The Space Development Strategy Headquarters, Japan

SPACE SECURITY INITIATIVE

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Purpose

As the 2022 National Security Strategy calls for defining the agenda and policies of space security into practice, the Space Security Initiative will outline the initiatives necessary for space security over the next decade, and reflect those efforts in the Space Basic Plan, which is a cross-governmental initiative.

This initiative first identifies the current status and challenges of security environment in space. Next, the Initiative sets forth space security objectives and approaches to strategically address space security challenges. Then, it indicates the space architecture for national security as a future vision of Japan's space applications, and the efforts that realize the architecture.

１. The Security Environment in Space: Current Status and Challenges

(1) Competition in Space

Today, space has become a major arena for geopolitical competition for national power over diplomacy, defense, economic, and intelligence, as well as the science and technology and innovation that support these national powers. In addition, the scope of space security is likely to expand beyond earth orbit to the region between the Earth and the Moon (cis-lunar region) as the growing economic significance of the Moon, including resource exploration.

A number of conflicts in the 21st century have proved that the use of outer space is directly linked to terrestrial military superiority. In the Russia’s aggression against Ukraine since February 2022, Western commercial satellites are directly supporting Ukrainian military operations, while advanced technologies, including artificial intelligence, have enabled autonomous satellite image data analysis. Further, the integration of cloud-based data management with a cutting-edge data solution technology has enabled satellite data more readily available for field units. Over the past few years, our neighboring countries have significantly increased the number of satellites that fly over our country and collect information by optical, synthetic aperture radar (SAR), and radio frequency signal sensors.

These growing significance of space systems in national security, coupled with the dual-use nature of space systems, where one satellite is used for multiple purposes, has accelerated cross-sectoral and comprehensive competition over space development and use of space in the civil, commercial, and security sectors. Furthermore, as geopolitical competition intensifies, space cooperation among countries sharing common values has increasingly deepened, and the cooperation with our ally and like-minded countries has become indispensable to ensure our national security.

(2) Growing Threats and Risks in Space

Threats in space are growing rapidly. Some countries are developing and deploying a variety of ground-based and space-based counter-space capabilities, including Direct-Ascent Anti-Satellite (DA-ASAT), which targets satellites in low earth orbit(LEO) by kinetic means, as well as non-kinetic means such as cyber and electronic attacks. Future threats include the development of DA-ASAT capabilities against satellites in geostationary orbit (GEO) and, the deployment of capabilities using high-power directed energy by the late 2020s.

Of these counter-space capabilities, there is concern that some capabilities whose damage is temporal or reversible may be used even in the peacetime as a means of military demonstration. Regarding the use of non-kinetic capabilities, including cyberattacks and electronic attacks, identifying the attribution of attacking entities and means of attack is especially challenging. Thus, the security environment in space becomes to be a gray zone where the boundary between peacetime and armed contingency is ambiguous. In a full-scale armed conflict, the use of capabilities that cause irreversible damage, such as DA-ASAT, is undeniable, and there is concern that if such capabilities are employed, they will bring a long-term, catastrophic impact on the safe and stable use of outer space.

Various risks are also expanding in space. Notably, the rapid increase in the number of space objects, including space debris and satellites, is resulting in a growing congestion in space. For example, China's ASAT experiment in 2007 generated more than 3,000 pieces of trackable space debris, most of which will continue orbiting for decades to come. Russia also conducted an ASAT experiment in November 2021, resulting in a large amount of space debris that has put international space assets at risk, including the International Space Station. Furthermore, with the emergence of large-scale satellite constellations, the rapid increase of space objects, including satellites, is further crowding orbits, with a corresponding increase in the risk of collisions.

(3) Advancing Innovation in the Private Sector

Today, innovations in space technology are rapidly advancing in the private sector. The private sector is accelerating technological innovation such as low-cost and multiple launches through reusable rockets and small rockets, the development of large-scale small satellite constellations, and advanced data analytics through the artificial intelligence and other cutting-edge technologies in space systems. Those innovation expands the opportunities of new space business. Rapid incorporation of these new technologies from the private sector into the security sector will increase the speed of the process from research and development (R&D) to demonstration, production, and application. In addition, expanding the use of commercial space services will enable the government to utilize advanced space systems within its budgetary resources.

