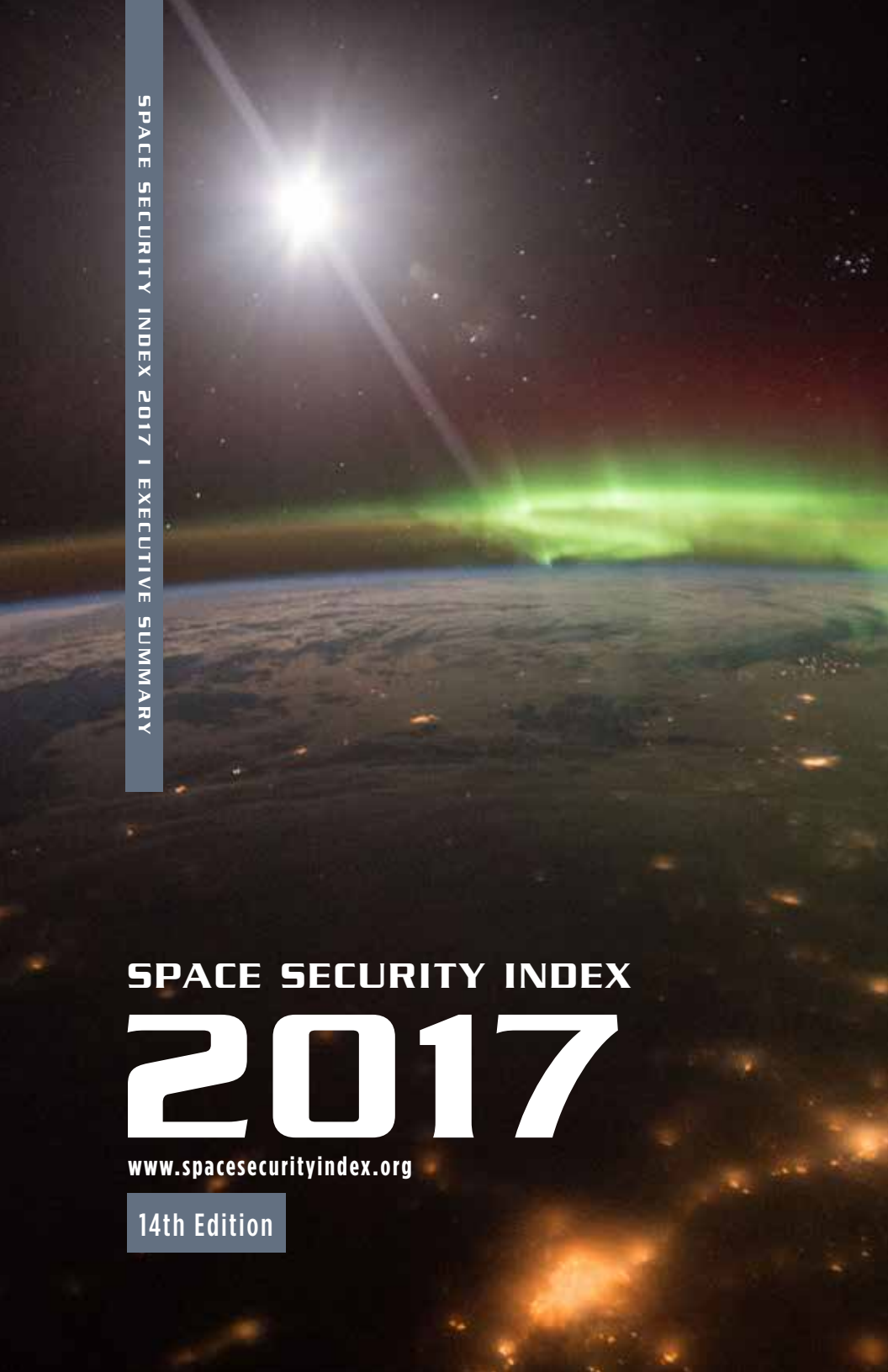
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Cover image: NASA astronaut Scott Kelly took this majestic image of the Earth at night, highlighting the green and red hues of the Aurora, 20 January 2016. Credit: NASA

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INTRODUCTION

Space Security Index 2017 is the fourteenth annual report on developments related to safety, sustainability, and security in outer space, covering the period January-December 2016. It is part of the broader Space Security Index (SSI) project, which aims to improve transparency on space activities and provide a common, comprehensive, objective knowledge base to support the development of dialogue and policies that contribute to the security and sustainability of outer space.

