Dual-Use Concept on Civil and Defense Uses of Outer Space

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The outer space utilizations play a vital role for both civil and defense fields. As for Japan, after the Basic Space Law was enacted, the new utilizations and R&D of space are promoted to enforce the national security. Under the circumstances, Dual-Use has become an important concept. However, the past studies were often focused on the technologies themselves which could be used for both civil and defense purposes as well. This paper deals with Japanese space policy, focuses on the Dual-Use concept on civil and defense uses and developments of outer space. First, the meaning of Dual-Use concept and the effectiveness of the system would be defined, and the key aspects such as data policy for integrating the dual system were dissected. Then, the operational configurations and retaining Dual-Use system were suggested, and early warning satellite system and space situational awareness project as the concrete applications of Dual-Use system would be discussed.

Key Words: Dual-Use, Civil, Defense, Space Policy

1. Introduction

Today the outer space utilizations play a vital role for both civil and defense fields in the world. As for Japan, it was confirmed at the Diet in 1969 that the basic principle of Japan’s space activities was strictly limited to non-military, in total compliance with Article 9 of Constitution. Therefore, the defense utilizations such as Early Warning Satellite system had been prohibited for more than 3 decades.

After the Basic Space Law was enacted in 2008, the new use and R&D of space assets are promoted to enforce the national security. Under such circumstances, Dual-Use has been noted as an important concept. However, the previous studies were often focused on the technical aspects, but very few on Dual-Use approaches or applications. Though U.S. and European countries have promoted the space Dual-Use projects, only the civil-use space assets have been developed in Japan for a long time. That would be one of the reasons for recent stagnating of space industry sales. In this background Dual-Use for the space applications has become an important concept. Exploring the Japanese own way, the prior European Dual-Use studies³ are useful references. It is also important to share the Dual-Use concept with the civil and defense stakeholders before promoting the concrete space projects.

This paper deals with Japanese space policy, focuses on the Dual-Use concept on civil and defense uses and developments of outer space. First, the meaning of Dual-Use concept will be defined. Then, the effectiveness of Dual-Use for both civil and defense will be discussed. Some space systems applicable for Dual-Use will also be discussed.

2. The Circumstances of the Outer Space Utilizations

2.1. Basic space law

The Basic Space Law was enacted in May 2008 to cope with challenges to Japan’s space policy such as lack of a comprehensive nation-wide strategy due partly to the absence of a policy-formulating headquarter. This law aims to work in a comprehensive and systematic manner to “change space policy from R&D-driven to utilization-driven underpinned by high technological capabilities”, to “utilize in the area of national security” beyond the generalized theory while maintaining an exclusively defense-oriented policy in accordance with the principle of pacifism enshrined in the Constitution of Japan, to make “improvement of industrial competitiveness”. Ministry of Defense (MOD) has not previously involved in other ministries’ program so far. But after it enacted, MOD decided to the basic policy for the space utilizations in 2009. In the context, it says that to develop or use the space assets effectively and efficiently, it is necessary for non-military programs to consider the defense perspective and build the Dual-Use systems. It also says that under the organic coordination over the whole government MOD should deepen cooperation with the civilian sector.

2.2. Japanese space industry sales and space budget

The change in the sales of space industry in Japan is shown in Figure 1.

![Fig. 1. Change in the sales of space industry in Japan.](source)

Source: Aerospace Industry Data Book 2010, Society of Japanese Aerospace Companies (SJAC)
From FY1985, the sales had grown until around FY2000, but after that it went down suddenly and could not be seen the sign of recovery. This situation is an urgent issue for Japanese space industry and government. It would be necessary to change the political scheme from the conventional approach.

Figure 2 shows the budgetary allocation in the government and the trend of Japanese space budget for several years. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) has the largest budget, which is more than 50% constantly. But the projects are mainly intended for research and development rather than utilization, so it doesn’t lead to expand the space utilisations. The second largest budget is Cabinet Secretariat (CS), which is used for Information Gathering Satellites system development, operation and maintenance. In this figure, MOD space budget was begun to be integrated from FY2008, and a budget for Ballistic Missile Defense was begun to be integrated from FY2009. The content of the recent MOD space budget is mainly for acquisition of commercial remote sensing satellite imageries. The Japanese military R&D activities in the space field are just started and those activities are still in the research phases. The other ministries or offices also certainly budget for the space uses, but they are only less than 10%. So there is room for expansion of the space uses. The point is how to expand the uses. The new approaches for the space uses are expected among not only the government but also the Japanese space industry in this aspect.

3. Dual-Use Concept on Civil and Defense Uses and Developments

3.1. Definition of terms and scope
In general, “dual use” means that the device or the system has been designed for or used by more than two actors. In this paper, Dual-Use implies that the device or the system has been designed for or used by national security users and civil users as shown in Figure 3.

