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Toward the Realization of the Space Security Initiative

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1. Introduction

In June last year (2023), the Space Security Initiative[1] was decided and published for the first time in Japan by the Space Strategic Headquarters[2] . The Space Security Initiative is a landmark in that it clarifies for the first time the specific goals and approaches for Japan's space security for the next 10 years. The Space Security Initiative was formulated under the direction of the National Security Strategy[3], which was approved by the Cabinet in December of the year before last (2022).

In this paper, I would like to discuss issues and directions for solutions to realize the Space Security Initiative, including the perspective of "drastically strengthening defense capabilities and the comprehensive security system" as indicated in the National Security Strategy

2. Positioning of the Space Security Initiative and goals it aims and approaches to achieving goals

Figure 1 shows the positioning of the Space Security Initiative with the three so-called Security Strategy documents[4] and the Basic Plan on Space Policy. As mentioned at the beginning of this paper, the Space Security Initiative was developed under the direction of the National Security Strategy published in last December, which recognized the need to strengthen response capabilities in the field of space security.

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[1] https://www8.cao.go.jp/space/anpo/kaitei_fy05/anpo_
[2] https://www8.cao.go.jp/space/hq/about.html
[3] https://www.cas.go.jp/jp/siryou/221216anzenhoshou/nss-j.pdf
[4] Three documents: National Security Strategy, National Defense Strategy, and Defense Force Development Plan (all approved by the Cabinet on December 16, 2022)

