EVOLUTION OF MICROSATELLITES AND HIGH ALTITUDE PSEUDO-SATELLITES (HAPS)

—POTENTIAL FOR NEW SATELLITE-BASED SERVICES—

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In recent years, IT giants such as US-based Google, and many startup companies have been accelerating investment in communications and earth observation systems using new platforms, ranging from microsatellites to large unmanned aircraft called high altitude pseudo-satellites (HAPS), seeking to create new satellite-based services. This report discusses the latest trends of the fast-evolving platforms, and provides an overview of new satellite-based services.

NEW PLATFORMS

Satellites, flying at altitudes of hundreds to 36,000 km, are used for communications, earth observation, and other purposes. Satellite-based communications and observation services have created a huge market, which accounts for 60% of the space industry market worth approximately USD 208 billion (2015) (SIA, 2016). Thanks to enhanced launch capabilities, satellites have become more technologically advanced and larger in scale, although the development cost is increasing. Development of a large-size satellite weighing a number of tons costs hundreds of millions of dollars. Amid this situation, recent years have seen a new platform trend towards miniaturizing satellites by limiting their functionality, and microsatellites that can be developed for 10 millions of yen, to hundreds of millions of yen each, have been put into practice. (In this report, satellites weighing up to 150 kg are largely defined as microsatellites.) While conventional large-size satellites are manufactured by Lockheed Martin of the US and other major companies, new entrants, including IT and startup companies, are now able to manufacture microsatellites.

As a satellite is deployed at a lower altitude, the distance of wave transmission becomes shorter, and communication latency becomes lower, too. This brings about advantages, such as smaller transmission equipment and more sophisticated photographed images. Moreover, microsatellites are easier to launch. If communication latency is low, the smooth distribution of video content is possible. However, there is a trade-off: The lower the altitude, the smaller the coverage of the satellite. New entrants are pressing forward with the building of communications and observation systems by deploying many low-cost microsatellites.

Besides microsatellites, there is another platform drawing a lot of attention called High Altitude Pseudo-Satellite (HAPS). This platform flies at an altitude of approximately 20 km in the stratosphere, and can be applied in communications and observation, among other fields. Developments that are close to practical use include unmanned aircraft with a wingspan as wide as tens of meters that can make repeated round trips between the stratosphere and the ground. In the stratosphere, where there is little traffic and the meteorological conditions are stable, HAPS can float in the air, as long as they are powered. Since HAPS orbit at a much lower altitude than satellites, the areas they can cover are more limited and smaller. However, HAPS have mobility, as well as the ability to take off from and land on the ground, which makes the flexible and prompt deployment possible, thus it is expected to be a new platform with the potential to become a complement or replacement for satellites. HAPS-related companies include Google and Facebook, which develop HAPS-reliant communications systems

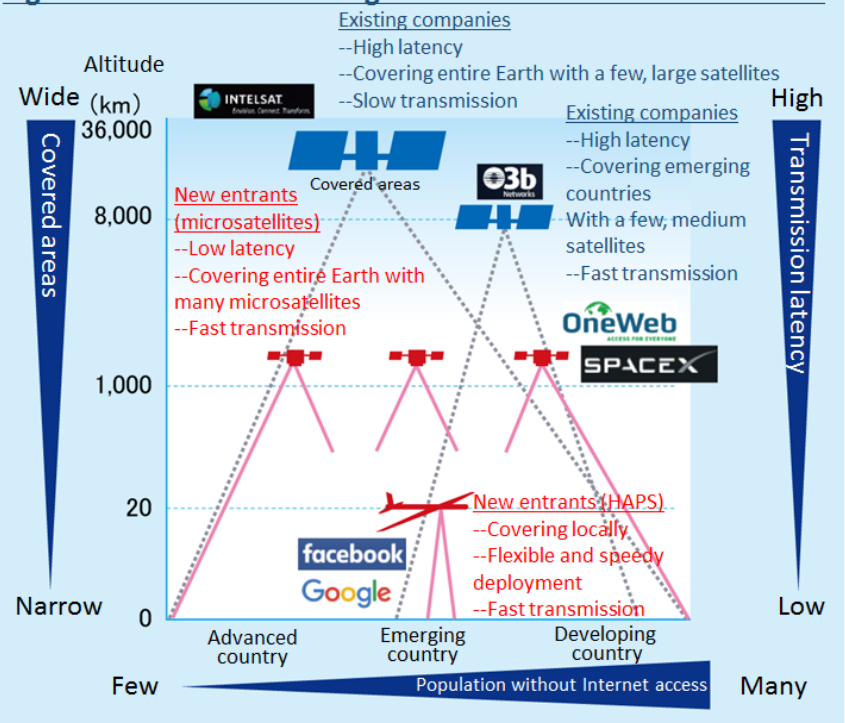
in the US, Airbus Defense and Space (Airbus D&S), which manufactures HAPS main units in Europe, Thales Alenia Space in France, and the Japan Aerospace Exploration Agency (JAXA) in Japan.

