



The Future of Space Technology and Economy

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Space is a growing industry and an important domain for national security. As a result, Japan has a strategy to maintain an independent space transportation system and to maximize its space utilization via international collaboration.

Regarding space utilization via international collaboration, the International Space Station (ISS) is a good example. Initiated in the 1980s thanks to collaboration between 15 nations, the ISS has been a symbol of international cooperation for more than 20 years. Approximately 110 nations and regions have participated in ISS utilization with more than 3,000 research projects conducted by more than 4,200 researchers. ISS serves as a testbed to increase innovation and competitiveness and will pave the way to send humans to the Moon and Mars in the Artemis Program.

The Japan Aerospace Exploration Agency's (JAXA) asteroid sample return missions (Hayabusa-1 and Hayabusa-2) are also good examples. While JAXA developed and launched the probes, the German Aerospace Center (DLR) provided the robots that explored the surface of the asteroids. The United States and Japan collaborated to enhance future explorations. Via cooperation with Australia, the sample capsules returned to Earth in the Woomera Desert. The Hayabusa missions demonstrate the international nature of collaboration for space research.

Regarding independent space transportation, Japan has liquid rockets called H-IIA and H-IIB, as well as a solid

rocket called Epsilon. Japan also has cargo transfer capabilities to ISS using H-II Transfer Vehicles (HTV) and has achieved 100% success rate in nine missions. The next generation of the HTV, which is called HTV-X, is under development. HTV-X will deliver cargo not only to ISS, but also to the Lunar Gateway in the Artemis Program.

Besides government-developed launch systems, there are several commercial launchers under development in Japan. Since the Space Activities Act came into effect in 2018 for satellite launches, commercial space activities have emerged in additional areas like launch systems, satellite development, data utilization, space exploration, and space tourism.

Now, we are facing a new era. The space domain is expanding from low Earth orbit to cislunar orbit. Space transportation has expanded to small satellites (smallsats), human space transportation, and eventually Point-to-Point (PtoP) transportation for cargo and humans. And for new sectors, it is important to leverage public-private partnerships. Regarding smallsats, according to [Bryce Space and Technology](#), in 2019, the average weight of smallsats was 109kg; U.S. launch providers launched 57% of smallsats; and almost half of 28 launches dedicated for smallsats happened in China. Approximately 100 Japanese smallsats are planned to be launched by 2025 for Synthetic Aperture Radar (SAR) constellations, Earth observation, and debris removal. It is desirable to accelerate the development of small launch vehicles inside Japan because several startups are working in the country

to meet these demands.

For human space transportation, a new era for space tourism developed in 2021. The number of private astronauts who flew to space, including suborbital flights, was 29. The figure exceeded the number of global governmental space agency astronauts, which was 19. This trend will continue and accelerate once PtoP develops. People will fly to near space to travel to other locations on Earth. For example, SpaceX announced a concept to use its fully reusable Starship to connect New York and Shanghai in 39 minutes. The U.S. Air Force's 2022 budget proposal requested almost \$50 million for Rocket Cargo to continue the work it began in 2020 with small contracts to SpaceX and Exploration Architecture Corporation (XArc). Rocket Cargo intends to deploy up to 100 tons of cargo to a certain place in less than one hour. PtoP demands will increase significantly for cargo and humans in the next decade.

In order to accommodate its demands and become an Asian hub for space tourism and PtoP, I established Space Port Japan Association with six co-founders in 2018 and have served as its representative director. Spaceports are essential for national security, aerospace and non-aerospace industries, transportation hubs, and education. All countries will benefit from utilizing spaceports, especially in the PtoP era. The Oita prefecture already partnered with U.S. Virgin Orbit and U.S. Sierra Space. Japan's Growth Strategy Action Plan, approved by the Cabinet in June 2021, specifies the goal to create a core center for space business in Asia, including commercial spaceports, with an eye toward Japan-U.S. cooperation.

Regarding norms for upcoming space

travel era, Space Traffic Management (STM) is of critical importance. STM should include deep-space, orbital, and sub-orbital objects, including PtoP, and should have synergy with aviation traffic management for suborbital flights. Therefore, joint efforts between aviation and space are vital. STM will also contribute to space debris management and sustainability of space activities. It is important to recognize the value of space sustainability and collaboration among nations and regions that share common goals.