National security user consists of defense (e.g. MOD and Japan Self Defense Forces (JSDF)) and crisis management or intelligence community. They are similar to the security certifications or information classification and so on. Each characteristic is discussed in section 3.3.

The civil user is subdivided into three different types (e.g. public, academic, and commercial users). The public users imply the Ministries, public offices and institutions. The academic users imply MEXT, Japan Aerospace Exploration Agency (JAXA) and universities. The commercial users imply private companies.

The Dual-Use concept contains not only the space assets like satellites and rockets but space systems with ground control, data processing facilities and so on. Further, the operational configuration and the type of retaining systems are also covered in this concept.

![Classification of space use.](image)

3.2. Meaning of Dual-Use concept
The space projects are needed the huge amount of budget and they have been taken for a long time. The utilisations of space systems have to be considered as national and international projects and they have multiple stakeholders in nature. The Dual-Use concept has to be a breakaway from the mono-project level. In this context, Dual-Use concept has to be the national strategic level. The advantages of Dual-Use concept for both civil and defense perspective are below.

- **Operational Efficiency of material / human resource**
  - Corresponding to stagnated budget
  - Forcing the military space power in the early stage

- **Strengthen space industry by means of**
  - Increasing domestic procurement of satellite
  - Responding to international market

- **Ensuring the transparency in defense policy**

First, there is no need to develop and operate the civil-only or defense-only system separately. This results in the prevention of redundant investments for both sides. In the development phase, if it is possible to leverage the civil or defense technology, the development phase would be able to be shorter and the budget would also be reduced. Since MOD/JSDF was allowed to the “full-fledged” space activities just after the Basic Space Law was enacted, the experts for the space field have not grown up yet and the numbers of the experts are limited overwhelmingly. The Dual-Use system makes human interaction between civil and defense and can utilize the limited human resource practically. There is a possibility to build up the defense space assets efficiently by utilizing the civil resources.

Second, there is a possibility to strengthen national space industry by domestic procurement of satellite. In 1990, Japan and the US government made an agreement about satellite...
procurement as well as supercomputer. According to the Aoki’s study\(^2\), conducted at a time of escalating trade friction with the US, the procurement agreement obliges Japan to open its Non-R&D satellite procurement to foreign satellite markets. The conditions imposed on Japan by the agreement are stricter than those set by the GATT (former WTO) Agreement on Government Procurement. But in the states of this agreement, there is the phrase that “this agreement ensures the consistency with WTO Agreement on Government Procurement.” In WTO Agreement on Government Procurement, there is an exception (Article XXIII Exceptions to the Agreement) that “Nothing in this Agreement shall be construed to prevent any Party from taking any action or not disclosing any information which it considers necessary for the protection of its essential security interests relating to the procurement of arms, ammunition or war materials, or to procurement indispensable for national security or for national defense purposes\(^3\). The purpose of the Dual-Use satellites includes national security or national defense. To obey this sentence, it is considered that they are able to evade the competitive tenders in accordance with WTO Agreement on Government Procurement. To induce Dual-Use concept, it is finally expected to strength the growth of national space industry.

Also, there is an additional possibility to respond to the international trends. In Europe, satellite manufacturer and space service industry proceed to design and develop Dual-Use system in order to correspond to both civil and defense customer at the same time. For example, COSMO-SkyMed, which is an Italian remote sensing Dual-Use satellite, makes civil defense demands satisfy simultaneously. Today the Dual-Use system is becoming the international trend. To establish the operation which opens to all users is the key aspect for catching the national and international trend. In Europe, satellite manufacturer and space service industry proceed to design and develop Dual-Use system in order to correspond to both civil and defense customer at the same time. For example, COSMO-SkyMed, which is an Italian remote sensing Dual-Use satellite, makes civil defense demands satisfy simultaneously.

Third, there is a possibility to ensure the transparency in defense policy. The defense policy may sometimes be pointed out its closed nature. To development and operate the Dual-Use system, the civil users may understand the defense policy and military operations moreover.

### 3.3. Key aspects of Dual-Use systems

To construct the Dual-Use system, it is necessary to harmonize both civil and defense characters and demands.

- **Civil System**
  - Commercial Standards
  - Multiplicity of Applications and services
  - Heterogeneity of Sources
  - Versatility / Instruments / Platforms
  - Confidentiality / Security in Commerce

- **Defense System**
  - Military Standards
  - High Performance
  - Security Certifications
  - Information Classification
  - Service Availability

- **Dual-Use System**
  - High Versatility in operational modes and different performance levels
  - Two separate domains: classified (Defense) and civilian domain
  - Interoperability
  - High Service Availability

![Fig. 4. Characteristics of Civil, Defense and Dual-Use System.](image)

Figure 4 shows the characteristics of civil, defense and Dual-Use system respectively. The most characteristic point of civil system is a necessity of disclosing the data which based on the customer principle. Especially the commercial system is vital to operate economically, which sometimes sacrifices the performance for the economy.

