Briefing Memo

Space Debris and Security

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Increasing Space Debris －Background of the Problem－

January 11, 2007 3,000 pieces

February 10, 2009 2,000 pieces

Do you know what these numbers represent? They represent numbers by which space debris increased on each of these days. Space debris is defined as all sorts of artificial objects that orbit around the earth but can no longer be utilized for any specific purposes (including satellites that exceeded their life, broken pieces and parts of disintegrated or exploded satellites, fairing of the nose sections of rockets, second- and third-stages of rockets and their broken pieces and parts, etc.). The first case in January 2007 shows the number of space debris generated when in an experiment China shot down its disabled meteorological satellite, Fengyun-1C, with an antisatellite (ASAT) missile launched from a military base in China. The second case in February 2009 shows the number of debris generated by a collision in earth's orbit between Russia's defunct Cosmos 2251 and the United States' operational commercial communications satellite Iridium 33. These two cases alone scattered some 5,000 debris in space around the earth.

That said, some may still think that 5,000 debris are not a big problem given the vastness of outer space. However, the number of space debris scattered about in outer space, particularly in the orbit often used by satellites, is about 22,000 pieces alone with a diameter of at least 10 centimeters that can be observed from the earth. Of which 5,000 came into being by the two incidents and accidents described. With around 1,000 satellites being in actual operation, it means that dozens of times more useless debris is drifting in outer space. Furthermore, as shown in the collision in 2009, there is the risk that a satellite in actual use (an Iridium satellite) may become debris in a collision with debris (a Cosmos satellite). Even the worst scenario is conceivable, where satellites collide with debris repeatedly resulting in a huge increase in the number of debris that would make use of outer space around the earth infeasible (called the "Kessler syndrome," named after a NASA scientist who predicted this scenario).

Space debris with a diameter of at least one centimeter orbiting in space is estimated to 500,000. Debris with a diameter of around 2 millimeters can pierce through a spacesuit, debris with a diameter of one centimeter or larger can mortally damage a satellite, and debris with a diameter of 10 centimeters or larger has energy powerful enough to completely destroy a satellite. In order to get out of the earth's sphere of gravitation and go into orbit, an artificial satellite requires a velocity of 7.9 km/s (or 28,400 km/h). When two space objects collide, they have certain angular degrees and their synthesized velocity can reach 10 km/s (36,000 km/h). Even a tiny screw or bolt can destroy a tough object when they collide with a velocity of 10 km/s. An ordinary artificial satellite unprotected by thick armor cannot survive. The International Space Station (ISS), a project in which Japan is also participating, has an extraordinarily-reinforced hull and is equipped with a special bumper preventing debris with a diameter of one centimeter from piercing through it. Even so, ISS altered its trajectory nearly 10 times since the start of its operation to avoid space debris, and in June, 2011 the entire crew including Dr. Satoshi Furukawa, a Japanese astronaut, evacuated to the Soyuz spacecraft for an emergency escape in preparation of unexpected problems. Viewed in this

light, you can understand how dangerous debris in outer space is. The use of space is deeply connected to our everyday life, but at the same time entails an inherent hazardous nature.

Attempts to Deal with Space Debris

In response to the deteriorating situation in outer space, discussions on countermeasures have begun at various forums. These represent attempts to monitor the situation of outer space and take appropriate responses as part of wider activities, or in other words, the Space Situational Awareness (SSA). The term SSA refers to the broad concept covering not only the observation and monitoring of space debris, but the monitoring of the functions and conditions of satellites operated by various countries, space weather forecasting solar winds and amounts of plasma having adverse impacts on satellites' functions and communications, and studies on dangerous astronomical objects that are likely to come closer to or collide with earth (near-Earth objects). In this paper, the author narrows it down to discussions on activities to observe and monitor space debris, and addresses discussions in Europe, the United States, and at the United Nations as well as developments in Japan.