COMMUNICATIONS SYSTEM USING MICROSATELLITES

Satellite communications are inferior to optical fibers in communication speed, but are able to provide communication environments for areas where terrestrial communication lines have not been sufficiently in place. Strong demand for satellite communications is thought to exist among approximately three billion people in emerging and developing countries in Asia and Africa, etc., who have no Internet access and for companies operating in remote areas, such as on the ocean. In the satellite communication market, Luxemburg's Intelsat has deployed large-size satellites at an altitude of approximately 36,000 km, covering the entire globe, and the UK's O3b has deployed medium-sized satellites at an altitude of approximately 8,000 km to provide high-speed communications primarily in emerging and developing countries.

The UK's OneWeb and the US's SpaceX are new players in this market. They plan to build communications systems using numerous microsatellites with a range covering the whole earth. These newcomers are differentiating themselves from existing operators with their low communication latency, as well as their coverage, and communications speed. OneWeb is in the lead and plans to deploy 648 microsatellites (weight: approx. 150 kg) at an altitude of approximately 1,200 km. Its first 10-satellite launches are scheduled for the second half of 2017, and the constellation of microsatellites is expected to become operational in 2019 as a communications system to encompass the entire Earth. The company tied up with Airbus D&S to manufacture these satellites efficiently for approximately USD 500,000 per satellite. The lifespan of a satellite is more or less five years, and thus, each satellite also needs to be replaced, as necessary, after the system is activated. Operating costs are said to be about USD 3 billion. Meanwhile, SpaceX will deploy about 4,000 satellites at an altitude of approximately 1,100 km, and launches are scheduled for 2017 and will use the company's Falcon 9 rockets. It is believed that operating costs are about USD 3 billion. Fig. 1 shows differentiation among new entrants.

Fig. 1 Differentiation among New Entrants in Communications



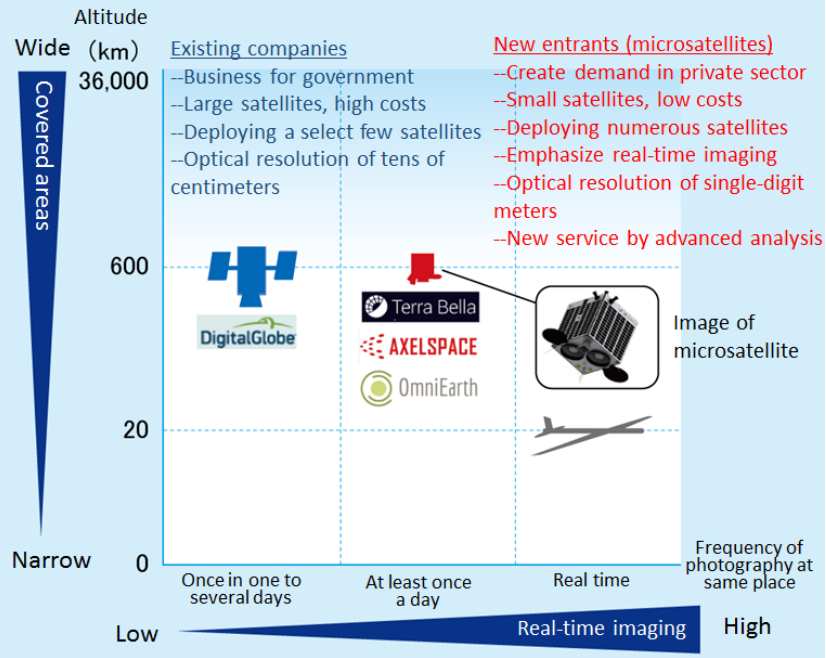
Source: Prepared by MGSSI

MICROSATELLITE-BASED EARTH OBSERVATION SYSTEM

Earth observation is used for security, disaster monitoring, understanding of crop yields, etc. Security use by governments accounts for 60% of the commercial satellite imaging market. Many companies already have satellites in place at low altitudes for high resolution satellite imagery. High-performance, large-scale satellites operated by US's DigitalGlobe at an altitude of approximately 600 km are capable of sensing an object of about 30 cm in length (represented as "optical resolution of 30 cm"). The company deploys only a select few of these large, high-performance observation satellites, given the high cost, and the same spot is photographed at an interval of one to several days.

