Cooperation between Japan and Europe in the Space Situational Awareness (SSA) Field

Yoshinori KOBAYASHI, Japan Space Forum, former Visiting Researcher at ESPI

Space Situational Awareness (SSA) is defined as the comprehensive knowledge of the population of space objects, of the space environment, and of the existing risks and threats to the space domain. It is within the technical ability of different space-faring actors to detect, track, identify and catalogue objects in outer space. SSA activities aim to recognise the situation and threats related to space and maintain the robustness of any space operation by commercial, civil and military actors. Monitoring the space environment needs to be conducted world-wide and it is difficult to tackle the issue with each country acting separately. In this sense, the building of a new framework for international cooperation among the U.S., Europe, Japan and other countries in SSA activities is required.

1. Introduction
The main implementing bodies of SSA activities are the United States Air Force (USAF) and the National Aeronautics and Space Administration (NASA) in the U.S., and the European Union (EU)/European Commission (EC) and the European Space Agency (ESA) in Europe. In the U.S., USAF is the entity that operates and maintains SSA assets, while the Secretary of Defence and the Director of National Intelligence are responsible for policy and international cooperation on SSA, as well as for cooperating with the industry. The U.S. operated Space Surveillance Network (SSN) is a key asset in the field of SSA, providing for a comprehensive space surveillance capability. Russia also has operational space surveillance capabilities and maintains a regularly updated space object catalogue. SSA activities are becoming more important in terms of a comprehensive security and safety policy related to space. Space-based systems, such as navigation, Earth observation and communication satellites have become indispensable to the good functioning of economic and government structures. Any loss of services from these systems would have a serious impact on a wide range of commercial, civil and military activities.

2. Current SSA Activities in Japan
Monitoring the space environment from Japan is conducted by the Bisei Space Guard Centre (BSGC) optical telescope facility, and the Kamisaiabara Space Guard Centre (KSGC) radar facility, located in the Okayama Prefecture. The Japanese government approved the plan to construct these facilities in 1998 as Japan's first facilities for autonomously monitoring space debris and Near Earth Asteroids (NEA). The review of the FY 1998 Space Development Programme was conducted in August 1998. The review pointed out that it is necessary for Japan to understand the exact orbits and distribution of space objects for space environment protection and space guard purposes, and that there is an urgent need to construct its own observation facilities. On the other hand, Okayama Prefecture developed the “Guideline for S&T Promotion in Okayama Prefecture” in March 1998 and invited to set up that kind of facility as part of the S&T promotion policy of the prefecture. The construction of the facilities was realised by securing a special budget for promotion of S&T in the local area. These facilities are owned and operated by the Japan Space Forum (JSF).

BSGC is equipped with a 50 to 25cm and 1m

---

1 C. Portelli, SSA European Scenario - A “dual use” system for Europe, 22 April 2011
diameter optical telescopes, mainly observing asteroids and space debris coming close to Geostationary Earth Orbit (GEO) satellites possessed by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and private companies like Sky Perfect JSAT Co., as well as the Japan Aerospace Exploration Agency (JAXA). BSGC is the only entity monitoring debris located in the area of GEO above the East Asia region. The 1m telescope is able to observe objects of a magnitude of X20 in brightness (about 1 square metre in size) or more in GEO, and the 50cm telescope was able to observe the small debris derived from China's anti-satellite test of 2007. BSGC recently upgraded the drive unit and CCD camera of its telescopes and is now trying to make observations of space debris located in Medium and Low Earth Orbit (see Tables 1 and 2).

KSGC is a radar facility dedicated to observing space debris in Medium and Low Earth Orbit. It has the capability to observe debris of 1m in diameter or more, at a range of about 600 km, and to track up to ten debris objects at once with its phased array antenna. The facility conducts an observation of re-entry of large structural objects and it successfully monitored the re-entry of H-II Transfer Vehicle (HTV) named “Kounotori”. KSGC was constructed as a pilot project towards a next generation facility, which aims at obtaining a sub-metre debris observation capability, equivalent to that of the U.S. and Europe (See Table 3).

Japan has the world’s first observation facility dedicated to observe space debris and Near Earth Asteroids (NEA).

Regarding their operation, the optical telescope is prepared for observation in the daytime every day and two observers perform an operation at nighttime until the morning. In contrast, the radar facility observes space objects for 16 hours per day by unmanned operation. It is operated by remote control from the Tsukuba Space Center of JAXA.

The main user of both the BSGC and KSGC facilities is JAXA, but the raw data unprocessed or non value added acquired by the facilities belong to JSF. The processed data or value added data belong to the organization that processed it. JAXA monitors Japanese civil and commercial satellites in orbit, as well as the space debris around these satellites, by using their observation data. In addition, JAXA tries to discover unknown asteroids and to verify the orbit of asteroids observed by the world-wide observation network. While Japan observes space debris with both facilities, it is largely dependent on the U.S. SSN’s Two Line Elements (TLEs). Moreover, Japan sometimes requests data from Germany’s TIRA Radar for conjunction analysis.

