Section 2 Trends in Space Domain

1 Space Domain and Security

Nearly 60 years have passed since a satellite was launched into outer space for the first time in the history of mankind. In recent years, technology leveraging outer space has been applied to various areas. While no state is allowed to own outer space, all countries can use it freely. Major countries thus make proactive efforts to use outer space.[1] For example, Earth observation satellites, such as meteorological satellites, are used to observe weather as well as land and waters; communication and broadcasting satellites are used for the Internet and broadcasting; and positioning satellites for global positioning systems are used to navigate aircraft and ships. These satellites have widely prevailed in social, economic, scientific, and other areas as essential infrastructure for the public and private sectors.

In the security field, military forces in major countries are actively involved in outer space activities and utilize a variety of satellites. There is no concept of national borders in outer space, meaning that the utilization of satellites enables the observation of, communication at, and positioning on any area on the Earth. Thus, major countries make efforts to enhance the capabilities of a variety of satellites and launch them for the purpose of enhancing C4ISR functions.[2] Such satellites include image acquisition satellites for reconnoitering military facilities and targets, early warning satellites for detecting the launch of ballistic missiles, satellites for gathering radio signals, communication satellites for communications between military units, and positioning satellites for navigating naval vessels and aircraft and enhancing the precision of weapons systems. In outer space, various countries are thus rapidly developing their capabilities to ensure their military superiority.

From the viewpoint of ensuring their military superiority, various countries are also rapidly developing their capabilities to impede each other's use of outer space. In January 2007, China conducted a test to destroy its aging satellite with a ground-launched missile. The resulting space debris[3] spread across the satellite's orbit, and came to be seen as a threat against space assets such as satellites owned by various countries.[4]

Furthermore, countries including China and Russia are thought to be also developing an anti-satellite weapon (ASAT) that does not directly hit and destroy a satellite by a missile, thus creating less space debris. For example, it has been noted that ASATs under development include a "killer satellite" to approach a target satellite and utilize a robot arm to capture the target and disable its functions. On this point, it has been noted that China has carried out experiments in outer space in which they have mobilized satellites close to other satellites to simulate the movements of a killer satellite. The United States has claimed to have confirmed very unnatural moves of a satellite launched by Russia in 2017 for checking space systems, indicating concerns about the satellite.

Furthermore, it has been pointed out that China and Russia are developing not only missiles and killer satellites but also jammers for interfering with communications between target satellites and ground stations, and laser weapons for attacking target satellites with directed energy. It has also been noted that China and Russia have been enhancing capabilities to operate these anti-satellite capabilities and impede the United States and its allies from using outer space.[5]

As the above illustrates, the risk to the stable use of outer space has become one of the critical security challenges for countries, thus it has become necessary to deal with this risk effectively in an effort to ensure stability in the use of outer space.

Against this backdrop, the existing international agreements, such as the Outer Space Treaty (the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies) that prescribes the exploration and use of outer space, do not have direct provisions on prohibiting the destruction of space objects and refraining from actions triggering space debris. Discussion on guidelines has been under way recently by the United Nations Committee on the

1 The Outer Space Treaty (The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies) that came into force in October 1967 defines such matters as the use of the Moon and other celestial bodies for peaceful purposes, the freedom in principle of exploration and use of outer space, and the prohibition of ownership. According to one of the concepts, outer space is considered to be the airspace more than 100 km above the Earth's surface. However, no clear international agreement has been reached on the definition of outer space.

2 The term "C4ISR" stands for command, control, communication, computer, intelligence, surveillance, and reconnaissance. The 1991 Gulf War is considered "the first high-tech war conducted in outer space in the history of mankind."

3 Unnecessary artifacts orbiting around the Earth, including satellites no longer in use, and launch vehicles' upper stages, parts, and fragments.

4 According to an April 2018 issue of the Washington Times (National Digital Edition) of the United States, China carried out an experimental launch of an anti-satellite missile in February 2018. Moreover, it was reported that Russia also carried out an experimental launch of an anti-satellite missile in March 2018.