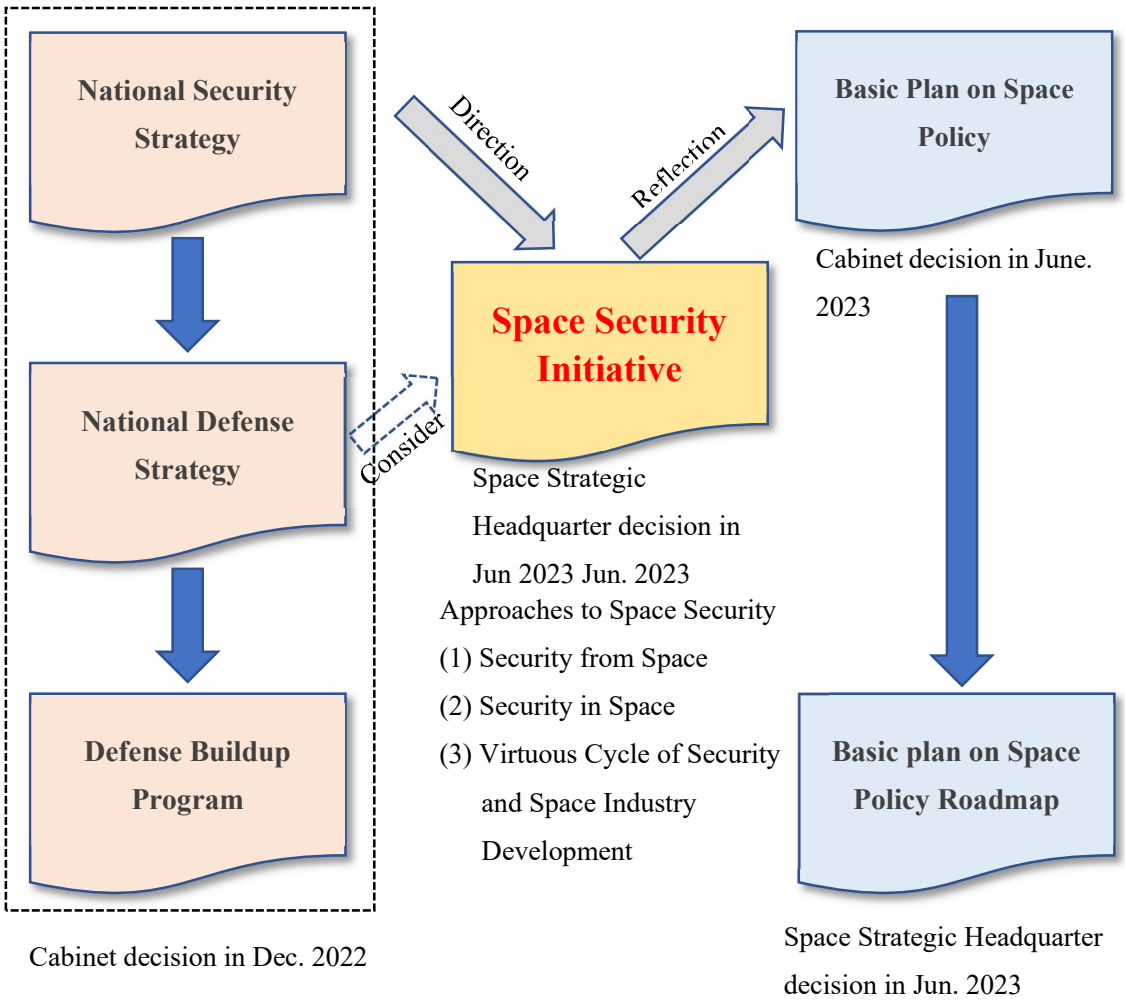

Figure 1 Enactment of the first Space Security Initiative in Japan

The Space Security Initiative states that the goals of space security are "for Japan, together with its allies and like-minded countries, to maintain stable utilization of and free access to outer space, while promoting national peace and prosperity, and national security through outer space," and that these goals will be achieved through the following three approaches.

- ✓ Drastic expansion of the use of space systems for security:
  Enhance wide-area, high-frequency, high-precision information gathering capabilities, acquire missile defense capabilities, improve resistance of satellite communications and satellite positioning functions to jamming and interception.
- ✓ Ensuring stable utilization of space:
  Strengthening Space Domain Awareness (SDA) capabilities.

- ✓ Realization of a virtuous cycle between security and development of the domestic space industries.

The first approach (ensuring security from space) and the second approach (ensuring security in space) specifically indicate the functions of space that Japan should equip itself with to counter the severe threats we are facing.

The Space Security Initiative also presents a conceptual diagram of the future "Space Architecture for Security[5] (hereinafter simply referred to as "Space Architecture" in this paper) as goals of the first and second approaches are pursuing. This conceptual diagram is shown in Figure 2.

