Space Security 2004

Executive Summary

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The Space Environment

Key Trends and 2004 Developments

Growing debris threats to spacecraft, but annual rate of new debris production is decreasing – The number of objects in Earth orbit has increased steadily since the dawn of the space age. Approximately 13,000 objects large enough to seriously damage or destroy a spacecraft are in orbit today – over 90 percent of which are space debris. While this represents a growing threat to spacecraft, the annual rate of new debris production has been decreasing since the early 1990s, due in large part to national space agency debris mitigation efforts.

The space debris population continued to grow in 2004. Work continued on US technologies to mitigate debris production, by de-orbiting non-operational satellites (e.g. the Terminator Tether) and extending the operational life of satellites (e.g. the ConeXpress). The US Missile Defense Agency (MDA) released an environmental impact statement that examined the anticipated space debris impacts of its planned missile defense space-based interceptors.

Increasing awareness of space debris threats and continued efforts to develop international guidelines for debris mitigation – There is widespread recognition that space debris is a growing threat. There have already been a number of on-orbit collisions with space debris. Since the mid-1990s, many space-faring states, including China, the EU, Japan, Russia, and the US, have developed national debris mitigation standards. In 2001, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) mandated the Inter-Agency Debris Coordination Committee (IADC) to develop a set of voluntary international debris mitigation guidelines.

While the IADC submitted proposed debris mitigation guidelines to COPUOS in 2004, they were sent back to the IADC for more work after several states suggested significant modifications. At the national level, the US Federal Communications Commission (FCC) adopted new regulations in 2004, requiring geostationary satellite operators to move satellites into 'graveyard orbits' 200 to 300 kilometers above GEO at the end of their operating life.

Growing demand for radio frequency spectrum – Expanding satellite applications are driving growing demand for radio frequency spectrum. The number of satellites operating in the 7-8 gigahertz band commonly used by GEO satellites has been increasing. Satellite operators now spend about five percent of their time addressing frequency interference issues. The growth in military bandwidth consumption has been dramatic. The US military used some 700 megabytes per second of bandwidth during Operation Enduring Freedom in 2003, compared to just 99 megabytes per second during Operation Desert Storm in 1991.

In 2004, the US and EU reached an agreement on their long-standing dispute over frequency allocation between the US Global Positioning System (GPS) and the proposed EU Galileo navigational system. The US FCC agreed to allow spectrum sharing between certain Low Earth Orbit (LEO) operators. Plans by Vietnam to launch its first telecommunications satellite in 2005 were delayed when negotiations on frequency use with the operators of neighboring satellites failed.

Growing demand for orbital slot allocations – There are more than 620 operational satellites in orbit today: about 270 in LEO, 50 in Medium Earth Orbit, and slightly more than 300 in GEO. Demand is greatest for GEO orbital slots, where most communications satellites operate. Competition for orbital slot assignments has increased, and disputes between satellite operators seeking slots are more frequent.

In reaction to this scarcity of orbital slots, some actors agreed to exchange or share rights to certain slots in 2004. Telesat Canada agreed to allow a DirecTV satellite to move into one of its slots in exchange for Telesat Canada's use of a DirecTV satellite in another orbital slot. New Skies sold the rights to an orbital slot to Intelsat, which had acquired a satellite that would be too close to avoid interference if New Skies were ever to launch to that slot. Pakistan announced plans to launch an indigenous satellite in a slot that it had maintained with a place-keeping satellite. The International Telecommunications Union (ITU) delayed internal reforms designed to address slot allocation backlogs and related financial challenges.

Space surveillance capabilities to support collision avoidance slowly improving – The US Space Surveillance Network uses 25 sites world-wide to monitor over 9,000 space objects in all orbits, providing the primary capability used by space actors for collision avoidance purposes. Russia maintains its Space Surveillance System with 14 sites, and monitors some 5,000 objects (mostly in LEO), but does not widely disseminate this information. The EU, Canada, France, Germany, and Japan are all developing new space surveillance capabilities.

In 2004, the US began restricting access to its space surveillance information, citing concerns about the potential for the information to be used for adversarial purposes. Japan's new space debris radar became operational and can detect objects one meter in diameter at a distance of 600 kilometers.

Space Security 2004 Survey Results

Half of all Space Security Survey respondents and a majority of Space Security Working Group participants assessed that there was little or no effect on space security in 2004 with respect to this indicator. A strong minority of experts assessed that space security was somewhat enhanced, citing progress on debris mitigation efforts and the conclusion of an agreement on GPS-Galileo frequency interoperability. Many considered that cooperative measures to coordinate the use of radio frequency spectrum, such as the new US FCC regulations on frequency sharing, would improve the availability of these resources. Some experts also noted that while competition over scarce resources could lead to significant conflicts in the future, such conflicts were currently still rare. Many experts who assessed that space security had been somewhat reduced cited as cause for concern the continued growth in the amount of space debris, and new US limitations on the Space Surveillance Network's provision of information to others on the orbital characteristics of satellites and debris. The potential for debris creation by kinetic energy space weapons, including the proposed testing of US space-based missile defense interceptors, was also mentioned as a cause for a negative assessment by several experts.

