Soviets would include NASA documents and NASA-funded contractor studies (U.S. Central Intelligence Agency 1985, 1–3).

A series of political upheavals began affecting the Soviet space program starting with the collapse of Soviet satellite regimes in Eastern Europe in 1989 and the eventual 1991 collapse of the Soviet Union and its replacement by the Russian Federation (Zelikow and Rice 1995; Brandon 1992; Falk and Szentes 1997; Aslund and Olcott 1999; Szporluk 2000). Initially, these events had limited effect on Soviet military space programs. The 1991 U.S. Defense Department assessment of Soviet military capabilities, issued in the aftermath of the failed August 1991 coup attempting to restore traditional Soviet power, acknowledged that Soviet space launch rates in 1989–1990 were 15% below what they were between 1980–1988. This report went on to mention that Soviet space launches remained more than double U.S. launches, that this declining launch rate had not degraded Soviet military space capabilities, and that the Soviets still had over 170 operational satellites in orbit and that these satellites were increasing in sophistication and had longer life spans (U.S. Department of Defense 1991, 41–42; U.S. Department of Defense 1990).

At the same time, a 1991 assessment on the future of Soviet space programs by the Library of Congress' Congressional Research Service predicted that the future of Soviet space programs was questionable given the societal transformation occurring in the Soviet Union at this time.

> The political future of the Soviet space program remains in doubt as the Soviet Union undergoes political and economic upheaval. Although the Soviets are much more open about the space program today, it is still almost impossible to understand clearly how much is being spent on space and exactly on what is being spent. Revelations about past Soviet space programs—particularly the unsuccessful program to send cosmonauts to the Moon in the late 1960s—are becoming commonplace, but plans for future programs are murky. Rising dissent among the Soviet populace and some government officials against the space program is evidenced by complaints ranging from space spending as a waste of scarce government resources, to environmental damage to areas around Soviet launch sites from years of launch operations (Smith 1991, 6).

The late 1991 collapse of the Soviet Union and its replacement by the Russian Federation produced significant changes in Russian space programs including those devoted to space warfare and defense. Between 1990 and 1995, Russian civilian space programs experienced an 80% budget reduction, and military space programs saw their budget slashed by 90%. Besides these draconian budget reductions stemming from the Russian Federation's constricted fiscal resources, the Russian government's practice of not giving final budget approval to current year budgets until mid-spring means all governmental agencies must survive on monthly handouts based on previous years' allocations. This caused lower level subcontractors to demand advance payment for delivering goods resulting in production stoppages by prime contractors. In addition, the Russian Space Agency (RSA) 1994–1995 budget suffered because of the need to finance Russian military operations in Chechnya (Twigg 1999, 70; Nguyen 1993, 413–423).

RSA was created by President Boris Yeltsin in February 1992 and was given responsibility for coordinating entities involved in Russia's civil space program while also coordinating efforts with the Ministry of Defense in cases such as satellite communications, where space missions have civilian and military applications. Declining government purchases of Russian space launch vehicle services have also forced this industry to market their products and services abroad (U.S. Central Intelligence Agency 1992, 2–3).

The ability of Russia's space launch industry to market these services abroad and retain some level of international economic and technological competitiveness was seriously restricted by Russia's declining economic position. This economic decline was most dramatically affected by precipitous space workforce reductions. Between 1991–1994, the Russian aerospace industry lost 115,000 engineering and technical personnel along with 90,000 industrial workers. The head of RSA estimated in late 1994 that only 100,000 of 360,000 aerospace industry workers would still be employed in that industry. Additional evidence of deterioration in this industry during this time is demonstrated by an aging workforce. More than half of research and design aerospace personnel were over 55, almost a third were 45–55, and only 1% were under 35 with many of these younger workers seeking more lucrative careers in other industries (Oberg 2002, 56–57; U.S. Congress, House Committee on Science 1998, 513).

Russia's military space programs were not immune to this deteriorating and spasmodic funding situation, which negatively impacted space research, industrial infrastructure, and combat training. Vladimir Ivanov, the Commander of Russian Military Space Forces in 1996, stated that his units only received 8% of their budget allowances for research and development, 20% for purchasing equipment, and 6% for capital construction. Military space force staffing was cut in half between 1990–1997, and launch and technical complexes and ground-based guidance systems were wearing out after two to three decades of use with no prospect of financial support to enhance the quality of these systems or replace them (Twigg 1999, 70).

The Russian Army General Staff chief announced in early 1997 that Russian capability to monitor global rocket launches was seriously degraded and that 60% of deployed monitoring satellites were beyond their normal service lives with no prospects of replacement because these products were no longer being produced. A report in the Russian press also mentioned that one military officer from the Strategic Missile Forces believed that this degradation in satellite monitoring capability increased the chances of Russia making an accidental nuclear strike against the United States (Twigg 1999, 70).

The disintegration of the Soviet Union also placed some Russian space launch facilities into new countries such as Azerbaijan and Kazakhstan and compelled the Russian Federation to seek agreements with these countries to have continued access to these facilities. In January 1994, Russia negotiated an agreement with Kazakhstan for a 20-year lease to the Baikonur Cosmodrome and agreed to pay the Kazakhs an annual rent of $115 million. An April 1994 agreement with Latvia to lease the Skrunda missile early-warning radar station for $5 million per year lasted until August 1998 when it was moved to Baranovichi, Belarus. Another agreement with Kazakhstan in October 1996 provided Russia with access to the Kapustin Yar missile test site for $26.5 million per year. Russia also signed a preliminary agreement with Azerbaijan in August 1997 for access to the Garbala early-warning radar station for an undetermined price and duration. Each of these agreements recognizes that host countries retain formal legal control over these facilities and specifies Russian rights and obligations in using these facilities (Cooley 2000/01, 113–116).

Despite these significant post-Soviet setbacks, the Russian Federation still retains a partially viable space program and remains interested in military uses of space. The Russian Space Forces (VKS) were created in June 2001 to increase the use of space for Russia's military information gathering requirements (Center for Nonproliferation Studies 2005?(a), 1).

