QSS-EXT-2142

Project Overview of The Quasi-Zenith Satellite System

12 September 2016

QZS System Services Inc. （QSS）
NEC Corporation

Contents

1. System Overview

Functional Capability:

- GPS Complementary
- GNSS Augmentation
- Messaging Service

Coverage: Asia and Pacific region

Signals (QZS-1):

- L1C/A, L1C, L2C and L5
- L1S (L1-SAIF) on 1575.42 MHz
- L6 (LEX) on 1278.75MHz

(L1Sb will be added as SBAS from 2020's)

(Today) 1st QZSS satellite "MICHIBIKI"

Four satellites constellation will be established and the service will start in 2018.

Quasi-Zenith Satellite System (QZSS)

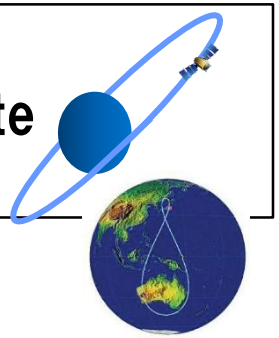
QZSS is positioning satellite system for complement and augment GPS.

【Contribution】:
- GNSS capability, Asia-Pacific region
- Japan - U.S. cooperation
- Enhancement of disaster management and national security

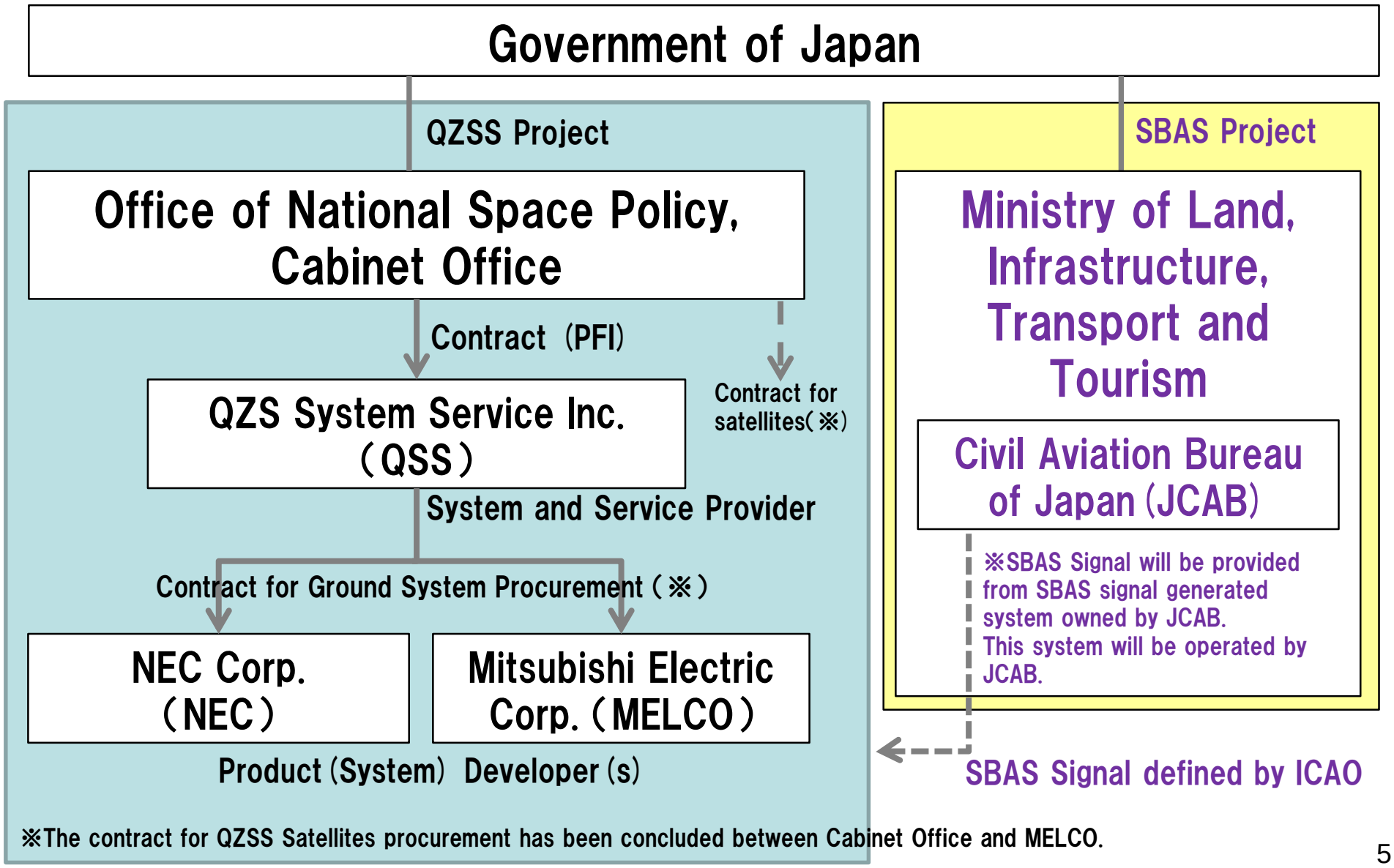
【Plan (Original) 】:
Prepare the 4 satellites constellation (3 QZ orbit + 1 Geostationary orbit) by the end of the 2010s. In the future, 7 satellites constellation shall be completed to enable continuous and more sustainable positioning.