Laws, Policies, and Doctrines

Key Trends and 2004 Developments

Progressive development of legal framework for outer space activities – Since the signing of the Outer Space Treaty in 1967, the international legal framework related to space has grown to include the Astronaut Rescue Agreement (1968), the Liability Convention (1972), the Registration Convention (1979), and the Moon Agreement (1979), as well as a range of other international and bilateral agreements and relevant customary international law. This legal framework establishes the principle, primarily through the Outer Space Treaty, that space should be used solely for 'peaceful purposes' and that space is not subject to claims of national sovereignty.

This legal framework prohibits the deployment anywhere in space of nuclear weapons or any other weapons of mass destruction. The abrogation of the Anti-Ballistic Missile Treaty in 2002 eliminated a long-standing US/USSR-Russia prohibition on space-based conventional weapons, stimulating renewed concerns about the potential negative implications of space weaponization for space security.

Since 1981, the UN General Assembly (UNGA) has passed an annual resolution asking all states to refrain from actions contrary to the peaceful use of outer space and calling for negotiations within the UN Conference on Disarmament (CD) on a multilateral agreement related to the Prevention of an Arms Race in Outer Space (PAROS). In 2004, the UNGA once again passed a PAROS resolution, with 178 in favor, none against, and abstentions from Haiti, Israel, Palau, and the US. This vote was consistent with several years of voting patterns on earlier UN PAROS resolutions, suggesting a consistent and widespread desire on the part of states to expand international law to include prohibitions against weapons in space.

COPUOS remains active, but the CD has been deadlocked on space weapons issues since 1998 – A range of international institutions, such as the UNGA, COPUOS, the ITU, and the CD, have been mandated to address space security issues. However, most critically for space security, the CD has been deadlocked since 1998 and unable to address the PAROS issue.

The CD remained deadlocked in 2004 and unable to undertake formal work on the PAROS issue. However, useful discussions were conducted on the margins of the CD. During an informal closed session on PAROS, several states called for the establishment of a CD expert group to discuss the broader technical questions surrounding space weapons. An additional informal meeting on 26 August 2004 provided states with an opportunity to make more detailed comments on issues related to space security and PAROS. COPUOS reached agreement in 2004 on the definition of a launching state, which could have a positive effect on issues associated with the application of the Liability Convention.

Space-faring states' national space policies consistently emphasize international cooperation and the peaceful uses of outer space – All space-faring states emphasize the importance of cooperation and the peaceful uses of space, including the use of space to promote national commercial, scientific, and technological advances. China, Brazil, and India tend to place a focus within their national space policies on the utility of space cooperation for social and economic development.

The trend toward greater international space cooperation continued in 2004. There was a deepening of space cooperation in Europe, with an expansion of European Space Agency (ESA) membership to include Luxembourg and Greece, and a partnership with Turkey. The draft EU constitution also explicitly called for a European space policy and space program. The US announced plans in 2004 for peaceful space exploration on the Moon and Mars. The US vision proposed fulfilling commitments to the International Space Station; restoring the Space Shuttle to flight, but retiring it by 2010; undertaking robotic and human exploration of the Moon, Mars, and the Solar System; developing a Crew Exploration Vehicle for missions beyond Earth orbit; and pursuing commercial and international cooperation.

Growing focus within national military doctrine on the security uses of outer space – Fueled by the revolution in military affairs, the military doctrine of a growing number of states, led by China, Russia, the US, and key EU members, is increasingly emphasizing the use of military space systems to support terrestrial military operations. Dependence on space systems has led several of these states to view space assets as national security critical infrastructure. US military space doctrine has also begun to focus on the need to ensure US freedom of action in space, while preventing adversaries from accessing and using space when necessary.

Several states continued to place a greater emphasis on military space applications in 2004. The EU, France, Japan, and Russia articulated new policies designed to increase the uses of space for national security purposes. The US Air Force (USAF) released a doctrine document that outlined in greater detail the practice of 'counterspace operations.' To the extent that the USAF vision of counterspace doctrine is accepted by the US Government, this represents a significant departure from the broadly accepted international legal norm that space should be preserved as an environment that is open to all and belonging to none.

Space Security 2004 Survey Results

A majority of Space Security Survey respondents and Space Security Working Group participants assessed that space security had been somewhat reduced or reduced in 2004 with respect to this indicator. The most commonly cited argument for this assessment was a strong sense that the apparent drive within US military space doctrine toward space control and counterspace capabilities could lead to the weaponization of space, and encourage other space actors to take countermeasures, such as the development of space systems negation capabilities. Some experts cited progress at COPUOS as a positive development with respect to space security. The deadlock at the CD, coupled with the perception that space-related international legal regimes are poorly enforced, was underscored by other experts as detrimental to space security. Finally, some experts pointed out that international space law has not been able to keep pace with the development of new national civil, commercial, and military space policies and capabilities.