Russian Space Forces commander colonel general Vladimir Popovkin said Russia had approximately 60 military satellites in orbit in late 2004, which is two-and-one-half times fewer than were in orbit in 1990, but that these satellites are newer and a greater percentage of them are functioning within their normal operational lives. Russia has five kinds of

GIOVE-A atop the Soyuz launcher on pad six at Baikonur Cosmodrome in Kazakhstan. This facility has served as the primary Soviet/Russian space launch center for five decades. *(European Space Agency)*

imagery reconnaissance satellites in use: Kometa, Kobalt, Yenisey, Araks (Arkon), and Neman. Kometa satellites update military topographic and mapping data by photographing large areas. The Kobalt provides detailed photo-reconnaissance data and is believed to have 20 retrievable film capsules to deliver the exposed film while still in orbit. Yenisey satellites take high-resolution wide format photographs of the earth's surface and remain in orbit for about one year and use film capsules to preserve their images. Araks and Neman satellites relay their images digitally. An Araks satellite with an estimated three-year life span was launched in July 2002, and a Neman satellite with a projected one-year life span was launched in August 2003, but neither of these satellites functioned successfully (Center for Nonproliferation Studies 2005?(b), 1).

Russia currently possesses four dedicated military communication satellites: Strela–3, Molniya–3K, Geizer, and Raduga. Strela–3 receives and transmits communications from isolated areas and serves as the central communications system for the Main Intelligence Directorate, while Molniya satellites are used for general purpose military communications. Following the July 2005 launch failure of a Molniya–3, Popovkin announced that its production would end and that it would be replaced by a new communications satellite. The Geizer serves as a relay satellite for data gathered by Araks and Neman satellites, while

Raduga satellites provide real-time military communications services including leadership and strategic forces communication (Center for Nonproliferation Studies 2005?(b), 2).

Russian navigation satellite assets also include the Parus and GLONASS systems. Parus provides navigation and communication services for the Russian Navy and the GLONASS system, which is similar to the United States GPS, is under development with 11 of these operational in mid-2004 with hopes of having 24 operational satellites by 2010 (Center for Nonproliferation Studies 2005(b), 2).

Additional Russian military satellite assets cover ballistic missile early warning, space monitoring, ballistic missile defense, and ASAT capabilities. Their early warning network consists of ground-based and satellite-based systems. The ground-based stations are located throughout the former Soviet Union although not all post-Soviet successor governments have cooperated with Russian efforts to maintain and upgrade these facilities. Oko and Prognoz satellites, which are launched into elliptical and geostationary orbits are the satellite components of Russia's ballistic missile early warning network. The last known test of a Russian ASAT took place in 1982, and the 2001–2002 edition of *Jane's Space Directory* described Russian ASAT programs as "inactive" (Center for Nonproliferation Studies 2005(b), 3; Fitzgerald 1994, 457–476; Menshikov 2000, 36–39; Kornukov 2001, 6–12; Zhuk 2003, 209–216).

The Russian space launch industry remains active in the international space launch market. Launches are conducted by Russian Space Forces at Baikonur in Kazakhstan, Plesetsk, and the Svobodnyy Cosmodrome in eastern Russia. Russia hopes to modernize Plesetsk and Svobodnyy to enhance its national launch infrastructure and save money for the space program. It has been working on upgrades at Plesetsk since 2001 and in October 2003 prioritized its work there with Popovkin announcing in August 2005 that Russia wanted all military launches conducted from Plesetsk by 2010. Additional upgrading of Svobodnyy will not occur until 2010, and this site allows rockets to be launched to solar-synchronous and polar orbits without crossing over foreign countries. In June 2005, Russian defense minister Sergei Ivanov repeated Russia's commitment to lease Baikonur from Kazakhstan through 2050 (Center for Nonproliferation Studies 2005(c), 1–2).

Russia has entered into international commercial launch partnerships with the United States, the European Space Agency, and numerous other countries and commercial entities. Its U.S. partnership, called International Launch Services, was established in 1995 and is responsible for 50% of the global space services market (Center for Nonproliferation Studies 2005(c), 2).

During August 2005, Russia and China engaged in joint military exercises lasting for a week, which may indicate increasing security cooperation between these two countries in space and other military arenas (Hyodo 2005, 1–5).

Russian military space efforts have experienced considerable success and failures during their nearly six-decade existence. It remains an important global player in military space endeavors, and Russia's increasing oil and natural gas revenues give it the opportunity to increase its investment in civilian and military space programs. The Kliper moon launch spacecraft of 2006 may be an indication of this enhanced Russian space investment (Russian Space Web 2007, 1–2). The Russian Federation still retains significant military space interests and assets that may increase given future international security trends such as the increasing power of China, problematic relations with the United States and NATO, and the threat of a nuclear Iran, consequently reinforcing the importance of space as a national security priority in the minds of Russian policymakers.

China

As China has grown in economic prosperity and overall national assertiveness since the 1949 Communist revolution, its view of national security interests has expanded to include space. A 1967 U.S. Government assessment stressed that a Chinese ICBM system could be deployed in the early 1970s and potentially as early as 1970–1971, that Chinese national resources could probably support moderate and increasing ICBM deployment through 1975, and that China was likely to launch a satellite as soon as possible for political benefit (U.S. Central Intelligence Agency 1967, 2).

The genesis of China's military space programs began in 1956 when it acquired two Soviet R-1 missiles, which were copies of German cryogenic liquid-propellant V-2 missiles of World War II provenance. The following year China acquired the more advanced R-2 missiles from the Soviets, and these had greater range and a larger payload than the R-1 while also using storable liquid propellants. Besides providing the ballistic missiles, the Soviets also gave China the R-2's blueprints and provided advisors to assist in developing a copy of the R-2, which enabled the Chinese to produce and deploy these missiles.

Chinese engineers and students received aeronautical engineering training at the Moscow Aviation Institute and gained experience with more advanced Soviet missiles such as the SS-3 and SS-4, and their knowledge of these missiles was also facilitated by making copies of restricted notes on these weapons. The 1960 Sino–Soviet ideological split ended such cooperation, but the Chinese used the knowledge gained from this brief cooperation and would later acquire from U.S.-trained scientists to expand the growth and progress of their military space programs (U.S. Congress. House Select Committee on U.S. National Security and Military/Commercial Concerns With the People's Republic of China 1999, 1:176–177).

Chinese ballistic missile and space programs grew significantly because of the influence of Qian Xuesen (1911–) who is considered the progenitor of China's ballistic missile force. A Shanghai native, Qian left China during the Japanese occupation in 1935 and emigrated to the United States where he received a master's degree from the Massachusetts Institute of Technology and a Ph.D. from the California Institute of Technology. During his time at Cal Tech, Qian worked with a rocket research group at the Guggenheim Aeronautical Library where his work focused on aviation engineering theory, supersonic and transonic aerodynamics, and thin shell stability theory for ballistic missile structures (House Select Committee on U.S. National Security and Military/Commercial Concerns With the People's Republic of China 1999, 1:177).