1. European Responses to Deal with Space Debris

As the problem of space debris becomes increasingly serious in the 21st century, European military sectors and research institutes are setting out to monitor the situation of outer space. France, Germany, Norway, Sweden and several other countries are observing space debris on their own. In addition, the European Space Agency (ESA) has also launched research into space debris. ESA is an international organization for space development and utilization, joined by 19 major countries in Europe. Though it is an international institution established separately from the European Union (EU), in recent years it is cooperating with EU such as by holding joint minister-level meetings. In 2010, ESA and EU came to share the perception about the need to establish SSA-responsive capabilities, including measures to deal with space debris. Even before sharing this perception with ESA, EU developed a draft of the Code of Conduct for Space Activities (prepared in 2008 and revised in 2010), which covers multilateral approaches to reduce space debris, contain ASAT actions, and ensures transparency and confidence-building about space activities. It also urges the United States and Japan, the two other developed countries, to support and cooperate with the draft Code of Conduct. In fact, early 2012 the United States and Japan announced their partnership with EU. Subsequently, moves are under way toward European-led international cooperation, with over 50 countries participating in multilateral conferences.

2. U.S. Response to Deal with Space Debris

In the United States, the Department of Defense is responsible for monitoring and following the overall situation of space, including space debris. This is because the United States and the U.S. military in particular have a high dependence on space. Maintaining the stable use of space is vital for them. In fact, if ASAT weapons were used against various satellites operated by the United States, the U.S. military's activities would be restricted to a considerable extent. Based on such judgments, in its new National Space Policy unveiled in 2010, the U.S. administration, has pointed out the importance of maintaining a stable space environment.

It is the Joint Space Operations Center (JSpOC) of the United States Strategic Command (USSTRATCOM) that is actually monitoring the situation of outer space, of space debris and the conditions of satellites of various countries. This is accomplished using instruments for observation deployed on the earth and in outer space, and by making lists of space objects (this is called "cataloging"). JSpOC is exploring space objects from the earth using radars and optical telescopes installed at dozens of locations throughout the northern hemisphere. Furthermore, since 2010, it has launched a satellite for Space-Based Space Surveillance (SBSS), thus beginning its outer space monitoring activities in earnest. However, though the existing U.S. observation network covers much of the northern hemisphere, the observational ability for East Asia and the southern hemisphere is not necessarily

sufficient, prompting the United States to seek cooperation from Japan and Australia. Furthermore, the United States has decided to cooperate with EU and support and promote EU's Code of Conduct for Space Activities.

3. The United Nations Committee on the Peaceful Uses of Outer Space UNCOPUOS)

The issue of outer space surveillance including space debris is also being addressed at the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), headquartered in Vienna, Austria, and joined by 71 countries. UNCOPUOS has considered measures to reduce space debris since 2003, and following the ASAT experiment by China in 2007, adopted the space debris guideline by consensus, including China which conducted the ASAT experiment. More recently, in 2010, UNCOPUOS set up a working group on the long-term sustainability of space activities, and in the following year of 2011, started discussions on space debris and space surveillance in general. It is now developing an environment making it easier for various countries to provide information on the observation of the conditions of outer space.

Japanese Response to Deal with Space Debris

1. Independent Responses

In Japan, the Japan Space Forum (JSF) and the Japan Aerospace Exploration Agency (JAXA) are monitoring debris in outer space. The JSF observes space debris by radar and optical telescope installed in Okayama Prefecture and sends observation data to JAXA for analysis. Data is also provided to Europe, the United States and the United Nations. At present, the observation of space debris is not part of the tasks of the Ministry of Defense or Japan Self-Defense Forces (JSDF).

The Basic Space Law, which Japan enacted in 2008 for the first time almost 40 years after it started space activities, and the basic plan for space policy prepared in 2009 and 2013 both underscore the preservation of the space environment as an important issue. Japan is in the process of considering the development of a system that can observe the situation of space, including space debris, with a high degree of accuracy.