Civil Space Programs and Global Utilities

Key Trends and 2004 Developments

Growth in the number of actors gaining access to space – By 2003, there were 10 actors with an independent orbital launch capacity, with an average of one new actor developing such a capability every eight years. A total of 44 states have accessed space through an independent launch capability or the launch capabilities of others. In the 1990s, the rate of increase in this capability doubled from just less than one to just less than two per year, mostly for civil space programs. Surrey Satellite Technology Ltd. of the UK has enabled seven countries to build their first civil satellite over the last 12 years.

2004 saw this trend toward greater civil space access continuing, with Iran announcing plans to launch a satellite in 2005, and South Korea and Russia signing an agreement on the joint development of a launch vehicle planned for use in 2007. The US Boeing Delta IV-Heavy launcher completed its first launch. While the Delta-IV Heavy launcher was developed primarily for the USAF, it will also provide new civil launch capabilities. Overall, a total of 28 civil assets, including satellites and human spaceflights, were launched in 2004, in addition to five launches involving the deployment of seven global utility satellites.

Changing priorities and funding levels within civil space programs – The general trend in recent years has seen civil space expenditures increase in India and China and decrease in the US, Russia, and the EU. The budget of the Indian Space Research Organisation grew over 60 percent in real terms between 1990 and 2000, while the US National Aeronautics and Space Administration (NASA) and ESA budgets dropped by 25 percent and nine percent respectively between 1992 and 2001. The annual number of civil space missions has generally held steady for the past decade, with a decreasing number of manned missions, and an increasing number of missions involving small satellites and micro-satellites. Civil space programs are increasingly including security and development applications. India has designed 19 telecommunications and remote sensing satellites for development applications, and Malaysia, Thailand, Chile, Algeria, Egypt, Nigeria, and South Africa are all placing a priority on satellites to support social and economic development.

In 2004, China announced its intention to establish a manned space station in Earth orbit within 15 years. The US announced a new NASA plan that included returning humans to the moon by 2020 and on to Mars. The US Congress granted NASA its full budget request of $16.2 billion for FY2005 — an increase of five percent over FY2004. China, France, Italy, Spain, and Saudi Arabia launched micro-satellites for civil applications in 2004, and India launched Edusat, its first dedicated educational satellite.

Steady growth in international cooperation in civil space programs – There have been a range of international civil space cooperation efforts over the past decades. These include the US-USSR Apollo-Soyuz docking of manned modules, USSR flights to the MIR space station with foreign representatives, joint NASA-ESA projects such as Skylab, and the Hubble Space Telescope. The most prominent example of international cooperation is the International Space

Station, involving 16 partner states, 44 launches, and an estimated cost of over $100 billion. International civil space cooperation has played a key role in the proliferation of technical capabilities for states to access space.

This trend toward greater international cooperation in civil space programs continued in 2004. A 10-Year Implementation Plan was agreed by the 47 countries within the Global Earth Observation System of Systems initiative. In May, Israel selected India to launch its first astronomy satellite. In October, France and Russia reached an agreement to allow the Soyuz rocket to be launched from the ESA spaceport in French Guyana.

Dramatic growth in global utilities as states acknowledge strategic importance of satellite-based navigation systems – The use of space-based global utilities, including navigation, weather, and search and rescue systems, has grown significantly over the last decade. For example, GPS unit consumption grew by approximately 25 percent per year between 1996 and 1999, generating sales revenue of $6.2 billion in 1999. Today, these systems have grown into space applications that have become almost indispensable to the civil, commercial, and military sectors, as well as most modern economies. Since 2001, satellite-based search and rescue systems have saved the lives of approximately 1,500 people per year, double the 1996 rate. The number of states developing satellite-based navigation capabilities has grown, from Russia and the US in 1990, to include three new systems led by China, the EU, and Japan in 2003. The strategic value of satellite navigation was underscored by the conflict over frequencies for Galileo and GPS.

A total of seven new global utilities satellites were launched in 2004, including one communications satellite and six navigation satellites. The longstanding EU/US conflict over Galileo/GPS frequencies was resolved in 2004. Progress was made on construction of the first two Galileo satellites, and agreements were reached between the EU and Israel and Ukraine on their formal participation in the program.

Space Security 2004 Survey Results

A significant minority of Space Security Survey respondents and Space Security Working Group participants assessed that there was little or no effect on space security in 2004 with respect to this indicator. Respondents who assessed that space security had been somewhat enhanced in 2004 tended to cite the resolution of the GPS/Galileo dispute, as well as new agreements with Ukraine and Israel that will enlarge the Galileo partnership. General growth in the use of global utilities, and corresponding growth in the number of space security stakeholders, was also emphasized as being positive for space security. The role of international civil cooperation in enhancing space security was also frequently noted.

Respondents who assessed that space security had been somewhat reduced in 2004 tended to cite as an issue of concern increased civil-military cooperation — particularly in the US but also in the EU — suggesting that this could encourage some actors to view civil space assets as potential targets for space system negation efforts. Some experts expressed concern about developments associated with the use of nuclear power on civil space missions.