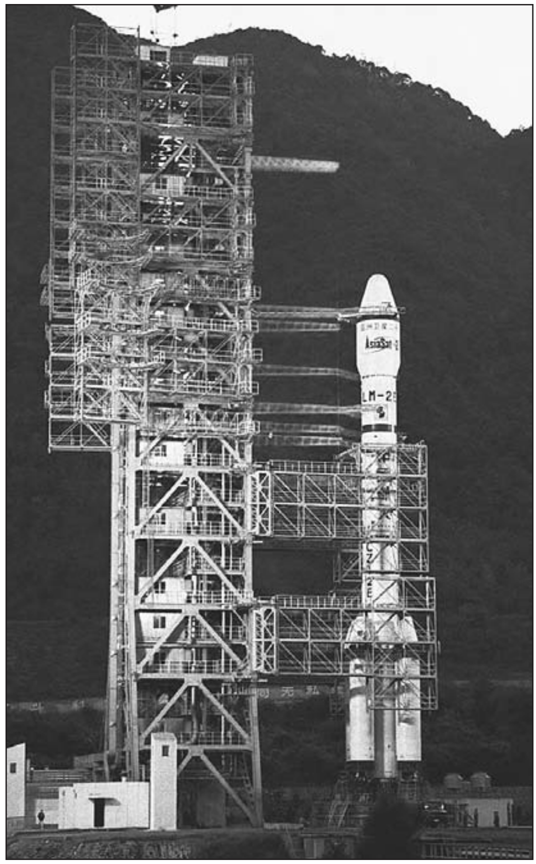
Qian later went on to work at the Jet Propulsion Laboratory and because of his work reputation and quality, he was recruited to join the U.S. Army Air Force in developing its long-range missile programs. He was commissioned as a colonel and began working on the Titan ICBM. However, during the 1950s, allegations arose that he was spying for China. He lost his security clearance, was removed from working on U.S. ballistic missiles, and eventually returned to China in 1955 with four other colleagues from the Titan design unit (House Select Committee on U.S. National Security and Military/Commercial Concerns With the People's Republic of China 1999, 1:178).

Following his return to China, Qian and his associates applied their U.S.-derived knowledge to China's nascent ballistic missile programs. He became the chief project manager in all of China's ballistic missile programs and served as the lead designer of the CSS-4 nuclear ICBM targeted at the United States. Qian also served as the first director of China's Fifth Academy, which is responsible for China's aeronautics and missile development research and is now called China Aerospace Corporation. In 1958 he presented his ideas for satellite development to Communist Party leaders. During 1962 Qian began training Chinese scientists to design and develop satellites including the Dong Fang Hong–1 satellite, which was the first Chinese satellite launched. Qian was personally commended for his satellite work by Mao Zedong and other Chinese Communist leaders, awarded the honorary rank of lieutenant general in the People's Liberation Army (PLA) for his ballistic missile program development work, and in 1991 President Jiang Zemin awarded him with a "State Scientist of Outstanding Contribution," which is the highest national honor a Chinese scientist can receive (House Select Committee on U.S. National Security and Military/Commercial Concerns With the People's Republic of China, 1:179; Descisciolo 2005, 52).

The first Chinese satellite launch was in 1970 using a CSS-3 ICBM launch package, which weighed 380 pounds and stayed in orbit for 26 days. A second successful satellite launch took place on March 3, 1971. Three unsuccessful attempts were made launching longer range and more powerful Long March rockets in 1973 and 1974 before achieving success in 1975. Most subsequent Chinese satellite launches have been of communications, weather, remote sensing, navigation, or scientific satellites, which may have military applications or dual civilian and military applications (Smith 2005, 1; House Select Committee on U.S. National Security and Military/Commercial Concerns With the People's Republic of China 1999, 1:200–201).

In 1974 China launched a series of satellites whose focus involved programs covering remote sensing and microgravity research, and over subsequent decades Chinese space capabilities have grown to encompass communication satellites, groups of launching rockets, a modern space launch complex, and an increasing list of customers for its launch services (Patterson 1995, 3).

In February 1975 the State Council of China approved a report on developing Chinese satellite communications outlined by the State Planning Commission and the National Defense Science and Technology Commission, which facilitated communication satellite development into national plans (Patterson 1995, 4).



AsiaSat 2 sits atop Long March 2E rocket ready for lift-off at the Xichang Space Center launch pad November 28, 1995. *(Manuel Ceneta/AFP/Getty Images)*

These civilian space endeavors were also balanced with a desire to enhance China's military capabilities in space. A 1974 CIA estimate mentioned that China's ICBM arsenal had the ability to hit U.S. forces in Asia and that China wanted to increase the range and striking power of those forces so they could strike the Soviet Union west of the Ural Mountains and the continental United States while also improving the survivability of their nuclear deterrent (U.S. Central Intelligence Agency 1974, 1–5).

China developed the Long March 3 rocket in 1977 to meet requirements for launching communications satellites into geosynchronous orbit and began developing the Long March 4 rocket during the late 1970s to launch meteorological satellites into sun-synchronous orbits for military and civilian purposes. China also began entering the commercial space launch industry around 1986, which proved to be fortuitous timing for them because of the temporary suspension of U.S. space launches following that year's space shuttle Challenger tragedy. This temporary moratorium on U.S. launches was reflected in U.S. policy changes allowing China to launch U.S. manufactured satellites if China signed agreements with the United States on competitive pricing, liability, and protection of U.S. technology. The China Great Wall Industry Corporation vigorously markets Chinese launch services, and revenues earned from Chinese commercial launches are shared between two government organizations, the Commission of Science, Technology, and Industry for National Defense (COSTIND) and the Chinese Aerospace Corporation (CASC) (House Select Committee on U.S. National Security and Military/Commercial Concerns With the People's Republic of China 1999, 1:206–207; Thompson and Morris 2001, 5).

China's nuclear capabilities expanded considerably in 1980 when it successfully tested the DF-5 ICBM, which was capable of reaching the continental United States and in 1982 it successfully tested its first submarine-launched ballistic missile (Roberts 2003, 3).

China's launch site infrastructure also began taking shape in the 1980s. Three of these facilities are responsible for managing Chinese launch capabilities as of late 2005. Xichang, in southeastern China near Chengdu, was opened in 1984 and is responsible for primarily launching communication satellites into geostationary orbit above the equator. Jiuquan or Shuang Cheng-tzu, located in the Gobi Desert, is China's first launch site and launches an assortment of spacecraft including those of China's human space-flight program. Taiyuan, south of Beijing, opened in 1988 and is used for launches into polar orbits, and its satellites include those used for weather and other earth observation assignments (Smith 2005, 1).

