Japan Aerospace Exploration Agency

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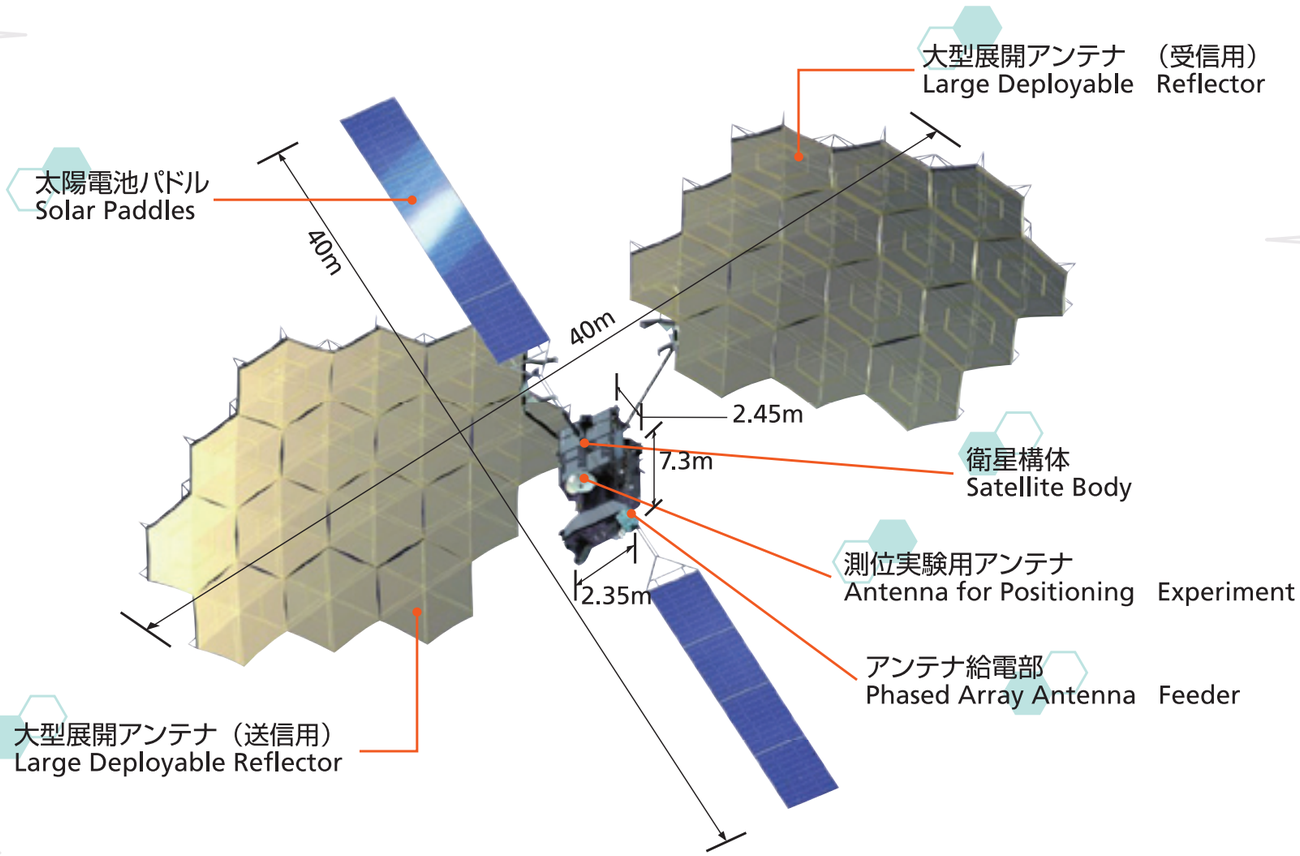
# Opening the door to the future by developing big antennas and providing security

## Overview of the Engineering Test Satellite VIII

# "KIKU No.8"

ENGINEERING TEST SATELLITE VIII

# The Engineering Test Satellite VIII "KIKU No.8" is one of the world's largest geostationary satellites




## Engineering Test Satellite VIII "KIKU No.8"

Over the years, Japan has launched a series of Engineering Test Satellites - ETS-I (KIKU-1) to ETS-VII (KIKU-7, Orihime/Hikoboshi). Each of these addressed the technological needs of its time. "KIKU No.8" (ETS-VIII), the eighth satellite of the series, is one of the world' s largest geostationary satellites with two large deployable antennas and two solar array paddles. The "KIKU No.8" was designed to be used for various space activities as well as to deal with increased communication demands including the use of mobile phones and other mobile devices.