Commercial Space

Key Trends and 2004 Developments

Continued overall growth in the global commercial space industry – The commercial space sector, including manufacturing, launch services, space products, and operating insurance, accounted for an estimated $2.1 billion in revenues in 1980 and $91 billion in 2003. Given recent declining revenues within the manufacturing and launch sectors, this growth is currently being driven by the satellite services industry, including telecommunications, which accounted for 60 percent of 2003 commercial space revenues. Major commercial satellite telecommunications companies today include PanAmSat, Loral, SES Americom, Intelsat, and News Corporation.

The commercial space sector continued to grow in 2004, with sector-wide revenues topping $100 billion. By June 2004, the number of Direct-to-Home television subscribers reached 23.4 million. The US FCC reported in January 2004 that satellites had overtaken cable broadcasters in the competition to provide television service. Military contracts continued to be a source of predicted growth for commercial space actors, second only to sustained telecommunications growth. The privatization of Intelsat in 2004 added a major new player to the commercial space sector. Consolidation appeared to be the priority for the Russian space industry. The Isle of Man announced a zero-tax policy for the space industry in an effort to attract commercial space activities.

Declining commercial launch costs support increased commercial access to space – Commercial space launches now account for about one-third of the total 60-70 yearly space launches. The costs to launch a satellite into GEO have declined from an average of about $40,000/kilogram in 1990 to $26,000/kilogram in 2000, with prices still falling. In 2000, payloads could be placed into LEO for as little as $5,000/kilogram. The European and Russian space agencies are the most active space launch providers. Today's top commercial launch providers include Lockheed Martin and Boeing Launch Services in the US, Arianespace in Europe, Energia in Russia, and two international consortia — Sea Launch and International Launch Service. Cheaper space access has become a key factor in the growth of high-resolution commercial satellite imagery.

There were 20 commercial space assets launched in 2004. Mojave Aerospace Ventures' SpaceShipOne became the first private sub-orbital spacecraft in 2004, winning a $10-million competition designed to spur innovation in commercial space access. Virgin Galactic announced a $100-million investment in SpaceShipOne flights, to begin in 2007.

Bigelow Aerospace announced the $50-million America's Space Prize for the first private orbital flight in 2004. Space Exploration Technologies sold the first contract for its Falcon V rocket, reportedly 60-70 percent less expensive than Boeing's Delta II and Delta IV launchers. US Congress passed into law the Commercial Space Launch Amendments Act of 2004, intended to promote the development of the emerging commercial human space industry.

Government subsidies and national security concerns continue to play an important role in the commercial space sector – The 1998 US Space Launch Cost Reduction Act and the 2003 European Guaranteed Access to Space program provide for significant government subsidization of the space launch and manufacturing markets, including insurance costs. The US space industry reportedly receives 80 percent of the total value of its space contracts from government funds, and in Europe this figure stands at 50 percent. The 1987 Missile Technology Control Regime (MTCR), designed to restrict the proliferation of missile technology, has tended to encourage actors outside the regime to develop capabilities that are restricted by the regime itself.

In 1999, the US transferred control of satellite export licensing from the Commerce Department to the State Department's US Munitions List, bringing satellite product export licensing under the International Traffic in Arms Regulations regime and significantly complicating the way US companies participate in international collaborative satellite launch and manufacturing ventures.

In 2004, the European Aeronautic Defence and Space Company signed an estimated $1.3-billion deal with ESA as part of the European Guaranteed Access to Space program, and signed a second contract with Arianespace for the production of 30 Ariane 5 launchers. Officials openly discussed the possibility of ending the Ariane rocket program after government subsidies run out in 2009. The US National Geospatial-Intelligence Agency also awarded a contract to ORBIMAGE Inc. large enough to secure its role in the industry in the coming years. In February 2004, the MTCR held an initial round of consultations with China regarding its intention to join the regime.

Space Security 2004 Survey Results

A significant minority of Space Security Survey respondents and a majority of Space Security Working Group participants assessed that there was little or no effect on space security in 2004 with respect to this indicator. A significant minority of experts assessed that the continued growth of the commercial space sector had a positive impact upon space security, often noting that this growth, combined with increasing military-commercial interdependence, would underscore the importance of secure and sustainable access to, and uses of, space. The continued vulnerabilities of commercial space assets and the minimal incentives for commercial actors to protect their satellites were highlighted by a number of experts who assessed that space security had been somewhat reduced with respect to this indicator.

Some respondents noted that growth in the commercial space sector was encouraging the development of new regulatory frameworks which could help to encourage the sustainability of space security. Further, some respondents noted that SpaceShipOne's successful sub-orbital space flight was a positive development related to growing access to space. Some respondents pointed out that, although they felt export controls may have a negative impact on the US commercial space sector, such controls were likely to motivate other space actors to develop their own capabilities, thus increasing secure access for the international community writ large.

