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A Plan of Constructing of a Space Observation Network in Southeast Asia Based on Korea-Japan Space Cooperation

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Abstract Recently, Ajou University, Korea with Institute of Space and Astronautical Science (ISAS) and Chiba University, Japan has done the micro satellite project. Research topics are high speed downlink communication and synthetic aperture radar (SAR) system. Based on these technologies, Ajou University has a plan to offer small satellite for industries and other countries by cooperating with other companies. Especially micro satellites and ground stations for the micro satellite is offer for Southeast Asian countries that have natural disaster. The final goal is to construct earth observation network and the very long base-line interferometer (VLBI) system by cooperating with Korea and Japan.

Key words　Micro satellite, SAR, Korea-Japan space cooperation, VLBI

11. Introduction

Recently, Korea-Japan cooperation of space project have actively processed in various fields such as space observation project using observation satellite, the launch success of KOMSAT-3 (Korea multi-purpose satellite-3) through the Japan rocket and Korea-Japan Very Long Baseline Interferometer (VLBI) observation network. Based on this cooperation, both of Korea and Japan can build the space observation network of small ground stations in South-East Asian countries. This space observation network enables space observations for practical purposes such as Southeast Asia's rich natural resource exploration and frequent floods, typhoons, hurricanes and other natural disasters monitoring as well as observations for scientific purposes such as the universe and the earth surrounding space.

Meanwhile, if the antenna receiver system of the small ground station can be replaced with the geodetic VLBI receiver, the coordinates system of ground station can be determined precisely through geodetic VLBI observation is enabled. Thus, it can build national geodetic system and create accurate digital maps in Southeast Asian countries. In addition, it can measure the variation of the plate movement accurately and predict the earthquake and tsunami to minimize the damage. Therefore, space observation network in Southeast Asia is very important and promising projects.

2. Korea-Japan Space Research Cooperation

2.1 Meteorological satellite data and operations training support

By the projects of the World Weather Watch (WWW) plan of World Meteorological Organization (WMO), Japan launched the Geostationary Meteorological Satellite - 1 (GMS-1) for cloud observations of Asia, Australia, and the Pacific region in July 1977. Accordingly, the Korea Meteorological Administration (KMA)

have received the weather video since April 1979. After that, the weather information is received from GMS-2, 3, 4, 5. The satellite data in real time has been received and utilized from MTSAT-1R, MTSAT-2 since July 2005.

As part of a cooperation project with the Japan Meteorological Agency (JMA), to efficiently operate the meteorological satellite work such as receiving and analysis of satellite data, management of the receiving facility, the staffs of KMA have annually dispatched to the Meteorological Satellite Center (MSC) under JMA and have received training since April 1979.

The dispatched staffs is as many as 30. On the basis of these experiences, Korea launched stationary Communication, Ocean and Meterological Satellite (COMS-1) in 2010 and this satellite is currently operating well. Accordingly, the level of the weather forecast has been greatly improved, and the government recently have pushed forward with the plan of the next generation meteorological dedicated stationary satellite (COMPSAT-2A) project.

2.2 Workshop on Korea-Japan cooperation in Earth Observation Satellite

Korean Society of Observation Satellite hold "The First Workshop on Korea-Japan Cooperation in Earth Observation Satellite" on August 2, 2002. After first workshop, workshop or forum was alternately held on Korea and Japan each year. In Korea, many experts from Korea Aerospace Research Institute (KARI), KMA, Korea Ocean Research and Development Institute (KORDI), Korea Astronomy and Space Science Institute (KASI), KAIST Satellite Research Center, Seoul National University (SNU), and Ajou University have involved. In Japan side, National Space Development Agency (NASDA) and the Institute of Space and Astronautical Science (ISAS) have joined.

Through the workshop, cooperation between universities and research institutes as well as details on the joint use of earth observation satellite between government-funded research institutes on both countries were also discussed. As a result, a joint research project between SNU and ISAS was started. That after nearly 10 years the joint research has been proceeded in the field of infrared astronomical observations, satellite. And subsequent joint research project between KASI and ISAS is planning to push for the development of next-generation infrared astronomical observation satellite (SPICA).

2.3 The development of the Korea-Japan Joint VLBI Correlator

The development of the Korea-Japan Joint VLBI Correlator (KJJVC) has been completed and installed to correlate the observed data from Korean VLBI Network (KVN) of KASI and VLBI Exploration of Radio Astrometry (VERA) of National Astronomical Observatory of Japan (NAOJ) in October 2009. The Memorandum of Agreement (MOA) of joint operation for KJJVC had been exchanged between KASI and NAOJ with a close cooperation in July 2011. KJJVC is composed of the various playbacks, raw VLBI Data Buffer (RVDB) system, VLBI Correlation Subsystem (VCS), Data Archive (DA) system, and control and operational software. The VCS is designed for correlation processing maximum 16 stations, a maximum of 8 Gbps/station, and 8,192 output channels for VLBI observation data. The system configuration, the operational results, and future plan are introduced in this paper.