The definition of space security guiding this report reflects the intent of the 1967 Outer Space Treaty that outer space should remain open for all to use for peaceful purposes now and in the future:

> TThe secure and sustainable access to, and use of, space and freedom from space-based threats.

The key consideration in this SSI definition of space security is not the interests of particular national or commercial entities, but the security and sustainability of outer space as an environment that can be used safely and responsibly by all. This broad definition encompasses the sustainability of the unique outer space environment, the physical and operational integrity of manmade objects in space and their ground stations, as well as security on Earth from threats and natural hazards originating in space.

Outer space resources play a key role in the activities and well-being of all nations, supporting applications from global communications to financial operations, farming to weather forecasting, and environmental monitoring to navigation, surveillance, and treaty monitoring. In this context, issues such as the threat posed by space debris, the priorities of national civil space programs, the growing importance of the commercial space industry, efforts to develop a robust normative regime for outer space activities, and concerns about the militarization and potential weaponization of space are critical elements influencing overall space security.

The information in the report is organized under four broad Themes, with each divided into various indicators of space security. This arrangement is intended to reflect the increasing interdependence, mutual vulnerabilities, and synergies of outer space activities.

The structure of the 2017 report is as follows:

- **Theme 1: Condition and knowledge of the space environment**
  Indicator 1.1: *Orbital debris*
  Indicator 1.2: *Radio frequency (RF) spectrum and orbital positions*

Indicator 1.3: *Natural hazards originating from space*
Indicator 1.4: *Space situational awareness*

» **Theme 2: Access to and use of space by various actors**
Indicator 2.1: *Space-based global utilities*
Indicator 2.2: *Priorities and funding levels in civil space programs*
Indicator 2.3: *International cooperation in space activities*
Indicator 2.4: *Growth in commercial space industry*
Indicator 2.5: *Public-private collaboration on space activities*
Indicator 2.6: *Space-based military systems*

» **Theme 3: Security of space systems**
Indicator 3.1: *Vulnerability of satellite communications, broadcast links, and ground stations*
Indicator 3.2: *Reconstitution and resilience of space systems*
Indicator 3.3: *Earth-based capabilities to attack satellites*
Indicator 3.4: *Space-based negation-enabling capabilities*

» **Theme 4: Outer space governance**
Indicator 4.1: *National space policies*
Indicator 4.2: *Multilateral forums for space governance*
Indicator 4.3: *Other initiatives*

The most critical challenge to the safety, security, and sustainability of outer space continues to be the threat posed by space debris to the spacecraft of all nations. The total amount of manmade space debris in orbit is growing each year, concentrated in the orbits where human activities take place.

Today the U.S. Department of Defense is using the Space Surveillance Network to track some 23,000 pieces of debris 10 centimeters in diameter or larger. Experts estimate that there are more than 500,000 objects with a diameter larger than one centimeter and several million that are smaller. As debris increases and outer space becomes more congested, the likelihood that space assets may collide with a piece of orbital debris or even with one another increases, making all spacecraft vulnerable, regardless of the nation or entity to which they belong.

Awareness of the space debris problem has grown considerably in recent years, and significant efforts have been made to mitigate the production of new debris through compliance with national and international guidelines. The development and testing of technology to actively remove debris may one day contribute to the sustainability of outer space; however, there is currently no political consensus that this should be done or by whom, and financial challenges exist. The growing use of small satellites and recent proposals to deploy large constellations of commercial satellites are raising additional questions about long-term sustainability.

Similarly, the development of space situational awareness (SSA) capabilities to track space debris provides significant space security advantages—for example, when used to avoid collisions. The sensitive nature of some information and the small number of space actors with advanced tools for surveillance have traditionally kept significant data on space activities shrouded in secrecy. But recent developments followed by the Space Security Index suggest that there is a greater willingness to share SSA data through international partnerships—a most welcome trend. In addition, commercial providers of SSA information have recently emerged.