In such circumstances, a clear identification of the government's demands in space security to the private sector will facilitate private investment and vitalize the space industrial base and its competitiveness by accelerating R&Ds and reducing manufacturing costs, that will contribute to further strengthening of space security efforts. Thus, space security policy needs to be designed to create an ecosystem that will realize a virtuous cycle of strengthening such security efforts and fostering the space industrial base and its competitiveness.

2. Objective and Approaches for Space Security

(1) Objective for Space Security

Space security requires to contribute to national security objectives through space. The objective of space security is “to promote the peace and prosperity of Japan and the safety and security of our citizens through outer space, together with our ally, like-minded countries, and others to maintain the stable use of and free access to outer space.”

To achieve this objective, we will seek two approaches: (1) "security from space," which is to use the capabilities provided by space system to protect our economic society as well as the space systems that are indispensable for our national security, and (2) "security in space," which is to defend and protect the space systems that are indispensable for our economic society against the expanding threats and risks in space.

Recognizing that outer space has become an arena for intensifying geopolitical competition over diplomacy, defense, economic, intelligence, science and technology, and innovation, we will strengthen cooperation with our ally, like-minded countries, and others while promoting unified efforts by our space-related ministries and agencies to ensure the above-mentioned two space security. Furthermore, we will strengthen domestic and international public-private partnerships to promptly incorporate achievements of the private sector's technological innovations and achievements in the space sector.

(2) Approaches to Achieving Objectives

We will achieve the space security objective through following three approaches.

Approach 1: Radically Expand the Use of Space Systems for National Security (security from space)

Japan will expand the use of data from space systems to address various security challenges, and to strengthen overall national power, including diplomatic, defense, economic, technological, and intelligence capabilities. In particular, we will effectively and efficiently utilize wide-area, high precision satellite data with higher revisit rate and faster data transfer speeds in order to seamlessly respond to security challenges in the most severe and complex security environment since the end of World War II. For this purpose, we will leverage satellite constellations and Information-Gathering Satellites (IGS), diversify communication satellites for security purposes, and enhance satellite position, navigation, and timing (PNT) capabilities

Approach 2: Ensuring Safe and Stable Use of Outer Space (Security in Space)

As space systems become increasingly vital for security, economic, and social activities, it is imperative to address the growing threats and risks in space, such as counter-space capabilities and space debris. To this end, we will ensure safe and stable use of space systems through Space Domain Awareness (SDA), satellite life cycle management using on-orbit services, accelerating government decision-making and response in contingency situations, and proactively contributing to international norms and rule making.

Approach 3: Realization of a Virtuous Cycle of Security and Fostering Space Industrial Base

A strong space-related defense capability is supported by a strong domestic space industrial base and a vibrant innovation base. Strengthening the space industrial base will lead to technological and commercial innovation, which will benefit Japan's national interest in economic as well as security areas. Thus, we will realize a virtuous cycle in which the application of commercial space technology to the security sector will foster the development of the domestic space industrial base, which in turn will strengthen our defense capabilities.

３. Establishing Space Architecture for National Security

(1) Space Architecture for National Security

Japan will establish a "space architecture for national security" as a future vision of “Radically Expand the Use of Space Systems for National Security (Approach 1)” and “Ensuring the Safe and Stable Use of Outer Space (Approach 2),” and to facilitate those efforts, we will realize a Virtuous Cycle of Security and Fostering Space Industrial Base (Approach 3). Furthermore, in this section, we will identify the key requirements that a space architecture for national security should meet based on the security environment and issues surrounding space.

