

Measures to Strengthen Space Cooperation among South Korea, the U.S., and Japan

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Abstract

This thesis is a study on the ROK-US-Japan space cooperation plan to solve the security crisis on the Korean Peninsula caused by the increase in China's space threat and North Korea's ICBM launches. South Korea, the U.S., and Japan's space activities cooperation began with cooperation for the development of pure space science and technology in the past and is developing into space security areas such as joint space exploration cooperation, response to space threats, and strengthening defense space capabilities. By revitalizing the space cooperation organization between South Korea, the United States, and Japan, it will be possible to cope proactively with space threats from neighboring countries. The strengthening of space cooperation between South Korea, the United States, and Japan will advance the security of the Korean Peninsula and the development of space science and technology between South Korea, the United States, and Japan.

Keywords: *Space cooperation, Space technology, New space era, Artemis Program, NASA, KARI, JAXA*

I. Introduction

After the 2021 South Korea-US summit, South Korea participates in the Artemis program.¹⁾ The cooperation in the space sector between the two countries is expected to be strengthened due to participation in the Artemis program, removal of the ROK-US missile guidelines, and collaboration in satellite navigation stated in the joint statement between the ROK and the US.²⁾ There will be more opportunities for South Korea to participate in various space activities projects with advanced space activities countries.

According to a recent report by Morgan Stanley, the global satellite industry grew 1.6 times over the past ten years – from \$167 billion in 2010 to \$271 billion in 2019. It is expected to continue to grow to more than \$1 trillion. In 2040, 50% of the growth in the space industry will be in the satellite high-speed internet sector. The demand for data use of autonomous vehicles, the Internet of Things, artificial intelligence, and virtual reality will increase exponentially, and launch vehicle costs will be reduced thanks to the recycling of satellite launch vehicles and the mass production of satellites. As a result, the space industry will grow significantly.³⁾ Compared to the automobile industry, the space industry has 1.7 times the added value and 2.5 times the ratio of R&D personnel, which can create many jobs. The average development period in the space sector is ten years, which is advantageous compared to other industries such as the shipbuilding and automobile industries whose average development period are five years and three years, respectively.⁴⁾

The Space Internet communication and video service business has been developing significantly because launch costs are reduced thanks to the recycling of Space X's rocket and the development of micro-satellite technology. South Korea's high-speed Internet technology and image data analysis technology utilizing artificial intelligence will potentially help grow its space industry significantly in the global market. However, South Korea's space activities budget is about 700 million dollars, which is 0.04% of the gross domestic product. The Korea Aerospace Research Institute (KARI), an institution specializing in space activities, also is allocated a budget of about 500 million dollars and the size of the manpower is about 1,000 people.⁵⁾

In the past, space competition stemming from military confrontation between the US and the Soviet Union during the Cold War greatly affected space activities. Space

1) The Artemis program is the first US-led lunar exploration program 50 years after the U.S. Apollo program in 1970. It is a cooperative space program of commercial and international partners to send astronauts to the moon by 2024 and build a manned space base by 2028.

2) Kim Hyun-wook 2021, p. 7.

3) Morgan Stanley 2020.

4) Park Jeong-il, 2021.

5) The Federation of Korean Industries, 2021.

is not only vital for military and national security but also has significant implications for economic and industrial development. The space sector is a national core industry with high added value at a high technological level that will lead to large production and have technological ripple effects. The space industry has also passed the era of state-led space activities; the space industry has entered the new space era characterized by the 4th industrial revolution, artificial intelligence (AI), and big data. Public-private partnerships in the space industry are increasing as private sectors' participation and competitiveness in space activities grow and space technology innovation capabilities are enhanced.⁶⁾

So far, research on space activities has focused on strengthening South Korea's space activities capabilities to respond to space competition in Northeast Asia and analyzing space threats from neighboring countries. Cho's 2016 study looks into the expansion of the space industry and the promotion of strengthening the capabilities of the space industry. He analyzed the arms race in space in Northeast Asia. Some studies focus on South Korea's space launch vehicle development, expansion of space exploration activities, and enhancement of space industry capabilities through space cooperation.⁷⁾ Hwang Jin-young examined major US space security-related policies and explained the president's leadership on space activities, space policy, and South Korea-US missile guidelines, emphasizing the importance of collaborative space activities between Seoul and Washington.⁸⁾ Kim Jong-beom argued for the improvement of Korea's national space capabilities by strengthening international space cooperation while explaining the civilian-military nature of space technology.⁹⁾ These studies suggest that international cooperation serves as a vehicle for enhancing Korea's space power. However, there is a need for an in-depth study on key areas and ways to strengthen cooperation after the signing of the South Korea-U.S. Artemis Accords and removal of the ROK-U.S. missile guidelines during North Korea's imminent seventh nuclear test and continuous ICBM provocations.

South Korea continues to develop and exchange space technologies such as ISS science experiments with NASA and JAXA (Japan Aerospace Exploration Agency), while the U.S. - ROK Defense Ministry and the Air Force continue to conduct space cooperation and share space surveillance information, but South Korea is not capable of responding to space threats from North Korea and its neighbors.

After the ROK-US summit in 2021, the ROK-US missile guideline was lifted, and the United States invited South Korea into the lunar exploration program. If Korea, the United States, and Japan fail to respond quickly and strengthen space cooperation now, it will be difficult to establish active response capabilities against

6) Ahn Hyun-Jun, 2021, p. 8.

7) Cho Seong-ryeol, 2016.

8) Hwang Jin-young, 2018.

9) Kim Jong-beom, 2020.

space threats from North Korea and neighboring countries in near future and they will miss important opportunities for South Korea's space science and technological development.

This study aims to propose the tasks needed to facilitate space cooperation between South Korea, the United States, and Japan and to find out the issues of space activities cooperation and ways to strengthen their cooperation. It is imperative that the three countries establish a strategy to respond to the growing space threats and space militarization undertaken by China, Russia, and North Korea while utilizing and supplementing the strengths and weaknesses of the space activities capabilities of the three countries.