Space Support for Terrestrial Military Operations

Key Trends and 2004 Developments

The US and USSR/Russia lead in developing military space systems – By the end of the Cold War, the US and USSR had developed extensive military space systems designed to provide military attack warning, communications, reconnaissance, surveillance, and intelligence, as well as navigation and weapons guidance applications. By the end of 2003, the US and USSR/Russia had together launched more than 2,000 military satellites, while the rest of the world had launched only 30 to 40.

The US has dominated the military space arena since the end of the Cold War. The US currently accounts for 95 percent of total global military space expenditures and maintains approximately 135 operational military-related satellites — over half of all military satellites in orbit. Russia is believed to have some 61 operational military satellites in orbit. The US is, by all major indicators, the actor most dependent on its space capabilities. The 2001 *Report of the Commission to Assess United States National Security Space Management and Organization* warned that the US' dependence on space systems made it uniquely vulnerable to a 'space Pearl Harbor' and recommended that the US develop enhanced space control (protection and negation) capabilities. The US has also begun to pursue responsive space lift capability, aiming to reduce the time to deploy new space systems.

While the US continued to lead in the development of military space programs in 2004, several key programs encountered cost overruns and delays. The US Space-Based Infrared System-High, the Space-Based Radar, the Transformational Satellite Communications System, and the Evolved Expendable Launch Vehicle were all over budget. In reaction, the US Congress cut funding for the Space-Based Radar and the Transformational Satellite Communications System. The US small satellite programs TacSat1 and XSS-11, both initially scheduled to launch in 2004, were delayed until 2005. The Responsive Access, Small Cargo, Affordable Launch Vehicle (RASCAL) program also encountered difficulties.

2004 also saw successes for some US military space programs. The 11^{th} Ultra High Frequency Follow-On satellite was handed over to the USAF after successful on-orbit testing by Boeing in March 2004. The Wideband Gapfiller satellite reported being on track to launch at the end of 2005. The Space Tracking and Surveillance System was noted to be ahead of schedule, and the Next-Generation GPS system reported being on track.

In June 2004, the Russian Space Forces launched the second of a projected four Tselina-2 signals intelligence satellites. In July 2004, the commander of the Russian Space Forces noted that Russia will focus on "maintaining and protecting" its fleet of satellites, including launching the remaining seven satellites needed to complete the GLONASS navigation system by 2008. In October 2004, Russian Federation Armed Forces announced that their troops had begun to receive GLONASS navigation units. Russia's space chief claimed in July 2004 that the government had been too slow to fund the Angara rocket as a replacement for the Proton, delaying the final development of the new rocket until 2008 at the earliest.

More states developing military space capabilities – Declining costs for space access and the proliferation of space technology are enabling more states to develop and deploy their own military satellites via the launch capabilities and manufacturing services of others, including the commercial sector.

China provides military communications through its Feng Huo series satellite, and has deployed a pair of Beidou navigational satellites to ensure it can maintain navigational capability in the face of US efforts to deny GPS services in times of conflict. China also maintains two Zi Yuan series satellites in LEO for tactical reconnaissance and surveillance functions, and is believed to be purchasing additional commercial satellite imagery from Russia to suit its intelligence needs.

EU states have developed a modest range of military space systems. France, Germany, Italy, and Spain jointly fund the Helios 1 military observation satellite system in LEO, which provides images with a one-meter resolution. France, Germany, and Italy are planning to launch six low-orbit imagery intelligence systems to replace the Helios series by 2008. The UK maintains a constellation of three dual-use Skynet 4 communications satellites in GEO. The EU Galileo satellite navigation program, initiated in 1999, is intended to operate principally for civil and commercial purposes, but will have a dual military function.

Israel operates a dual-use Eros-A imagery system as well as the military reconnaissance and surveillance OFEQ-5 system. India maintains its Technology Experimental Satellite as well as a naval satellite, both of which provide military reconnaissance capabilities. Japan operates the commercial Superbird satellite, which also provides military communications and has two reconnaissance satellites, one optical and one radar, which it launched in 2003.

A total of 26 military space assets were launched in 2004, including 21 by the US and Russia, and 12 by other states. China reportedly launched three military reconnaissance satellites in 2004. In December 2004, France launched four 120-kilogram Essaim signals intelligence satellites. The Israeli Air Force changed its name to the Israeli Air and Space Force in 2004, while the launch of its OFEQ-6 reconnaissance satellite failed in its third stage in September. South Korea announced the creation of an Air Force Space Command, and Thailand signed a deal with a French company for production of its first intelligence and defense satellite.

Space Security 2004 Survey Results

A majority of Space Security Survey respondents and Space Security Working Group participants assessed that space security had been somewhat reduced, or reduced, in 2004 with respect to this indicator. The most common supporting argument for this assessment was that the growing importance of military space systems, combined with perceptions of their vulnerabilities, was driving a new space systems protection-negation dynamic which was undermining the sustainability of space security. While it was clear that a majority of expert respondents assessed that space systems had improved terrestrial military operations, a lack of transparency and trust between key military space actors remained a significant problem.