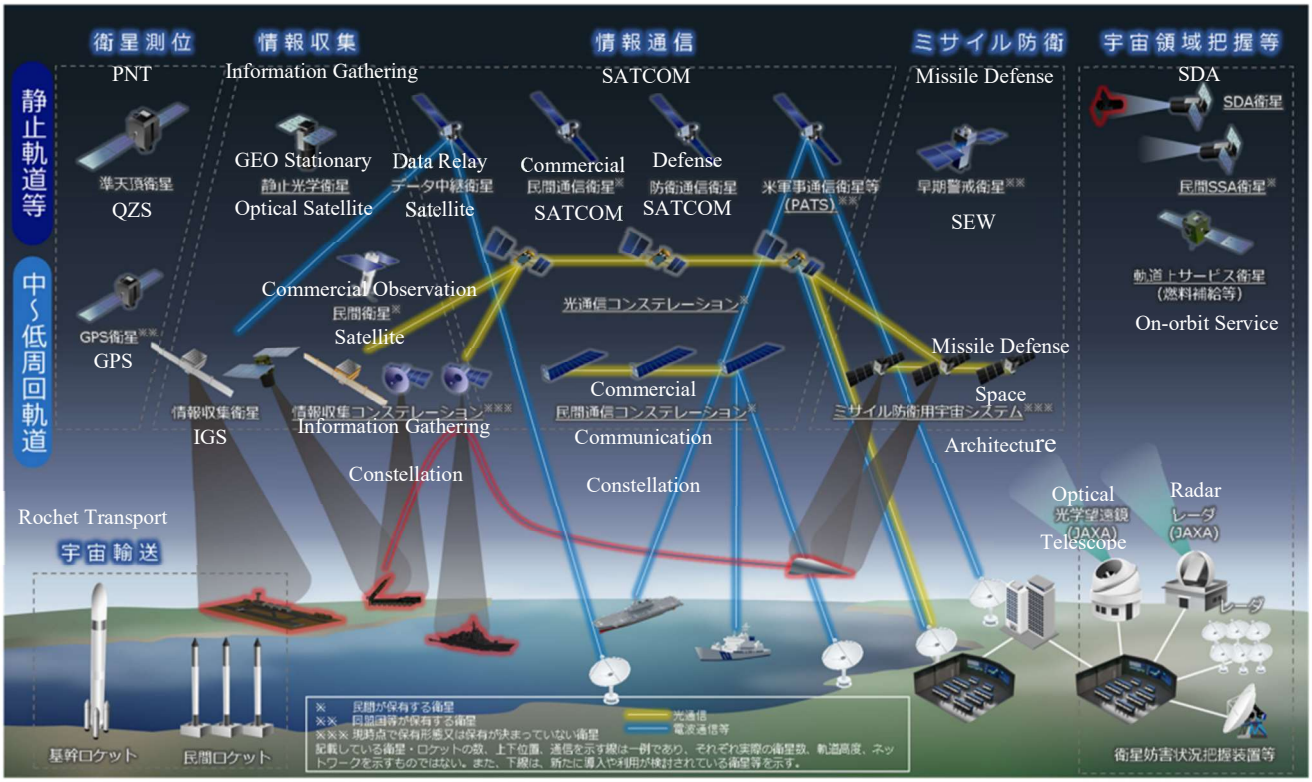

Figure 2 Conceptual Space Security Architecture in Space Security Initiative

Taking into account of the facts that our daily lives heavily depend on space, that the space technologies are mostly dual-use, and that commercial space technologies are rapidly advancing these days, the third approach (realization of a virtuous cycle between security and space industry development) is attempting to realize that strong space-related defense capability will be supported by a strong domestic space industry and vibrant innovation base and that the utilization of commercial space

[5] Space Security Initiative p6

activities in the security field will promote the strengthening of the space industry base resulting in the commercial technology innovations.

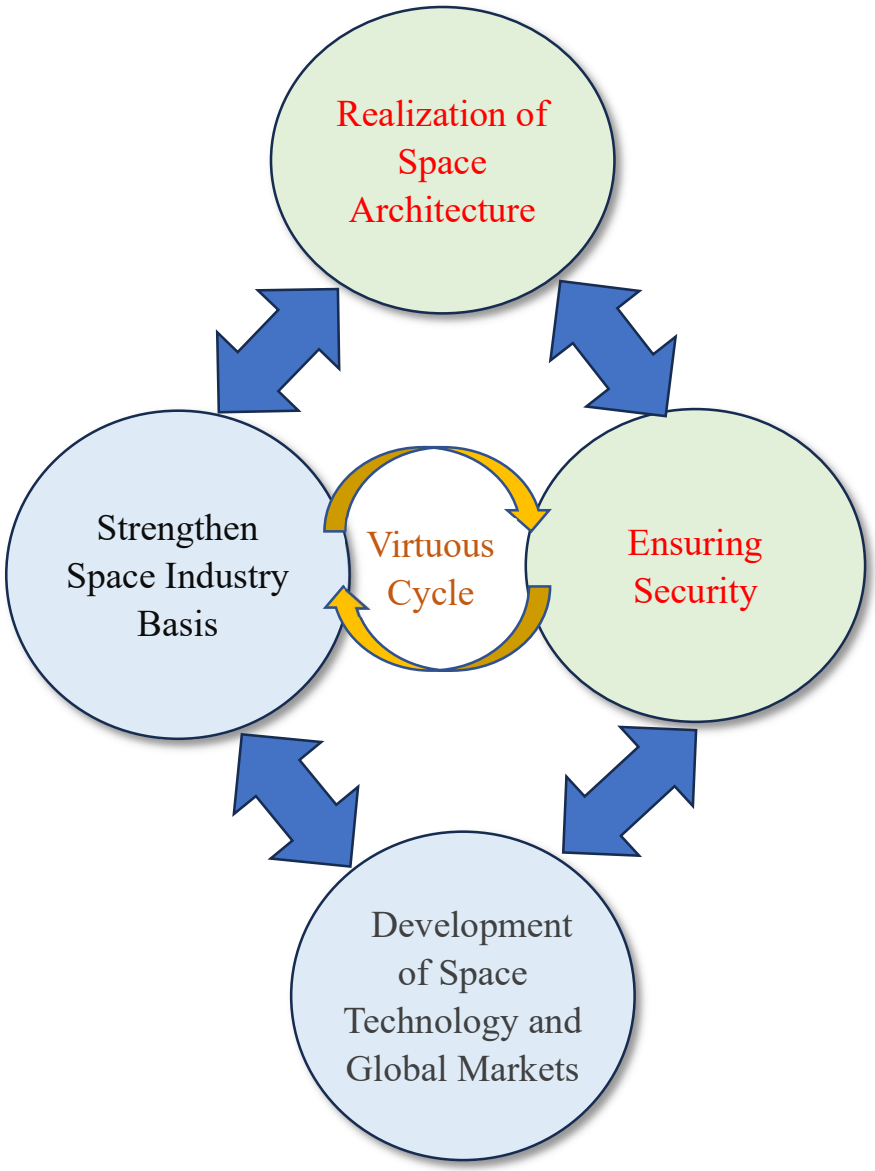

Figure 3 Virtuous cycle of the security and space industry basis Development

The recognition of the relationship between security and industry presented here is more in-depth than the recognition in the National Security Strategy and the National Defense Strategy[6], which stated that "the defense production and technology base is, so to speak, the defense capability itself", from the perspective

[6] https://www.mod.go.jp/j/policy/agenda/guideline/strategy/index.html

of the versatility of the space industry and technology base. Figure 3 shows a schematic diagram of the virtuous cycle between security and the development and enhancement of the space industry, based on the author's understanding.