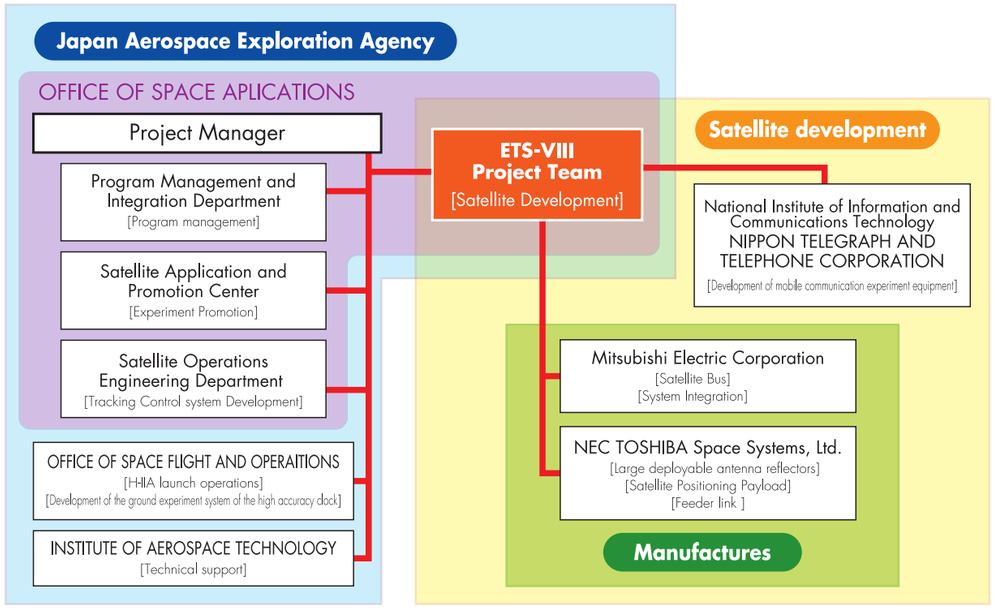
## Technologies to be verified by the "KIKU No.8"

- Highest global standard technology for a three-ton class geostationary satellite bus to cope with diversified missions
- World's largest cutting-edge deployable antenna technology
- Mobile satellite communication system technology using portable terminals and mobile satellite digital multi-media broadcasting communication system technology that enables image and high quality voice transmission
- Key technology for improving satellite positioning system

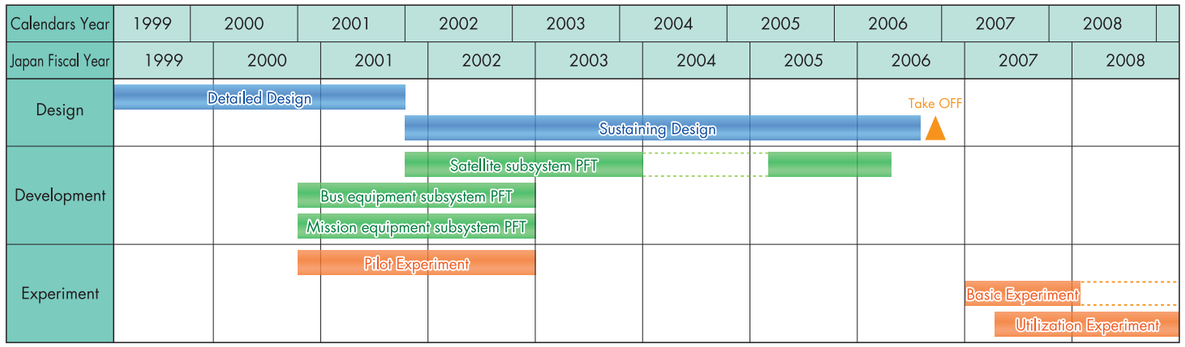
## Major Characteristics

| | Major Characteristics |
|---|---|
| Launch vehicle | H-IIA Launch Vehicle (H2A204 type) |
| Launch site | Tanegashima Space Center |
| Satellite mass | approx. 5.8 tons (at launch) |
| Power generation | approx. 7,500 W (for three years after launch) |
| Design life | 10 years after launch (for bus equipment)<br>3 years after launch (for mission equipment) |
| Size | Main body (at launch): approx. 7.3 m (H) x 4.6 m (W) x 3.7 m (L)<br>After deployment of antennas and solar array paddles (in orbit): approx. 40 m (W) x 40 m (L) |
| Orbit altitude | approx. 36,000 km (Geostationary orbit: 146 deg. E) |