Two men monitor a simulated rocket launch at the command and control center in Xichang, China. Mission control is six kilometers from the launch pad. *(Roger Ressmeyer/Corbis)*

President Ronald Reagan's 1983 inauguration of the SDI ballistic missile defense program had a significant impact on Chinese views of the global security environment. Initial Chinese reaction was cautious with some officials asserting that SDI was an understandable and appropriate attempt to counter Soviet attempts to gain strategic superiority. As time evolved, China began distinguishing between ballistic missile defense research and deployment, favoring the former but opposing the latter. Debate over Chinese nuclear doctrine intensified within Chinese military and political circles with there being some evidence that this debate instigated a Chinese move from what could be called "minimum deterrence," to nuclear threats, to a more vigorous posture called "limited deterrence" (Roberts 2003, ES-2; Glaser and Garrett 1986, 28–44).

The end of the Cold War, collapse of the Soviet Union, and declining U.S. interest in SDI seemed to indicate to the Chinese that ballistic missile defense was a less salient issue to U.S. security interests. Ballistic missile defense received new impetus from the 1990–1991 Persian Gulf War and its aftermath, which saw the United States gain renewed interest in theater missile defense (TMD). Chinese policymakers began to worry about the potential consequences of U.S. TMD deployments in East Asia, which were being taken in response to large-scale enhancement of Chinese theater missile forces with Taiwan and its national independence being the primary target of these Chinese missiles (Roberts 2003, ES-3).

In the late 1990s and the early 2000s, the Chinese government launched a concerted campaign against U.S. missile defense plans. Such U.S. responses were propelled by the 1998 North Korean test of a long-range missile that overflew Japan and instigated a U.S. policy decision to deploy a national missile defense system as soon as possible. China claimed that ballistic missile defense was a threat to the viability of its nuclear deterrent, jeopardized what it saw as strategic stability, would reverse "progress" made in deescalating the nuclear "arms race," would ignite nuclear and missile proliferation and an arms race in space, consolidate alleged American global hegemony, exacerbate the Taiwan problem, expand Japan's East Asian regional security role, and deepen U.S. East Asian involvement, whereas China wishes such involvement reduced (Roberts 2003, ES-3; Lee 2001, 85–120; Bermudez 1999; Gertz 2000, 38–43).

U.S. concerns over Chinese space capabilities were enhanced by charges of Chinese espionage at the U.S. Department of Energy (DOE) laboratories and involving thefts of sensitive U.S. space technologies from corporations such as Loral and Hughes. A U.S. House of Representatives select committee chaired by Rep. Christopher Cox (Republican from California) was charged with examining these allegations and released its unclassified three-volume public report in June 1999. Report findings indicated that China had stolen design information on the United States' most advanced nuclear weapons as well as U.S. missile technology and used it for Chinese ballistic missile applications, that this stolen technology was applicable to Chinese ballistic missiles and space-lift rockets, and that U.S. satellite manufacturers had transferred missile design information and technology to China without obtaining legally required U.S. Government licenses.

The Cox Report also revealed that this illicitly obtained information and technology improved the reliability of current and future Chinese rockets and missiles whose uses can include military communications and reconnaissance satellites, space-based sensors, space-based weapons, and satellites for state-of-the-art command and control and sophisticated intelligence collection capabilities. The report also mentioned that China had proliferated missile and space technology to countries as diverse as Iran, Pakistan, Saudi Arabia, and North Korea and other incidents that the report could not disclose without adversely affecting national security (House Select Committee on U.S. National Security and Military/Commercial Concerns With the People's Republic of China 1999, 1:ii, xii, xiv–xv, xvii, xxxvii, 1:172–232, and 2:2–217; Smith 2001, 7-10).

The 1990s saw additional noteworthy developments in Chinese military space programs. In 1992, Chinese President Jiang Zemin approved Project 921 inaugurating a manned space program, and in 1993 PLA chief of staff Chi Haotian visited Russia's Star City cosmonaut training center near Moscow beginning greater bilateral Sino–Russian space cooperation, which continues to the present. In 1999 the Shenzhou 1 rocket, which is an upgraded version of Russia's Soyuz rockets, was unveiled, in 2000 the Chinese launched Beidou 1 as their first navigation satellite, and in October 2003 China's first manned mission was launched on the Shenzhou 5 rocket carrying Lt. Col. Yang Liwei as China's first astronaut on a flight lasting 21 hours and 14 orbits, and which may also have deployed a military intelligence satellite (Descisciolo 2005, 53–54, 60, 62).

The 1990s and early years of the 21st century have also seen Chinese military literature place increasing importance on using space as an arena for military conflict and as an area of military research. Laser radars have become a Chinese military research priority. The Chinese have experimented with lidars, which are similar to radar in that they use laser light reflected from targets and received by optical lenses to locate targets. Lidars use an intensively widened beam to acquire a target, and the beam is reduced to a pencil beam to enhance target calculations. Particular emphasis has been placed by the Chinese on CO2 lasers, and they have also conducted research on a higher powered laser radar, which has space tracking ability (Stokes 1999, 110–111; Feigenbaum 2003; Pillsbury 2000, 363–375).

China has augmented its military space capabilities by secretly acquiring U.S. Patriot missile technology after the 1990–1991 Persian Gulf War, seeking to develop an electromagnetic missile capable of causing severe disruptions to the electronic systems of attacking aircraft and missiles, developing military doctrine advocating the physical destruction of adversary reconnaissance platforms, and developing ballistic missile defense programs capable of countering missiles with a range of 2,500 kilometers (Stokes 1999, 112–115; Frieman 2001, 163–185).

A detailed critique of Chinese military space policy and doctrine is presented in a recent U.S. Army War College assessment, which argues that literature from China's Academy of Military Science, COSTIND, and CASC has supported China developing a military space capability since the 1991 Gulf War. These Chinese organizations recognize the United

States' high reliance on military space systems as a potential "Achilles heel." These and comparable appraisals go on to mention that the PLA and Chinese defense industries are developing active and passive counterspace measures that are being integrated into Chinese military doctrine such as the belief that it is easier to develop ASAT weapons instead of ballistic missile defenses and developing camouflage standards for its deployed missiles to counter foreign optical, infrared, and radar satellite systems (Stokes 1999, 117–118; Johnson-Freese 2003, 259-265; Mulvenon et al. 2006, 67–76; Scobell 2003).