2.4 The development of the Korea-Japan infrared astronomical satellite

The Infrared Astronomical Satellite Research Group of ISAS in Japan Aerospace Exploration Agency (JAXA) and Department of Astronomy in SNU signed the memorandum of understanding (MOU) to develop infrared astronomical satellite (AKARI) in 2000. After the MOU, they have conducted joint research for seven years. Korea-Japan cooperation project in astronomy was done by the preparation for three years and the co-workshop of the two governments and various meetings. In SNU, satellite data processing pipe line development and observational simulation study was performed before AKARI satellite launch. After the launch, the satellite observation data processing and work in scientific research field was performed. For this research, a professor per year, total six professors were sent as fellowship qualifications, and eight graduate students were sent for six years.

As a result, professors and students of SNU were able to announce over 60 international journal papers, and a few students got doctoral degrees through this project. On the basis of this, in Korea, KASI is planning to participate in the international joint development project of next-generation infrared astronomical satellite SPICA, which is planned by ISAS.

2.5 Korea-Japan space geodetic observation and space geodesy observation center construction

In 1995, Korea's first space geodetic observations were carried out. Through the observed outcomes, the origin of the national geodetic system was determined based on the World Geodetic System (WGS). After that, in accordance with the trend that a new national geodetic system was introduced based on the WGS globally, the National Geographic Information Institute (NGII) was to build a system of geodetic VLBI. Ajou University (Graduate school / Space Survey and Information Engineering) receives a research project of a geodetic VLBI system from NGII, and research project had been carried out on 10 years.

In Korea, there is no expert at geodetic VLBI system because it is first time to introduce this system. Thus, Ajou University invited two Japanese VLBI experts as research professor to perform a research project. Based on the good result, geodetic VLBI system construction project was performed jointly with Korean domestic companies. This project was running well through the active support by Japan's Geospatial Information Authority of Japan (GSI) and Kashima Space Research Center VLBI research Group under National Institute of Information and Communications Technology (NICT). As a result, in March of 2012, a space geodetic observation center was established in Sejong-si, Korea. In the future Korea-Japan joint space geodetic observation will be able to pursue actively.

2.6 KOMPS-3 satellite launch by H-II rocket

KOMPSAT-3 is an earth observation satellite which is operating at the altitude of 685km sun-synchronous orbit and has a sub-meter class EO camera. It was launched successfully with GCOM-W by the H2-A rocket on May 18th 2012 at Tanegashima Space Center. It was the first cooperation between Korea & Japan in the field of space business. KARI and MHI/JAXA have had many technical interface meetings and safety reviews for 2 years. The experience of KOMPSAT-3 launch operation will be shared, and the lessons & learned will be discussed. KOMPSAT-3 is providing 0.7m high-resolution optical images which are more precise than those from KOMPSAT-2. The images will be demonstrated as well.

3. Strategies and Research Goals

As shown in Chapter 2, Korea-Japan space cooperation projects came to perform well for a long time and its performance was good. Ajou University has been involved several micro satellite projects to educate young research engineers and to promote satellite industry business in Korea according to the National Space Program.

According to the project named “The Development of Elementary Technologies for Next-generation Micro Satellite”, we will draw concrete specifications of the next-generation micro satellite technology during the next three years. Based on these results, we have plan to participate in the project of the next-generation micro satellite that will be offered in 2016 with the corporation.

In this chapter, first, the Korea-Japan joint development of micro SAR satellites is discussed and then the building strategies and goals of Southeast Asia Space observation network are discussed based on the section 3.1.

3.1 Korea-Japan joint development of next generation micro SAR satellites

The space technology in the multi-purpose satellite, the micro satellite can be developed at low cost in a short period of time while the multi-purpose development will take a long period of time to research and need a huge amount of investment. Therefore, the micro satellite development has an advantage in the development of space technology.