【Current Status】:
System and application verification by using the first satellite, MICHIBIKI.

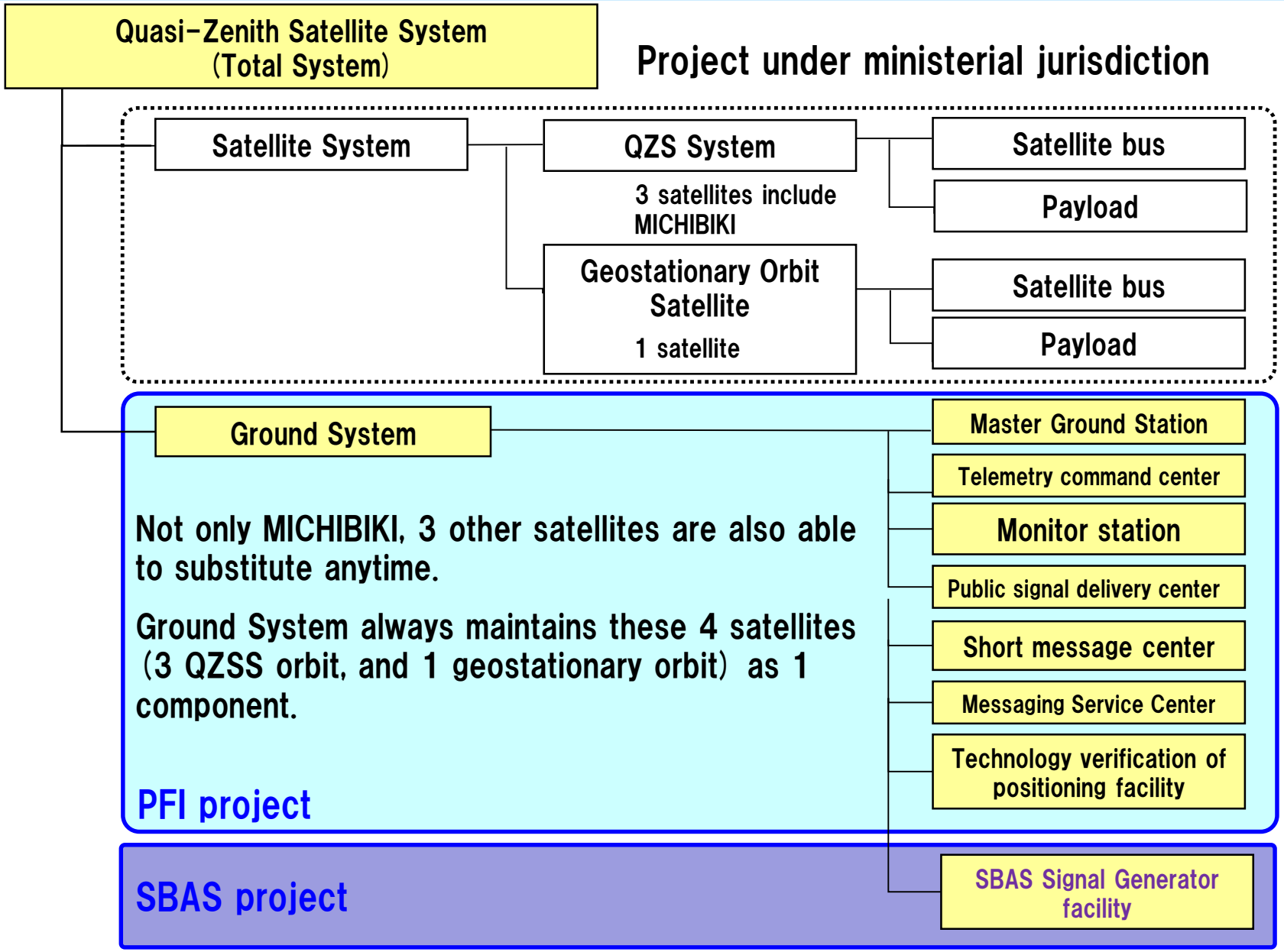
【Number of Satellites】(as of the beginning of 2018JFY)
QZ Orbit: 3 satellites constellation, Geostationary Orbit: 1 satellite