3. Issues related to fundamental reinforcement of Japan's defense capabilities and the construction of Space Architecture

The Space Architecture identifies six functions as necessary:

- ✓ PNT[7]
- ✓ information gathering
- ✓ communications
- ✓ missile defense
- ✓ space domain awareness
- ✓ space rocket transportation

The requirements are that all of these six functions should have together are,

- ✓ Interoperability (data compatibility) with allies and like-minded countries,
- ✓ Survivability and resiliency against threats, and
- ✓ Economy through the use of private services.

On the other hand, among the seven areas of capabilities[8] that "Three Security Strategy documents[9]" call for Japan to focus on in drastically strengthening the defense capabilities necessary for its security in the future, the areas in which space utilization is most directly needed are considered to be the four areas shown in Figure 4;

- ✓ Integrated air and missile defense (IAMD) capabilities
- ✓ Stand-off defense capabilities and counter-attack capabilities utilizing stand-off capabilities
- ✓ Cross-domain operation capabilities
- ✓ SSA[10] /SDA[11] and those countermeasures capabilities

In other words, the construction of the Space Architecture outlined in the Space Security Initiative must be proceeded with the rapid acquiring of these four defense

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[7] PNT: Position, Navigation, and Timing

[8] Seven areas are stand-off defense capability, integrated air defense missile defense capability (IAMD), unmanned defense capability, cross-domain operation capability, command and control (C2) and intelligence-related capabilities, mobile deployment capability/civil protection, and sustainability and resilience.

[9] National Security Strategy, National Defense Strategy, and Defense Buildup Program

[10] Space Situational Awareness

[11] Space Domain Awareness

capabilities as a top priority.