## Development Organization/Responsibility Sharing



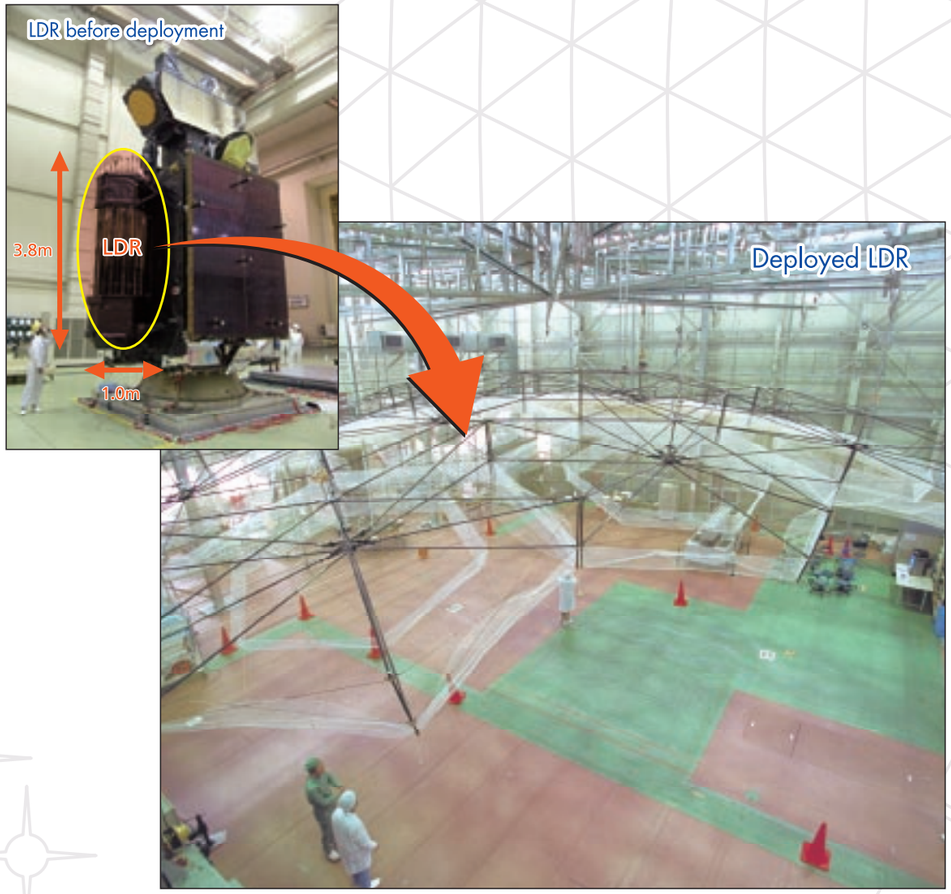

## Development Schedule



# Major Characteristics of KIKU No.8 Onboard Equipment

## Large Deployable Reflector (LDR)

The terminals used on the ground for portable terminal mobile communications can be smaller in size if we can increase the intensity of radio frequency emitted to the covered area (service area) for the communications by making an onboard antenna larger. Therefore, the large antenna onboard the KIKU No.8 is about 19 m x 17 m when it is deployed in space.




The modular structure is applied to the antenna in order to meet the requirements of the largest size class in the world with a high accuracy as well as to easily cope with the expected future needs of the even larger aperture diameter by increasing the number of modules or by changing the size of the module itself.

For the compact stowage of the antenna reflector, the mesh structure is adopted. The material used for the mesh structure needs to be resistant to deformation when it is exposed to the very harsh space temperatures that vary from 300 degrees Celsius down to minus 200 degrees (C). Therefore, the LDR is made of molybdenum plated with gold that is widely used for filaments for light bulbs.





