



Overview of the Tracking and Control Center at the Tsukuba Space Center

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1. Outline of the Tsukuba Space Center

JAXA's Tsukuba Space Center (TKSC), located in Tsukuba Science City, sits on a 530,000 square-meter site with beautiful natural surroundings. It is a central facility for JAXA with various testing and operation facilities. The TKSC plays an important role including research on and the development of spacecraft, such as satellites and rockets, tracking and controlling launched satellites, development of the Japanese Experiment Module (JEM) "KIBO" as part of the International Space Station project, and astronaut training.

2. Role of the Tsukuba Tracking and Control Center

The Tsukuba Tracking and Control Center plays a pivotal role for smoothly and systematically carrying out tracking and control operations of satellites that have been launched in Japan. The center has the following three functions.

a. Network Control

Many satellites are moving in their respective orbits over the earth, thus it is idealistic that we can freely communicate with a satellite by a radio frequency whenever we want to monitor its status or send a command. Therefore, it is better to have as many ground radio frequency stations (tracking and communication stations) in various places as possible so that we can access a satellite anytime and more flexibly. JAXA performs tracking and control operations of satellites by using both Japanese and overseas ground stations.

The Tsukuba Tracking and Control Center is in charge of determining responsibility sharing and the setting up of data transmission lines among ground tracking and communication stations for satellites, as well as managing the operations by systematically putting stations and information together (Figure-1 and 2.)

For the Advanced Land Observing Satellite (ALOS), the space network that consists of the Data Relay Test Satellite (DRTS), and Tsukuba and Hatoyama Feeder Link Stations will be mainly used.

b. Satellite Control

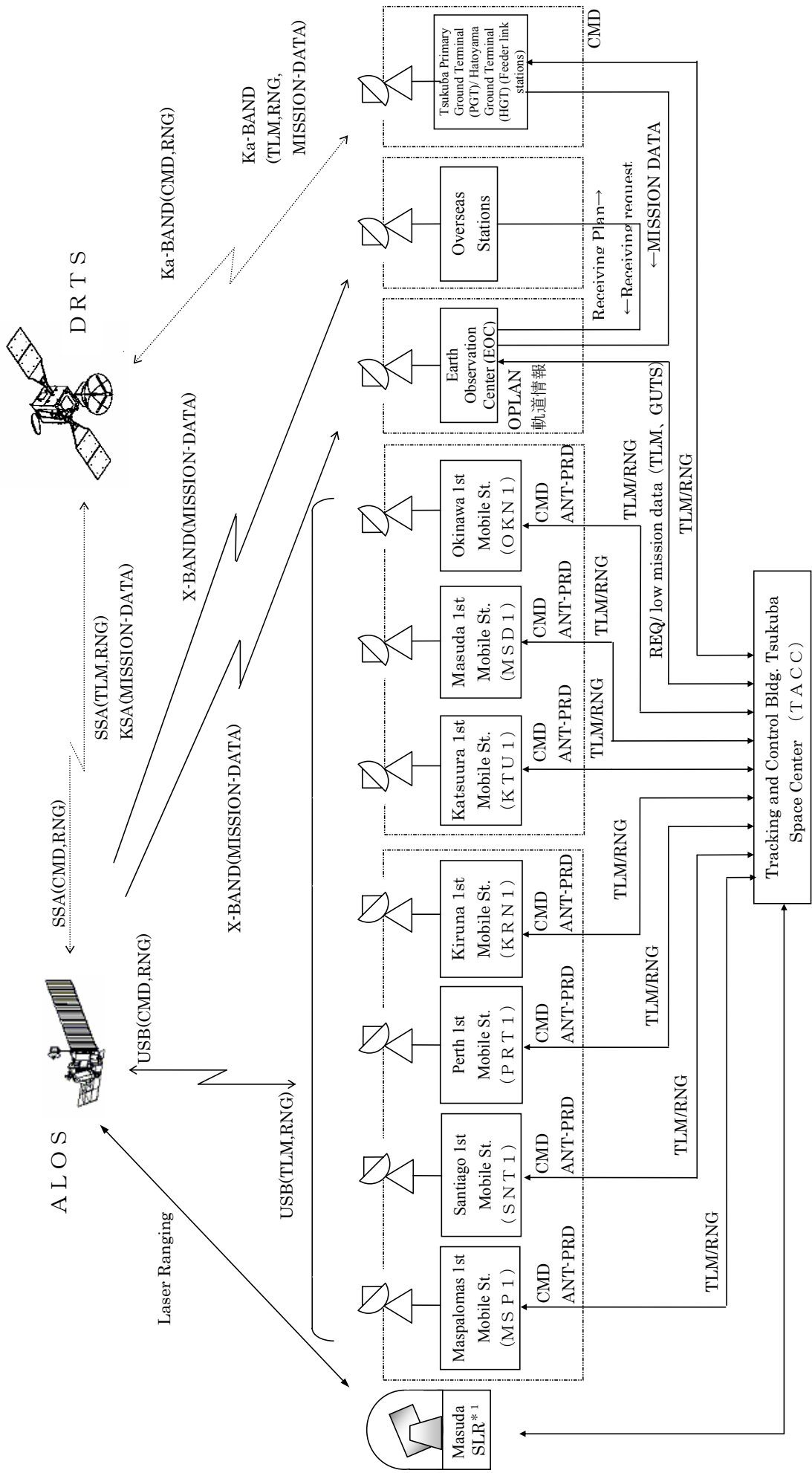
Status information on satellite onboard equipment is sent from the satellites as "status signals (telemetry)" to the Center via tracking and communication stations in Japan or overseas or data relay satellites. At the Center, telemetry is processed in real time (or semi-real time), satellite conditions are monitored, operation plans for each piece of onboard equipment are drawn up, and commands are sent for controlling satellites.