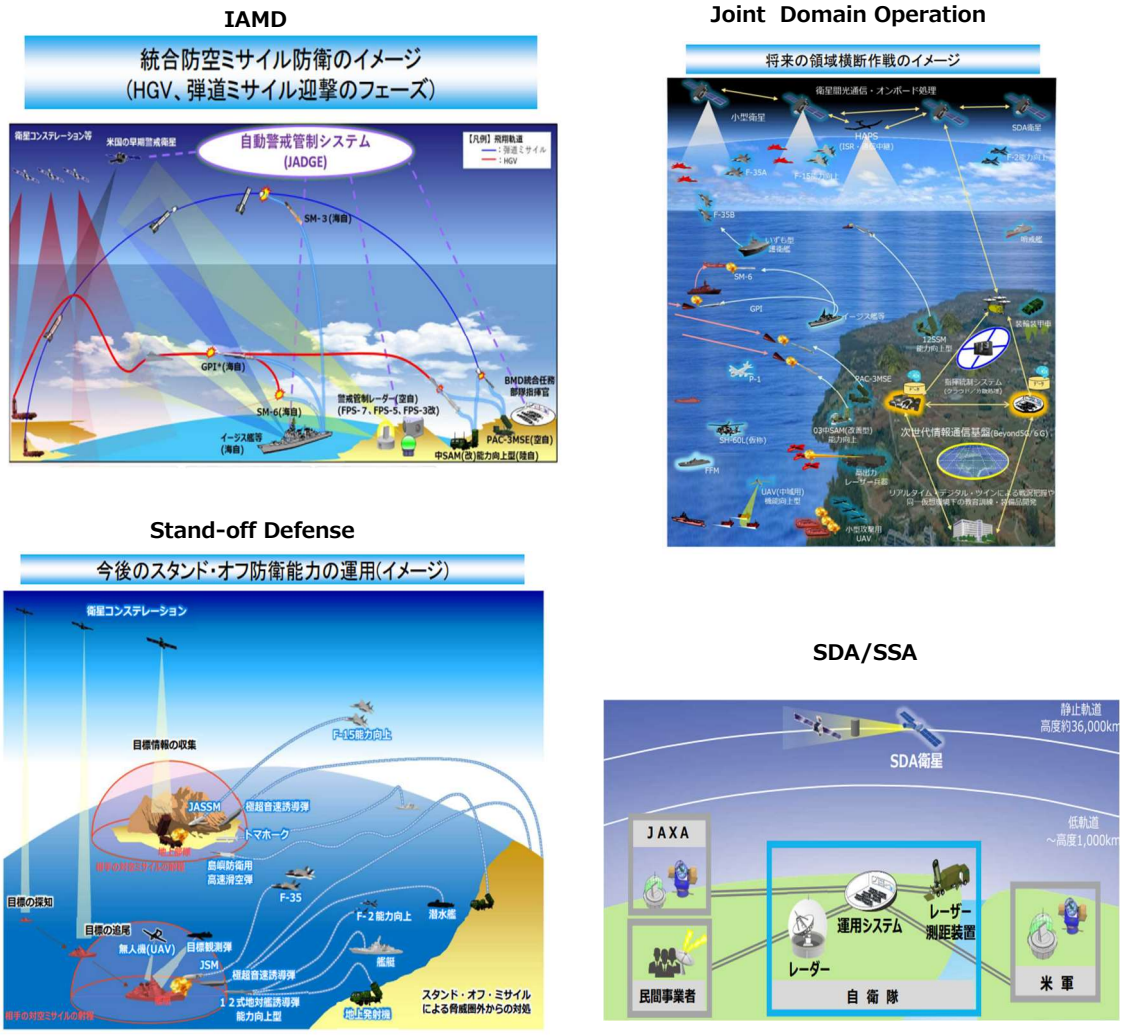

Figure 4 Areas where defense capabilities need to be urgently strengthened through space utilization

Functions of Space Architecture	Options of Acquisition or Use				Areas of Defense Reinforcement			
	Japan Gov. Owns or Plans to Own	Ally Owns	Commercial Owns or Plans to Own	Not Decided Type of Ownership	IAMD	Stand-off defense	Joint all domain operation	SSA/ SDA
PNT	QZSS	GPS	-	-	✓	✓	✓	✓
Information Gathering	IGS, Geostationary optical satellite	-	Commercial Satellite	Information-Gathering Constellation	✓	✓	✓	-
SATCOM	Defense Communication Satellite, data Relay Satellite	U.S. military communications satellite (ex. PATS)	Communication Constellation	-	✓	✓	✓	-
Missile Defense (Tracking &Detection)	-	Early-warning satellite	-	Tracking Satellite Constellation (ex. PWSA)	✓	-	-	-
SDA/SSA	SDA Satellite, Radar, Telescopes	-	Commercial SDA System	-	-	-	-	✓

Figure 5 Four areas of defense reinforcement and options of acquisition or use described in the Space Security Initiative. Ticks indicate the required functions for each area of the defense reinforcement

In the blue columns on the left side of the Figure 5 show the 5 functions that comprise the Space Architecture excluding rocket transportation and the acquisition options for building each function as described in the Space Security Initiative. The orange columns on the right side of the Figure 5 show the space architecture functions required for achieving the four capability areas of IAMD, Stand-off Defense, Cross Domain Operations, SSA/SDA.

The PNT function provided by such as GPS and Quazi-Zenith Satellite System (QZSS) is the foundation for the establishment of JADC2[12] among the various defense assets that are globally or widely distributed. If the assets participating in JADC2 could not have a common PNT standard, the integration and fusion of information among different types of sensors and handover of various types of information would be impossible, and resultantly, JADC2 would not be established.

For the JADC2 of the IAMD and stand-off defense (counter-attack capability), reconnaissance information concerning target collected by various satellites must be transmitted to the C2BM[13] center on the ground through the high-speed communication (radio or optical) satellites to generated the integrated targeting information by fusing various satellite information prior to the launch of a missile. Even after missile launch, updated targeting information (especially for moving target) must be collected by satellites and the mid-term guidance information generated by the ground system must be continuously transmitted to the missile in flight. After the first missile engagement, the information on its effectiveness must be collected again by satellites to determine the next course of action.

Thus, in order to realize the course of F2T2EA[14] of the IAMD and stan-doff defense capabilities, high-frequency and high-resolution information collection using satellites and low latency and high-capacity satellite information communications are essential.

Besides, the recent IAMD has been faced with the new challenge of the emerging threats such as HGVs[15] that take irregular orbits at a hyper-sonic speed (over Mach 5 cruising speed). To cope those kinds of HGVs threats, the U.S. has proposed the need for a new missile defense space system dedicated to detecting and tracking HGVs, and the Ministry of Defense also started the study[16] on this matter with a view to possible future cooperation with US.