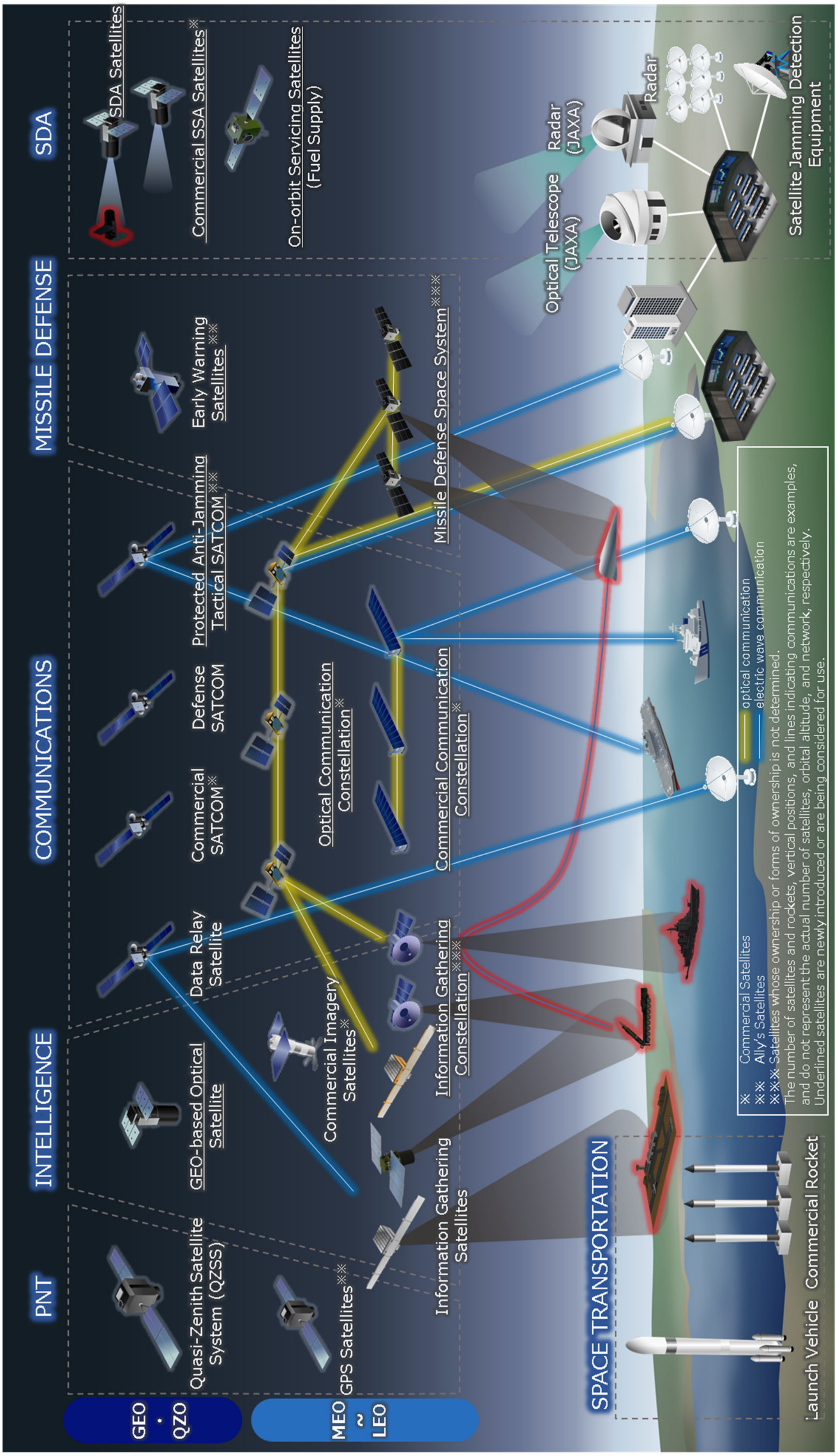

Figure: Space Architecture for National Security

(2) Requirements for the Space Architecture for National Security

(i) Compatibility and interoperability of satellite data, cyber security, and information security

The architecture must provide compatible satellite data to ensure timely use of satellite data by government policy-making, intelligence, and operations sections, as well as to facilitate cooperation with the ally and like-minded countries. The architecture also needs to ensure interoperability with the ally and like-minded countries, especially with respect to SDA and areas where multilateral cooperation is a prerequisite.

This requires the timely improvement and updating of security solutions in the entire space system and the bolstering the cybersecurity posture. In addition, an information security structure, including a security clearance program, must be in place. Furthermore, these mechanisms should be applied to the framework for establishing security standards and procurement of space systems by relevant authorities, as well as to the partnership with private space operators.

(ii) Resilience against threats and risks in space

The architecture must ensure the resilience of the entire space system against threats and risks in space. Therefore, the architecture requires the retention of a large number of satellites with the same functions of the space system and the same functions in a variety of forms. The architecture should also ensure the overall space system resilience from physical and non-physical aspects, such as protection of ground stations and cyber resilience.

(iii) Economic efficiency through the use of commercial services

The architecture should leverage commercial services with higher economic efficiency to rapidly procure the required capabilities while incorporating innovative technologies. In particular, the architecture should best optimize the use of commercial services especially in the areas where innovation is accelerating such as telecommunications, earth observation, and data solutions. In expanding the use of commercial services, the service provider must ensure the levels of cybersecurity and information security and soundness of supply chain and the investment in order to maintain the safety and stability of the services.