More nations are participating in outer space activities as technological barriers to entry go down. However, the limitations of some space resources such as radio frequencies and orbital positions challenge the ability of newcomers to gain equitable access.

Access to the benefits of outer space has also accelerated through the growth of space-based global utilities over the last decade. Millions of individuals rely on space applications on a daily basis for functions as diverse as weather forecasting, navigation, and search-and-rescue operations.

International cooperation remains key to both civil space programs and global utilities. Collaboration in civil space programs can assist in the transfer of expertise and technology for the access to, and use of, space by emerging space actors. Projects that involve complex technical challenges and mammoth expense, such as the International Space Station, require nations to work together. The degree of cooperation in space, however, may be affected by geopolitical tensions on Earth.

The role that the commercial space sector plays in the provision of launch, communications, imagery, and manufacturing services and its relationship with civil and military programs make this sector an important determinant of space security. A healthy space industry can lead to decreasing costs for space access and use, and may increase the accessibility of space technology for a wider range of space actors. Recently, commercial actors are driving the development of new technologies, services, and economic activities in outer space.

The military space sector wields considerable influence in the advancement of capabilities to access and use space. Many of today's common space applications, such as satellite-based navigation, were first developed for military use. Space systems have augmented the military capabilities of a number of states by enhancing battlefield awareness, offering precise navigation and targeting support, providing early warning of missile launch, and supporting real-time communications. Furthermore, remote sensing satellites have served as a technical means for nations to verify compliance with international nonproliferation, arms control, and disarmament regimes.

However, the use of space systems to support terrestrial military operations could be detrimental to space security if adversaries, viewing space as a new source of military threat or as critical military infrastructure, develop negation capabilities to neutralize the space systems of other nations.

The security dynamics of space systems protection and negation are closely related and space security cannot be divorced from terrestrial security. In this context, it is important to point out that offensive and defensive space capabilities are not only related to systems that are physically in orbit, but include orbiting satellites, ground stations, and data and communications links.

No hostile anti-satellite attacks have been carried out against an adversary; however, recent incidents testify to the availability and effectiveness of anti-ballistic missile systems to destroy satellites in outer space. The ability to rapidly rebuild or repair space systems after an attack could reduce vulnerabilities in space by making these systems more resilient to harmful acts. Similarly, the use of smaller spacecraft that may be deployed as distributed systems can improve continuity of capability and enhance security through redundancy and rapid replacement of assets. However, the development of advanced on-orbit capabilities in outer space could also enable space-based negation activities.

International instruments that regulate space activities have a direct effect on space security because they establish key parameters for acceptable behavior in space. These include the right of all countries to access space, prohibitions against the national appropriation of space, and the obligation to ensure that space is used with due regard to the interests of others and for peaceful purposes. International space law, as well as valuable unilateral, bilateral, and multilateral transparency and confidence-building measures, can make space more secure by regulating activities that may infringe upon the ability of actors to access and use space safely and sustainably, and by limiting space-based threats to national assets in space or on Earth.

While there is widespread international recognition that the existing regulatory framework is insufficient to meet current and future challenges facing the outer space domain, the development of an overarching normative regime has been slow. Space actors have been unable to reach consensus on the exact nature of a space security regime, although specific alternatives have been presented.

Proposals include both legally binding treaties, such as the proposed Treaty on the Prevention of the Placement of Weapons in Outer Space, and of the Threat or Use of Force against Outer Space Objects (known as the PPWT), and politically binding norms, such as the proposed International Code of Conduct for Outer Space Activities.

Because our coverage of space security is captured across many different indicators, *Space Security Index 2017* includes a Global Assessment, which is intended to analyze and evaluate the effects of changing trends, critical themes, key highlights, breaking points, and new dynamics that are shaping the security of outer space and require international attention.

The Global Assessment is prepared by a different expert on space security every year to encourage a range of perspectives over time. The author of the current assessment is Dr. Laura Grego, a Senior Scientist at the Union of Concerned Scientists and longtime contributor to the Space Security Index process.

The information in *Space Security Index 2017* is from open sources. Great effort is made to ensure a complete and factually accurate description of events. Project partners and sponsors trust that this publication will continue to serve as both a reference source for capacity building, and as a tool for supporting trust, transparency, and dialogue in the pursuit of policymaking to enhance the safe, sustainable, and secure use of outer space for all users.