In the Space Security Initiative, the options for acquiring each function of the Space Architecture are divided into four categories such as,

- ✓ Japanese Government owns or plans to own
- ✓ Ally (US) owns

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[12] JADC2: Joint All Domain Command and Control

[13] C2BM: Command and Control, Battle Management

[14] F2T2EA: Find, Fix, Track, Target, Engage, Assess

[15] HVG: Hypersonic Gliding Vehicle

[16] 2022 White Paper on Defense, p263,
https://www.mod.go.jp/j/publication/wp/wp2022/pdf/R04030103.pdf

- ✓ Commercial owns or plans to own
- ✓ Not decided the type of ownership and weather Japanese government owns or not in the future

What is noteworthy about these four options for the establishment of the Space Architecture seems to be that the use or procurement of commercial space development and services is becoming more active in the field of space security as well as in addition to the state-led space development for far.

Another notable feature is the realization of the high frequency and high-precision information gathering and the low-latency and high-capacity communications by using an affordable satellite constellation. In this context, it is evident in the Space Security Initiative that there are particularly high expectations for the commercial optical communication satellite constellation service[17] which is beginning to be used in Japan as an ultra-low latency and high-capacity satellite communication network.

The use of domestic and foreign commercial satellite services is a global trend even in the field of space security, and is desirable in terms of consolidating investment in R&D resources, reducing operation and maintenance costs, and accelerating the virtuous cycle between security and the development of the civil space industry.

On the other hand, because the ultimate objective of the Space Architecture is to ensure national security, in case of using commercial satellite services or sharing the Space Architecture with commercial sectors, it is essential to sufficiently consider whether the performance to be achieved and the services to be provided would be fully meet the requirements of the space security, whether the functions and performance would augmentable for future threat. It is also essential to fully consider whether or not the satellite will be sufficiently resilient to various types of military obstructions including cyber-attack and electromagnetic interference. In some cases, it might be necessary to consider the government funds to add the dedicated performance and functions[18] required for government on the commercial space architecture and service.

Looking at the major government-led projects described in the current Basic Plan on Space Policy Roadmap, those projects related to the Space Architecture are found to include such as an augmentation of the present Quasi-Zenith Satellite System

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[17] For example, see https://www.rd.ntt/_assets/pdf/forum/2021/N01_j.pdf , https://jpn.nec.com/solution/space/optical/index.htm, https://www8.cao.go.jp/cstp/anzen_anshin/gaiyou/05_hikaritu.pdf,

[18] For example, SpaceX's Starshield is a dedicated communication lines for the US government, https://www.spacex.com/starshield/

(QZSS) to the seven satellites system, a plan of co-hosted payload of U.S. SDA satellites on the QZSS, an augmentation of the Information-Gathering Satellite (IGS) to 10 satellites system, and a launch of an SDA satellite by the Ministry of Defense in FY2026.

On the other hand, just by looking at the current Basic Plan on Space Policy Roadmap and the Defense Buildup Program, it is difficult for us to comprehensively understand how those plans will lead to the agile strengthening of the defense capabilities especially in such four areas of IAMD, Stand-off capabilities, missile defense and SSA/SDA. It is considered to be necessary to more qualitatively and quantitatively visualize the roadmap specialized for the Space Architecture in a manner that is both consistent with the Basic Plan on Space Plan roadmap and the Defense Buildup Program like the US PWSA[19] projects. That kind of roadmap is considered to be very helpful not only to efficiently promote agile defense capability buildup but also to enhance the understandability and the predictability of the industries, start-ups, and academia as well as other entities such as think-tanks.

In terms of relations with the U.S., the procurement options of the Space Architecture construction include continuous use of GPS and early warning satellite information, and ensuring interoperability with the U.S. military communication satellite (PATS)[20]. Regarding the Space System for the missile defense, the cooperation with the U.S. is one of the promising options although Japan has not yet decided whether or not it would own such system. It goes without saying that Japan, which lags far behind the U.S. in the development of space assets for national security, must cooperate in some way with the U.S. under the Japan-U.S. security regime. However, it is also very important to strategically promote the bilateral cooperation in a manner that contributes to the effective establishment of Japan's Space Architecture and the strengthen of the space industry and technological basis in Japan, while taking into account the need to further strengthen the Japan-U.S. security regime in the space field.

4. Issues related to the development of Japan's space industry and the construction of space architecture

Figure 6 summarizes the organizations responsible for realizing the Space Security Initiative and the Space Architecture as well as the objectives and

[19] PWSA: Proliferated Warfighter Space Architecture, a constellation of low Earth orbit satellites for military use, promoted by the Space Development Agency of the U.S. Department of Defense.
[20] PATS: Protected Anti-Jam Tactical SATCOM

characteristics of each organization. In the past, the traditional space industry (old space[21]), which was the recipient of orders from governments and government-led projects, was the main player in space development. On the other hand, as is the global trend, a number of ventures and start-up companies (news space)[22] have come forward in Japan, mainly in the field of space development and utilization in the private sector. Various space development research projects are also underway in academia[23].

