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Security Nexus Perspectives

CONSIDERING TECHNICAL INFORMATION PROTECTION THROUGH AN EVALUATION OF ASAT TECHNOLOGY IN JAPAN

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Summary

Recent civil space missions have highlighted the significant advances Japan has accomplished in this high technology field. While deserving recognition and celebration, in an increasingly competitive space domain, urgent attention is also needed in safeguarding the intellectual property and technical information around these missions. Japanese advances in space are widely admired around the world, but likely also prime targets of industrial espionage and theft by malign actors. In a world of dual-use technologies, moreover, there is an unfortunate prospect some of the greatest innovations pioneered could be stolen and re-purposed for applications supporting hostile military space missions. Strengthened information protection can play a vital role in addressing both these risks.

On or about 6 December 2020, the Japanese asteroid probe *Hayabusa 2* will be returning to earth, making its landing at the Woomera Test Range in Australia. The completion of this second asteroid mission by the Japan Aerospace Exploration Agency (JAXA) marks a significant advance in Japanese civil space capabilities, and a further milestone in cooperation and collaboration among like-minded space-faring nations (see e.g., JAXA 2020a). These accomplishments certainly deserve recognition and celebration. In this highly competitive realm of advanced technology development and control over a crucial space domain, however, urgent attention is also needed in safeguarding the intellectual property and technical information around

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these missions. Japanese advances in space are widely admired around the world, but likely also prime targets of industrial espionage and theft by malign actors. In a world of dual-use technologies, moreover, there is an unfortunate prospect some of the greatest innovations pioneered could be stolen and re-purposed for applications supporting hostile military space missions. Strengthened information protection can play a vital role addressing both these risks.

The potential dual-use character of some Japanese space advances was signaled in the *Space Threat Assessment 2020* published by the Center for Strategic and International Studies (CSIS) (see Harrison *et al.* 2020: 51). Focusing on the *Hayabusa 2* mission to the asteroid *Ryugu*, the *Assessment* highlighted the deployment of a Small Carry-On Impactor (SCI) to launch a projectile at the asteroid's surface to generate rubble to be collected and returned to earth. This capability, it was noted, had the potential to be re-purposed as a co-orbital anti-satellite (ASAT) weapon.

The scope for such re-purposing, of course, is not limited only to the technologies around the *Hayabusa 2* mission. Indeed, a wider review of recent Japanese advances in space technologies suggests a surprising list. Generally speaking, if an ASAT capability is understood as comprising: (1) a capability to find and identify a target satellite; (2) a capability to launch a vehicle to intercept the target; (3) a capability to maneuver and approach within striking distance; and (4) a capability to disable or destroy the target; Japan already has in its possession all the necessary elements.

(1) Finding and identifying

At successful launch, all satellites are assigned a unique identifying code (e.g.,, an international designator, also known as a Committee on Space Research or COSPAR ID; or Satellite Catalog Number, also known as a U.S. Space Command or USSPACECOM object or ID number). Using these codes, satellite orbital data can generally be obtained in the public domain through a range of sources and tracking tools (see e.g., Kelso 2020 for a periodically updated index of tracking software and tools).

Though tracking may no longer present a challenge, it remains crucial that confirmation of the precise location and identity of the target satellite can be obtained. In this respect, it is significant JAXA will be substantially upgrading its Space Situational Awareness capabilities, with new and upgraded capabilities coming on stream from 2023 (see e.g., JAXA 2020b, and Yoshitomi 2019). Dedicated primarily to observing space debris, these capabilities will enable objects larger than 10 centimeters to be identified and tracked. Centered on the Bisei Space Guard Center and Kamisaibara Space Guard Center, Okayama Prefecture, these enhanced optical and radar capabilities will be augmented by upgraded analysis capabilities at the Tsukuba Space Center in Ibaraki Prefecture. With the availability of such enhanced precision, the task of finding and identifying satellites will be well within the reach of Japan.

(2) Launch capability

Regarding launch capabilities, Japan's successful track record is well known. A large number of satellites and probes have been carried aloft by an impressive array of launch vehicles, including the *Epsilon*, the H-

IA, H-IIB and soon to be available (by 2021) H-III rockets (see e.g., JAXA 2020c for details on these launch vehicles).

Each of these offers different payload capabilities, range, and the potential to place objects at different orbital altitudes. The H-IIA rocket, for example, has a satellite launch capability of about 10 tons in low earth orbit, and 4 to 6 tons in geostationary orbit when supplemented by a booster. The larger H-IIB further extends these limits. The *Epsilon* has successfully carried satellites for a variety of missions, and is itself based on proven solid booster technology (its predecessor was the M-V rocket), launching astronomical satellites, Mars probes, and solar observation satellites. Though smaller than the H-IIA, the *Epsilon* has in sun-synchronous orbit a launch capacity of at least 450 kg and in long elliptical orbit, 365 kg or more.

In light these diverse capabilities, launching an ASAT-capable payload successfully presents few challenges for Japan. Launch is a well-practiced routine, with proven capacities catering to different payload sizes and orbital altitudes.

(3) Maneuver and approach capabilities

The ability to maneuver an unmanned space vehicle and approach a target satellite presents possibly the most challenging aspect of an ASAT deployment. Given the distances involved and consequent time lags in communications with earth stations, these capabilities pose myriad technical challenges and are fraught with hazards. In this field, Japan can draw on nearly two decades of experimentation, innovation and experience, with the most recent *Hayabusa 2* mission exemplifying the advances achieved to date.