3. Political Discussions on SSA in Japan

The establishment of a Japanese Basic Space Law on 21 May 2008 was an important step for the Japanese SSA. One of the main objectives of the law is opening the door to the use of outer space for “non-aggressive” national defence purposes and to the promotion of SSA activities in the space industry. To achieve these objectives, the law directed the Japanese government to establish the Strategic Headquarters for Space Policy, led by the Prime Minister within the Cabinet Office, and to reconstruct its governing structure of space activities.

Over a decade ago the Space Activities Commission (SAC) headed by the Prime Minister managed Japanese space activities. Then a reorganisation of government ministries and agencies occurred in 2001 and SAC became an advisory body for Ministry of Education, Culture, Sports, Science and Technology (MEXT). It is said that the reorganisation led to a decline of management capacity for space activities in Japan. Through establishing the Strategic Headquarters for Space Policy, the headquarters led by the Prime Minister now manage all space activities, while inconsistencies between the vertically divided administrative functions of ministries are also resolved and space activities’ streamlined. The Japanese government has prohibited the Ministry of Defence and the Japanese Self Defence Force (JSDF) from using outer space for defence purposes since 1969, when the Japanese Parliament decided to conduct space activities only for peaceful purposes in the strict sense. Japanese space policy has significantly changed with the enactment of the Basic Space Law.

The Japanese Basic Space Law calls for increasing international cooperation in order to preserve the space environment. It specifically foresees that:

- Japanese space activities shall be conducted in a manner that would contribute to the removal of various threats against people’s lives and livelihoods, protect the peace and safety of the international community, and the national security of Japan.

• Japanese space activities shall be conducted in a manner that would fulfill a role in the international community, as well as contribute to securing national benefits in the international community through enhanced diplomatic power and international cooperation.

In June 2009, following the enactment of the Japanese Basic Space Law, the Strategic Headquarters for Space Policy drew up the Basic Plan for Space Policy, which is the first national comprehensive strategy document covering its overall space policy. In line with the Japanese Basic Space Law, the plan describes the basic policy and the measures which the government should take from FY2009 to FY2013, anticipating developments within the next ten years. The plan describes the lines that have a particular influence on future SSA activities in its basic pillars:

• Bearing in mind related international agreements and the principle of pacifism enshrined in the Constitution of Japan with the Basic Space Law in mind, this new approach to the use of space and related R&D is intended to reinforce Japanese national security by improving information gathering capabilities, and especially early warning and surveillance activities, in the light of the international situation, and especially the circumstances in the North East Asia region.

• Regarding the promotion of space for diplomacy, it is important for Japan to utilise space activities as a tool for diplomacy and assert itself in the international society in order to enhance its international leverage and presence, and increase its soft power.

• The use and R&D of space itself requires a certain degree of consciousness towards the Earth environment and at the same time towards the space environment as well. In the future, as a country aiming to expand the use and R&D of space, Japan is required to take the lead in contributing to the decrease of debris occurrence caused by the launch of Japanese rockets and satellites and to increase the level of debris monitoring for preserving the space environment in collaboration with the international community.

In addition, the following actions were described as specific measures facilitating Japanese SSA in the Basic Plan for Space Policy: a) observation of space objects to understand the population of debris; b) efforts to limit the generation of debris caused by Japan’s use of space; c) R&D in technologies to remove already existing debris; d) efforts to improve space weather forecasting, including solar activities. As previously described, Japanese SSA facilities can only detect orbital objects of a minimum size of approximately 1m in LEO so far. The Plan indicated the need to acquire the ability to observe sub-metre class debris, especially in LEO, and to determine their orbital characteristics by working together with the Ministry of Defence (MoD) and other countries. Apparently the MoD is interested in Japanese SSA and it is utilising observation facilities of space debris. It is expected that their requirement will be gathered by symposia or consultations and integrated into the future Japanese SSA architecture study.

Japan is planning to have a capability to observe sub-metre class debris in the future.