	Government and Related Organizations	Private Sector (Old Space)	Private Sector (New space)	Academia
Organizational Objectives	• Space utilization, research, exploration, and security • Promote advanced technology development and innovation • Strengthening the space industry basis	• International market expansion, increased revenues • Continuous technical improvement	• Rapid creation of new technologies and solutions and a virtuous cycle of management	• Space research and exploration, development of new technologies • University-launched ventures, etc., oriented toward social implementation
Characteristics	• Emphasis on the need to utilize space in the National Security Strategy, and Basic Plan on Space Policy, etc. • Oriented toward a virtuous cycle of strengthening defense capabilities and the space industry bassis • Ministry of Defense lacks knowledge and human resources in space • Contracting system and project management is cumbersome and lacks speed	• Proven experience in both the traditional defense and space businesses • Aiming for a virtuous cycle between public and private sector businesses in terms of profitability and technological improvement • Expect anchor tenancy by government projects, • Expect to acquire ad technology • Proven and Reliable security system	• Expect venture capital, anchor tenancy, etc. for secure funding • Not comfortable with government contracts such as competitive contracts, long-term and deferred payment contracts, etc. • Challenges exist regarding security and reliable supply chain • Lack of understanding of defense missions	• The main focus is to contribute to academia by publishing papers. • Challenges exist regarding security and reliable supply chain • Lack of understanding of defense missions • Opposition perception to the defense and security related work exit

Figure 6 Objectives and characteristics of the organizations involved in the realization of the space security

[21] Mitsubishi Heavy Industries, Ltd., IHI Cooperation, Mitsubishi Electric Cooperation, and NEC Cooperation

[22] Synspective, QPS Laboratory, AXEL SPACE, Astroscale, Interstellar Technologies, Space One, SKY Perfect JSAT, etc.

[23] For example, Professor Shinichi Nakasuka of the University of Tokyo (nano-satellites, navigation guidance and control of spacecraft, space equipment systems, intelligence and autonomy), Professor Seiko Shirasaka of Keio University (on-demand small synthetic aperture radar (SAR) satellites)

On the other hand, looking at the current status of these organizations from the perspective of the space security, we feel that, unfortunately, Japan is not yet in a situation where the collective strength of the important organizations involved in space utilization and development as described above is necessarily concentrated. In Japan, it is highly desirable to establish an ecosystem that contributes to space security (Space Architecture construction), in which the government, private industries (old space and new space), and academia all participate together. The establishment of an ecosystem is synonymous with the realization of a virtuous cycle between security and space industry and technological basis, which is the goal of the Space Security Initiative, and will be realized under the strong leadership of the government avoiding the stove-piping administration of related ministries.

The current characteristics and challenges of each organization are summarized in Figure 6, so we will not list them all here, but would like to mention the main issues.

In Japan, the "House of Representatives Resolution on the Development and Utilization of Space in Japan (1969)[24] (the principle of the peaceful use of space)" prohibited or greatly restricted the use of space and research and development by the Ministry of Defense and the Self-Defense Forces for many years until the Basic Space Law[22] was enacted in 2008. Unfortunately, even after the Basic Space Law was enacted, there has been no significant progress in space utilization and R&D by the Ministry of Defense and the Self-Defense Forces, and only recently has significant progress been made in light of the need to strengthen response capabilities in the space security field as clearly described in National Security Strategy in 2022. Therefore, it must be said that the Ministry of Defense and the Self-Defense Forces are extremely lacking in knowledge and human resources related to space, and it is desirable to make further efforts to improve knowledge and develop human resources in cooperation with related ministries and agencies and JAXA.

The so-called "old space" that has played a central role in Japan's government-led space development since the end of World War II has steadily accumulated advanced space technologies through the various projects (mostly space science and expl0ration) undertaken by government. Unfortunately, however, it has not yet reached the stage where it can be said to have firmly acquired an autonomous

[24] https://www8.cao.go.jp/space/comittee/27-anpo/anpo-dai2/siryou2-1.pdf

market by playing a key-role in the international space market. It is necessary to continue to build up its strength through the government R&D projects and the strengthening of anchor tenancy[25] .