Space Systems Protection

Key Trends and 2004 Developments

The US and Russia lead in general capabilities to detect rocket launches, while the US leads in the development of advanced technologies to detect direct attacks on satellites – One key element of space system protection is the timely detection and warning of attacks to enable defensive responses. US Defense Support Program satellites provide some warning of conventional or nuclear ballistic missile-based anti-satellite (ASAT) attacks. Russia began rebuilding its aging missile launch warning system in 2001 by replacing its Oko series satellites with three early-warning satellites (two in HEO and one in GEO). France is due to launch two missile-launch early-warning satellites, Spirale-1 and 2, in 2008. Most actors have a basic capability to detect a ground-based electronic attack, such as jamming, by sensing an interference signal or by noticing a loss of communications. Directed energy attacks such as laser dazzling or blinding, or microwave attacks, move at the speed of light, making it very difficult to obtain advance warning. The US is also developing capabilities to detect in-orbit attacks on satellites through its Rapid Attack Identification, Detection and Reporting System (RAIDRS) program.

In 2004, the US allocated $189 million for a contract to produce a Pathfinder satellite for its new Space-Based Space Surveillance System. The US RAIDRS program received $6.6 million in FY2004, and $16.4 million was requested for its development in FY2005. The 2004 US Defense Authorization Act included restrictions on the provision of satellite orbital information to other actors, a move which could restrict the abilities of other actors to maintain space situational awareness for protection purposes.

Protection of satellite ground stations is a concern, while protection of satellite communications links is poor but improving – Many space systems lack protection from attacks on their ground stations and communications links. For example, a second primary ground station for the critical US GPS system was only put in place some six years after the system itself was operational. The vast majority of commercial space systems have only one operations center and one ground station, leaving them vulnerable to negation efforts. While many actors employ passive electronic protection capabilities, such as shielding and directional antennas, more advanced measures, such as burst transmissions, are generally unique to military systems and the capabilities of more technically advanced states. The US has been developing a variety of jamming protection capabilities, including its Global Positioning Experiments project, which would use airborne pseudo-satellites to provide GPS signals with the capability to overpower jammers.

2004 saw evidence of greater efforts to address the protection of satellite ground stations and communications links. China announced that it would launch a 'jam-proof' communications satellite in 2005. The US completed testing of a jam resistant phased array antenna for its Advanced Extremely High Frequency defense communications satellites. In March 2004, a US National Security Telecommunications Advisory Committee study emphasized that the most likely threats to commercial satellites are attacks on ground facilities, from computer hacking or, possibly but less likely, jamming of communications.

Protection of satellites against some direct threats is improving, largely through radiation hardening, system redundancy, and greater use of higher orbits – Both the range of actors employing satellite protection capabilities and the depth of these capabilities are increasing. China, the EU, and Japan are developing navigation satellites that will increase the global redundancy of such critical systems. States are increasingly placing military satellites into higher orbits where vulnerability from various attacks is lower than in LEO, due to greater warning times and difficulty of access. Most key US/NATO and Russian military satellites are already hardened against the effects of a high-altitude nuclear detonation. Reflecting concerns about the protection of commercial satellites, in 2002, the US General Accounting Office recommended that "commercial satellites be identified as critical infrastructure."

This growing emphasis on protection capabilities continued in 2004. The EU and US agreement on Galileo-GPS helped to secure greater redundancy of satellite navigation systems through interoperability. The US is reportedly developing a stealth satellite, known as Misty-3, with enhanced protection through its ability to evade detection by the space surveillance systems of other actors.

Russia and the US lead in capabilities to rapidly rebuild space systems following a direct attack on satellites – Russia and the US maintain critical space systems protection capabilities through the ability to responsively re-constitute satellite systems. The US is supporting two responsive initiatives. The FALCON - Force Application and Launch from CONUS (CONtinental US) program seeks to develop a rocket capable of placing 100-1,000 kilograms into LEO within 24 hours, and the RASCAL program seeks to deliver 50-130 kilograms into LEO on short notice. The US is also supporting the High Frequency Active Auroral Research Program, focused on measures to mitigate the environmental impact of a nuclear attack in space.

In 2004, Russia conducted a military exercise which included launches to simulate "the replacement of satellites lost in action." In the US, contracts worth $41 million were signed for Phase II of the FALCON program.

Space Security 2004 Survey Results

A majority of Space Security Survey respondents assessed that there was little or no effect on space security in 2004 with respect to this indicator, while the largest number of Space Security Working Group participants assessed that space security had been 'somewhat enhanced.' Several expert respondents made the point that this positive assessment was justified by a growing awareness of the need for protection capabilities, coupled with enhanced capabilities to resist jamming of communications links. A number of expert respondents argued that threats to satellites are being inflated. Most agreed that there was insufficient effort being focused on efforts to protect satellite ground stations from attacks, where vulnerabilities are greatest. Experts frequently noted concerns associated with a nuclear attack in space related to the announcement by North Korea that it now possesses nuclear weapons.