5 Source: "Worldwide Threat Assessment" by the U.S. Director of National Intelligence in January 2019

column

Space Security Trends

As there is no concept of national borders in outer space, artificial satellites can be used to collect information from and conduct communications and positioning at any location on the earth, prompting countries to use satellite-based space systems as military infrastructure. Specifically, military forces of the United States and other major countries use reconnaissance satellites for collecting image and radio data, positioning satellites for finding accurate locations and guiding missiles, early warning satellites for detecting ballistic missile firings, and communications satellites for enabling communications between distant units.

Laser laboratory aircraft (A-60)

[Jane's by IHS Markit]

<Description>
The A-60 is a Russian aircraft mounted with a high-power laser weapon that reportedly test emitted laser beams aimed at a satellite in 2009.

As military forces grow dependent on space systems, some countries are developing and improving anti-satellite (ASAT) weapons in order to prevent enemies from working effectively in military operations by depriving their satellite of function. For example, it is pointed out that China and Russia are continuing to develop and test "ASAT missiles" launched from the ground or aircraft for physically destroying satellites, "killer satellites" for directly colliding with other satellites or using robot arms to catch other satellites and deprive them of function, "directed-energy weapons" for emitting high-power laser beams to deprive satellites of function or directly destroy them, and "jammers" for disrupting communications between satellites and ground stations.

Under such situation, the U.S. Department of Defense has recognized that China and Russia are considering counterspace capabilities as a means to weaken the military effectiveness of the United States and its allies, promoting initiatives to maintain relative advantages in space, including a bill sent to Congress to create a space force as a new military service.

Peaceful Uses of Outer Space (UN COPUOS) and the Inter-Agency Space Debris Coordination Committee (IADC).[6] Moreover, countries are working on Space Situational Awareness (SSA) by monitoring the solar activity with a potential impact on satellites and electronic equipment on the Earth, and threats caused by meteors reaching Earth, in addition to threats posed by anti-satellite weapons and space debris to space assets.

See Part III, Chapter 1, Section 2-3-1 (Responses in Space)

2 Various Countries' Outer Space Initiatives

1 The United States

The United States launched its first satellite, Explorer 1, in January 1958, following the satellite launches by the former Soviet Union. The country has since then proceeded with a variety of space activities in fields including military, science, and resource exploration, such as launching the world's first reconnaissance satellite and landing on the Moon. Today, the United States is the world's leading space power. The U.S. Forces clearly recognize the importance of outer space for their actions, and on this point, actively utilize outer space for security purposes. In June 2010, the United States released the National Space Policy that presents the country's basic guidelines for space policy. The National Security Strategy (NSS) revealed in December 2017 points out that many countries are said to have purchased satellites to back up their strategic military activities, and some countries even pursuing a variety of ASATs on the basis of belief that the capability to attack assets in outer space will give them asymmetrical advantages. But having noted

6 In 2007, the chairperson of the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS) proposed to discuss "the long-term sustainability of outer space activities" in relation to civil space activities, for the purpose of defining risk reduction for long-term sustainable activities and equal access to outer space. Based on this proposal, discussions have taken place towards working out some guidelines. Among other international discussions on the use of outer space, there are talks on the development projects of the WOOMERA Manual on the International Law of Military Space Operations as well as the Manual on International Law Applicable to Military Uses of Outer Space (MILAMOS) that discuss new legal problems regarding outer space.

that, the United States indicated that unlimited access to and freedom in activities in outer space were vital interests of the United States, and that the long-term goals in outer space were given consideration by the National Space Council in an effort to develop strategies. The National Space Strategy was announced in March 2018, which demonstrated its recognition that their adversaries had turned space into a warfighting domain, and that the United States would seek to deter, counter, and defeat threats in the space domain that are hostile to the national interest of the United States and its allies. Based on these strategic guidelines, the U.S. DoD has set the goal of maintaining and strengthening U.S. space superiority for security purposes, recognizing that the United States needs to prepare for the possibility of conflict extending into outer space. In this regard, President Donald Trump directed the DoD in June 2018 to build a space force that would be separate from the other military branches such as the army, the navy and the air force, and ordered the Pentagon in December 2018 to establish the United States Space Command as a unified combatant command.[7] In February 2019, the DoD submitted a proposal to Congress that would see the creation of the space force within the Department of the Air Force.