In addition, government-led development to date has tended to repeat the development of satellites and rockets on a one-off basis, lacking a clear exit strategy or criteria and a viewpoint of acquiring technological capabilities and strengthening fundamental technologies over the medium to long term. For this reason, it can be said that resource investment for a front-loading[26] in R&D projects has been lacking in Japan so far. Lack of a front-loading in projects increases the probability that projects will have to be postponed or suspended due to the emergence of unaware technological risks in the course of the project, and as a result, that might cause technological stagnation in space development. The resulting burden of cost overruns is also a major concern for the development of the space industry.

As mentioned earlier, space ventures and start-up companies (new space) have started the various space development and the space utilization services in Japan. It is expected that new spaces will play an active role in the future as a trusted supply chain for the construction of space architecture. However, because new spaces have a weak financial base than large companies in general, more direct supports from the government than old spaces, including direct support for R&D, strengthening of anchor tenancy, promotion of venture capital, and utilization of PFI[27] are needed. In addition, since new space has still little experience in government contract scheme concerning such as security and payment, it is also necessary to support the establishment of a contractually required security system[28] and to consider new methods of government contract scheme being suitable for new space, which has a relatively weak financial position. In the U.S. government, led by mainly DoD, is introducing OTA[29] contracts, which are suitable for companies having innovative

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[25] Continuous procurement of services by government and other entities for commercial services

[26] Conduct the necessary research and development well in advance of the start of a full-scale project in order to minimize the technical risk of the project.

[27] PFI: Private Finance Initiative, a mechanism to utilize private funds in the procurement of public services. It was applied to the Ministry of Defense's X-band satellite (Kirameki).

[28] The strengthening of the supply chain system could also be supported by the Law for Strengthening the Defense Industrial Base, which has been went into effect in October 2023.

[29] OTA: Other Transaction Authority, A system that allows for negotiated contracts with flexible contract terms and conditions based on individual circumstances not subject to Federal Acquisition Regulation (FAR), and other related regulations (Competitive Contracting Act, Bayh-Dole Act, etc.), as well as federal cost accounting standards

technologies and companies that have no experience in government R&D procurement (non-traditional contractors), in order to encourage their new entry into public procurement and to obtain innovative technological solutions.

In today's world of rapid technological innovation, it is extremely important to actively pursue innovative technologies in the construction of Japan's Space Architecture. This is because maintaining and demonstrating technological superiority in space is a decisive factor in improving Japan's deterrence capability. From this perspective, it is obvious that the participation of academia, which is responsible for research and development of emerging innovative technologies, is indispensable.

On the other hand, in space, only well-proven technologies in the space environment usually can be applied due to an extremely large temperature changes in the vacuum environment, difficulties in heat-exchange, a harsh environmental condition such as high-dose cosmic rays, and the fact that it is not easy to deal with problems, repair, and replenishment compared to on the ground system. Therefore, the progress of technological innovation in space cannot help being inherently slower than on the ground.

Today, technological innovation on the ground by the advanced sensors, IoT[30] using optical communications, and edge computing, etc., is advancing extremely and is the driving force behind various social changes and security benefits. In the future, one of the focal points of space architecture construction will be how quickly these cutting-edge technologies can be incorporated in space in the same manner as on the ground. From this perspective, it is extremely important not only to conduct research and development of individual elemental technologies of the Space Architecture, but also to conduct empirical research on the development of efficient and effective methods and means to ensure operation and reliability in the space environment.

Regarding the participation of academia in the Space Architecture development, there is still a strong sense of rejection to the defense and security research among academia, which is a challenge unique to Japan. It is necessary to promote the understanding of the academia based on the recognition of the Space Security Initiative that states "The utilization of space technology in the security field will promote the development of the domestic space industry and the

[30] IoT: Internet of Thing

strengthening of the space industry basis will be translated into technological and commercial innovation,

5. Conclusion

The Space Security Initiative has just been literally presented, and it is extremely important from the perspective of immediately ensuring Japan's national security and the development of the space industry how quickly the Space Architecture concept can be realized. In addition, the realization of the Space Architecture outlined in the Space Security Initiative critically important for the realization of drastic reinforcement of defense capabilities in four areas: IAMD, stan-doff defense capabilities, cross-domain operation capabilities, and SSA/SDA capabilities as described in this paper.

In addition to the several issues already discussed in this paper, the more practical issues such as the short time for realization of the Space Architecture and the budgets constraint cannot be ignored. It is even more important for the government, together with the private sector and academia, to continue to take the necessary actions strategically and promptly to resolve these issues by mobilizing their collective strength.