2. International Cooperation

In the field of international cooperation, Japan is providing data to and exchanging data with the ESA as part of cooperation with Europe, and is also proactively taking part in discussions on the EU's Code of Conduct for Space Activities. Japan shows an understanding for the U.S. SSA including the observation of space debris, and is providing and exchanging data with the United States in much the same way as Europe. In addition, at the Japan-U.S. security consultative committee (the 2+2 meeting), the two countries reached an agreement on the SSA as one specific area of Japan-U.S. cooperation. In response to this accord, a technological feasibility test is scheduled to take place on how the SDF's air-defense radar network can be utilized for surveillance of the space situation. This points to the possibility of SDF's network being added to JAXA's space observation network, which can be understood as a major change in Japan's preparedness for surveillance of the space situation. Such cooperation with Europe and the United States has now become an irreversible flow, with the Japan-U.S. Summit Meeting also making a reference to cooperation in the Code of Conduct for Space Activities (proposed by EU) and the SSA. (However, it has to be noted that Japan needs to consider an appropriate domestic setup to deal with the unresolved problem of whether JAXA should continue to take charge of the collection and management of data of space observation including space debris. The Ministry of Defense should take over the tasks, or an organization under the direct control of the Cabinet such as the Cabinet Satellite Intelligence Center should be responsible for them as a matter for the state as a whole.)

Furthermore, Dr. Yasushi Horikawa, JAXA Technical Counselor, is serving as chairman of UNCOPUOS in Vienna for two years starting in 2012. Thus, Japanese leadership with his initiative is expected in the promotion of the observation of the space situation, including space debris and the sharing of information and consideration of

debris removal technology. In addition, Japan has been strengthening its approaches to the member states of the Association of Southeast Asian Nations (ASEAN), contributing to deepening an understanding of this problem in Asia.

Conclusion

Needless to say, surveillance of the situation of outer space where space debris is ever growing alone is not solving the space debris problem fundamentally. The next necessary step is the removal of debris, but at the moment the removal technology is no more than just an idea. Still, it is noteworthy that Japan has the cutting edge in the development of debris removal technology. For example, Japan is one of the world leaders in technology to slow the velocity of defunct artificial satellites and debris by attaching charged tethers to them and incinerating them by forcing them to plunge into the atmosphere. Robotics technology, in which Japan excels, can also be applied in many areas. As with garbage collection service on earth, the removal of debris from outer space requires funding. It is essential to create an international funds and a framework for providing funds. In addition, as international space law is interpreted as giving ownership of malfunctioned satellites to their registered states, no third state may be able to remove them without prior consent of such registered states. In consideration of these points, it may be necessary to develop a new framework of international space law concerning the provision of funds for debris removal, and the release of ownership of removed satellites, etc.

In any case, the best we can do at the moment is to monitor the space situation in as much detail as possible, and when the risk of a satellite in operation colliding with debris is predicted, to avoid the collision appropriately by making use of the satellite's attitude control system. To that end, it is necessary to capture debris in outer space and satellites of various countries with the utmost accuracy by using many observation systems, internationally integrate the data into catalogs, update the data as necessary to enhance their credibility and prevent any serious accident. As one of the advanced countries in space use, Japan must make its utmost efforts in cooperation with Europe, the United States and the United Nations. Under the circumstances where no individual country can observe the space situation to its fullest extent, it is natural for Japan to proactively cooperate with the Code of Conduct for Space Activities proposed by EU, deepen cooperation with the United States and mutually complement the capabilities of advanced countries and international organizations in order to accurately capture the conditions and developments of space debris and satellites of various other countries.

For Japan, proactively using outer space from both economic and security aspects as well as the sustainable and stable use of outer space is a matter of important concern. Japan needs to not only pay full attention and get involved in the observation of space, but also acknowledge various aspects of debris removal technology and the development of relevant international legal frameworks.

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