China, as an increasingly important international political, economic, and military power, has sought to reassure the global community that its purposes in space are benign. In 2000, the Chinese government released *China's Space Activities* as a white paper that sought to describe and explain Chinese space policies. This document asserted China sought to adhere to existing international agreements on peaceful uses of outer space and that its overall national space policies aims are:

- to explore outer space and learn more about the cosmos and the earth;
- to utilize outer space for peaceful purposes, promote mankind's civilization and social progress, and benefit the whole of mankind; and
- to meet the growing demands of economic construction, national security, science and technology development and social progress, protect China's national interests, and build up the comprehensive national strength (China Internet Information Center 2000, 1).

The 2002 Chinese defense policy statement also asserted that China opposed weaponizing outer space, theater ballistic missile defense in northeast Asia with particular opposition to any such defense for Taiwan, and that it regretted the U.S. decision to abrogate the ABM Treaty (China Internet Information Center 2002, 2–3). The 2004 version of this document made a brief reiteration of Chinese rhetoric about the peaceful uses of outer space with no additional elaboration (China Internet Information Center 2004, 2; Zhang 2005, 6–11).

Despite these Chinese rhetorical protestations of peaceful space policy intent, the United States remains very concerned about the nature of Chinese military space policy and overall military power. This concern was most vividly expressed in the 2000 defense-spending budget passed in 1999, which required the Defense Department to prepare annual reports for Congress on Chinese military power and strategy (An Act to Authorize Appropriations for Fiscal Year 2000 and for Military Activities of the Department of Defense for Military Construction, and for Defense Activities of the Department of Energy, to Prescribe Personnel Strengths, for Such Fiscal Year for the Armed Forces, and for Other Purposes. Public Law 106–65. 113 U.S. Statutes at Large 2000, 781–782).

The 2000 edition of this report noted that while China had the ability to launch military photoreconnaissance satellites, their technology was obsolescent by Western standards. This report went on to mention that the China–Brazil Earth Resources satellite launched in October 1999 could help Chinese efforts to develop better military reconnaissance satellites and that China and Russia had 11 joint space projects including those involving cooperative manned space activities (U.S. Department of Defense 2000, 14–15).

This report's 2002 edition noted improvements in China's command, control, communications, computers, and intelligence (C4I) capabilities thanks to negotiations with the Belarusian firm Agat to produce relevant battle management software and that China has purchased new space systems such as over-the-horizon radar to increase its ability to detect, monitor, and target western Pacific naval activity. In July 2001, a five-year Sino–Russian cooperation agreement was signed in which these countries established organizations to jointly develop a regional missile defense system and create programs to develop new generation high-tech weapons and equipment (U.S. Department of Defense 2002, 4–5).

In 2003, this report stressed that China likely had thorough knowledge of U.S. and foreign space operations due to open-source information on U.S. space systems and operations, that China had acquired technical assistance applicable to developing laser radars to track and image satellites, that it may have the ability to damage optical sensors on satellites that are vulnerable to laser damage, and that it still desired to develop an ASAT system between 2005–2010 (U.S. Department of Defense 2003, 36).

The 2004 edition of this report detailed additional Chinese military space warfare enhancements but also acknowledged that it still lacked information about the motivations and decision making behind China's policy making in this area because of the considerable secrecy surrounding Chinese national security policy making and the reluctance of Chinese leaders to engage in genuine transparency on these issues (U.S. Department of Defense 2004, 7).

The 2006 edition of this Pentagon report noted continuing Chinese interest in developing radiofrequency, laser, and ASAT weapons, mentioned that China would eventually deploy satellites with advanced imagery, reconnaissance, and earth resource systems capabilities for military purposes to supplement existing coverage with Russian and Western technology. This report also acknowledged that China had launched its second manned space mission on October 12, 2005 with its two-person crew returning safely five days later after performing experiments in space for the first time. There was also acknowledgement of press reports stating that China wants to perform its first space walk in 2007, rendezvous and dock spacecraft between 2009–2012, and have a manned space station by 2020 (U.S. Department of Defense 2006, 32–34).

Besides its launch facilities at Jiuquan, Taiyuan, and Xichang, China maintains an advanced telemetry, tracking, and command network including eight domestic ground-tracking stations, foreign ground-tracking stations in Kiribati in the South Pacific and Namibia, four tracking ships, and two space control facilities. It also established a Space Target and Debris Observation and Research Center in March 2005 to help prevent space

Chinese astronauts Fei Junlong (L) and Nie Haisheng wave as they walk to the launch tower of the Jiuquan Satellite Launch Center in northwest China's Gansu Province on October 12, 2005. *(China Newsphoto/Reuters/Corbis)*

debris strikes against satellites and manned spacecraft (Center for Nonproliferation Studies 2006(a), 1–2).

China's three Beidou 1 navigation satellites, the most recent being launched in May 2003, are believed to have the capability to improve the accuracy of China's long-range weapons and data available to its military forces. The Zi Yuan remote satellites that are part of the China–Brazil Earth Resources Program are believed to have an estimated three- to nine-meter resolution and are considered useful for military purposes despite Chinese assertions that they are used for civilian purposes. There is some evidence that China wants to upgrade its satellites so they have one-meter resolution capability, which may enable them to have the ability to broadcast military data such as maps and enemy force deployments to small field stations (Center for Nonproliferation Studies 2006(b), 1).

China is clearly intent on becoming a major political, economic, and military participant in space. Whether this involvement is benign or has assertive or even hostile military intent toward the United States or other countries is the subject of considerable debate (Lele 2005, 67-75; Lim 2004, 30-39; McCabe 2003, 73-83; Murray and Antonellis 2003, 645-652; Saunders 2005, 21-23). Nevertheless, keeping track of Chinese military space trends and developments and related regional security developments such as its January 2007 destruction of a polar-orbiting weather satellite (British Broadcasting Corporation 2007, 1–3) and related regional security developments such as North Korea's efforts to develop ballistic missiles (Bennett 2004, 79–108) will become increasingly important for the foreseeable future for U.S. and other international military policymakers and for those studying international security trends and developments. These trends, as described in this section on China, make it likely that China will become the primary competitor to U.S. military space policy aspirations in the years and decades to come.

Europe

Many European countries including France, Germany, and the United Kingdom have sought to develop indigenous national space programs and have achieved varying degrees of success with these programs. The growing importance of the European Union (EU) in continental politics and policymaking has influenced European efforts to work together to achieve cooperative solutions to various public policy issues. Civilian space policy and military space policy have gradually become a greater part of this trend, and the concluding section of this chapter will examine the factors shaping historical and contemporary European military space policy.