On the other hand, the characteristics of defense system are that the data security certifications, high performance, high data accessibility, assured service availability and even the vulnerability in the emergency situation. These issues are usually considered more important than economy.

It is critical that how integrate the contradictory characteristics into the Dual-Use system. The main subjects of constructing Japanese Dual-Use system are below.

1. Assure of purposiveness
2. Data policy
3. Management of MOU
4. Treatment of space related law (the Law concerning the JAXA)

### 3.3.1. Assure of purposiveness

The first subject is to assure of purposiveness of the Dual-Use system. When the system has multiple purposes by the deferent users, there is a possibility to make differences from the required functions or performances which necessary to reach those objectives. In case that the Dual-Use system designed to reach the duplicate objectives, it should be assured of purposiveness by means of taking sufficient terms for the initial development phase, especially concept design phase.

### 3.3.2. Data policy

The second subject is the data policy and treatment of the data. The data policy is one critical prerequisite for the efficient Dual-Use system operation. According to Rathgeber’s paper\(^4\), the data policy comprises the rules and procedures for handling and distributing information gained by sensors (raw data) or manipulated/refined by subsequent system stages (processed data) as well as the mechanisms to control and enforce compliance with these rules and procedures. Some European Dual-Use systems like the German TerraSAR-X satellite program are treated in the study of data policy. The defense/intelligence satellites like those foreign systems usually require the ability to deal with classified data. To assure of this request, both space assets and ground control/communication systems have to be equipped with the additional classification system. This also applies to the Dual-Use system.

### 3.3.3. Management of MOU

The third subject is the management of the Memorandum of Understanding (MOU) or the coordination among the organizations. Finoccio et al. reported in their study\(^5\) that there was an example that Italian Ministry of University and Research and the Ministry of Defense signed a MOU for their co-operation in the domain of space research and development in 2007. This MOU is a fundamental management for Dual-Use programs and enables their mutual relationship of co-operation affect to the technology and scientific research activities in the area of common interest. In Japan, there isn’t such a management plan between MOD and MEXT yet. But there are obviously increasing the projects such as Quasi-Zenith Satellite System (QZSS) “Michibiki” that...
multiple users are concerned with the project, so it will be necessary for the complex projects to set the proper MOU among the stakeholders.

3.3.4. Treatment of space related law (the Law concerning the JAXA)

The fourth subject is the treatment of space related law, e.g., the JAXA Law. JAXA is the largest space institute in Japan and in the near future JAXA might be the prospective partner with MOD/JSDF. But there hasn’t been little relation with each other in the space field. The biggest reason is the existence of the Law concerning the JAXA based upon the Diet resolution in 1969. The Diet resolution had been interpreted that the JSDF would not be allowed to be a user of Japanese-made satellites and rockets since it would constitute military use of outer space. Adhering to this interpretation, the JAXA Law is defined that Japan’s space activities shall be restricted with the sphere of non-military purposes in Article 4. In the near future, as shown in the Space Basic Law Annex Article 3, the cooperative relationships with JAXA and MOD/JSDF, which shall be based on the results of the government study on the objectives or scope of JAXA activities, is needed from the long-term perspective.

4. Operational Configurations and Type of Retaining Dual-Use System

4.1. Operational configurations of Dual-Use

Operating the Dual-Use space system, it is important to note that how the operating configurations because it can be analyzed easily to each classified configuration. The space system operation is classified into two groups. The “Configuration 1” has one function with both civil and defense uses as shown in Figure 5.

![Figure 5. Example of the Dual-Use configuration for the space asset (one function with both users).](image)

Configuration 1 corresponds to the following example cases.

- a) A remote sensing satellite with an observing function used by defense purpose (e.g. reconnaissance) and civil purpose (e.g. earth observation).
- b) A telecommunication satellite with a communication function used by defense and civil purposes.
- c) An early warning satellite with the thermal infrared sensor used by defense purpose (e.g. missile early warning) and civil purpose (e.g. resource exploration, forest fire monitoring).

This configuration should be considered about the data treatment and be needed suitable data policy.

The “Configuration 2” has multiple functions with each single user as shown in Figure 6. Configuration 2 corresponds to an example case of QZSS with positioning function and miscellaneous signal data transmission function. In this configuration, the data from each function would be possible to be treated separately by each user. The multiple satellite system such as tandem satellites which has been attention in recent years can also be organized as a derived type.