II. The international trend of space activities

1. Concept and Purpose of Space activities

Space activities can be defined as all activities related to space use and exploration by securing space technology through research and development on the production and launch activities of space objects such as satellites and space launch vehicles.¹⁰⁾ The U.S. National Aeronautics and Space Administration (NASA) established the term Aeronautics and Space Activity, first addressing and studying the problems of flight in and out of the Earth's atmosphere, secondly developing, testing, and operating aviation and spacecraft, and thirdly other space activities necessary for space exploration.¹¹⁾

Advanced space powers continue to invest in space activities and develop advanced technologies. Space power contributes to national economic power and industrial technology. The success of space activities can boost people's pride in their country and provide convenience in people's lives with information generated by satellite. In addition, space forces judge enemy military threats based on information collected from various sources in space and support the preparation of military operational plans.¹²⁾

The purpose of space activities can be classified into three categories: hard power, soft power, and social infrastructure. Hard power means military use of space. The launch of satellites and manned spacecraft enhances soft power by enhancing the excellence of the state and regime's advanced science and technology and national status. Lastly, space power for GPS services such as navigation, satellite communication supported by global communication, and disaster response helps establish social infrastructure.¹³⁾ All three types of international relations are

10) Ministry of Science and ICT and Korea Research Foundation, 2020, p. 35.

11) NASA, 1958.

12) Lee Seong-man and Kang Chang-bu, 2015, pp. 397-398.

observed in the space domain: conflict, competition, and cooperation. The Cold War-era and the current U.S.-China space race highlight the importance of international cooperation in building a big-budget space system and implementing space programs.

2. The history of space activities

The first period of space activities was between 1958 and 1972, when the Soviet Union launched the first Sputnik 1 satellite on October 4, 1957, leading to the development of military satellites and the development of the space industry for the Apollo manned spacecraft program. Between 1973 and 1986, the first space station and space shuttle were developed, the civilian use of space technology such as GPS increased, and new space activities in countries such as China, Japan, and Europe emerged. The third period led to the operation of the second-generation space station and the expansion of civilian space technology. The fourth period increased the use of digital technology and diversified international space program cooperation between 2003 and 2018. The fifth phase is expected to increase market products using signals and data from 2019 to 2033, build third-generation space stations, facilitate space exploration, and implement new manned space programs.¹⁴⁾ Currently, the Moon and Mars exploration programs of India, China, and the United States are underway, and active space activities are proceeding, including global satellite Internet network construction projects, satellite data sharing, and international cooperation on climate change.

3. Scope and Object of Space activities

To study space cooperation among South Korea, the United States, and Japan, we should be aware that space technology, and space system development capabilities are very important for private-led space activities in the New Space era. In addition, the demand for space exploration to secure resources and study the space environment is increasing, and space operational capabilities for the safe protection and operation of space assets are becoming essential for space activities. This study aims to evaluate South Korea, U.S., and Japan space activities and analyze South Korea's cooperation with the United States and Japan in developing space systems such as space technology, satellites, and space launch vehicles, furthering space exploration and space environment research, and strengthening space operations and military security. First, space technology development has a great economic ripple effect, and many technologies provide convenience to private life through space technology development. For example, LASIK surgery using laser technology, solar cells, water purifiers, fire protection devices, MRIs, and air purifiers are products

13) Kazuto Suzuki 2013, pp. 24-34.

14) Kim Jong-beom 2020, p. 7; OECD, 2016.

using space technology. The development of advanced space technologies such as satellite communication and navigation services can help develop the space industry in South Korea, the United States, and Japan. The development of satellites and space launch vehicles includes satellite production and satellite operation in space, rocket propulsion systems for space launch vehicles, precision guidance capabilities, and launch services. Second, space exploration and space environment research will share scientific data on the moon, Mars, and solar weather, and third, space surveillance and military security will protect the enemy's attacks on satellites and space assets, support intelligence, and maintain control of the land, sea, and air forces. The scope and targets of space activities cooperation between South Korea, the United States, and Japan are as follows.

<Table 1> Scope and targets of space activities cooperation between ROK, the United States and Japan

Category	The field of space cooperation	Details
South Korea-U.S.-Japan space cooperation	Space technology and space system development	satellite communications and navigation services, Commercial Space Activities and Space Transport Services
	Space Exploration and International Space Station	Astronomical exploration and resource development activities such as the moon and Mars, and participation in the ISS.
	Space Operations and Military Security	Space control, including space surveillance, space defense and attack, and space weapons development

III. ROK-U.S.-Japan Space Policy

1. U.S. Space Policy and Space Power

(1) U.S. Space Policy

The United States is leading the military and commercial use of space. After the establishment of NASA in 1958, the United States participated in the space race with the Soviet Union. Since then, it has implemented space policies with the Apollo manned spacecraft launch plan, the Strategic Defense Initiative, and the creation of the Space Command.¹⁵⁾ After the Apollo success, NASA planned to build the space station by 1975 to strengthen space exploration and built and operated a reusable 1981 space shuttle to move the station and save money. Due to the space shuttle

15) Jeong Heonju, 2021, p. 24.

accident and the high cost of developing the shuttle, Atlantis' last flight in 2011 ended its 30-year history.

In 2021, the Biden administration announced that it would continue to operate the National Space Council, a U.S. space policy group, which was re-operated by the Trump administration in 2017. The Biden administration's space policy is currently under development. In the Trump administration, Trump organized a space committee to resolve space activities conflicts between ministries in line with the U.S. priority policy and appointed Vice President Pence as chairman to promote U.S. space policy.