c. Flight Dynamics

At the Center, orbits for satellites are determined based on tracking data acquired by each ground station. Orbit estimation that is necessary for tracking a satellite by the space network and ground stations is also carried out. An orbit control plan that is a prerequisite for maintaining a satellite within its scheduled orbit range is compiled based on the calculated satellite orbit, then actual control results are evaluated.

For cartography, one of the ALOS's major objectives, it is necessary to determine the precise measurement of the position of the satellite when it takes high-resolution images.

By processing data from the ALOS onboard dual-frequency GPS receiver at the Center, satellite positioning will be determined with accuracy to a meter.



* 1) Supported by the International Laser Ranging Service (ILRS) in Japan and overseas

CMD : Command
TLM : Telemetry
RNG : Ranging Data

ANT-PRD : Antenna Prediction
SLR : Satellite Laser Ranging

REQ : Operation Request
OPLAN : Operation Plan

MISSION DATA : Mission Equipment data

Figure-1: ALOS Tracking and Control System

The photo below is of a tracking and control room where all kinds of information and data from ground stations as well as launch vehicle flight data from the launch site are gathered in real time when a satellite is launched. The room plays the role of a control tower for satellite tracking and control as the data and information are displayed without delay so that operators understand the situation immediately to issue necessary instructions and commands swiftly and accurately.



3. Tracking and Control Network

For the network control function, JAXA normally uses three Japanese tracking and communication stations (in Masuda, Katsuura, and Okinawa), and four overseas stations (in Kiruna, Santiago, Perth, and Maspalomas.)

For the ALOS, the space network is scheduled to be mainly used from the initial verification phase after completion of the function verification with the data relay satellite system. Mission data acquisition in the regular operational phase will be carried out at the Hatoyama Feeder Link Station via the Data Relay Test Satellite (DRTS or “Kodama.”)