Space Systems Negation

Key Trends and 2004 Developments

Proliferation of capabilities to attack ground stations and communications links – Ground segments and communications links remain the most vulnerable components of space systems, susceptible to attack by conventional military means, computer hacking and electronic jamming. A number of electronic jamming incidents targeting communications satellites have been reported in recent years, with interruptions in US broadcasting service blamed on Iran working within Cuba, Turkey blocking Kurdish news broadcasts, and the Falun Gong group in China. Iraq's acquisition of GPS-jamming equipment for use against US GPS-guided munitions during Operation Iraqi Freedom in 2003 suggested that jamming capabilities are proliferating. The US appears to be the leader in developing advanced technologies to temporarily negate space systems by disrupting or denying access to satellite communications.

US leadership in developing capabilities to negate satellite communications continued in 2004 with the deployment of the US Counter Satellite Communications System, a mobile system designed to target satellite communications signals. A December 2004 US *Presidential Directive on Space-Based Positioning, Navigation and Timing Systems* called for the development of US capabilities to deny local access to GPS signals, without disrupting other services.

The US leads in the development of space situational awareness capabilities to support space negation – Several space actors are increasingly investing in space surveillance capabilities for debris monitoring, satellite tracking and telemetry, and asteroid detection. The US and Russia maintain the most extensive space surveillance capabilities. China and India also have satellite tracking, telemetry, and control assets essential to their civil space programs. Canada, France, Germany, and Japan are all actively expanding their ground-based space surveillance capabilities. Although this technology enhances transparency and enables space collision avoidance, it also provides capabilities for targeting and space negation. For example, the US has explicitly linked its development of enhanced space surveillance systems to its efforts to enable offensive counterspace operations.

The US continued development of a range of space surveillance capabilities linked to space control applications in 2004, including the Orbital Deep Space Imager, designed to operate in GEO to provide a near real-time operating picture in support of space control operations; the Rapid On-Orbit Anomaly Surveillance and Tracking system, which will use lightweight components to provide low-cost space situational awareness; the Deep View program, designed to provide images of smaller objects in orbit; and, the Space Surveillance Telescope, designed to identify harder-to-detect orbital objects.

Ongoing proliferation of ground-based capabilities to attack satellites – A variety of US and USSR/Russian programs throughout the Cold War and into the 1990s sought to develop ground-based ASAT weapons employing conventional, nuclear, and directed energy capabilities. The capability to launch a payload into space to coincide with the passage of a satellite in orbit is a basic requirement for conventional satellite negation systems. Some 28 states have demonstrated sub-orbital launch capabilities, and of those, 10 have an orbital launch capability. As many as 30 states may already have the capability to use low-power lasers to degrade unhardened satellite sensors.

The US leads in the development of more advanced ground-based kinetic-kill systems with the capability to directly attack satellites. It has intensified its efforts to deploy a ground-based ballistic missile defense system, widely assessed to provide an inherent LEO satellite negation capability.

In 2004, the first kill vehicles for the US ground-based missile defense system were deployed to Fort Greely, Alaska. The US Airborne Laser, designed for boost-phase missile defense, successfully generated a laser beam and is moving to flight testing — a key milestone for another system with an inherent satellite negation capability. The USAF "Counterspace Operations" doctrine released in 2004 recommended the development of satellite negation options, including kinetic-kill ASATs and directed energy weapons. The US Congress cut funding for the Counter Surveillance/Reconnaissance System, believed to be a mobile system designed to use lasers to disrupt the sensors of surveillance satellites.

Increasing access to space-based negation enabling capabilities – Space-based negation efforts require sophisticated capabilities, such as precision in-orbit maneuverability and space tracking. Many of these capabilities have dual-use potential. For example, micro-satellites provide an inexpensive option for many space applications, but could be used as kinetic-kill vehicles. The US leads in the development of most of these enabling capabilities, though none appear to be integrated into space-based negation systems.

US programs in this area experienced some setbacks in 2004. Tests for the NASA Demonstration for Autonomous Rendezvous Technology satellite and the Air Force Experimental Spacecraft System-11 were delayed. Other actors, both commercial and governmental, have made recent advances in acquiring access to space — the basic enabling technology for both ground-based direct ascent and space-based ASATs. SpaceShipOne of the American company Mojave Aerospace Ventures, became the first private manned spacecraft by successfully completing a test flight into space on a sub-orbital trajectory. The Iranian Defense Minister was reported in 2004 announcing Iran's intentions to launch a satellite into orbit using indigenous launch capacity based on its extensive missile program.

Space Security 2004 Survey Results

A majority of Space Security Survey respondents and Space Security Working Group participants assessed that space security was somewhat reduced or reduced with respect to this indicator in 2004. Deployment of the US Counter Satellite Communications System was frequently cited as a significant development, as was continued pursuit of enabling technologies for permanent negation of space systems, including those developed through US ballistic missile defense programs. Several participants acknowledged the current US emphasis on temporary and reversible negation techniques, but noted that retaining the option of using space negation systems, particularly kinetic-kill weapons, negatively impacts space security. Some respondents noted that budget limitations on many US programs for negation enabling technologies limited the potential negative impact of these systems.