![Figure 6. Example of the Dual-Use configuration for the space asset (multiple functions with each single user).](image)

4.2. Type of retaining Dual-Use system

A space system consists of huge subsystems and it will be needed a large budget and long manufacture term. On the Dual-Use project, from the viewpoint of cost and management of the authority to use, the important thing is that how each user retains the system. A foreign typical example is COSMO-SkyMed satellite system. The Italian government (Italian Space Agency and Italian Ministry of Defense) has 100% stake in COSMO-SkyMed satellite system, so basically the government has the authority to use the system and excess services are provided for commercial users. Another example is Skynet-5. This satellite is a Dual-Use satellite for communication in UK, which has adopted Private Finance Initiative (PFI) system. The PFI project is carried out with private fund, advanced management skill and technical capability. In the Skynet project, the commercial company (Paradigm Secure Communications) has carried out the program. Instead, UK government purchases the service provided by the company. Initially UK Ministry of Defense (UK MOD) had operated the Skynet series. But after the Skynet-5 project, UK MOD contracted with the company that MOD didn’t retain and operate the satellite system. MOD just had the authority to use the communication line. In Japan, the next weather observing satellite will be considered PFI system by Japan Meteorological Agency. Besides these types, there is a scheme of Public Private Partnership (PPP), which allocates rights according to the government investment and private sector’s. German observation satellite TerraSAR-X project is the typical example of PPP. In this case the treatment of data policy has to be decided among the stakeholders to operate certainly.

In Japan, the Basic Plan for space policy, published by strategic headquarters for space policy in 2009, says that to expand the base of the space utilization industry and reinforce the international competitiveness, government will examine to purchase a commercial service, and promote PPP activities for help of the private sectors entry into public service. The next Japanese observation satellite ALOS-2 will be studied PPP.

5. Concrete Applications for Dual-Use

It is useful to compare civil and defense functions. Table 1 shows the comparison of defense and civil missions. Most of the space utilizations are able to have civil and defense
missions simultaneously. For example, Early Warning System has functions of missile detection and others, but at the same time it can play roles as resource exploration or weather observation and so on. Based on this content, some practical concrete applications for Dual-Use will be suggested.

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<th>Civil</th>
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5.1. Dual-Use application of early warning satellite

In the framework of Ballistic Missile Defense (BMD), the US early warning satellite system provides Japanese MOD the shared early warning (SEW) information. Since Japan doesn’t have such a space system, a study of Dual-Use early warning satellite system would be useful in the near future.

The thermal infrared sensor, which is mounted to the early warning satellite, has been studied for the missile seeker by MOD. There is a possibility for the thermal infrared sensor to be used not only the military objectives but also civil purpose such as resource exploration and forest fire monitoring listed in Table 1. In Japan, the Ministry of Economy, Trade and Industry (METI) developed a thermal infrared on-board sensor called ASTER, and METI has also been developing the space-borne Hyper-spectral and Multi-spectral sensor with Japan's Earth Remote Sensing Data Analysis Center (ERSDAC) and NEC Corporation from 2007. This state-of-the-art sensor is intended to use in various civil applications such as agriculture, forestry, disaster monitoring, resource explosion, and so on. The hyper-spectral sensor covers the same wavelengths as a part of the defense purpose, so it is expected that there is a possible to apply for the Configuration 1 Dual-Use asset especially in the development and demonstration phase.

5.2. Dual-Use application of Space Situational Awareness

The space assets are already essential to our daily life. To ensure the safety of the space assets is widely required in the recent years. Increasing the space debris became the serious problem for the space assets. As one approach to ensure the safety, monitoring the satellites and certain numbers of space debris is the effective measure to avoid the collision in space. The U.S. air force has played an important role in this field called Space Situational Awareness (SSA). Detecting or tracing the debris has been done with both the military radar systems and the civilian observatory facilities in the world. In Europe, SSA project is undergoing according to Rathgeber’s recent study. In Japan, JAXA has been conducted debris detection, tracking and satellite evacuation. In addition to JAXA facilities, the military assets such as ground radar system for BMD might be useful for SSA. It will be expected that the construction of Dual-Use SSA system prevents the collisions from space threats effectively.

6. Conclusion

The Basic Plan for space policy declared that Japan should turn the wheel toward the space utilizations. Remaining the traditional development style is difficult to break away from the stagnation of Japanese space utilizations. A different approach is required to overcome this situation.

This paper focused on the Dual-Use concept. It pointed out that there were several problems which the scope of utilizations is quite limited and future growth of the industrial sales is anxious. It showed that the Dual-Use could be an advanced approach for both space industry and government.

In 2010, National Defense Program Guideline was published in Japan. This guideline described that Japan would promote its efforts to develop and use outer space as global commons, from the perspective of strengthening information gathering and communications functions. As the global commons, the space assets have become more important than before. From the perspective of Dual-Use, under the civil and defense cooperation, it is needed to conserve and actively promote the space utilizations.

Acknowledgments

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References