４．Approach 1: Radically Expand the Use of Space Systems for National Security (security from space)

(1) Establishment of a Wide-Area, High Revisit Rate, High Precision Information-Gathering Posture from Space (Intelligence)

We will seamlessly obtain information from space over a wide terrestrial area by combining various means, including the use of governmental and commercial satellites and the strengthening of cooperation with our ally and like-minded countries.

To this end, we will develop a higher revisit rate information collection posture through the information gathering constellation, GEO-based optical satellites, and expanded procurement of commercial services, supplemented by various cooperation with our ally and like-minded countries. Through these efforts, we will advance target detection and tracking capabilities required for the stand-off defense capability and maritime domain awareness. We will also increase the speed of satellite data transfer through optical communications constellation and improve our image processing capabilities by artificial intelligence.

In addition, we will enhance the intelligence capability of the government-owned IGS by steadily increasing the satellites, collecting high-quality and high-resolution satellite imagery, and improving the speed of satellite data transfer through the data relay satellite, to provide the information necessary to the policy-making in the midst of rapid changing security environment. We will also strengthen cooperation among the Cabinet Satellite Intelligence Center, the Ministry of Defense (MOD), the Self-Defense Forces (SDF), and other relevant ministries and agencies to further effectively utilize the collected information.

(2) Responding to Missile Threats by Space Systems (Missile Defense)

We will continue the cooperation with our ally on early warning satellite. Further, we will pursue a technical demonstration of the missile defense space systems (A system that seeks continuously detects and tracks missile threats in a wide terrestrial area, quickly shares information among various weapon system, and sends data to interceptors), while considering the possibility of cooperation with the ally, and study the acquisition of required capabilities to respond to the development and deployment of ballistic missiles and hypersonic gliding vehicles (HGVs) by neighboring countries.

(3) Establishment of a Multi-Layered, Anti-Interception and Anti-Jamming Satellite Communications Posture (Communications)

We will establish a multi-layered and redundant satellite communications (SATCOM) network utilizing GEO (e.g. defense SATCOM, commercial SATCOM, and the U.S.-led Protected Anti-Jamming Tactical SATCOM), LEO (e.g. commercial communications constellations, optical communications constellation) and other satellites. These will enable us to connect satellites to ground stations, inter-satellites, and inter-ground stations, to meet the growing demand associated with the expanding missions of the MOD and the SDF, as well as to address enhanced jamming capabilities by neighboring countries. To this end, we will develop anti-intercept and anti-jamming defense SATCOM structure interoperable with our ally and like-minded countries. In addition, the Japan Coast Guard (JCG) will promote the use of commercial SATCOM, such as the communication constellation, in order to increase the transmission speed and capacity of information and communication, while improving the redundancy and secrecy of information and communications and responding to jamming.

(4) Enhancement of Satellite Positioning Functions (PNT)

We will strengthen satellite PNT capabilities by improving the capability and reliability of Quasi-Zenith Satellite System (QZSS). We will also ensure resilient PNT capabilities through cooperation with the ally, including the use of GPS satellites. The MOD and the JCG will advance the introduction of multi-signal receivers, including the use of QZSS signal. In addition, the MOD will promote studies on the utilization of PNT signals in space.

(5) Building a Large-scale and Flexible Space Transportation Posture (Space Transportation)

We will continue to operate and improve the flagship launch vehicle to ensure sovereign space access capability in order to build a variety of space systems and maintain and improve their functionalities and capabilities. In this effort, we will strengthen our launch capabilities, including the enhancement of the transportation capacity and reducing launch costs, as well as facilitating studies and initiatives concerning expanding opportunities of launches of flagship launch vehicles and launch sites. We will support the commercialization and enhancement of launch capabilities of private launch vehicles that are under development in our country, allowing the government to utilize them for quick launch of small satellites. Furthermore, the public and private sector will take actions necessary for the dispersion of launch sites and the development of launch sites that can accommodate a variety of launch services, including airborne launches.

５． Approach 2: Ensuring Safe and Stable Use of Outer Space (Security in Space)

(1) Enhancing and strengthening of space Domain Awareness (Space Domain Awareness)

In addition to Space Situational Awareness (SSA), which is to determine the position and orbit of space objects, we will enhance and strengthen Space Domain Awareness (SDA), which is to determine the operation and utilization of space objects as well as their intentions and capabilities.