A 2003 review of European space policy produced under the auspices of the European Union's Institute for Security Studies makes the following appraisal of space policy in European integration.

> Space developments have been independent of the general process of European integration. . . different civilian and military bodies, either exclusively national or acting through various partnerships, have contributed to defining space policy and developing industrial activities. The European Space Agency has become the main authority in the European space industry. However, the growing role of the European Union, the development of military space activities, and changes in the industrial sector are new features that have to be taken into account along with the internal evolution of the national space sectors in individual European member countries (Silvestri 2003, 11):

Following World War II, the United Kingdom secretly began development of the Blue Streak intermediate range ballistic missile program in 1955 and in 1959 began cooperation with the United States on the Ariel scientific satellite, but the British rejected a 1958 proposal to cooperate on space technology with other European nations. Intellectual and policy changes within Britain's then governing Conservative Party would result in the decision to pursue greater cooperation with Europe during the 1960s, and the British would began turning away from the idea of developing their own nationally unique military space capability (Madders 1997, 5–25).

The first attempts for more unified Western European space policy collaboration began during the 1960s. The European Launcher Development Organization (ELDO) began when its convention was signed on March 29, 1962 by Australia, Belgium, France, West Germany, Italy, the Netherlands, and the United Kingdom to give these countries a collaborative space launch capability; it began operations on February 29, 1964 (Madders 1997, 41–55; de Maria 1993; Krige 1994).

Just over two months later, European countries signed a convention creating the European Space Research Organization (ESRO) on June 14, 1962. Signatories to this pact were Belgium, Denmark, France, West Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, and the United Kingdom, and ESRO began operations on March 20, 1964 (Madders 1997, 41–42; Krige 1994). ESRO's mission was to promote peaceful space research and technology collaboration among European states. Its infrastructure would eventually include the European Space Technology Center (ESTEC) in Delft and later Noordwijk, the Netherlands where research, design, development, integration, and testing activities would be handled; an adjacent European Space Laboratory would carry out ESTEC research programs; the European Space Data Center at Darmstadt, West Germany would coordinate tracking, telemetry, and command stations; a sounding rocket facility at Kiruna, Sweden; and the European Space Research Institute (ESRIN) in Frascati, Italy, the responsibility of which was theoretical space science work (Madders 1997, 55–61).

This arrangement in which ELDO and ESRO served as dual European space policy agencies continued for another decade. Dissatisfaction with this arrangement among Western European countries resulted in the replacement of these two agencies with the European Space Agency (ESA) in 1975. This dissatisfaction with European space policy agencies began as early as 1966 when arguments began to be made that there were too many European space organizations and that there needed to be more cost-effective use of these organizations and their capabilities. This desire for greater space policy uniformity was given increased impetus by the 1971 British entry into the European Common Market, which demonstrated a heightened determination by that country to play an enhanced role in European affairs. This move was further accelerated by Michael Heseltine, the British official responsible for space policy. He sought to enhance coordination of British national space capabilities by urging that similar initiatives be taken at the European level (Krige, Russo, and Sebasta 2000, 23).

Continental negotiations to begin revising the organizational structure of European space agencies began in 1971 and continued until 1975. The Convention creating the ESA was signed on May 30, 1975 by Belgium, Denmark, France, West Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, and the United Kingdom. Ireland signed the Convention on December 31, 1975, Canada became a cooperating state in December 1978, Austria signed an Association Agreement with ESA in October 1979, and ESA officially came into existence when France deposited its ratification instrument on October 30, 1980 (Krige, Russo, and Sebasta 2000, 23; Krige and Russo 2000; Bonnet and Manno 1994; Zabusky 1995).

In its founding charter ESA described its institutional mandate as follows:

> The purpose of the Agency shall be 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 (Madders 1997, 180).

An important application of ESA's civilian space capabilities was its development of the Ariane launch vehicles, which were first test launched in 1979 and began operational

Ariane 5G ready to lift off from the Europe's Spaceport in Kourou, French Guiana in 2004. *(European Space Agency)*

launches in 1982. ESA reached an agreement with France to launch these vehicles from a preexisting French launch facility in use since 1964 at Kourou in French Guiana in northeast South America. Kourou is approximately 500 kilometers north of the equator and this location makes it highly suitable for launching satellites into geostationary transfer orbit, which requires few changes to a satellite's trajectory. Kourou's location also enables launches to benefit from the "slingshot" effect of the energy created by the earth's rotation speed around the axis of the north and south poles, which enhances launcher speed consequently saving fuel and money while extending satellite life. Through spring 2004, the ESA had spent 1.6 billion euros developing and enhancing Kourou's ground facilities and infrastructure (Smith 2001, 8; Krige, Russo, and Sebasta 2000, 18–22; European Space Agency 2004, 1–2).

Although ESA began with a strictly civilian mission and orientation, geopolitical developments in the 1980s caused European countries to began looking at possible military and defense applications of space and how ESA might be able to play a role in supporting national military space policies that might have the potential to become European in scope.

Impetus for this reexamination of ESA's civilian-only charter was influenced by President Ronald Reagan's proposed SDI in 1983, which caused some European political figures to see space as having military as well as political applications. A leading European leader responding to this thinking was French president François Mitterand (1916–1996).

In a February 7, 1984 speech in the Netherlands, Mitterand asserted that if Europe were capable of launching a manned space station enabling it to observe, react, and deter possible threats it would enhance European defense and be a response suitable to what he saw as emerging military realities (Scheffran 1999, 92).

The Western European Union (WEU), a European intergovernmental organization concerned with national security (Western European Union 2002) issued a 1984 report advocating an increased military component for European space activities. This prescient document maintained that space would play a leading role in future warfare, that the force projection capability differences between space-faring and non-space–faring nations would be similar to the difference between nuclear and nonnuclear nations, and that ESA should look at developing ASAT and missile defense capabilities (Scheffran 1999, 92–93).

Further support for European military space programs came from reports produced by the German Society for Foreign Policy during the late 1980s and 1990. These studies recommended that satellites be used for applications such as reconnaissance, communications, early warning, disarmament verification, and surveillance of emerging security threats such as ballistic missiles (Scheffran 1999, 93).