The National Space Policy announced by the U.S. president at the White House provides general information about the U.S. space policy. When Obama announced the national space policy in 2010, he suggested revitalizing the space industry, expanding international cooperation, and guaranteeing space security.¹⁶⁾ In the U.S. National Space Strategy released in 2018, President Trump emphasized that the U.S. national interests are the most important areas of war and argued that the United States should build its dominance in space.¹⁷⁾ It also emphasized international cooperation to strengthen the U.S. space military power in space and secure U.S. economic interests.¹⁸⁾ The U.S. space policy can be evaluated based on whether or not it ensures the advancement of national interests while maintaining and strengthening space dominance, expanding the commercial interest of space, and suppressing space threats from rival countries through space cooperation with allies. President Trump established the U.S. Space Command in 2019 as a separate, independent military unit that would respond to major threats attacking and interfering with U.S. space assets and strengthen space military power to ensure the smooth use of space. The U.S. Air Force had been responsible for space and cyberspace, but with the creation of the Space Force, the United States reaffirmed that space was an important area of security in the 21st century. Through the space policy guidelines, the Trump administration emphasized the continued development of space exploration programs through cooperation in the space sector with private companies and other countries.¹⁹⁾

(2) The US Space Strategy and Space Power

The end of the Cold War weakened the U.S.-Soviet space competition. However, the development of advanced weapons and satellite communication further strengthened the development of space for military purposes.²⁰⁾ After the 1991 Gulf

16) Hwang Jin-young and Lee Jun, 2021, p. 4.

17) Park Byung-kwang 2020, p. 4.

18) Yoo Jun-gu 2018, p. 1.

19) Kim Jong-beom 2020, p. 73.

20) Suzuki 2013, p. 83.

War, the United States implemented military operations with the support of space assets while using advanced precision-guided weapons. Throughout the wars in Kosovo, Iraq, and Afghanistan, the United States has achieved modernization of military weapons through various space-based intelligence surveillance and reconnaissance activities, UAV attacks, and precision-guided weapons.

The Pentagon is establishing a defense space strategy to support the national space policy. The 2020 Defense Space Strategy, which aimed to secure the U.S. space advantage and ensure important national interests in future space, identified the main goals of future space defense. First, to build comprehensive military interests in space, the United States aims to reorganize the U.S. defense organization by securing military interests and improving its space-based intelligence monitoring and reconnaissance capabilities and command and control capabilities. Second, it integrates military space power into nation, combined, and joint operations. Space operations, reconnaissance surveillance capabilities, and military professionals are included in military planning to integrate space forces into U.S. military operations. Third, it aims to curb enemy attacks in space and create a strategic environment by establishing standards and regulations for activities in space. Lastly, the United States hopes to strengthen space cooperation in cooperation with allies, private partners, commercial entities, and other U.S. government agencies.²¹⁾

As of May 1, 2022, 5,465 satellites are in operation in space. Among them, 3,433 (62%) are operated by the United States, 541 by China (10%), 172 by Russia (3%), and 1,319 by other countries (24%). Among other countries, Japan operates 84, and South Korea operates 17 satellites. The United States uses space with the world's best technology, carrying out navigation, communication, and reconnaissance activities through the world's largest satellites and space assets.²²⁾

2. South Korea's Space Policy and Space Power

(1) South Korea's Space Policy

The 1980s laid the foundation for South Korea's space activities. With the importance of the universe in national security and the increase in the economic benefits of the future space industry, South Korea established the Aerospace Research Institute after enacting the Aerospace Industry Development Promotion Act in 1987. In the 1990s, South Korea began its space projects in earnest, launched Korea's first satellite, Woori Star 1, in 1992, and established the mid- to long-term basic plan for space activities (1996-2015) in 1996 to enact the first national space activities plan. In addition, in 1999, it launched a multi-purpose practical satellite to

21) US DOD 2020; Ministry of Science and ICT and Korea Research Foundation 2020, pp. 71-72.

22) UCS Satellite Database 2022,

<https://www.ucsus.org/sites/default/files/2022-08/Changes%20to%20the%20UCS%20Satellite%20Database%205-1-22.pdf>(accessed: October 22, 2022).

secure the first Earth observation satellite. In the 2000s, South Korea consolidated the foundation of its space program. In 2002, a liquid propulsion science rocket was developed to secure the basic technology to manufacture a liquid rocket. In 2005, the Space activities Promotion Act was enacted to lay the legal foundation for space activities. In 2006, the National Space Commission was established and a comprehensive government plan for space activities was established while major space activities-related issues were deliberated. In 2007, the first basic plan for space activities was established to secure Korea's independent space activities capabilities, contribute to the development of the national economy by entering the global space market, improve the quality of life of the people, and promote public pride through successful space activities.

In the 2010s, Korea entered the space developing nation. It became a country with geostationary satellites with the launch of Chollian satellites in 2010. In the following year, the second basic plan for space activities promotion was prepared to establish Korea's core space technology early, expand the use of satellite information, and expand private participation to strengthen the space industry. In addition, in order to revitalize space activities, space technology personnel were trained, space-related infrastructure was expanded, the system was reorganized to advance space activities, and various international cooperation has increased. After the successful launch of the Naro in 2013, a mid- to long-term space development plan was prepared to suggest a long-term space development direction until 2040. In 2018, the 3rd Basic Plan for Space development Promotion was proposed to improve the safety and quality of life of the people and practical space development, specifying the space activities plan by 2022 and setting the vision and goal of space activities by 2040.²³⁾

In the 2020s, South Korea was able to secure self-launching capabilities through the development of Korean Space launch vehicle, diversify satellite development, and upgrade and diversify Korea's space activities capabilities through space exploration. In January 2021, the 3rd Space activities Promotion Plan was announced to promote the independence of Korean space launch vehicle technology, advance satellite utilization services and development such as disaster and real-time national crisis response, start space exploration such as lunar exploration, launch a national satellite navigation system, and switch space activities. In June 2021, South Korea reviewed and confirmed the third amendment to the basic space activities plan, including the use of solid rocket fuel and the expansion of private companies' participation in space activities projects in the new space era. In December 2022, the 4th Basic Plan for Space activities Promotion will be announced.