Among U.S. government organizations, the National Aeronautics and Space Administration (NASA) under direct control by the President is responsible mainly for non-military space development, while the DoD undertakes military research, development, and operation of observation and reconnaissance satellites.

2 China

China began working on space development in the 1950s, and in April 1970, the county launched its first satellite "Dong Fang Hong I," mounted on the transportation launch vehicle "Long March 1," using technology enhanced through its missile development.

China has thus far conducted activities such as manned space flight and lunar rover launches. It is speculated that China's space development is intended to enhance national prestige and develop space resources.

China's defense white paper "China's Military Strategy" (May 2015) states that outer space is a commanding position

Launch of BeiDou 42 and 43, a Chinese satellite positioning system by China on November 19, 2018 [Avalon/Jiji Press Photo]

in strategic competition among all nations. Meanwhile, China asserts that its activities in outer space constitute "peaceful use of outer space," and underscores that China is "opposed [to] the weaponization of and arms race in outer space, and [will take] an active part in international space cooperation." China also commits to "[keep] abreast of the situation of outer space, deal with security threats and challenges in that domain, and secure its space assets." In addition, "China's Space Activities in 2016," China's white paper on space activities released in December 2016, presents a vision to "build China into a space power" and for "the realization of the Chinese Dream." It also presents a schedule of space vehicle launches[8] up to 2020.

While traditionally emphasizing international cooperation and the peaceful use of space, China has fallen short of denying its military use of space and proactively used space for military purposes, including information collection, communications,[9] and positioning. In fact, it is pointed out that China launched 29 military satellites as of November 2018, exceeding six for the United States and eight for Russia.[10] Furthermore, as described earlier, China continues to develop ASATs. In January 2007, China conducted a test using a ground-launched missile for destroying its own satellite. In July 2014, China implemented an anti-satellite missile test that was not accompanied by the destruction of any satellite.[11] It is also suggested that China is developing killer satellites, jammers, and directed-energy weapons,[12] including laser beams.

7 At present, the Joint Force Space Component Command under the control of the U.S. Strategic Command operates the U.S. Forces' outer space capabilities.

8 The paper cites not only a lunar rover but also the launch of worldwide services using the BeiDou Navigation Satellite System, Mars exploration, asteroid exploration, and Jupiter exploration. As for space exploration, it was announced in January 2019 that China's Chang'e 4 became the world's first vehicle to land on the moon's far side.

9 In August 2016, China launched the world's first quantum science satellite, called Mozi, which will be carrying out a proof-of-concept mission for quantum communication between space and a ground station.

10 Source: "Union of Concerned Scientists"

11 The February 2015 "Worldwide Threat Assessment" of the U.S. Director of National Intelligence notes that in July 2014, China tested an anti-satellite missile without destroying a satellite.

12 According to the "Annual Report to Congress: Military and Security Developments Involving the People's Republic of China" published by the U.S. DoD in May 2018, China continues to develop directed-energy weapons, electronic countermeasure systems (jammers), and a variety of capabilities, including the capability to counter satellites, designed to limit or block the use of space assets by adversaries during a crisis or conflict.

It is reported that China is developing and operating satellites that can be used for both military and civilian purposes. For example, the possibility of military use of the BeiDou satellite positioning system[13] has been pointed out, as it has been reported that the purpose of the launch of global service in 2018 was to satisfy military needs. A Chinese state-owned corporation, which develops and produces satellite carrier rockets, has claimed to continue the launch of new rockets in the Long March series and develop a launch vehicle that can carry a large satellite.[14] However, the corporation has been reported to have been developing and producing ballistic missiles as well, indicating that the development of satellite carrier rockets is applicable to that of ballistic missiles.[15] China is thus expected to focus on space development through close cooperation between government, military, and private sectors.