Expert participation in the Space Security Index is a key component of the project. The primary research is peer-reviewed prior to publication through various processes. For example, the Space Security Working Group in-person consultation is held each spring for two days to review the draft text for factual errors, misinterpretations, gaps, and misstatements. This meeting also provides an important forum for related policy dialogue on recent developments in outer space.

For further information about the Space Security Index, its methodology, project partners, and sponsors, please visit the website **www.spacesecurityindex.org**, where you can find the full report, *Space Security Index 2017*, in the Autumn of 2017. Comments and suggestions are welcome. Note that, unless specified, all monetary amounts are in U.S. dollars.

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EXECUTIVE SUMMARY

Definition of space security: secure and sustainable access to and use of space, and freedom from space-based threats

Theme 1: Condition and knowledge of the space environment

INDICATOR 1.1: Orbital debris — Space debris poses a significant, constant, and indiscriminate threat to all spacecraft. Most space missions create some space debris, mainly rocket booster stages that are expended and released to drift in space along with bits of hardware. Serious fragmentations are usually caused by energetic events such as explosions. These can be both unintentional, as in the case of unused fuel exploding, or intentional, as in the testing of weapons in space that utilize kinetic energy interceptors. Traveling at speeds of up to 7.8 kilometers (km) per second, even small pieces of space debris can destroy or severely disable a satellite upon impact.

The number of objects in Earth orbit has increased steadily. This was accelerated by recent events such as the Chinese intentional destruction of one of its satellites in 2007 and the accidental 2009 collision of a U.S. Iridium active satellite and a Russian Kosmos defunct satellite. There have already been a number of collisions between civil, commercial, and military spacecraft and pieces of space debris. Although a rare occurrence, the reentry of very large debris could also potentially pose a threat on Earth.

There is international consensus that debris is a problem that needs to be mitigated. Voluntary guidelines have been developed by the Inter-Agency Space Debris Coordination Committee (IADC) and endorsed by the UN General Assembly, but implementation remains a challenge that is further complicated by new technologies and practices. Capabilities for active removal of existing debris are being developed, but there is no consensus that it should be done.

2016 Developments

Space object population

- Legacy hardware failures cause several minor on-orbit breakups

Debris-related risks and incidents

- Minor damage to spacecraft, orbital maneuvers caused by space debris
- Concerns raised by uncontrolled spacecraft reentries

International awareness of debris problem increases as progress toward solutions continues

- Compliance trends with debris mitigation guidelines vary
- Focus expands on deorbiting satellites to mitigate debris
- First substantive efforts to develop active-debris-removal capabilities face economic and political obstacles
- Filings for large constellations of satellites raise questions about debris mitigation
- Political efforts made to minimize space debris advance

INDICATOR 1.2: Radio frequency (RF) spectrum and orbital positions — The growing number of spacefaring nations and satellite applications is driving the demand for access to limited radio frequencies and orbital slots. While interference is not epidemic, it is a growing concern for satellite operators, particularly in crowded space segments. Issues of interference arise primarily when two spacecraft require the same frequencies at the same time and their fields of view overlap or they are transmitting in close proximity to each other. More satellites are locating in Geostationary Earth Orbit (GEO), using frequency bands in common and increasing the likelihood of frequency interference. The increased competition for orbital slot assignments, particularly in GEO, where most communications satellites operate, has caused occasional disputes between satellite operators. The International Telecommunication Union (ITU) has been pursuing reforms to address slot allocation backlogs and other related challenges. Prospects for large constellations of satellites are adding pressure to regulate these space resources.

2016 Developments

- Bringing-into-Use deadlines extended for expanded range of cases
- Concerns related to regulation, congestion, and interference follow filings for large satellite constellations
- Technological efforts are made to use radio frequency more efficiently
- Radio frequency interference an ongoing concern

INDICATOR 1.3: Natural hazards originating from space — Such hazards fall into two categories: Near-Earth Objects (NEOs) and space weather. NEOs are asteroids and comets in orbits that bring them into close proximity to Earth. By mid-2016 there were 14,653 known Near-Earth Asteroids, 1,723 of which were identified as Potentially Hazardous Asteroids, whose orbits come within 0.05 astronomical units of Earth's orbit and have a brightness magnitude greater than 22 (approximately 150 meters in diameter). Increasing international awareness of the potential threat posed by NEOs has prompted discussions at various multilateral forums on the technical and policy challenges related to mitigation. Ongoing technical research is exploring how to mitigate a NEO collision with Earth.