23) Ministry of Science and ICT, Korea Research Foundation, pp. 96-106.

(2) South Korea's Space Strategy and Space Power

South Korea's space activities are undertaken by major national space activities institutions and private space companies under the leadership of the Ministry of Science and ICT. Satellite and space launch vehicle development programs are underway while complying with the purpose of peaceful use of space. In 2021, Korea announced three major space strategies: promoting space exploration projects through the development of Korean space launch vehicles, developing satellites such as multi-purpose satellites and communication and weather satellites that support public services, and strengthening private space activities capabilities in the New Space era.²⁴⁾ After the success launch of the Nuri in 2022, space technologies such as satellites and space launch vehicles will be transferred to private systematic comprehensive companies to leap up the space industry.

Along with the development of satellites, an important step in space activities is to secure its own space launch capability in its own country without using space launch services from other countries. South Korea's space launch vehicle technology was restricted by the ROK-U.S. missile guidelines. However, the complete lifting of the ROK-U.S. missile guidelines in 2021 allowed the country to develop its space launch vehicle. Starting with science rockets developed in 1993, South Korea succeeded in launching Naro in 2013 through technical cooperation with Russia, developed its own Korean SLV capable of launching 1.5 tons of practical satellites, successfully launched Nuri, a Korean SLV, in 2022, and launched CubeSat produced by performance verification satellites. The successful launch of Nuri contributed to South Korea's independent space launch capabilities, as securing space transport capabilities, including the production of space launch vehicles, will determine the success or failure of Korea's space program to meet the demand for satellite launch in Korea.

South Korea began to produce and launch its very first satellite in 1992. After launching the first multipurpose satellites in 1999, five multi-purpose satellites were used for low-orbit observation while the Chollian satellite and geostationary complex satellite were used to provide weather and marine information. Optical imaging and radar satellites are used for civilian purposes, although they are limited due to resolution and revisit cycles for use in military operations. Amid intensifying space competition, South Korea has failed to increase the number of the space programs, which requires a large budget and period for technology development and investment.

South Korea's space budget is \$700 million, which is lower than those in advanced countries such as \$47.6 billion in the United States and \$3.3 billion in Japan. The nation's space technology should be improved by continuously expanding investment in space activities.²⁵⁾ In the defense sector, according to the

24) Dong-A Science, March 25, 2021

mid-term defense plan of the Ministry of National Defense for 2019-23, the proportion of space development budget, including reconnaissance and communication satellites, is very low at 2.8% of the total budget for defense improvement.²⁶⁾ The South Korean military is seeking to expand its U.S.-dependent intelligence surveillance and reconnaissance assets to shift operational control, but it is forced to rely on U.S. intelligence capabilities due to a lack of technology to develop ultra-precision optical sensors and satellite sensors. It is necessary to strengthen space operational capabilities such as technology development of satellite sensors for the transition of operational control and the ability to operate multiple information satellites and monitor space.

The ROK Air Force has mainly carried out missions to space operations and support in the defense sector. Since the second half of 2020, the Army and Navy became interested in space operations and established space activities plans to reorganize and start research. The Air Force continues to invest in training professionals in the space sector and lead space operations to advance to the Aerospace Force.

The Air Force receives space information from the U.S. Space Command on space objects and satellites over the Korean Peninsula, issues warnings about space activities threatening South Korean satellites to threats, and supports safe space activities. However, the level of sharing U.S. space situation awareness information is limited to conduct independent space surveillance activities like advanced space powers .

In 2020, the Air Force announced its three-stage space development plan to prepare for the future space era and announced its major space capabilities. In the first stage, the Space Odyssey Project was proposed, which would link missile defense and space surveillance systems by 2030 and strengthen missile defense capabilities and centralized control in the space area. In the second stage, the Air Force integrates air and space operational capabilities by 2040 and launches satellites by cargo aircraft.²⁷⁾ As the importance of space operations increases in national security, it is necessary to provide national support for the implementation of space plans and strengthen ROK-U.S.-Japan trilateral space cooperation.

3. Japan's Space Policy and Space Power

(1) Japan's Space Policy

In 1969, Japan signed the Japan-U.S. Space Technology Agreement, laying the foundation for important aerospace cooperation with the United States. Japan was able to invest in space activities thanks to its own space launch vehicle test and its

25) Profiles of Government Space Programs(Euroconsult, 2020.

26) Yoon Woongjik, 2017, p. 7.

27) National Defense Daily, May 26, 2020; Kim Gwi-geun, June 28, 2021.

cooperation with the United States in the space field. In 2008, the Framework Act on Space was enacted that defined the framework for Japan's space activities and utilization. In 2009, the Framework Plan on Space Activities Policy was drafted based on the Framework Act on Space. After proclaiming the 4th Basic Plan for Space in 2020, Japan announced its basic policy on space development over the next 20 years. The Fourth Space Master Plan stated that Japan would contribute to the national interest by strengthening the industrial, scientific and technological foundation to support strategic and independent space activities and strengthening strategic cooperation with major allies.²⁸⁾

(2) Japan's Space Strategy and Space Power

Japan successfully launched the first Ohsumi satellite in Asia in February 1970 and carried out space activities in cooperation with the United States. Japan's space activities are actually investing in the space sector with various missions by the Japan Aerospace Exploration Agency (JAXA), which conducts private space programs. The private space sector is investing mainly in space science and exploration, manned spaceflight, and space launch vehicles. Japan began space exploration in 1985 and launched the first Hitten lunar probe in 1990. Hayabusa 2, the Japanese spacecraft launched in 2014, recently landed on an asteroid and succeeded in collecting asteroid soil samples. Japan manufactures and operates KIBO, an experimental module, on the International Space Station (ISS), conducts various space experiments and contributes to civilian international space cooperation. As the importance of space security increases, the defense sector is developing information gathering satellites (IGS) for earth observation purposes and next-generation communication satellites to strengthen communication security.