## Mobile Communications Equipment (COMM)

The COMM equipment receives and transmits communication signals between the ground stations (terminal stations) and the "KIKU No.8" for mobile communication experiments. The following are the main features of the COMM.

### Communications by portable terminals are possible by selecting and concentrating a communication area.

Efficient communication is possible by selecting and concentrating on a target area for communications such as a disaster-stricken. This is due to the COMM's multi-beam formation technology which can configure a target communication area by multiplying radio frequencies emitted from 31 elements in space.

Portable terminal (image)

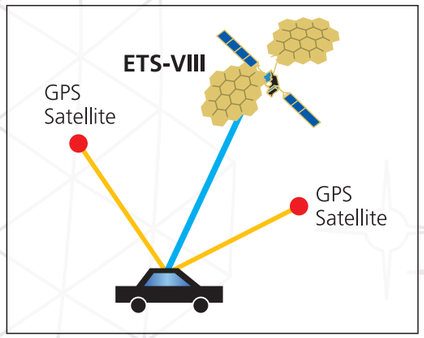
Ultra-small mobile terminal (image)

### Stable communications are possible during disasters due to halved latency of satellite communication.

The COMM enables satellite communications without going through an exchanger at a ground station thanks to its onboard exchanger that can set the direction and frequency of each communication signal. In the case of conventional satellite communications using a ground station, the radio frequency has to make two round trips between the satellite and the ground. With the onboard exchanger, the radio frequency is required to make only one round trip, which helps to reduce the time lag of communications by half. Communications can also be secured even when a ground station is affected by disaster.

## High Accurate Clock (HAC)

The HAC is a transmitter to generate and send to the ground positioning signals that are similar to those used for the Global Positioning System (GPS). It is also equipped with a relaying function for positioning signals sent from the ground to the ground. Positioning signals are generated based on output signals from an atomic clock whose radio frequency is very stable. Using the "KIKU No.8," we will perform experiments for orbit/time determination and user positioning experiments with a GPS satellite using positioning signals generated by the HAC.




## Deployable Radiator (DPR)

The DPR releases heat generated inside the satellite by transporting heat to the heat rejection panel. Its mechanism is to deploy the heat rejection panel (radiator panel) in orbit and send heat to the heat rejection panel by fluid (ammonia) circulating inside the satellite. The DPR' s technology is expected to be applied for future practical use of heat control equipment for efficient heat transportation and rejection of a future super large-sized satellite. The "KIKU No.8" will verify the characteristics of heat transportation through the heat rejection panel by simulating heat generation by a heater in the satellite.