WEU issued an additional report on ballistic missile defense in November 1992 that sought to build on its 1984 findings. This report acknowledged Europe was not threatened by ballistic missile attack from the former Soviet Union, but stressed the emerging danger of proliferating ballistic missile technology and the absence of security of nuclear, biological, and chemical warheads stored on the territory of former Soviet republics that were now part of the Commonwealth of Independent States. WEU went on to warn that numerous third world countries in the Mediterranean and Middle East were making concerted efforts to acquire ballistic missiles capable of reaching Europe and that European countries should work on developing ballistic missile defenses (Scheffran 1999, 96–97).

Despite these WEU warnings of the growing military importance of space to European countries and the increasing security threat from ballistic missile technology proliferation, European countries and the European Union have been slow to take substantive steps to address these situations. A 1999 British analysis for this slow European response to space's increasing military importance provides useful background, guidance, and context.

There are three fundamental reasons why a European perspective differs significantly from that of either the United States or the United Kingdom. The first is Europe's fragmentation; because Europe is not a unitary body, the development of any European policy requires the agreement—or at least the tacit consent—of a number of different states, each with their own political agendas to be taken into account. Secondly, the historical background to the development of space research and activity differs within Europe. Historically, the driving force behind the early days of space activity in the United States, and to a large extent in the United Kingdom, was the military. However, this motivating factor has not been the case at the European level. The originators of European space research were scientists rather than the military or politicians (McLean 1999, 47).

An additional decisive factor prompting a lackadaisical European response to military space issues concerns the European national security relationship with the United States and the NATO alliance.

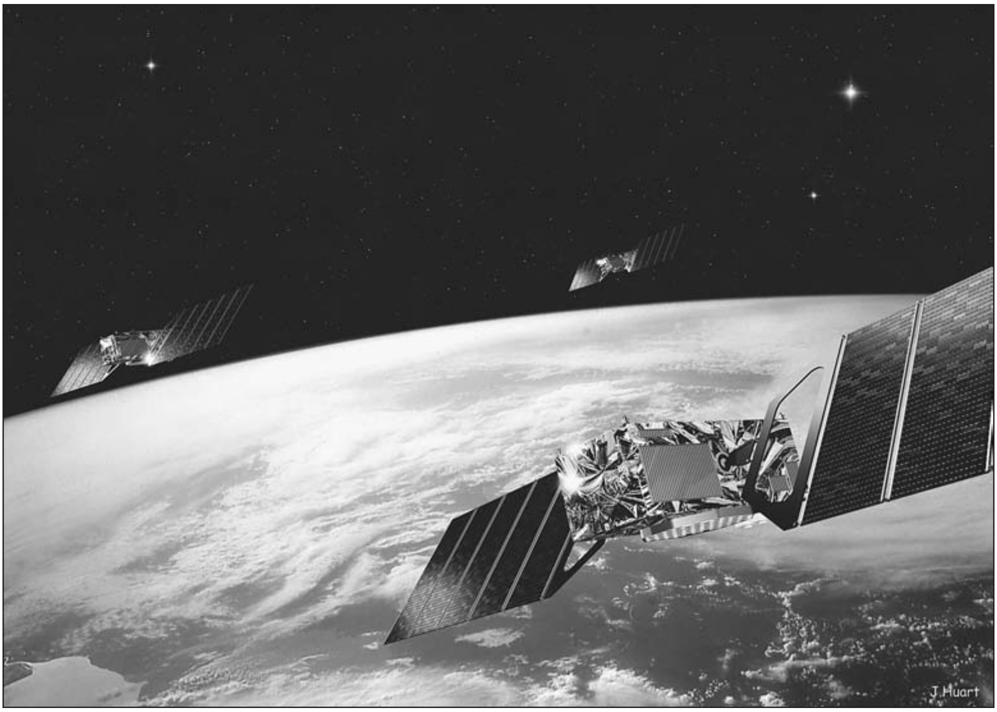
Finally, reliance on the United States is a fundamental reason. The security architecture of Western Europe stems from the North Atlantic Treaty. The transatlantic partnership that is at the heart of NATO is the bedrock of European security, and, within the NATO framework, each of the member states contributes to the security of the others. In terms of military space capability, the United States undoubtedly has the greatest panoply of space assets, and the European members of NATO have seen little reason to duplicate such assets. With a few exceptions, the European allies have been content to assume that, when necessary, U.S. military space capability would be activated (McLean 1999, 47).

Some European military thinkers have recognized the need for Europe to develop an expanded military space capability. There is general acknowledgement that European countries possess the individual national and collective industrial and space science capabilities to develop such a capacity, including ballistic missile defenses. Further, it is also recognized that a European theater missile defense system under NATO auspices should include sensors for early warning and surveillance of ballistic missile attack and missile launch, an interceptor to destroy ballistic missiles at any stage of flight, and necessary battle management and C4I capabilities to handle requisite data processing, communications, and information dissemination skills for ballistic missile defense (Schmidt and Verschuur 1997, 3–5).

The 1990s and early years of the 2000s saw some tentative steps towards expanded European military space capabilities. One example of this is the Galileo satellite system. The European Commission (EC), the European Union's executive organization, proposed Galileo in 1999 for radio-navigation purposes with the project being jointly funded by EU and ESA. In May 2003, these two organizations removed barriers to the Galileo's development (European Commission 2003, 013).

Although publicized as a civilian satellite, Galileo has military applications. An analysis of this system by the European Union's Institute for Security Studies mentions that Galileo's position, navigation, and timing (PNT) capabilities enable it to provide military planners and commanders the ability to achieve greater management effectiveness of infrastructure, troops, and munitions. Galileo's global coverage also makes it possible for its services to be offered or sold to interested parties, which could produce unintended consequences and produce troubling security implications for the EU and its allies (Lindstrom and Gasparini 2003, 4).

The importance of global navigation satellite systems (GNSS) such as Galileo in managing military applications helps U.S. and allied militaries work together in a variety of operational and logistical capacities including positioning and directional information and guiding munitions to intended targets. One analysis describes how GNSS systems such as Galileo or the United States' GPS satellites can influence combat operations.



Artist's concept of the European Space Agency's Galileo satellite system. *(European Space Agency/ J. Huart)*

The capability to synchronize the movement of different units on the battlefield from space, air, sea, and land provides the current and future field commander with unprecedented area awareness. Combined with the accurate weapons guidance provided by GNSS, there is improved strike effectiveness that may minimize the amount of collateral damage caused during an operation. The possibility to strike from a distance reduces risks to military personnel involved in operations. The use of navigation and positioning technology may also reduce the risk of accidents due to friendly fire. Likewise, PNT services can lower risks to personnel operating or patrolling around unmarked borders where boundary transgressions can have dire implications (Lindstrom and Gasparini 2003, 7).