Japan expressed its commitment to peaceful space activities. However, due to the increased missile threat from North Korea, it shifted its policy and developed space programs for military use. The satellite operated as an observation satellite is believed to have a military-grade resolution. Increased threats shown in North Korea's passage of Taepodong missiles into Japanese airspace in 1998 and continued ballistic missile tests compelled Japan to continue its research and development in space to strengthen its security. Japan enacted the Framework Act on Space in 2008 and began to engage in military activities in space through the Japan Aerospace Exploration Agency (JAXA) Act. In addition, space launch vehicles were developed, which enhanced their technological capabilities to build ballistic missiles.²⁹⁾

In 2018, Japan's defense plan outlined the strengthening of Japan's military power in new areas such as space and cyber. Since 2019, defense budgets have been

28) ICT, White Paper on Space, p. 83.

29) Han Eun-ah, "A Study on Military Changes in Japan's Space Development Policy," *Journal of Japanese Research*, No. 37, 2013, pp. 97-121.

allocated to new areas such as space and cyber. It appears that anti-satellite attack weapons and space debris that threaten the peaceful use of space are affecting Japan's space operations.³⁰⁾ Based on advanced space science and technology, Japan continues to cooperate with the United States in space to cope with the U.S.-China space competition in Northeast Asia.

Through cooperation with the United States, Japan is strengthening its intelligence sharing and surveillance of military activities in North Korea and around the Korean Peninsula by improving the reconnaissance capabilities of Japanese satellites. Japan operates a total of 84 satellites, eight of which are reconnaissance satellites, three electron optics, and five radar imaging satellites to monitor North Korea's missile launch bases and military activities to maintain all-weather intelligence surveillance capabilities. It plans to operate 10 spy satellites by 2025. North Korea's continued missile provocations provide Japan with an opportunity to boost its space military. Japan has an H-2A liquid fuel rocket that can carry 16 tons of satellites in low orbit around the Earth and operates Epsilon Launch Vehicle, a solid fuel rocket for 1.2 tons of warheads that can be launched at all times. Japan is preparing to launch the H3 with the next-generation rocket and plans to secure competitiveness in the international commercial satellite launch market by shortening international cooperation, shortening the launch period, and lowering the launch cost. It also has its own GPS called the Quasi-Zenith Satellite System (QZSS) to support navigation services, precision guidance of the Japanese weapon system, and communication services.³¹⁾

Recently, Japan signed a memorandum of understanding to send SDF personnel to the U.S. Space Command as liaison officers and is strengthening space cooperation at the level of alliance with the United States. Japan is building a space alliance with the United States by participating in a global Sentinel joint exercise that monitors space objects and tracks satellites in space. In addition, the Air Self-Defense Force established a space operation unit in 2020 and is strengthening its space military operational capabilities by conducting satellite surveillance missions in China and Russia.³²⁾ To strengthen Japanese space security, the Space Operations Unit will be fully operational with 100 people by 2023. Japan plans to operate a ground-based SSA system to strengthen its space situational awareness (SSA) capability in 2023 and will launch an SSA satellite by 2026. Japan continues

30) Cho Eun-il, National Defense Research Institute, "The Major Contents and Security Implications of the 2020 Japan Defense Budget," *Analysis of the Security Situation in Northeast Asia*, April 20, 2020, p.3.

31) Kim Kyung-min, "Japan's satellite, aircraft carrier, and submarine power, the gap with Korea is widening," *JoongAng Ilbo*, September 27, 2019, <https://www.joongang.co.kr/article/23588217> (accessed: October 24, 2022).

32) Yoon Sang-ho, "Japanese Self-Defense Forces liaison officer deployed to the U.S. Space Command at all times" ...*The U.S.-Japan Alliance for Space*," *Dong-A Ilbo*, April 5, 2021.

to cooperate with the United States in space to cope with the U.S.-China space race in Northeast Asia, strengthening its responsiveness to anti-satellite weapons and space debris that threaten the peaceful use of space.³³⁾

IV. Challenges and Strategies for Strengthening Space Cooperation among the ROK, the United States and Japan

1. South Korea-U.S.-Japan Space activities Cooperation

The ROK-U.S.-Japan trilateral space cooperation has not yet been formed. Space cooperation is underway between the United States and Japan. Space cooperation between South Korea and the United States began in the private sector before the government. It was developed in cooperation with TRW Company in the United States when it manufactured the KOMPSAT (Korean multi-purpose satellite)-1, Korea's earth observation satellite. Since then, satellite development has mainly cooperated with European company like Airbus and France's Thales. However, a number of satellite components and subsystems are imported from the United States through procurement and are used to make satellites. In 1996, the Ministry of Science and Technology signed an MOU for space science cooperation between NASA and Korea to start space cooperation. After agreeing to strengthen space cooperation between the two countries through the 2008 Korea-U.S. summit, the Ministry of Education and NASA signed a letter of intent for space technology cooperation with the United States in 2008, laying the foundation for the space cooperation agreement system.³⁴⁾ The Korea-U.S. space cooperation was continued through the Korea-U.S. Space Cooperation Dialogue in 2014 and the Korea-U.S. Space Policy Dialogue in 2015.³⁵⁾

At the 2015 Korea-U.S. summit, the two countries made efforts to conclude the Korea-U.S. space cooperation agreement that would strengthen the Korea-U.S. space cooperation agreement. In 2016, the efforts so far were finally achieved through the signing of the Korea-U.S. space cooperation agreement. South Korea was the first Asian country to sign an intergovernmental space cooperation agreement with the United States, which resulted in the establishment of a legal framework for the two governments' space cooperation.³⁶⁾ As Korea's space technology development and space capabilities in the international community are recognized, demands for international cooperation such as intergovernmental cooperation are increasing. Korea's participation in the Artemis program and the

33) Cho Eun-il, 2020, p.3.

34) Ministry of Science and ICT and Research Foundation, p. 287.

35) Hwang Jinyoung, 2018. p. 12.