With regard to SDA, we will develop and deploy a new SDA satellite in addition to ground-based radar, optical telescopes, and satellite jamming detection equipment, and will consider the operation of multiple SDA satellites, taking into account trends in other countries. Besides participating in multilateral exercises, we also strengthen the cooperation with the Combined Space Operations Center (CSpOC) operated by the U.S., U.K., Australia, Canada, and aim to join the Combined Space Operations Initiative (CSpO) organized by the U.S., U.K., Australia, Canada, New Zealand, France, and Germany to strengthen our efforts to defend governmental and commercial satellites of Japan, our ally, and like-minded countries.

Regarding SSA, the Japan Aerospace Exploration Agency (JAXA) and the MOD will continue to cooperate in this area, and the MOD will expand the acquisition of commercial SSA information collected from ground- and space-based sensors, including SSA satellites. We will also establish a framework that allows satellite operators to provide orbital information to the MOD's SSA system and establish a public-private information cycle that enables MOD to distribute more reliable SSA information to private operators.

In addition, in conjunction with these efforts, the MOD and the SDF will continue to develop the capabilities to hinder command and control as well as information and communications at the other end.

The MOD and SDF will utilize the space weather programs of the National Institute of Information and Communications Technology (NICT) in their operations.

(2) Satellite Life Cycle Management Using On-Orbit Services

In order to contribute to the long-term and cost-effective operation of various large GEO satellites and SDA satellites that require high maneuverability propulsion technology as space becomes a warfighting domain, we will accelerate the establishment of on-orbit service technologies such as propellant refueling technology and utilize these technologies to manage the life cycle of the satellites.

(3) Government Decision-Making and Response in Unforeseeable Contingencies

We will organize and strengthen the framework for information sharing among the relevant authorities, the SDF, and private operators, as well as the structure for information collection, analysis, and sharing among the Cabinet Secretariat, the Cabinet Office, the MOD and the SDF, and for implementing government decision-making. This will lead to correct understanding and analysis of the circumstances correctly in the case of unforeseen space-related contingencies, and allow the public and private sectors to work together to appropriately respond to the situation. We will also strengthen cooperation with our ally in responding to space-related contingencies.

(4) Proactive Contribution to International Norms and Rules in Outer Space

We will actively contribute to discussions at the United Nations (UN) and other organizations, play a proactive role in shaping norms for responsible behavior in outer space through cooperation with the ally, like-minded countries, and others, and promote the development of international norms and rules for the use of outer space, including from the perspective of national security. In particular, we will extend our commitment to "not to conduct destructive, direct-ascent anti-satellite (ASAT) missile testing" to other countries, which we decided in September 2022. We will also support other countries in the formulation of domestic regulations framework and promote technological development to mitigate the creation of space debris and remediation of existing space debris in accordance with the international guidelines adopted by the UN Committee on the Peaceful Uses of Outer Space.

６．Approach 3: Realizing a Virtuous Cycle of Security and Fostering Space Industrial Base

(1) Strengthen the Public-Private Joint Efforts to Develop Advanced and Fundamental Technologies

We will review issues related to the sustainment and development of technological, industrial, and human capital bases across the security and civil space sectors, identify technologies that Japan should foster the development of, and formulate a Space Technology Strategy that includes a technological roadmap showing a timeline for the development of such technologies. This will clarify the path for the development of advanced and fundamental technologies and their commercial and practical application, in addition to the national missions.

Furthermore, relevant agencies responsible for security, civil and commercial space, and R&D, will take the lead in strengthening cooperation among the other ministries and agencies, JAXA, the Japan Science and Technology Agency (JST), the New Energy and Industrial Technology Development Organization (NEDO), and the National Institute of Information and Communications Technology (NICT). In addition, relevant ministries and agencies will cooperate on personnel exchanges and technical cooperation with domestic and foreign research institutes and private companies, in order to study the application of cutting-edge technologies. Also, each ministry and agency will cultivate and recruit talented personnel with expertise in space, and study the establishment of a mechanism for information sharing and personnel exchange, including space career paths, among the relevant ministries and agencies.