ENGINEERING TEST SATELLITE VIII

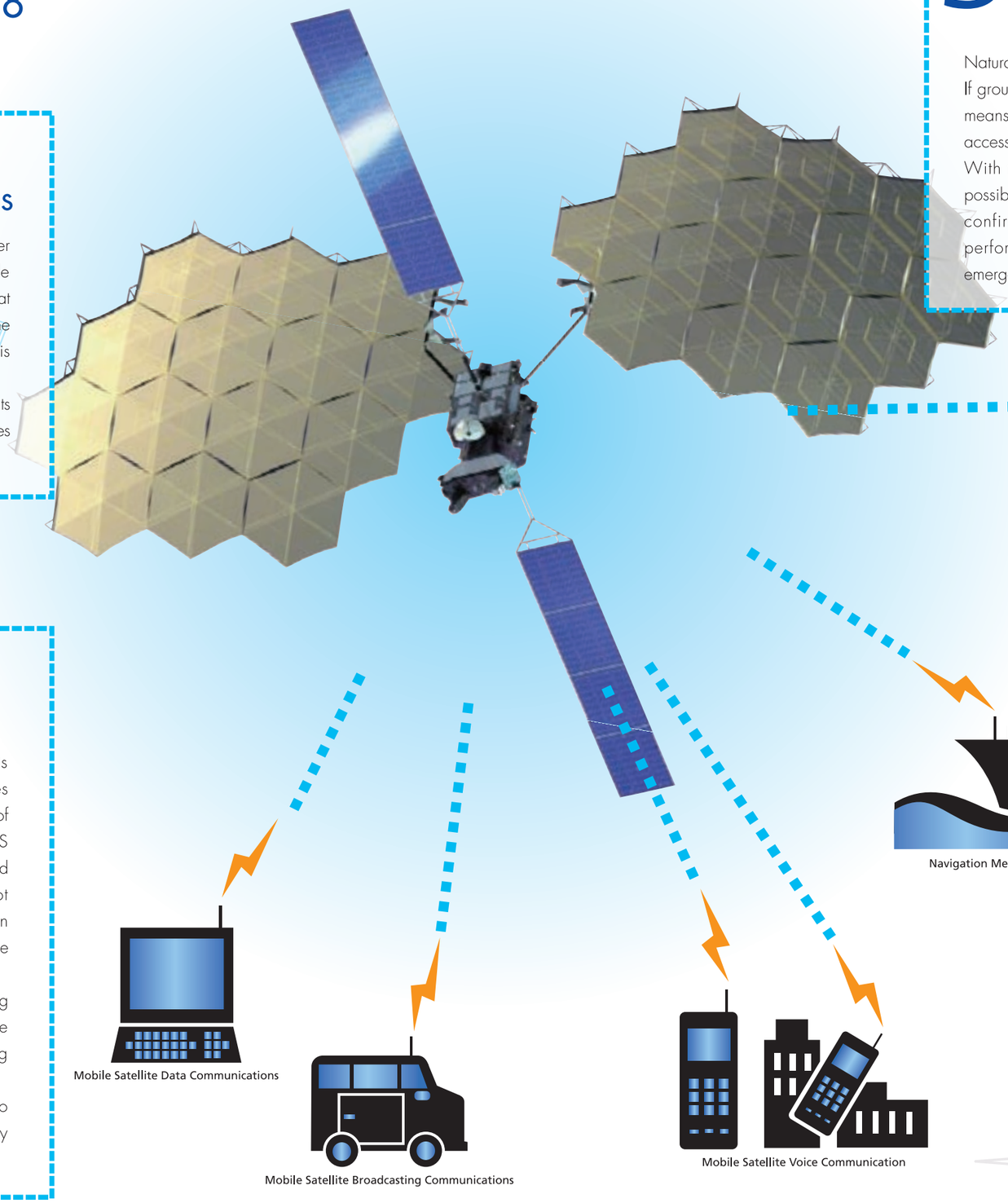
# Other possible communications through the "KIKU No.8"

## 1 For anywhere, anytime communications

The KIKU No.8 expands its large antennas in space over Japan. Therefore, communication becomes possible anywhere, anytime between mountainous areas, islands, at sea, or even in neighboring Asian countries. Thanks to the KIKU No.8, the risk of being out of reach when contact is badly needed will be dramatically reduced.
The KIKU No.8 antenna is one of the world's largest and its sensitivity is also high, meaning a very small terminal replaces cumbersome communication ground equipment.

## 2 For more convenient car navigation

The GPS satellite is now well known thanks to its application in car navigation systems. GPS satellites work better in measuring precise positions when more of them are visible from the ground. However, a GPS satellite is an earth orbit satellite which circulates around the earth, thus, the number of visible satellites is not constant. Sometimes, very few of them are visible in certain areas, and the position measurement may not be very accurate.
If we can use a geostationary satellite as a positioning satellite, we can increase the number of available satellites to make continuous accurate positioning measurements possible.
The KIKU No.8 will perform various experiments to acquire basic technologies to use a geostationary satellite as a positioning satellite.



## 3 For a quick response to disasters

Natural disasters such as earthquakes and typhoons are unpredictable. If ground relay stations or telephone stations are destroyed, there is no means for communications, and no information about damage will be accessible.
With the exchanger onboard the KIKU No.8, communication is possible without being affected by disasters on the ground. Therefore, confirmation of people's safety and rescue operations can be performed smoothly. The KIKU No.8 will display its abilities in emergencies.

Disaster Measures, Emergency Communications



Navigation Message



Mobile Satellite Data Communications



Mobile Satellite Broadcasting Communications



Mobile Satellite Voice Communication

## i-Space Project

JAXA is implementing the "i-Space project" Information Technology (IT) is technology to make our life rich and convenient. For the further development of an IT society, JAXA is promoting the "i-Space" project as space infrastructure (information infrastructure) composed of communication satellites.

Wideband InterNetworking engineering test and Demonstration Satellite (WINDS,) which will play an important role in the "i-space" project along with the Kiku No.8.