36) Cho Hong-je, 2017, p. 493; Munhwa Ilbo, March 4, 2016.

lifting of the South Korea-U.S. missile guidelines will allow South Korea and the United States to cooperate and collaborate on space after the 2021 summit.

In the 2020 Korea Technology Level Assessment Report, the United States is the world's top space technology holder. Among them, South Korea's space launch vehicle development and operation technology is 60% of the U.S., and space environment observation and surveillance analysis technology is 55.5% of the U.S., and space exploration and utilization technology is 56% of the U.S.³⁷⁾ In order for Korea to strengthen space cooperation with the United States, it is very important to share space policy information, expand space cooperation measures on areas of common interest between the two countries, and jointly respond to space-related international issues.³⁸⁾

Since 2013, the defense sector has been sharing space situational awareness information and exchanging space experts through the Korea-U.S. Defense Space Cooperation Conference. Recognizing the importance of space cooperation, South Korea and the United States are strengthening space cooperation as South Korea and the United States jointly respond to increasing space threats.³⁹⁾ The Korean Air Force has been conducting a working-level meeting of the ROK-U.S. space integration team since 2012, jointly writing scenarios for space operations during various command post drills, specifying how to carry out space operations to support combined operations, and analyzing space threats.⁴⁰⁾

Space cooperation between South Korea and Japan is essential because Japan is a world space technology powerhouse, and there is a high possibility of cooperation. However, due to historical issues, cooperation at the national level is limited. Since early 2002, Korea has started cooperation in space activities with the Japan Space activities Agency (NASDA) and has participated in the International Space Congress (IAC) to continue cooperation in space and space education programs between the two countries. It also continues to strengthen international networks and cooperate in space activities between Korea and Japan through multilateral consultative bodies such as the Asia-Pacific Space Agency Forum (APRSAP), led by Japan.⁴¹⁾

President Biden emphasized space cooperation among the three countries when he visited Korea and Japan in 2022.⁴²⁾ The formation of a space cooperation system among South Korea, the United States, and Japan is crucial for peaceful space activities and response to Chinese space threats. It can contribute to peace in

37) Korea Institute of Science and Technology Planning and Evaluation, 2021, p. 27.

38) Lee Jun, 2021, p. 2.

39) National Defense Daily, May 25, 2021

40) National Defense Daily, November 19, 2020

41) White Paper on Space Development, p. 298.

42) Sung Ho-cheol, "The reason why Biden didn't forget the space cooperation card in Korea and Japan, May 24, 2022."

Northeast Asia, such as a military cooperation system formed by defense ministers and Joint Chiefs of Staff. Space cooperation among South Korea, the United States, and Japan must be implemented to strengthen the three-way security cooperation to counter North Korea's continued nuclear and missile threats.

2. South Korea-U.S.-Japan Space activities Cooperation Tasks and Strategies

The United States is trying to maintain U.S. space leadership and strengthen its space power through space cooperation with its allies. The three countries can cooperate in space activities, including space technology and space system development, space exploration and environmental research, and space operations. The security crisis on the Korean Peninsula is intensifying due to China's military buildup in Northeast Asia, intense strategic competition between China and the United States, and North Korea's nuclear and missile capabilities.

(1) Space technology and space system development

1) Strengthening Space Technology Cooperation and Exchange

The United States uses international regimes such as MTCR to control exports of space industry-related technologies, builds protections for space industry technologies under U.S. domestic law, and demands compliance from other countries. U.S. domestic laws restrict the transfer of state-of-the-art technologies to Korea, such as the U.S. Department of Commerce's Export Administration Regulations (EAR) and the State Department's International Traffic in Arms Regulation (ITAR) to control dual-purpose products that can be used for space and missiles.⁴³⁾ South Korea sought international cooperation in developing Naro's first-stage engine because of U.S. export regulations. International space cooperation in acquiring and transferring space technology will gain momentum by participating as an international partner in space activities projects, as the ROK-U.S. missile guidelines are lifted and the United States wants to strengthen space cooperation with Korea. It is possible to increase investment in the private space industry and improve aerospace technology in Korea. It is very important to continuously expand Korea's investment in space activities and foster professional technical personnel. If the size of R&D investment in the space industry and the level of aerospace technology in major countries are rated at 100 percent, Japan can rate it at 89 percent and Korea at 60 percent.⁴⁴⁾

In 1970, Japan changed its independent rocket development policy and promoted the introduction of technology from the United States, which Japan destroyed its Q rocket program, received liquid rocket technology from the United States, and successfully launched its own N-1 rocket five years later.⁴⁵⁾ South Korea should

43) Kim Jongbeom, 2020, p.73.

44) OECD (2016); Korea Institute of Science and Technology Planning and Evaluation (2021).

push for cooperation with the United States and Japan to jointly respond to security threats in Northeast Asia caused by North Korea's nuclear and missile advances and improve South Korea's low space technology.

South Korea's satellite development technology shows that satellite and main body design have technological capabilities, but the localization rate of components of payloads, which are important sensors of satellites, is 41%, and technology should be developed through Korea-U.S. technology cooperation. As the joint statement on satellite navigation cooperation was signed through the ROK-U.S. summit, South Korea is expected to further strengthen satellite navigation interoperability with the United States as it begins to build a Korean satellite navigation committee system (KPS).⁴⁶⁾ In addition, by actively participating in the U.S.- or Japan-led space symposium and actively participating in the International Space Cooperation Organization, the latest space technologies can be acquired and space cooperation between the three countries can be strengthened.⁴⁷⁾

South Korea should take advantage of the good opportunity for space cooperation among South Korea, the United States, and Japan to develop its space and defense capabilities. In the space sector, it may be possible for the three countries to form a strong space technology alliance like military cooperation. South Korea needs to present the field of space cooperation ahead of time to what the United States and Japan want from Korea's space capabilities. Unlike in the past, when Korea received unilateral technical support and control from the United States, we should take lessons from the fact that South Korea and the United States have developed a complementary partnership to respond to threats on the Korean Peninsula, including China and Russia, and strengthen space cooperation for three countries' space security.⁴⁸⁾ Korea should cooperate with the United States and Japan in producing small satellites, which are recognized as Korea's strengths in space, and develop Korea's weaknesses such as satellite sensor capabilities, space rocket engine production, space exploration, and cooperation in exchanging the latest space technologies.