"Space weather" is a term that over the past few years has come to refer to a collection of physical processes, beginning at the Sun and ultimately affecting human activities on Earth and in space. The Sun emits energy as flares of electromagnetic radiation and as electrically charged particles through coronal mass ejections and plasma streams. Powerful solar flares can cause radio blackouts and slow down satellites, making them move to lower orbits. Increases in the number and energy of charged particles can induce power surges in transmission lines and pipelines, disruptions to high-frequency radio communication and Global Positioning System (GPS) navigation, and failure or incorrect operation of satellites.

2016 Developments

Near-Earth Objects

- United States emphasizes NEO early warning and preparedness, but knowledge gaps remain
- Coordination through International Asteroid Warning Network and Space Mission Planning Advisory Group progresses
- Efforts to mitigate threats from hazardous asteroids face several setbacks

Space weather

- United States adopts National Space Weather Action Plan and National Space Weather Strategy
- Efforts ongoing to improve space weather forecasting, response
- UNISPACE+50 process includes focus on international space weather framework
- Growing concerns about vulnerabilities posed by solar storms and changes in Earth's magnetosphere

INDICATOR 1.4: Space situational awareness — Space situational awareness (SSA) refers to the ability to detect, track, identify, and catalog objects in outer space, such as space debris and active or defunct satellites, as well as observe space weather and monitor spacecraft and payloads for maneuvers and other events. SSA enhances the ability to distinguish space negation attacks from technical failures or environmental disruptions and can thus contribute to stability in space by preventing misunderstandings and false accusations of hostile actions. Increasing the amount of SSA data available to all states can help to increase the transparency and confidence of space activities, which can reinforce the overall stability of the outer space regime. The Space Surveillance Network puts the United States far in advance of the rest of the world in SSA capability. Other states are developing independent SSA capabilities, but there is currently no global system for space surveillance or data sharing, in part because of the sensitive nature of surveillance data.

2016 Developments

- United States continues to prioritize improved SSA capabilities
- Russia, France, Japan, China advancing independent SSA capabilities
- United States expands bilateral SSA-sharing agreements

- Proposals presented on multilateral sharing of orbital data
- United States considers civilian role in space traffic management
- U.S. commercial actors continue to expand SSA role, upgrade capabilities to meet needs

Theme 2: Access to and use of space by various actors

INDICATOR 2.1: Space-based global utilities — These global utilities are space assets that can be used by any actor equipped to receive the data they provide. The use of space-based global utilities has grown substantially over the last decade. Millions of individuals rely on space applications on a daily basis for functions as diverse as weather forecasting; navigation; surveillance of borders and coastal waters; monitoring of crops, fisheries, and forests; health and education; disaster mitigation; and search-and-rescue operations. Global utilities are important for space security because they broaden the community of actors that have a direct interest in maintaining space for peaceful uses. Many, such as the GPS and weather satellites, were initially developed by military actors, but have since become applications that are almost indispensable to the civil and commercial sectors. Advanced and developing economies alike depend on these space-based systems.

2016 Developments

- Upgrades continue to Positioning, Navigation, and Timing systems, with attempts to improve interoperability and cooperation
- Efforts to prevent gaps in global weather monitoring and forecasting progress
- Use of satellite-based AIS system contributes to global marine governance
- Access to high-resolution remote sensing data expands
- Space resources become more important in monitoring climate change
- New initiatives develop to make data from national space systems public, expand access
- Space resources continue to be important for disaster response

INDICATOR 2.2: Priorities and funding levels in civil space programs — Civil space programs can have a positive impact on the security of outer space. They constitute key drivers in the development of technical capabilities to access and use space, such as those related to the development of space launch vehicles. As the number of space actors able to access space increases, more parties have a direct stake in space sustainability and preservation for peaceful purposes. As well, civil space programs and their technological spinoffs on Earth underscore the vast scientific, commercial, and social benefits of space exploration, thereby increasing global awareness of its importance.