This market has drawn new entrants, such as Google-affiliated Terra Bella. Those new competitors use numerous microsatellites to cover a wide range of areas and setting themselves apart from existing operators through their greater frequency image capturing capability. They seek to create new demand, particularly in the private sector, by taking advantage of real-time imagery and sophisticated image analysis. Microsatellites orbit at about 600 km, approximately the same altitude as existing operators. Terra Bella began to operate microsatellites in 2013 and intends to launch at least 10 satellites from 2016 to 2017. Moving images can be captured at approximately 1m optical resolution. Ultimately, with 24 satellites deployed, the same spot will be captured every three hours. Among Japanese operators, Axelspace is to launch three satellites in 2017, and to deploy 50 satellites by 2022. There are also US-based entrants, such as OmniEarth, BlackSky, Planet Labs, and Spire. Fig. 2 shows differentiation among these new entrants.

Fig. 2 Differentiation among New Entrants in Earth Observation



Note: Image of microsatellite above is attributed to Axelspace document
Source: Prepared by MGSSI

TREND OF HIGH ALTITUDE PSEUDO-SATELLITE (HAPS)

The communications field is leading the way in the development of HAPS for commercial use, driven by Google and Facebook. Their aim is not to own communications lines, but to expand Internet access to those who do not have it, and HAPS is one of the means to do this. Google's project is called Project Skybender, using "Solara 50," a solar-powered HAPS with a wingspan of 50 m and manufactured by Titan Aerospace, a Google-subsidiary. By employing next-generation, 5G high-speed communications technology, this HAPS's transmission speed is expected to achieve single-digit gigabits per second (Gbps). Facebook's HAPS "Aquila," made of carbon fiber, has a wingspan of 42 m and runs on solar power. Its targeted non-stop flight time is three months. With laser communications from the ground to the HAPS, the HAPS radiates radio waves in a diameter

of approximately 50 km directly below itself, and the transmission is expected to be at a single-digit Gbps. On the other hand, application of HAPS in the observation field is mainly for security use. For instance, “Zephyr,” a HAPS to be brought to market by Airbus D&S in 2016, has been chosen by the United Kingdom Ministry of Defense.

While technology innovation is making progress, legislation for commercial use of HAPS has yet to be established. It will probably not be until 2019 or later when the International Civil Aviation Organization (ICAO), which formulates standards for international air navigation, amends the international standards concerning unmanned aircraft. Another challenge is allocation of radio-wave frequency bands commercially available in the stratosphere. With the help of the US government, Google and Facebook are jointly lobbying the International Telecommunication Union (ITU), which coordinates the shared global use of the radio spectrum.

OUTLOOK FOR NEW SATELLITE-BASED SERVICES

The communications market created by microsatellite communications systems is expected to amount to approximately USD 7 billion in 2018, and to reach approximately USD 30 billion in 2027 (Frost & Sullivan, 2016). In emerging and developing countries, ground communications operators will be able to provide 4G/LTE or high-speed communications to local areas or remote islands, bringing Internet access to an additional 1.7 billion people. For corporations, it may become possible to advance business operations by connecting remote locations. One example is smartification, such as remote operations by shipping enterprises and offshore oil & gas developers. HAPS will further expand the market by complementing microsatellites. Facebook is suggesting the possibility of licensing its HAPS communications system to other companies. The market created by new communications systems will be so enormous that it could even drive out existing satellite communications operators.

Earth observation markets, including microsatellites, are growing, and a market focused on the sale of images will reach approximately USD 2.4 billion in 2015 to USD 4.5 billion in 2024 (NSR, 2015). Another new market is expected to form in the field of sophisticated image analysis using artificial intelligence (AI). New entrants in earth observation are seeking a way to create value in this field. One of the services provided by Google, etc., using microsatellite images, is the grasp and prediction of detailed changes of objects, such as business behavior and economic trends. Services aimed at business behavior will include the prediction of sales trends by grasping the number of vehicles in parking lots, and changes in said number, while those for economic trends will include the prediction of oil production by grasping changes in the number of drilling rigs of oil and gas fields, storage tanks, and tankers in particular countries. Meanwhile, HAPS will make it possible to continuously capture images from the same place over a long period of time, with an optical resolution of several centimeters. HAPS, combined with satellites, will create new image sales and imagery service markets. The earth observation service is likely to become indispensable to industry and corporations.