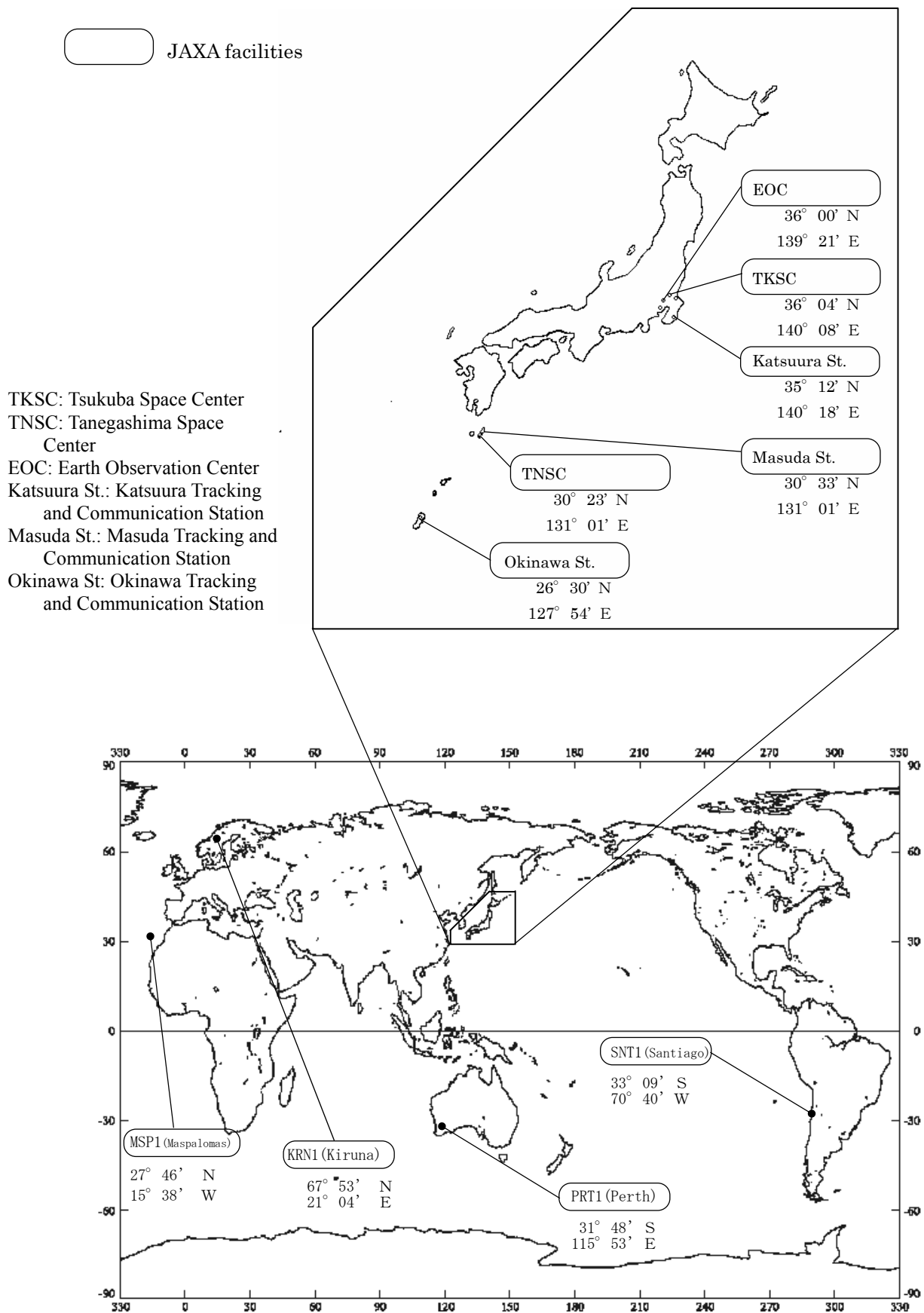


Figure-2: Map of Launch / Tracking and Control Facilities

4. Types of Tracking and Control Data

a. House Keeping Data

House keeping data shows the health conditions of a satellite including battery voltage, power generation of a solar battery, electric current condition, temperature of each piece of equipment, and attitude. Data is acquired by decoding and understanding telemetry data sent from a satellite.

b. Command Data

Command data is instructions to a satellite such as to turn on or off onboard equipment and to use a gas jet to control its orbit or attitude.

c. Tracking Data

Tracking data is precise position information measured at a tracking and communication station at a certain time including the distance to a satellite, range rate, elevation angle, and azimuth. Based on these pieces of information, the position of an on-orbit satellite is calculated by the flight dynamics system, and its position is estimated for a certain time.

5. Operations for the Advanced Land Observing Satellite

At the Center, tracking and control are being performed using the network shown in Figure-1 and 2 for smooth satellite operations by acquiring telemetry data, sending command data, determining orbits and making orbit estimation.

For the ALOS, JAXA plans to carry out tracking and control and mission data acquisition using the space network as part of the inter-orbit communication experiment.

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