4. Challenges to the Progress of Japan’s SSA Activities

Even though the Basic Plan for Space Policy has been formed, Japan does not in fact have any concrete strategic policies and implementation plans to give effect to the foreseen measures. The U.S. and Europe are conducting activities towards their own streamlined SSA design in collaboration with other stakeholders, in order to facilitate the sustainable development of their space activities. So far, Japan has contributed to the international community through observing debris, conducting debris space proximity analysis, taking debris collision avoidance measures and establishing space debris mitigation guidelines. However, there is no concrete streamlined SSA concept involving government organisations, or the private companies that own and operate commercial satellites. It is necessary for Japan to accurately assess the current situation of SSA activities in the U.S., Europe and other countries, and to proceed with discussing a concept SSA study in light of Japan’s interests. Yet, the Japanese economy faces an era of low growth that requires financial reforms, while the country’s declining demographics will result in increased social welfare expenditures in the future. Consequently, although the need for achieving a sub-metre debris observation capability has been indicated in the Plan, the annual budget increase and adequate implementation structures required

3 Leaflet of Basic Plan for Space Policy, June 2009  
http://www.kantei.go.jp/jp/singi/utyuu/basic_plan.pdf

4 Basic Plan for Space Policy, 2 June 2009  
http://www.kantei.go.jp/jp/singi/utyuu/basic_plan.pdf

5 Setsuko Aoki, Kokusai-Jousei No.81, p367-379  
http://spacelaw.sfc.keio.jp/sitedev/archive/JSSA.pdf  
(Japanese)
Cooperation between Japan and Europe in the Space Situational Awareness (SSA) Field

may not be forthcoming. Even in this situation, however, Japanese SSA should be established as an important programme from the aspect of international cooperation and the safety of humankind.

Mitigation of space debris and avoidance of asteroids collisions to the Earth are challenges common to all humankind.

In general, SSA activities present challenges common to all humankind, such as debris observation, proximity analysis, in orbit collision avoidance measures, space weather information gathering, Near Earth Objects monitoring, and the international standardisation of space debris mitigation procedures. In this sense, some SSA activities are suitable to be conducted in collaboration with other countries. The U.S. has a powerful and global network in the SSN, and Europe will conduct its SSA activities on the premise of cooperation within the European region and with other countries through European institutions, such as ESA and the EC. While Japan’s national security is still based on the axis of Japan-U.S. relations, its contribution to extending international cooperation is required.

5. European SSA Initiatives

Europe is recognising the need to develop an autonomous SSA capability\(^6\) in order to protect European space infrastructure. At the same time, close transatlantic cooperation in this field would be desirable for Europe, since no European SSA can presently fully substitute the expertise and capabilities fielded by the U.S. system. Furthermore, improving international cooperation in space and increasing Europe’s role in it has been recognised as a top space policy objective for Europe, as well as a key element of the “Europe 2020” strategy, which is the EU’s development strategy through smart, sustainable and inclusive economic activities for the coming decade. Space can support these objectives by creating high-skilled employment and commercial opportunities, boosting innovation, and improving the citizens’ well-being and security. In this framework, SSA development will also create skilled jobs and targeted investments.

European SSA will initially make use of existing ESA, European and international partner assets, federated together into SSA services to create new operational capabilities. These will later be extended by a new infrastructure that will include search radars and optical survey telescopes, and may even include dedicated satellite missions in the future. The European SSA programme is currently implemented as an optional ESA programme, as far as its design, development and deployment are concerned. The SSA Preparatory Programme (SSA PP), to which €49.65 million were allocated in total, was authorised at the ESA Ministerial Council of November 2008 and formally launched in January 2009. After an initial development period foreseen until 2012, the system’s full operational service development could begin upon ESA member states approval at that time.

When the full SSA programme begins, additional systems will be developed and deployed as required, in order to achieve a certain degree of European autonomy in this area. The decision regarding the continuation of the SSA Programme is scheduled to take place during the next ESA Ministerial Council, foreseen in 2012. The objective of the full SSA programme would be to achieve the full operational capability of the ground infrastructure segment, as well as begin the development of space-based infrastructure (GEO and sub-GEO, LEO constellation for Survey and Tracking\(^7\)), with the horizon of establishing a comprehensive European SSA system by 2020. The foreseen budget for the full programme is projected at approximately €500 million. Additional funding from the EU would also constitute a very important contribution to achieving full European SSA activities.

6. Recommendations

As described above, Japan has contributed to the international community in a variety of debris related activities. Japan is only the second country to create its own standardisation for space debris mitigation and has been engaged in establishing the mitigation guidelines of the Inter-Agency Space Debris Coordination Committee (IADC) and the UN Space Debris Mitigation Guidelines, in addition to reporting measures taken by Japan in this area to the subcommittees of the UN Committee on the Peaceful Uses of Outer Space every year\(^8\). In this context, Japan needs to make efforts towards establishing or subscribing to a code of conduct for space activities and developing an effective monitoring system of the code’s implementation within the international community. Japan should continue contributing to the international community’s efforts in this field, and by doing so increase its own international standing and influence in space policy matters. One of the ideas would be to create a regional SSA in the Asia-Pacific region.

\(^6\) Brochure of SSA Programme, ESA, 2008

\(^7\) Supra note 1.