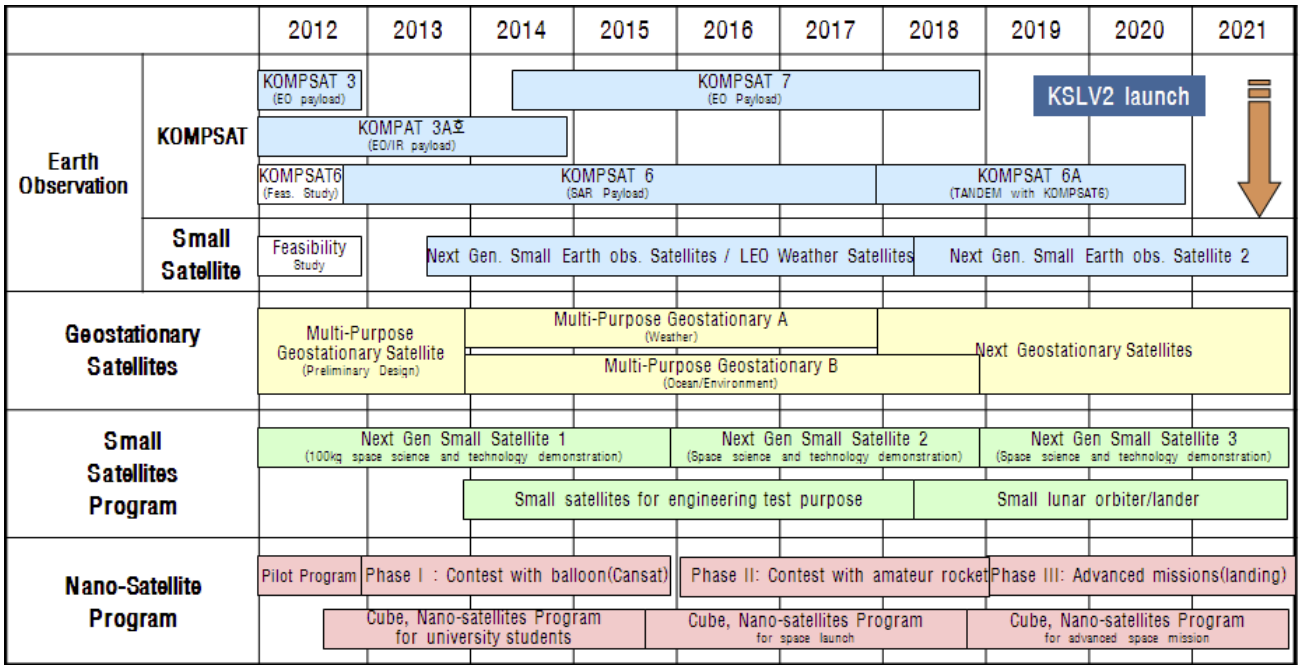

Figure 1. National Space Program Roadmap

As shown in Figure 1, this micro satellite development is included as part of the "Korea National Space Development Program Roadmap" by detailed action plan. The proven technology in the micro satellite can be adapted to the multi-purpose satellite in the future.

The multi-purpose satellite can be made in Korea by the using the micro satellite technologies. And Korea government has a plan to launch a next generation micro satellite per 3~4 years. The core technologies for the micro satellite are an ultra-light and low-power X-band RF transmitter-receiver, wireless inner satellite networks for substituting instrumentation wired networks and etc. These technologies have been not studied in Korea before, Ajou university collaborate with Space science lab in JAXA, Japan which develops the high speed downlink transmission technology in satellite networks. And also Ajou University prepares to sign a MOU with professor Josaphat in National Chiba University, Japan who are excellent for development of the micro SAR satellite. The mirco SAR satellite is most popular as the utility of the micro satellite.

If the micro SAR satellite is developed by National Space Program, Ajou University will develop the standard satellite for micro satellite with corporations and supply it to domestic and foreign countries. Then it will help to accelerate the space industry. Especially, it contributes to the advancement of science and economy of countries in Southeast Asia which have many natural disasters.

3.2 Establish a space observation network in Southeast Asia

Countries in Southeast Asia have rich natural resources but they have many natural disasters, too. Thus these countries have needs of space observations and the installing the micro ground station help to gather and utilize the desired data effectively. The space observation network can be utilized as the remote sensing exploration or the observation of natural disasters. Moreover, it is the benefits of the micro ground station that the cost of a installing the micro ground station is much cheaper than that of the large ground station (Antenna diameter:8-30m).

Meanwhile, in Southeast Asia, the geodetic VLBI observation network is not existed and the world geodetic system is not used. However, in these days, most countries commonly use the world geodetic system as a national geodetic system. To establish the world geodetic system of a country, the origin point of national geodetic system should be determined exactly.