China is considered to have become one of the space powers through investments, research and development, and the introduction of technologies from the United States and other countries. It has been suggested that China could threaten U.S. superiority in outer space in the future.[16]

Among organizations, the Strategic Support Force, established in December 2015 as a force under direct control by the Central Military Commission, is pointed out as being in charge of outer space, cyber, and electronic warfare, while the details of its missions and organization have not been published. The Equipment Development Department of the Central Military Commission is believed to be in charge of launching, tracking and controlling satellites and conducting manned space programs. The State Administration for Science, Technology and Industry for National Defense, which belongs to the State Council's Ministry of Industry and Information Technology, works out and implements space-related programs. The China National Space Administration takes charge of civilian programs and represents the Chinese Government externally by concluding international agreements.

3 Russia

Russia's space activities have been continuing since the former Soviet Union era. The former Soviet Union successively launched multiple satellites after it launched the first satellite in the history of mankind, Sputnik 1, in October 1957, and had the largest number of launched satellites in the world until the collapse of the former Soviet Union. The satellites included many military satellites, and progress was made in the use of space for military purposes by the United States and the former Soviet Union during the Cold War era. Russia's space activities have declined since the former Soviet Union collapsed in 1991. However, the country has recently started to expand its space activities once again.

Regarding the country's trends in security, the National Security Strategy of the Russian Federation, approved in December 2015, states that the opportunities for maintaining global and regional stability are shrinking significantly with the deployment of the U.S. weapons in outer space. In response to the United States' release of the annual MDR in 2018, Russia expressed concern that the implementation of plans in the MDR would launch an arms race in space with hugely negative consequences for world peace and stability.

In March 2016, Russia released the Federal Space Program for 2016-2025 as a specific future guideline for space activities, including the development and deployment of domestic space satellites and manned flight programs.

Meanwhile, Russia has taken advantage of its space capabilities for military operations. In its air assault operation in Syria in 2015, Russia reportedly used a total of 10 satellites, including image gathering satellites as well as data relay satellites (a kind of communications satellites), to ascertain Syrian domestic conditions. It is also pointed out that Russia has repeated tests to fire ground-launched anti-satellite missiles and has been developing anti-satellite missiles to be launched from Mig-31 fighter jets. In the Russian Far Eastern city of Vostochny, Russia has almost completed its space center and is reportedly constructing a new launching site. Future moves, including the military's engagement with the center, are attracting attention.[17]

From an organizational perspective, the Roscosmos State Corporation for Space Activities is in charge of space activities related to Russia's scientific and economic areas, while the Russian Ministry of Defence is involved in space

13 BeiDou offers not only positioning services but also interactive short message services. It is suggested that the services allow naval ships using the BeiDou system to identify locations of foreign ships and other information and provide the information to other BeiDou-using ships on a real-time basis, contributing to improving maritime and other information gathering capabilities.

14 As for the Long March 9 rocket (for launching very large satellites), which can lift a satellite of up to 140 tons into a low orbit and is reportedly planned for launching such vehicles as manned lunar landers, its developers said in October 2018 that the first Long March 9 would be launched between 2028 and 2030.

15 Moreover, it is regarded that China is focusing also on the development of satellite earth stations and operating a space base for civilian use in Patagonia, Argentina. Furthermore, the country has launched a manned space program with the aim of constructing its own space station.

16 According to the annual report of the U.S.-China Economic and Security Review Commission of November 2015.

17 The new launch site has been built to replace the Russian-leased Baikonur Cosmodrome in Kazakhstan.

activities for security purposes. The Russian Aerospace Force[18] conducts actual space activities for military purposes, manages facilities for launching satellites, among other activities.

4 Europe

Regarding European outer space activities, the EU, the European Space Agency (ESA)[19], and European countries are promoting their own unique space activities and are cooperating with each other to implement space activities.[20] France succeeded in launching its own satellite for the first time in 1965, and the United Kingdom in 1971. Italy and Germany used launch vehicles developed by the United States to own satellites in 1964 and 1965, respectively. Meanwhile, the ESA launched its first satellite in 1979.

The ESA signed a "framework agreement" with EU in 2004 to prescribe that they will coordinate on proceeding with space development and hold regular minister-level council meetings. The joint council meeting held by the ESA and the EU in 2007 approved the European Space Policy. The European Space Policy mentions improving synergy effects between space activities for civil and defense purposes, and the importance of implementing space activities based on coordinated efforts among member states and ensuring an internationally competitive space industry. The policy identifies security as one of its areas of priority.