A much earlier effort involved the Lunar probe *Kaguya*, launched atop a H-IIA rocket in 2007. *Kaguya* successfully orbited the moon, approached the surface at low altitude and conducted observations, before eventually crashing in 2009 and ending its mission. At a distance of about 380,000 km, the mission was a highly successful demonstration of Japanese capabilities controlling an unmanned spacecraft at distance (see e.g., JAXA 2020d).

Approach capabilities were subsequently refined further through the *Kounotori* HTV (H-II Transfer Vehicle) (see e.g., Orbital Velocity 2020 for details). The HTV is an unmanned space carrier that can carry up to 6 tons of cargo to the International Space Station (ISS). With an ability to maneuver safely to close range, it demonstrated a new precision in approach and maneuver, albeit at a relatively closer low earth orbit.

It was the *Hayabusa* and *Hayabusa 2* missions that demonstrated longer distance capabilities in approach and maneuver. With significant improvements to the original *Hayabusa* platform, in 2018, *Hayabusa 2* arrived at the asteroid *Ryugu* – a distance of about 300 million kilometers from earth (and time lag of up to 17 minutes each way in communications with earth stations). Utilizing improved engines, guidance and navigation systems, antennas and attitude control systems, it initially maintained a distance of around 20 kilometers, before dropping to altitudes of just 55 and 9 meters from the asteroid surface for the deployment of two rovers and successful retrieval of asteroid samples (see e.g., JAXA 2020a).

Looking towards the future, it is highly likely such maneuver and approach capabilities will be enhanced further. JAXA, for example, is developing capabilities around "rendezvous technology", focused primarily on space debris removal. Space debris presents special challenges in retrieval. Varying considerably in size, they may range from smaller objects resulting from previous collisions to entire satellites that have ceased operations. Whatever their size, all are in a sense "invisible" as they possess no operable control devices, nor reflectors or means of communications. Debris, therefore, are immensely difficult to detect, position accurately, and approach and maneuver towards – a task made even more challenging and hazardous if they are rotating and "tumbling". Based around the *Kounotori* supply ship, JAXA is presently conducting research to develop safe and reliable "rendezvous technology" for space debris removal (see e.g., JAXA 2020e). While without doubt meant solely for peaceful purposes, it should be apparent that in the wrong hands, this same capability may be harnessed to accurately approach and maneuver towards satellite targets with hostile intent.

(4) Destructive capabilities

As mentioned previously, the *Hayabusa 2* mission featured a SCI to create a crater on the surface of the asteroid *Ryugu*. A copper projectile weighing 2 kg was launched at a speed of about 2 km per second at the surface of the asteroid. The SCI successfully demonstrated a controlled explosion in space providing propulsion to an object in a purposeful direction. As pointed out in the previously referenced CSIS *Assessment*, given the mass and velocity involved, the SCI of *Hayabusa 2* possessed tremendous destructive power that could be deployed against extremely fragile satellites and spacecraft. In the wrong hands, it could be a potent satellite destroyer.

A similar capability exists in the form of the Small Satellite Orbital Deployer (J-SSOD) (see e.g., JAXA 2020f). J-SSOD is a device developed in Japan to launch ultra-small satellites – called CubeSats – measuring 10 × 10 × 10 cm in size (or, in CubeSat measurement terminology, 1 unit or 1U, weighing less than 1.33 kg). Currently housed in the ISS, these ultra-small satellites are launched from the ISS and orbit around earth as larger satellites do. Again, while originally conceived with peaceful purposes in mind, this capability to launch smaller objects in space can be extremely destructive to larger, fragile satellites if harnessed for malign purposes to engineer collisions.

Finally, in a less "kinetic" sense, mention should also be made of an emerging capability in the space debris removal field (likely available from 2026) relevant to this discussion of destructive potential. In a collaborative effort between JAXA, commercial and research players in Japan, satellite-mounted lasers will be developed to remove space debris (see e.g., Kyodo News 2020). By irradiating targeted objects, lasers will alter their orbits to descend into the earth's atmosphere where such debris will burn up. While this of course is an admirable technological innovation benefitting safety and space traffic management while also stimulating the development of an emerging space debris industry, the potential use of such technology for hostile purposes should be clear. Targeted satellites may be destroyed by altering their orbital paths. Short of that, lasers may be used to damage or degrade sensitive satellite components, temporarily or even permanently blinding mission-critical sensors, and rendering satellites useless (see e.g., Harrison *et al* 2020: 3).

To summarize: To a great extent, Japan already has the basic technology to develop an ASAT capability. Though focused entirely on civil and commercial space and devoted to fostering scientific discovery, technological advances and safety in space, because of their dual-use potential, these technologies may readily be re-purposed to become weapons of destruction. In his book, Herman Kahn, founder of the Hudson Institute, wrote: "It is a natural tendency not to think about topics that are not desirable." (Kahn 1962: 14). In the context of Japan, this tendency is reinforced by a prohibition on a security or military aspect to space activities. Hence, even if the parties are vaguely aware of the possibility of their scientific, technological and commercial efforts becoming "weaponized", they tend not to say anything. But it is important for researchers and engineers conducting research and development in space who might not be inclined to think about how the technology they are researching may be applied to weapons that they should nonetheless remain aware of these potential applications and capabilities and the impacts they might have. With that awareness, there should be a vigilance around maintaining proper management safeguards to enhance systems and facilities for the prevention of technology spills, protection of intellectual property and prevention of espionage and theft. The world prizes highly Japanese technology, innovations, and scientific advances. If not already, Japanese researchers and engineers involved in advanced space technology should be acutely aware of the value of their research from a security perspective.

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November 2020