\(^8\) Supra note 5.
For geographical reasons Japan has a priority responsibility in the region. Japan should be able to set up cooperation with Australia on activities in the southern hemisphere, where a space monitoring capability is lacking, noting that Australia has recently moved toward cooperation with the US in the area of SSA. Furthermore, there is a possibility of cooperation with emerging countries like China and India, although it is unclear what their SSA capabilities are. Japan needs to be alert to initiatives of China and India in the field of SSA, for the purpose of a possible cooperation with them.

As the Basic Plan for Space Policy of Japan describes, it is important for Japan to utilise space activities as a tool of diplomacy, asserting itself within the international community and enhancing its international leverage and presence. Japan will be able to boost its influence in the international community by enhancing its capacity to monitor the space environment, including space debris. This kind of enhancement will also promote Japan to the position of an indispensable partner within the international community.

In this sense, Japan should immediately proceed to study its own comprehensive SSA concept and consider the construction of the next generation space monitoring facility, involving the Ministry of Defence and other countries. Apart from exploring cooperation with the U.S., it would be also necessary for Japan to reinforce its cooperative ties with Europe, which has already started its own SSA activities, and to aspire to closer international cooperation with Russia too. Japan has already used a European radar facility named FGAN on a contract basis to observe Japanese satellites, while JAXA is involved in cooperation with the French space agency CNES, and so on. The first step of further cooperation between Japan and Europe will be data sharing. One of the examples of the future Japan-Europe SSA cooperation could be the case of observing debris around geostationary Earth orbit (GEO) satellites above each region and sharing its data.

In order to accelerate the development of international cooperation on this issue, Japan should take the initiative for an international symposium on SSA as a first step, where all the key players would gather to consider creating a joint world-wide road-map of improved SSA activities, and where possibly a “global SSA” concept might be discussed. In this symposium, the topic would be how a global SSA could materialise in terms of technological, operational and programme management by all participant countries. Most possibly, global SSA cooperation will start with data sharing. Ideally, the Strategic Headquarters for Space Policy in Japan would take the lead for the Japanese part of global SSA, with each ministry, JAXA and JSF contributing.
- Structure             Folk-type equatorial
- Focus mode           Cassegrain-type, F/3
- Total FOV            3 degrees
- Number of CCDs       4
- CCD mosaic FOV       2.4 x 1.2 degrees
- Spectral range       400-1100 nm
- Operating Temp.      -100 degrees Celsius
- CCD Catalog No.      Hamamatsu Photonics kk, 2k4kBICCD-5877
- CCD type             a back-illuminated 2048 x 4096 pixels
- CCD size             60mm x 30mm
- Pixel size           15 micrometers

Table 1: Specifications of 1m Optical Telescope

- Focus mode           Cassegrain, F/2 / Baker Richey Chretian, F/5
- FOV                 2 degrees / 5 degrees
- Structure           Folk-type equatorial / German-type equatorial
- CCD camera          2k x 2k pixel CCD cell

Table 2: Specifications of 50cm/25cm Optical Telescope

- Frequency           S-Band (3GHz)
- Output Power        70kw
- Type of Antenna     Active Phased Array (1,395Tx/Rx modules)
- Antenna Aperture    2.8 x 2.8m
- Beam Width          2 degrees
- Antenna Beam Steering Elevation: 54 degrees fixed and 15-75 degrees by electrical scanning
                         Azimuth: +/-45 degrees by electrical scanning and +/-270 degrees by mechanical positioning
- Observation Capability Max. Range: 1,350km
                         Min. RCS: 0.786m² (1m diameter) at 600km slant range
                          10 objects are tracked simultaneously
- Operation Modes     Initial Acquisition: Box scanning
                         Nominal Operation: Auto tracking
                         Re-entry Observation: Multi-Stage observation, Shift Observation, Shift and Repeat Observation

Table 3: Specifications of Radar Facility
Cooperation between Japan and Europe in the Space Situational Awareness (SSA) Field

Mission Statement of ESPI
The European Space Policy Institute (ESPI) provides decision-makers with an informed view on mid-to long-term issues relevant to Europe’s space activities. In this context, ESPI acts as an independent platform for developing positions and strategies.

Available for download from the ESPI website
www.espi.or.at

Short title: ESPI Perspectives 53
Published in October 2011

Editor and publisher:
European Space Policy Institute, ESPI
Schwarzenbergplatz 6 • A-1030 Vienna • Austria
http://www.espi.or.at
Tel: +43 1 7181118-0 / Fax: -99
Email: office@espi.or.at

Rights reserved – No part of this report may be reproduced or transmitted in any form or for any purpose without permission from ESPI. Citations and extracts to be published by other means are subject to mentioning “Source: ESPI Perspectives 53, October 2011. All rights reserved” and sample transmission to ESPI before publishing.

ESPI Perspectives are short and concise thought or position papers prepared by ESPI staff as well as external researchers.

Any opinion expressed in this ESPI Perspective belongs to its author and not to ESPI.
The author takes full responsibility for the information presented herein.