As the social and economic benefits derived from space activities have become more apparent, civil expenditures on space activities have continued to increase, as has the number of states participating in space activities. Virtually all new spacefaring states explicitly place a priority on space-based applications to support social and economic development as well as dual-use security-related functions.

2016 Developments

- Major space programs prioritize access to space and deep space exploration
- Continued investment in emerging space programs focuses on complementary military and industrial benefits
- China's space program achieves significant new milestones
- North Korea completes second successful satellite launch
- Global participation expands, with focus on industrial and socioeconomic benefits of space

INDICATOR 2.3: International cooperation in space activities — Due to the huge costs and technical challenges associated with access to and use of space, international cooperation has been a defining feature of civil space programs throughout the space age. Scientific satellites, in particular, have been cooperative ventures. International cooperation remains a key feature of both civil and global utilities space programs. By allowing states to pool resources and expertise, international civil space cooperation has played a key role in the proliferation of the technical capabilities needed by states to access space. Cooperation agreements on space activities have proven to be especially helpful for emerging spacefaring states that currently lack the technological means for independent space access. Cooperation agreements also enable established spacefaring countries to tackle high-cost, complex missions as collaborative endeavors with international partners.

Finally, cooperation enhances the transparency of space programs and can foster both technical and cultural understandings. The International Space Station remains the most prominent example of international cooperation. As a source of technology transfer and influence, it can also be used to advance strategic and political interests.

2016 Developments

- Cooperation holds as partners consider the future of the ISS
- Lunar exploration emerges as focus for expanded international cooperation
- Ongoing geopolitical competition shapes patterns of space cooperation
- Cooperation accelerates capabilities for emerging space programs
- Several cooperative initiatives seek to broaden space access for developing countries
- Nascent United States-China space cooperation efforts proceed cautiously

INDICATOR 2.4: Growth in the commercial space industry — The role that the commercial space sector plays in the provision of launch, communications, imagery, and manufacturing services, as well as its relationship with civil and military programs make this sector an important component of space security. A healthy space industry can lead to decreasing costs for space access and use, and may increase the accessibility of space technology for a wider range of space actors. Increased commercial competition in the research and development of new applications can also lead to the further diversification of capabilities to access and use space. Recent growth in the commercial space sector has been driven by the pursuit of new satellite and launch technologies; new services related to communications and Earth observation; and the pursuit of new activities, including human space launch, exploration, and resource extraction.

2016 Developments

- Proposals for large satellite constellations envision internet as a new space-based telecommunications service
- Increased revenues made available for commercial space launch providers
- Launch failures demonstrate vulnerability of commercial sector to disruption
- Innovations in manufacturing, services, and launch capabilities linked to use of small satellites
- Nascent space-based industry focused on exploration and extraction
- Private sector experiments with new funding models

INDICATOR 2.5: Public-private collaboration on space activities — The commercial space sector is significantly shaped by the particular security concerns and economic interests of national governments. There is an increasingly close relationship between governments and the commercial space sector. Various national space policies place great emphasis on maintaining a robust and competitive industrial base and encourage partnerships with the private sector. The space launch and manufacturing sectors rely heavily on government contracts. The retirement of the space shuttle in the United States, for instance, opened up new opportunities for the commercial sector to develop launch services for human spaceflight. Governments play a central role in commercial space activities by supporting research and development, subsidizing certain space industries, and adopting enabling policies and regulations. Conversely, because space technology is often dual-use, governments have sometimes taken actions, such as the imposition of export controls, which hinder the growth of the commercial market.

2016 Developments

- Regulatory and financial incentives encourage growth of national space industries
- Commercial space launch, Earth-imaging companies continue to face national security restrictions
- Increasing U.S. defense use of private sector capabilities meets with some setbacks

- United States continues to focus on public-private partnerships for next-generation space exploration
- India and China encourage more private participation in domestic space programs

INDICATOR 2.6: Space-based military systems — Space assets are being used for terrestrial military purposes by a growing number of states. The United States has dominated the military space arena since the end of the Cold War and continues to give priority to its military and intelligence programs, which are now integrated into virtually all aspects of military operations. Russia maintains a large fleet of military satellites, but many of its systems were developed during the Cold War. China does not maintain a strong separation between civil and military applications, but its program is growing rapidly and supports an increasing number of military functions, as does India's. In the absence of dedicated military satellites, many actors use their civilian satellites for military purposes or purchase data and services from civilian satellite operators. However, the number of states with dedicated military satellites is increasing.