Space cooperation between Korea and Japan began in 2000. The Korea Aerospace Research Institute and NASDA agreed to hold the Earth Observation Working Group meeting and study on joint utilization of ISS. Korea held a joint seminar on the utilization of the Korea-Japan space environment and cooperation following the hosting of the Asia-Pacific Forum (APRSAF) organized by Japan in Korea. Korea and Japan continue bilateral talks between Korea and Japan on space exploration and space experiments, but, space exchange programs between Korea and Japan should be more active through space cooperation.

45) Han Eun Ah, 2013, p. 103.

46) Yoo Yong-won, June 17, 2021.

47) Lee Jun, 2017, pp. 87-89.

48) Lee Sang-hyun, 2019, p.99.

2) Revitalizing Commercial Space Activities between South Korea, the United States, and Japan

With the emergence of countries and various companies seeking to secure commercial interests using the potential of the space sector, the space industry is growing significantly and space technology is further developing the Fourth Industrial Revolution.⁴⁹⁾ In the New Space era, private U.S. space companies actively participate in space activities with the U.S. government, increasing the U.S. national space competitiveness. A private space company launched a space travel service, and SpaceX signed a contract with NASA to successfully carry astronauts to the space station. In South Korea, commercial space activities in various fields such as space launch vehicle projects and small satellite production by private space companies are also increasing. Strengthening business investment and research and development activities among private companies can boost commercial space activities and strengthen the technological competitiveness of private companies by boosting commercial space activities. Korea should secure space manpower, enhance technology, and promote South Korea-U.S.-Japan startup exchanges by strengthening support for space startups.

(2) Space exploration and space environment research

1) Increase participation in manned and unmanned lunar exploration

Korea will be able to enhance its capabilities in the space age by participating in the U.S.-led Artemis program, improving Korea's space activities capabilities, and enhancing the participation of private space companies. Artemis is the first U.S. project to land a female astronaut on the moon in 2024, using innovative state-of-the-art science and technology and systems. It aims to send astronauts to Mars by 2028 based on the technology and exploration experience gained from lunar exploration.⁵⁰⁾ Japan plays a major role in U.S. space activities, including the development of payloads, while participating in the U.S. Artemis program.

The lunar orbiter project, Korea's first space exploration program, launched the Danuri lunar probe from the United States on August 5, 2022, and is currently flying toward Moon orbit and is scheduled to arrive at Moon orbit in mid-December. It uses Space X's Falcon 9 rocket to secure the core technology needed for lunar exploration through orbiters, landers, scientific payloads, and deep space communications. Space exploration technology can contribute to economic effects such as spin-offs in the future and will provide the foundation for Korea to become a space power by achieving the development of the space industry through cooperation with NASA. Japan successfully launched a lunar probe in 1990 and has long experience and technology in space exploration. Thus, South Korea can take advantage of the

49) Jeong Heonju, 2021. p. 10.

50) NASA, 2021.

strength of Korea's space development personnel and combine advanced space technology from the United States and Japan to conduct space exploration programs. Participation in the space exploration program will also enable South Korea to acquire technologies for commercial use and military purposes of space, such as satellite docking, removal of space debris, and satellite surveillance.

2) Strengthening Space Meteorology and Space Environment Cooperation Project

In order to actively cope with global climate change caused by global warming, the Korea Meteorological Administration and the U.S. Oceanic and Atmospheric Administration (NOAA) discussed weather satellite development and satellite information sharing in 2017 and shared Arirang 5 satellite data between Korea Aerospace Research Institute and NOAA in 2018. The Korea Aerospace Research Institute was jointly conducted with NASA's Solar System Exploration Research Institute, a joint space science research project, and Korea Astronomy & Space Science Institute is working with NASA to research solar physics, including the development of solar observation equipment. Since 2014, researchers have been dispatched for space cooperation to expand Korea's role in global space science and technology by jointly participating in space science research with the United States or international organizations.⁵¹⁾ It will also contribute to strengthening weather information exchange and cooperation with Japan as well as the United States by sharing Korea's marine and meteorological satellite data with Japan and jointly researching various space weather and environmental fields such as marine monitoring, climate change, and disaster prediction.

(3) Space Operations and Military Security

1) Strengthening the South Korea-U.S.-Japan Defense Space Exchange

Notable dialogues on space cooperation between South Korea and the United States include the Defense Cooperation Working Group (SCWG) and the Space Policy Dialogue hosted by the U.S. State Department and NASA. The Ministry of National Defense has been operating SCWG regularly since 2013, sharing information on the Space Situational Awareness (SSA), training military space experts, participating in joint space operation drills, and conducting joint research and development of the Korea-U.S. space policy. It operates the electronic optical satellite monitoring system and plans to launch the first military reconnaissance in 2023, which is a good opportunity to strengthen the combined intelligence monitoring and reconnaissance capabilities such as joint use and intelligence sharing by the ROK-US Defense Ministry.⁵²⁾

51) Lee Joon and Hwang Jin Young 2017, pp. 28-31.

52) Kim Gwi-geun, May 31, 2021.

South Korea conducts military exercises with Japan, but cooperation in the defense and space sectors is not underway. If we promote exchanges in the defense and space sectors as part of strengthening cooperation in the defense sector, such as combined military exercises between South Korea, the United States, and Japan, we will be able to contribute to strengthening defense cooperation, such as monitoring and sharing of North Korea's nuclear and missile threats.

By training space-related military professionals and participating in the U.S. Space Military Course and Space University education, they will be able to form a wide network of space-related connections and acquire expertise. The ROK Ministry of National Defense needs to establish a leading space force enhancement plan and establish a space organization to strengthen space surveillance and space operational capabilities through the participation of the Army and Navy.