The EU and ESA are planning a satellite positioning system "Galileo" and an Earth observation program "Copernicus," and European Defense Agency (EDA)[21]is implementing a reconnaissance satellite project "Multinational Space-based Imaging System (MUSIS)."[22] It is believed that in the future these initiatives will be utilized for the security field in Europe.

5 India

India has promoted programs to develop communications, positioning and observation satellites. At the end of January 2019, it released a space mission calling for promoting research and development on a manned space initiative by 2020.[23]

India is believed to have operated a positioning satellite that can position locations around India[24] and launched an Earth observation satellite, which is believed to be also used for security purposes. In February 2017, India successfully launched a satellite launch vehicle loaded with 104 satellites at low cost,[25] marking the largest number ever carried on a single rocket in the world, which indicates its high technological capabilities. In March 2019, Prime Minister Modi announced that the country successfully tested a missile to shoot down a low-orbit satellite.

Among organizations, the Space Agency oversees the Indian Space Research Organization (ISRO), which implements space development policy, develops and launches launch vehicles, and develops and manufactures satellites.

6 The ROK

The ROK is considered to have started full-scale space development from the latter half of the 1990s. Current space development is promoted based on the Third Basic Space Development Promotion Plan announced by the Moon administration under the Space Development Promotion Act implemented in 2005. The plan proposes a vision towards 2040, giving priority to (1) the establishment of its own launch vehicle technology, (2) the advancement of satellite-using services and satellite development, (3) the initiation of space exploration, and (4) the development of the Korean Positioning System (KPS).

In November 2018, the ROK, which had traditionally depended on other countries for launching satellites, announced that it successfully tested the Nuri domestic launch vehicle under development.

Among organizations, the Korea Aerospace Research Institute leads research and development as an

18 According to the Russian Ministry of Defence, the Aerospace Forces were created by merging the Air Force and the Aerospace Defence Forces, and started performing its tasks in August 2015. The tasks of the Aerospace Forces include: (1) providing focused combat command to the air force; (2) conducting aerial and missile defense; (3) launching and controlling satellites; (4) warning about missile attacks; and (5) monitoring outer space.

19 The ESA was established in May 1975 based on the ESA Convention targeting to establish a single European space organization focusing on the peaceful use of space research, technology, and application areas. The organization was formally established in October 1980.

20 In September 2000, the European Commission (EC) and the ESA created the European Strategy for Space, which committed to pursue Europe's coherent and effective space activities. The strategy envisioned that the EC would make political and strategic decisions on space policies and that the ESA would function as the implementing organization. For the satellite positioning system "Galileo" currently in operation and the environmental and security monitoring program "Copernicus," the EU and ESA are complementing each other in carrying these projects forward, with the former mainly taking charge of the policy dimension and the latter the technical dimension.

21 The EDA was established in 2004 to improve Europe's defense capabilities for crisis management purposes and to execute and maintain security and defense policies.

22 The MUSIS was started by Belgium, Germany, Greece, France, Italy, and Spain. The organization was joined later by Poland in December 2010. This is a joint project succeeding such projects as "Helios 2" (a French military reconnaissance satellite), "Pleiades" (a French Earth imaging satellite used for military and civilian purposes), "SAR-Lupe" (a German group of military radar satellites), "COSMO-SkyMed" (an Italian constellation of Earth observation satellites), and "Ingenio" (a Spanish optical satellite).

23 In December 2014, the ISRO succeeded in the test launch of a large launch vehicle carrying an unmanned capsule.

24 In April 2016, India succeeded in launching the seventh satellite constituting the Indian Regional Navigation Satellite System (IRNSS).

25 All 104 satellites were launched and placed into polar orbit at the same time. They comprised India's roughly 700 kg Cartosat-2D Earth observation satellite and 103 small satellites weighing less than about 10 kg each (1 each from Israel, Kazakhstan, the Netherlands, Switzerland, and the United Arab Emirates (UAE), 2 from India, and 96 from the United States).