2016 Developments

- U.S. funding, launches, prioritize Space Mission Assurance
- Management and organizational changes for force integration and space control proceed in United States
- Russia modernizes surveillance and reconnaissance capabilities
- China enhances access to reconnaissance and Positioning, Navigation, and Timing capabilities
- Europe seeks to enhance cooperative, dual-use of space capabilities
- Germany, United Kingdom, France look to next-generation military systems
- India takes steps to formalize its military uses of outer space
- Rising security tensions in Asia drive increased focus on military space
- Focus on military space capabilities emerges in the Middle East
- Canada, Australia continue to develop space-based military capabilities
- U.S. military pursues international cooperation, adds space component to existing alliances

Theme 3:
Security of space systems

INDICATOR 3.1: Vulnerability of satellite communications, broadcast links, and ground stations — Satellite ground stations and communications links constitute likely targets for space negation efforts, since they are vulnerable to a range of widely available conventional and electronic weapons. While military satellite ground stations and communications links are generally well protected, civil and commercial assets tend to have fewer protective features. Many actors employ passive electronic protection capabilities, such as shielding and directional

antennas, while more advanced measures, such as burst transmissions, are generally confined to military systems and the capabilities of more technically advanced states. Because the vast majority of space assets depend on cyber networks, the link between cyberspace and outer space constitutes a critical vulnerability.

2016 Developments

- Electromagnetic interference with satellite communications remains widespread
- United States enhances protected SATCOM
- Ground stations demonstrate vulnerabilities to cyberattacks; industry pursues voluntary cybersecurity measures
- Advances made in laser-based communications between satellites
- China launches quantum entanglement experiment

INDICATOR 3.2: Reconstitution and resilience of space systems — The ability to rapidly rebuild or repair space systems after an attack could reduce vulnerabilities in space. The capabilities to refit space systems by launching new satellites into orbit in a timely manner to replace satellites damaged or destroyed by an attack are critical resilience measures. Multiple programs show the prioritization of, and progress in, new technologies that can be integrated quickly into space operations. Smaller, less expensive spacecraft that may be fractionated or distributed on hosts can improve continuity of capability and enhance security through redundancy and rapid replacement of assets. While these characteristics may make attacks against space assets less attractive, they can also make assets more difficult to track, and so inhibit transparency. The ability to use redundant terrestrial capabilities or to operate through the systems of other space actors is also an important source of resilience.

2016 Developments

- United States continues to emphasize resilience through focus on Space Mission Assurance
- Work on reusable and rapid-response launch systems continues in several countries
- Civil and commercial on-orbit satellite servicing capabilities advance
- Efforts continue to build resilience through alternatives to space-based GPS
- United States enhances capabilities to detect threats to space-based systems
- United States looks for deeper space system integration with international partners

INDICATOR 3.3: Earth-based capabilities to attack satellites — Launching a payload to coincide with the passage of a satellite in orbit is the fundamental requirement for anti-satellite capability. Ground-based anti-satellite weapons (ASATs) employing conventional, nuclear, and directed energy capabilities date back to the Cold War, but no hostile use of them has been recorded. Conventional anti-satellite weapons include precision-guided kinetic-intercept vehicles, conventional explosives, and specialized systems designed to spread lethal

clouds of metal pellets in the orbital path of a targeted satellite. A space launch vehicle with a nuclear weapon would be capable of producing a High Altitude Nuclear Detonation that would cause widespread and immediate electronic damage to satellites and produce the long-term effects of false radiation belts, which would have an adverse impact on many satellites. Security concerns about the development of negation capabilities are compounded by the fact that many key space capabilities are dual-use. Recent incidents involving state use of anti-ballistic missile systems against their own satellites (China in 2007 and the United States in 2008) underscore the detrimental effect that such systems can have for space security. Such use not only produces space debris, but contributes to a climate of mistrust among spacefaring nations.