2) Joint Response to Space Threats from China, Russia, and North Korea

The recent launch of a Chinese spacecraft, the construction of a Chinese-led space station, and the strengthening of cooperation between China and Russia in space activities could pose a threat to U.S. space operations. China's possession of anti-Satellite (ASAT) attack capabilities and attempts to militarize space pose a major threat to U.S. space security. After conducting the first satellite attack experiment in 2007, China continued to modernize its anti-satellite attack weapons in 2010, 2013, and 2014.⁵³⁾ Russia conducted kinetic satellite attack tests in 2017 and 2020. In 2020, it is strengthening its attack capability against U.S. satellites through weapons tests for ground-based direct-ascending satellite attacks.⁵⁴⁾ Recently, North Korea has been threatening South Korea-U.S. space assets by electronic jamming, EMP attacks, and hacking attacks on the South-U.S. ground space system. Recently, North Korea succeeded in developing a super-powerful EMP bomb. As the threat of EMP to the U.S. and South Korea increases, the U.S. Air Force is planning a response plan, and the South Korean Air Force also needs to join in developing countermeasures.⁵⁵⁾

V. Conclusion

In response to the question of why the three countries should cooperate in space activities, South Korea should establish a specific plan for the necessity of ROK-US-Japan space activities cooperation and future space activities cooperation development plans. ROK-U.S.-Japan space activities have developed from

53) Space News, January 11, 2016.

54) US Space Command, 2020.

55) Pry 2021; JoongAng Ilbo, June 24, 2021.

discussions for pure space science and technology development in the past and are changing to a situation requiring cooperation and the performance of complementary roles such as joint space exploration cooperation and joint response to space threats. Space cooperation in the defense field by the ROK-U.S.-Japan military training should not only disseminate and share information about space object threats in outer space but also allow South Korea's space power to be practically applied to military operations and security fields. South Korea should draw up a development plan through an objective analysis of Korea's space power to determine which areas to focus on.

It is a great opportunity for South Korea to demand that the US strengthen Korea-US space activities along with the signing of an agreement on a manned lunar exploration program. In the space launch vehicle field, South Korea attempted to develop its own in accordance with the ROK-US missile guidelines and MTCR but relied heavily on Russia for technological development for the development of the Naro. It was launched with Russian core technologies, such as engine manufacturing, that were not freely transferred to South Korea due to international technology transfer controls. In the case of Japan, it was provided space launch vehicle technology from the United States. Japan currently has the ability to operate reconnaissance satellites and build Earth reentry vehicles that can be converted into ballistic missiles, thereby gaining superiority and economic benefits in the international space market.

The space industry is increasing investment as world powers recognize it as a core field of the future industry. Based on these discussions, this study intends to present the following policy suggestions.

First, we need to move beyond the idea that South Korea's space activities are a waste of the national budget. Space technology has a huge ripple effect. For example, various technological developments such as infrared sensors, MRI, and LASIK have been tested in space and later used in our daily lives. There were also skeptics about the development of a space launch vehicle, which requires an astronomical budget as Naro's second launch failed. The third launch was successful based on the lessons learned from the failure of the Naro launch, and the Nuri was launched successfully in 2022. It provides convenience in daily life such as navigation information and satellite imagery through space activities and has a great impact on high-tech industries such as military security, satellite communication, disaster warning, soil measurement, and geographic information construction.

Second, it is necessary to closely analyze the international space activities situation, establish South Korea's space policy, and implement the space activities plan. The competition for supremacy by major powers in space is an opportunity for the United States to strengthen the ROK-U.S.-Japan space cooperation, such as South Korea's participation in the U.S. lunar exploration program, and to develop South Korea's space science and technology. The United States needs partners such

as South Korea and Japan to engage and maintain space security in its allies. South Korea, the United States, and Japan must analyze the strengths and weaknesses in space activities cooperation and analyze the opportunities and crises that South Korea can afford to make good use of the opportunities of space cooperation. South Korea's participation in the manned lunar exploration program in May 2021 could strengthen the space alliance with the United States as an ally in space and strengthen cooperation with Japan in the space field.

Third, space cooperation is not limited to scientific and technological development or economic gains. The competition of great powers in outer space is recognized as an important space in addition to the land, sea, and air domains and is a key area for warfare. The great powers are in an invisible race for dominance in space. The importance of South Korea-US-Japan space cooperation should be recognized from a security perspective as it can advance South Korea's science and technology in the era of the 4th industrial revolution and improve the defense space capabilities of South Korea, the US, and Japan in the context of increasing threats from China's space and North Korea's ballistic missiles.

Fourth, the operation of the Korea-US-Japan cooperative organization should be activated to facilitate cooperation in defense and civil space fields between South Korea, the United States, and Japan and to resolve major issues and limitations. In addition to the private space activities cooperation between the US NASA, KARI of Korea, and JAXA of Japan, it is necessary to strengthen space cooperation between the defense authorities of the US, Korea, and Japan. Defense space cooperation between the US and Japan is a way to actively respond to China's space threats and North Korea's security threats. South Korea is participating in joint space training with the United States and participating in space military education at US space education-related institutions.

Fifth, it is necessary to establish an independent space agency, such as the Korea Space Agency, that will play the role of a space activities control tower in South Korea and lead international cooperation between the United States and major advanced space activities countries.⁵⁶⁾ Major advanced countries in space, such as NASA in the United States, Germany's National Aeronautics and Space Administration, France's National Space Center, China's National Aeronautics and Space Administration, and Japanese Strategic Headquarters for National Space Policy, have government organizations dedicated to space activities. A new Korean space agency should be used as a good opportunity for the development of South Korea's space power by strengthening cooperation in space activities between Korea, the United States, and Japan and revitalizing the development of the space industry.

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56) Lee Chang-jin, 21/06/10.

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