Space-Based Strike Weapons

Key Trends and 2004 Developments

While no space-based strike weapons (SBSW) have yet been tested or deployed in space, the US continues to develop a space-based interceptor for its missile defense system – Although the US and USSR developed and tested ground-based and airborne ASAT systems between the 1960s and 1990s, there has not yet been any deployment of space-to-Earth or space-to-missile SBSW systems. Under the Strategic Defense Initiative in the 1980s, the US invested several billion dollars in the development of a space-based interceptor (SBI) concept called Brilliant Pebbles, and tested targeting and propulsion components required for such a system. The US and USSR were both developing directed energy SBSW systems in the 1980s, although today these programs have largely been halted.

US research and development efforts associated with the SBI program declined in the 1990s, but were revived by the US MDA in 2000. The Near-Field Infrared Experiment (NFIRE), due for launch in 2006, was planned to be the first fully integrated SBSW spacecraft with a sensor platform and a kinetic-kill vehicle. Further MDA plans include the deployment of a test-bed of three to six integrated SBI by 2011-2012. The annual SBI budget is estimated to be only about $100 million within a broader MDA budget of $10 billion. However, even at these funding levels, the timeline for developing the technical capabilities for SBI appears to be decreasing. While such a system would have limited strategic utility, it would represent the first deployment of weapons in space.

In February 2004, the MDA requested $68 million for FY2005-2006 for the development and deployment of the NFIRE satellite. It would include a sensor package which would test lightweight infrared sensors for missile tracking, as well as a kill vehicle planned to simulate missile intercept maneuvers, demonstrating necessary attitude control, high-G thrust maneuvering, and autonomous missile tracking.

In May 2004, the US Senate Armed Services Committee authorized funding for NFIRE, but added the condition that the test be conducted in such a way as to avoid intercepting the target. In June 2004 the US House of Representatives cut funding for NFIRE. By August 2004, the House of Representatives and the Senate settled to maintain funding for NFIRE at the requested amount.

In August 2004, citing technical difficulties, the MDA announced that the NFIRE kill vehicle main thruster had been removed and that the launch date had been pushed back from the first quarter of 2006 to the last quarter, with test missile flybys moved to 2007. Presently, NFIRE is planned to perform a test with a 20-kilometer flyby of one or two missiles to simulate a kill operation. These developments suggest that the MDA considers itself just a few years away from being able to deploy a fully integrated SBSW system.

A growing number of actors are developing SBSW precursor technologies outside of SBSW programs – A majority of SBSW prerequisite technologies are dual-use. They are not related to dedicated SBSW programs, but are developed through other civil, commercial, or military space programs. While there is no evidence to suggest that states pursuing these enabling technologies intend to use them for SBSW systems, their development does bring these actors technologically closer to such a capability.

Both the number of such technologies being pursued in non-SBSW programs and the number of actors doing so are increasing. For example, India and Israel are developing precision attitude control and large deployable optics for civil space telescope missions. In the last 12 years, a total of nine states have deployed a first small or micro-satellite — a key SBI precursor technology. China and the EU are developing re-entry technologies which are also required for the delivery of mass-to-target weapons from space to the Earth.

The trend toward the progressive development of dual-use capabilities that are also prerequisite SBSW capabilities continued in 2004. On 22 March and 18 October respectively, Israel and the Ukraine joined the EU Galileo project, providing the basis for their future access to a key, high-precision satellite navigation capability. French micro-satellites were launched in the joint civil-military Myriade micro-satellite program in June and December. On 24 October, China announced a civilian space telescope mission that will demonstrate precision attitude control capabilities.

Space Security 2004 Survey Results

A majority of Space Security Survey respondents and Space Security Working Group participants assessed that there was little or no effect on space security in 2004 with respect to this indicator. One of the most common comments supportive of a more negative assessment was related to the potential of SBSW to stimulate an arms escalation dynamic, in particular by encouraging the development of space systems negation capabilities by other states. Another frequently mentioned concern expressed by experts was related to the apparent determination of the US MDA to pursue the development and deployment of interceptors for a space-based anti-ballistic missile system. Others noted that the scale of US spending on SBSW was relatively modest. Many respondents welcomed the decision by the MDA to remove the kill vehicle on NFIRE, noting that this was a positive development with respect to space security.

Overall Space Security 2004 Assessment

Overall, a strong majority of 71 percent of Space Security Working Group experts assessed that space security had been somewhat reduced in 2004. The most common reason for this assessment was the view that developments in military space doctrine, particularly in the US, could limit the secure access to space and lead to negative strategic reactions internationally. Many experts also pointed to the development of ASAT technology through funded military and dual-use civil programs. Some 8 percent of SSWG respondents assessed that space security had been somewhat enhanced in 2004 referring to increased international cooperation, budget cuts in certain ASAT-capable military space programs, and commercial sector growth. Finally a solid minority of 21 percent assessed that, on a balance, developments in 2004 had had little or no effect on space security.