2016 Developments

- Development and testing of exoatmospheric anti-missile technology continues
- Interest in directed energy applications rekindles, but capabilities for use against space objects remain nascent

INDICATOR 3.4: Space-based negation-enabling capabilities — Deploying space-based ASATs—using kinetic-kill, directed energy, or conventional explosive techniques—would require enabling technologies much more advanced than those required for orbital launch. Space-based negation efforts require sophisticated capabilities, such as precision on-orbit maneuverability and space tracking. Microsatellites, maneuverability, and other autonomous proximity operations are essential building blocks for a space-based negation system, but they have dual-use for a variety of civil, commercial, and non-negation military programs. While some nations have developed these technologies, there is no evidence that they have integrated them into dedicated capabilities for space system negation.

2016 Developments

- Military, civilian, and commercial actors demonstrate advancing capabilities for on-orbit maneuvering and proximity operations

Theme 4: Outer space governance

INDICATOR 4.1: National space policies — The development of national space policies that delineate the principles and objectives of space actors with respect to access to and use of space has been conducive to greater transparency and predictability of space activities. National civil, commercial, and military space actors all operate according to these policies. Most spacefaring states explicitly support the principles of peaceful and equitable use of space, and emphasize space

activities that promote national socioeconomic, scientific, and technological goals. Virtually all space actors underscore the importance of international cooperation in their space policies; several developing nations have been able to access space because of such cooperation. Major space powers and emerging spacefaring nations increasingly view space assets such as multiuse space systems as integral elements of their national security infrastructure. The military doctrines of a growing number of states emphasize the use of space systems to support national security and as an extension of terrestrial domains of warfare.

2016 Developments

- Developments in U.S. military strategy recognize 'normalized' warfighting in space
- Security-related aspects of European space policy included in the European Defence Action Plan
- China's White Paper on Space Activities emphasizes peaceful use, cooperation in context of comprehensive space power
- National policies seek to advance private space exploration and space resources utilization
- African Union adopts African Space Policy and Strategy linked to Agenda 2063 for socioeconomic transformation
- New national space policies signal growing importance of outer space

INDICATOR 4.2: Multilateral forums for space governance — A number of international institutions make available multilateral forums where space security issues can be addressed. The United Nations provides the General Assembly First and Fourth Committees, UN Space, the UN Committee on the Peaceful Uses of Outer Space (COPUOS), the International Telecommunication Union, the Conference on Disarmament, and the International Committee on Global Navigation Satellite Systems. Europe has led in an initiative to develop an International Code of Conduct for Outer Space.

2016 Developments

- UN COPUOS agrees on an initial set of draft guidelines for long-term sustainability of space activities, develops a compendium on non-legally binding UN instruments on outer space, and expands agenda
- Work at the Conference of Disarmament continues to stall
- UN General Assembly resolutions reflect points of consensus, divide
- UNISPACE+50 preparations proceed with adoption of themes
- India joins the Missile Technology Control Regime and Hague Code of Conduct Against Ballistic Missile Proliferation
- EU remains committed to International Code of Conduct process within a UN framework
- International Civil Aviation Organization calls for UN space travel regulations

INDICATOR 4.3: Other initiatives — A growing number of diplomatic initiatives relate to bilateral or regional collaborations in space activities. Examples of this include the work of the Asia-Pacific Regional Space Agency Forum and discussions in the African Union to develop an African space agency. The UN Institute for Disarmament Research (UNIDIR)—an autonomous unit in the UN system—has also played a key role in facilitating dialogue among key space stakeholders. Every year UNIDIR partners with civil society actors and some governments to bring together space security experts and government representatives at a conference on emerging security threats to outer space.

2016 Developments

- The first UN High-Level Forum adopts the Dubai Declaration
- The Hague Space Resources Governance Working Group initiates work
- The International Committee of the Red Cross warns of grave humanitarian consequences to weaponization of outer space
- BRICS Declaration calls for international agreement to prevent weaponization of outer space
- G7 Summit in Hiroshima, Japan considers outer space governance
- Host Germany asked to focus on space at G20 Summit in 2017
- Process initiated to develop Manual on International Law Applicable to Military Uses of Outer Space
- China and United States hold first Dialogue on Outer Space Security
- Asgardia declares itself the first space nation

2017

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