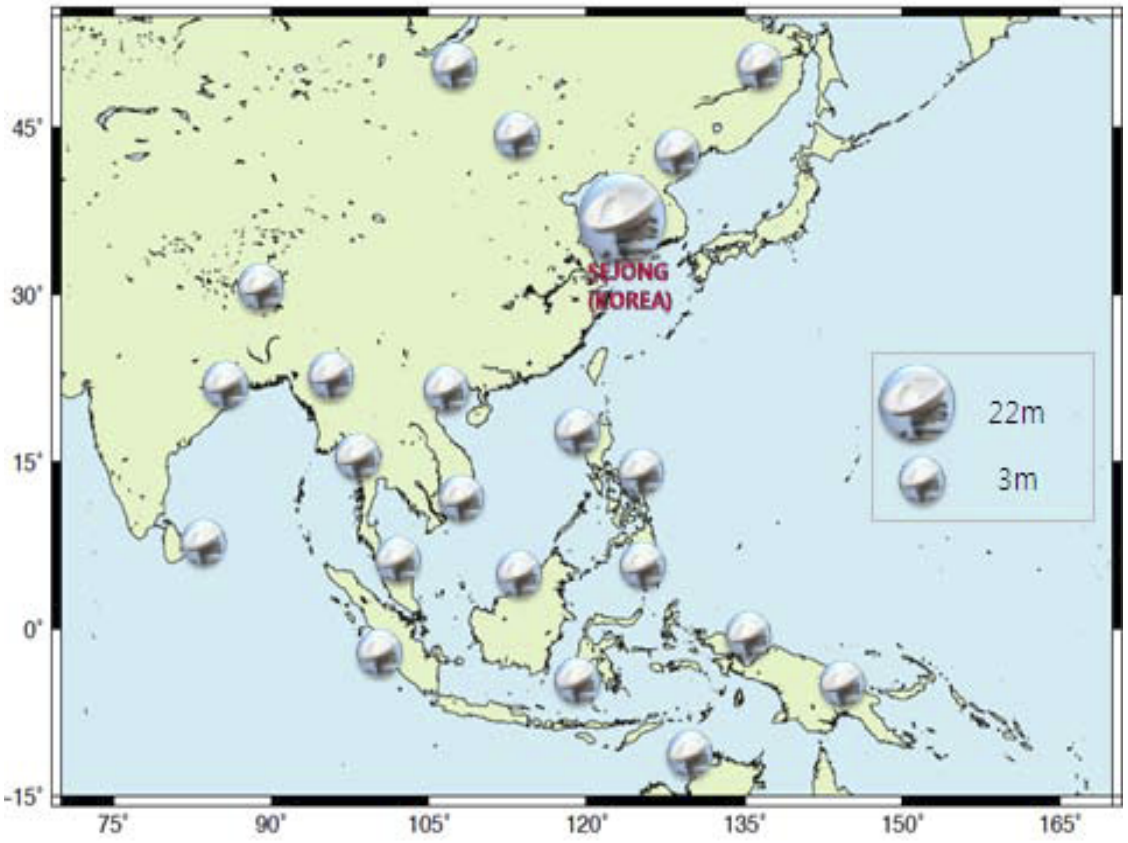

Figure 2. Establish of observation networks in Southeast Asia (Plan map)

For determining the point, the country should install the geodetic VLBI observatory station and sign in International VLBI Service (IVS), then do the international VLBI observation. The measured point becomes a origin point of the national geodetic system, and the new coordinates system of the whole country are determined based on it. Finally, the new national geodetic system is established based on the world geodetic system.

For the geodetic VLBI observation, if the diameter of a antenna at one side is more than 20m, then 3m is acceptable as a diameter of the other side antenna. As shown in Figure 2. if the space VLBI station (in Sejong-si, Korea) which has the 22m-diameter antenna play a role as the central station, then the geodetic VLBI observation can be possible by using the micro ground station with the 3m-diameter antenna in Southeast Asia. For that, only requirement is that the replacement the antenna receiver for the satellite communication with the antenna for the geodetic VLBI receiver.

When the geodetic VLBI observation is possible, each countries can not only determine the origin point of the new national geodetic system, but also measure the variation of plate movements in Southeast Asia region. Therefore, they can minimize damages from the natural disaster such as earthquake and tsunami by predicting and simulating the plate movements of 10, 100 and 1000 years later.

4. Conclusion

According to the project named “The Development of Elementary Technologies for Next-generation Micro Satellite”, we will draw concrete specifications of the next-generation micro satellite technology. Based on these results, we have a plan to participate in the project of the next-generation micro satellite that will be offered in 2016 with the corporation. Finally, we are going to build a micro SAR satellite and disseminate it to domestic and

foreign countries. Especially, let the micro SAR satellite be used for monitoring natural disasters and sensing earth resources spreading in Southeast Asia region. For this work, micro ground stations should be supplied. Consequently, the development of space will be revitalized.

Meanwhile, if the micro ground station is used to observe a geodetic VLBI, the terrestrial reference system for new countries based on the world geodetic system can be established. And it helps to minimize damage of natural disasters such as a tsunami or an earthquake by predicting the diastrophism.

By establishing the space observatory network at the Southeast Asia region, both of Korea and Japan could contribute to establish the space observatory network for East Asia regions. Furthermore, based on the trust between Korea and Japan, we can found East Asia Space Agency (EASA) similar to Europe Space Agency (ESA). Finally, this work encourages the vitalizations of the space development and the development of the economy of science.

5. Acknowledgement

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