The EU hopes to have launched and deployed a total of 30 Galileo satellites and affiliated ground stations by 2008. An additional belief of EU policymakers is that Galileo assets will benefit increasing international demand for global satellite services and derivative products, which they believe will increase 25% a year and create 100,000 skilled jobs by 2020 (European Commission 2003, 014).

Concern over Galileo's military capabilities has been expressed by some in the U.S. military. One assessment asserts that Galileo reflects a European belief that they should have greater independence from the United States in space policy and that Europe believes Galileo has superior performance capabilities than GPS, that it is more accurate and reliable, and that it has fewer design vulnerabilities than GPS. This same assessment also asserts that Galileo gives Europe an economic opportunity to obtain international satellite market share from the United States and become the global standard in this industry (Beidleman 2005, 150).

Additional concerns expressed by the author of this critical assessment of Galileo's military capabilities as applied to U.S. security are that Galileo could interfere with GPS signals and nullify U.S. navigational warfare capabilities, that Galileo's encryption program has questionable security, and that Galileo's projected widespread international usage and participation could increase future hostile use of Galileo against U.S. national interests (Beidleman 2005, 150–151).

In anticipation of such concerns the United States and EU announced in January 2004 that they were working on a GPS/Galileo cooperation agreement, which would enable Galileo to meet its performance requirements while protecting U.S. and NATO national security needs by separating the signals emitted by Galileo and GPS military services (United States Mission to the European Union 2004, 1–2). Agreement between these parties on this subject was reached and signed at a U.S.–EU conference in Shannon, Ireland on June 26, 2004 (United States Mission to the European Union 2006, 1).

Another European space program with military aspects is the Global Monitoring for the Environment and Security (GMES) initiative. GMES was initiated in 1998 to create an operational system for providing and using space-based information. GMES seeks to establish an independent European capability for Earth observation and monitoring by collaboratively pooling national and multilateral European space assets. An example in this latter category is a 2000 Franco–German decision to develop an independent joint military satellite system. GMES will support both civil and military national satellites used for military purposes by enhancing imagery and mapping capacities (Center for Nonproliferation Studies 2006(c), 1; Fiorenza 2000, 46).

Further official EU support for GMES was provided at the Gothenberg Summit in June 2001 when the European Council called for establishing GMES by 2008. GMES was set up as a collaborative venture between the European Commission and ESA to provide independent, operational, and relevant support in various objectives with its military applications stressing the importance of supporting the EU's Common Foreign and Security Policy (CFSP) and providing early warning capabilities (European Commission 2003, 015–016; Silvestri 2003, 12).

Besides these tentative European forays into military and intelligence uses of space that can augment existing national military space capabilities, the EU has also sought to promote disarmament in space. The following series of quotations by prominent EU policymakers reflects such inconsistent European thinking on military uses of space. EU Research commissioner Phillippe Busquin made the following observations on March 19, 2003 advocating an expanded European military space presence:

> Security must be a key element of a European space policy. The global tensions that we face today are an irrefutable argument for investing in effective space program to meet our security needs, be they civil or military. If China is able to send

> astronauts into space by the end of this year, there should be no reason why Europe cannot develop the space assets that are fundamental to any credible security policy. We have the technological know-how in Europe, but we need to better organise ourselves to define our ambitions and realise them (Center for Nonproliferation Studies 2006(d), 3).

A February 16, 2004 statement by ESA director Jean-Jacques Dordain commented that the distinction between civilian and military space systems made limited sense because the same satellites could be used for both purposes. He went on to assert that defense was the primary force stimulating the development of space systems offering civilian benefits while contending that European civil institutions played the primary role in European security and defense (Center for Nonproliferation Studies 2006(d), 2).

An additional illustration of what can be seen as contradictory European attitudes toward military uses of space was reflected by Ambassador Chris Sanders to a United Nations committee on October 19, 2004. Sanders said the EU was aware of the international community's increasing involvement in space initiatives, which he said should be for peaceful purposes to prevent an "arms race" in space and that the EU believed that the UN's Conference on Disarmament was the only multilateral international organization for negotiating space disarmament agreements (Center for Nonproliferation Studies 2006(d), 1).

An effort to lessen the confusing and contradictory nature of European attitudes toward space military applications was provided in a report produced by the Austrian think-tank the European Space Policy Institute (ESPI). ESPI's November 2005 report *A New Paradigm for European Space Policy: A Proposal* features a number of useful recommendations for bringing greater coherence to European military space programs. These recommendations include enhancing national capability coordination and reducing duplication in military communications' C4Is; breaking down barriers between military and civilian space programs and between ESA programs and security-oriented national or multinational programs; recognizing that an enhanced military program would be beneficial to dual technology aspects of space science and technology and achieve cost efficiencies for civil and military applications; allowing technology developed for civil programs such as meteorological satellites to be used for defense applications while also considering that restrictions placed on civil programs may limit their defense utility; and increasing European commitment to space-based applications with liberally defined defense and security missions. Examples of such missions would include treaty verification, disaster and environmental monitoring, and space surveillance (European Space Policy Institute 2005, 19; McLean 1995, 239–248; Logsdon 2002, 271–280; Peter 2005, 265–296; Gleason 2006, 7–41).

The ESPI report went on to assert that EU space policy should consider how the European space industry would benefit from an expansion of defense and security space programs since participating companies would receive benefits from dual use technology and cost savings by developing common platforms and components. The report also stressed its belief that general European industrial revenues would increase as a result of heightened spending in defense and security space programs (European Space Policy Institute 2005, 23).

European military space efforts will probably experience incremental growth because of the desire of some European leaders to achieve greater independence from U.S. military space policies and overall U.S. national security policies. These leaders will have to struggle against other individual leaders and countries who are more comfortable with U.S. military space policy leadership and do not wish any alterations to reduce the strength of the NATO alliance. Programs such as Galileo and GMES are likely to continue and will gradually increase some European military space capabilities in areas such as threat detection and surveillance.

The ongoing reluctance of many European nations to surrender national security sovereignty to the purported European Common Foreign and Security Policy and conflicting EU stances on whether space should be militarized will continue and make it difficult to produce a unified European military space policy posture. This lack of European security policy cohesion may prove particularly detrimental if Iran's nascent nuclear program develops into a credible security threat to Europe and may have other negative consequences for collective European security and the security of individual European countries. Given the increasing economic and international security importance of space, it is imperative that European nations work collaboratively with the United States or develop their own effective space security architecture or face the prospect that space could be controlled by nations and interests hostile to democratic governance, political pluralism, and free market economics.

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