(2) Ensuring Autonomy of Critical Technologies

We will identify the critical technology components that should be maintained autonomy to a certain degree as well as safety and stability of the supply chain that composes the space systems necessary for security, and clarify the direction to promote the domestic production of these components in the Space Technology Strategy. In addition, when pursuing for domestic production, the public and private sectors will discuss ways to share the costs in the initial stage of development in order to incentivize the industry to commercialize and monetize the technology while assuming that the industry will bear the costs after the start of mass production as a privately led project. Through these efforts, we will maintain and ensure the autonomy of critical technologies and improve the international competitiveness of Japanese industries by reducing manufacturing costs through expansion of the scale of production.

(3) Enhancing Implementation Capabilities through the Comprehensive Efforts of the Public and Private Sectors

With rapid technological evolution and innovation in the space sector, we will leverage the comprehensive efforts of the public and private sectors. This will enable the government to conduct effective R&D and agile equipping of space systems. In particular, the MOD will play a central role in research studies from the standpoint of strategic and operational needs. In addition, the MOD will facilitate efforts toward the agile acquisition of space systems by proactively seeking proposals from the private sector and leveraging their technologies. Furthermore, based on the needs of the MOD and the SDF, we will leverage R&D of advanced technologies conducted by governmental organizations for defense purposes, thereby linking governmental R&D efforts to fundamental reinforcement of defense capabilities.

In implementing these efforts, we will emphasize common fundamental technologies in building a "space architecture for national security". For instance, technologies to utilize satellite constellations actively and expand the use of space include advanced design, manufacturing, and testing technologies for mass production, and optimization of networks in satellite constellations. In addition, technologies to meet the increasing demand for communications include full digitalization and software defined satellites, and application of the EHF bandwidth. Furthermore, technologies that contribute to SDA and mission assurance include downscaling size and weight of various satellite buses and sensors, autonomous satellite operations, decentralization of ground systems, and opportunities for space demonstration and recovery.

(4) Strengthening JAXA's Role as a Center of Excellence for Space Development

There is an urgent demand to boost our R&D capabilities and technological capacity, as rapid technological advancement brings revolutionary transformation to space development. Under such circumstances, we will strengthen JAXA's R&D structure as a center of excellence, expand and enhance its human resources, and reinforce its role as a driving force for a comprehensive R&D network that includes universities, industry, and other organizations.

JAXA will also strengthen its cooperative relationship with other security-related organizations, including the MOD. Specifically, JAXA will further strengthen cooperation with the MOD to further leverage JAXA's expertise and technology for projects regarding space security, and we will study ways to apply JAXA's expertise in the distribution of research funds from security agencies to other entities.

(5) Promoting Privately Led Development and Expanding Government Support

Besides government-led development of equipment related to security to date, we will expand cooperation with the private sector through increased government support for companies which develop critical technologies for national security to encourage innovation in the private sector and privately led development. This includes spin-off to the private sector of the achievements of common and fundamental technologies from government-led projects, such as IGS, and rapid spin-on of private innovations to the government side. Through these efforts, we will strengthen the international competitiveness of the space industrial base while improving the speed and reducing the cost of government-led projects, creating a virtuous cycle between these two models of development.

(6) Selective and Comprehensive Support for Competitive Companies

To harness the vigor of industry driving innovation, we will expand our support programs for companies in different industries and start-ups developing technologies that are also critical to national security. In particular, we will expand comprehensive support, including the provision of risk money, the design of domestic programs, and international collaboration, for industries with high dual-use potential and global business opportunities, such as on-orbit services, small SAR and optical satellites, optical communication satellites, and small rockets.

(7) Diversifying Public-Private Investment and Contracting Schemes Corresponding to the Level of Technological Maturity

Many of the government-led R&D programs have been contracted R&D in which the government invests entirely. Going forward, for projects that are expected to be applied in the national security area and in which the private sector takes the initiative in advancing the technological maturity, the government will continuously provide the necessary support to advance the technological maturity while also seeking investment from the private entities themselves. To this end, the government and industry will optimize their investment burdens in technological development and the ways of subsidies to ensure that new technological development will incentivize new business opportunities.

Conclusion

The Space Security Initiative outlines the cross-governmental efforts required for space security over the next 10 years. In light of the rapid advancement of space-related technologies and rapid changes in the security environment surrounding Japan, we will continuously evaluate and verify the effectiveness of these actions, and if significant changes in the situation arises, we will consider the necessary review and make the necessary revisions.

Space is an area that offers great potential for security, civil, and commercial. Japan will strategically implement space security effort, seize opportunities for growth, and ensure peace and prosperity for our country.