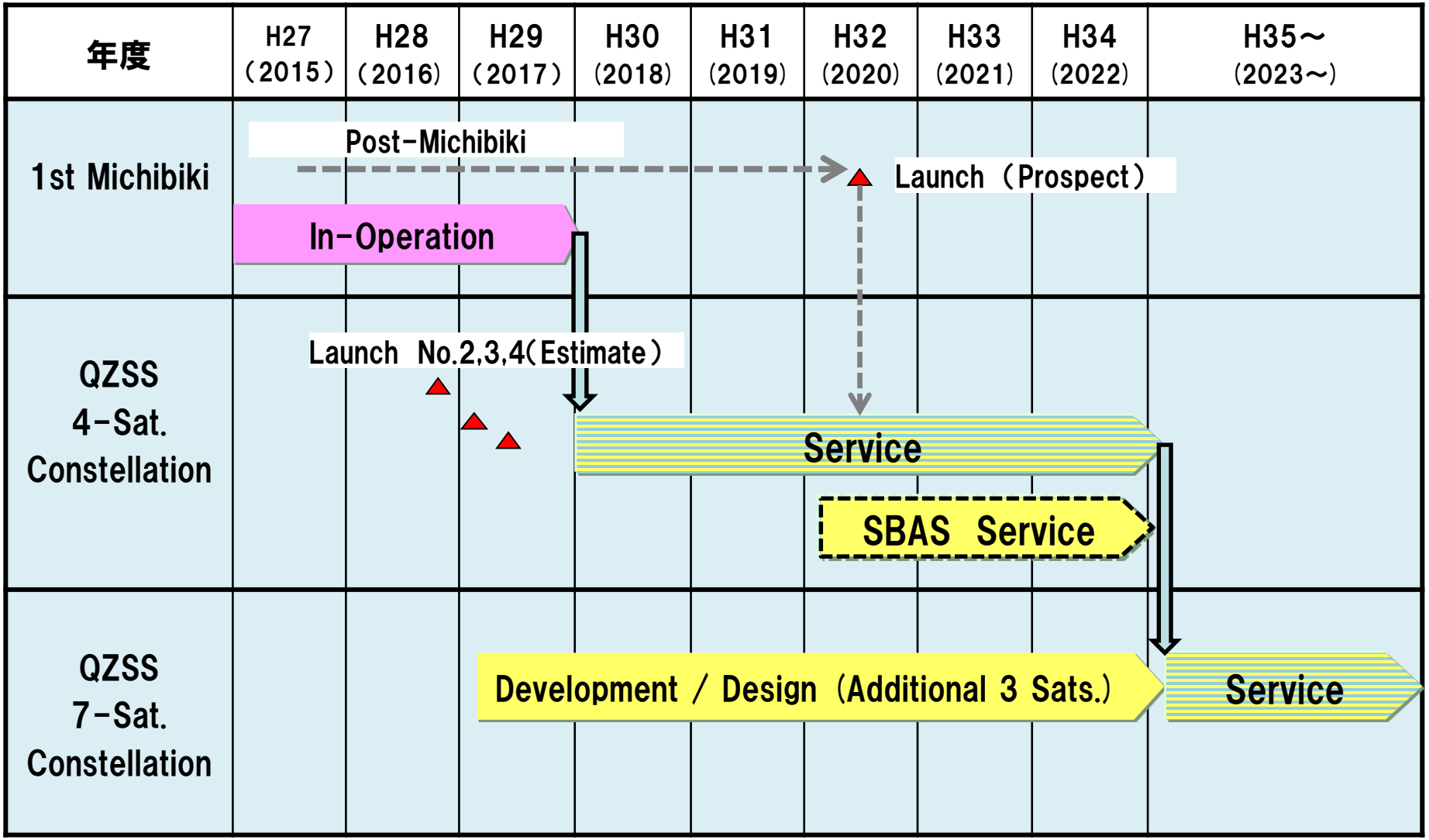
Organization and Contractual Frameworks



System Configuration of QZSS

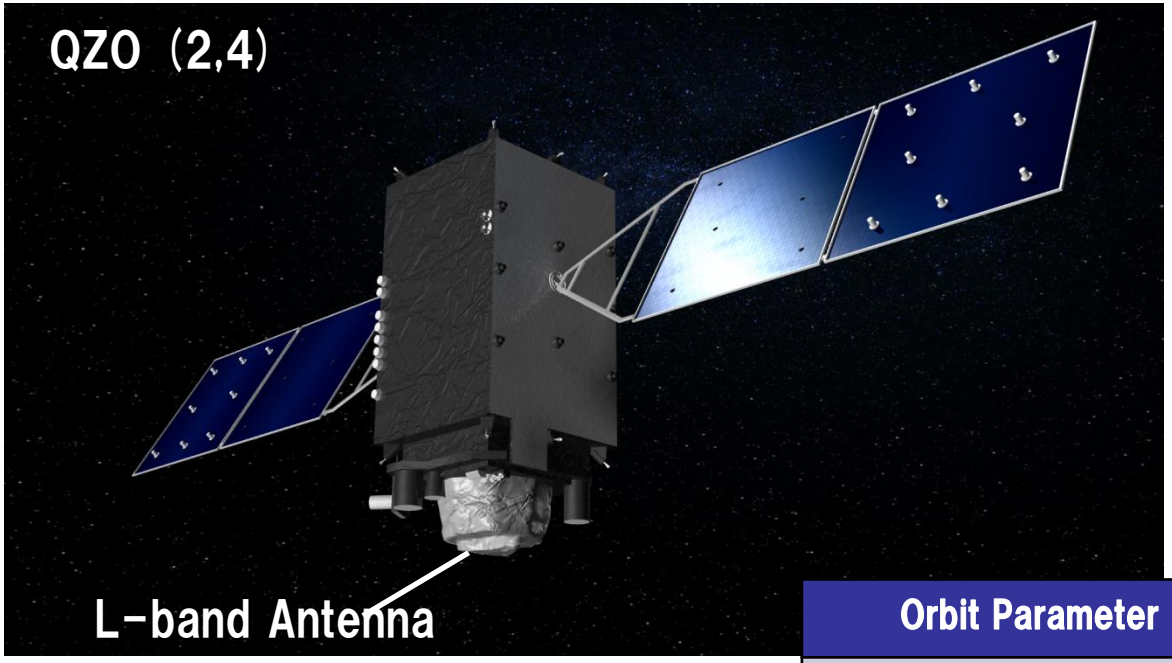


QZSS Program Schedule (Update)



SBAS Service will be available from 2020's under Ministry of Land, Infrastructure, Transport and Tourism jurisdiction.

QZSS Satellite (s) Overview

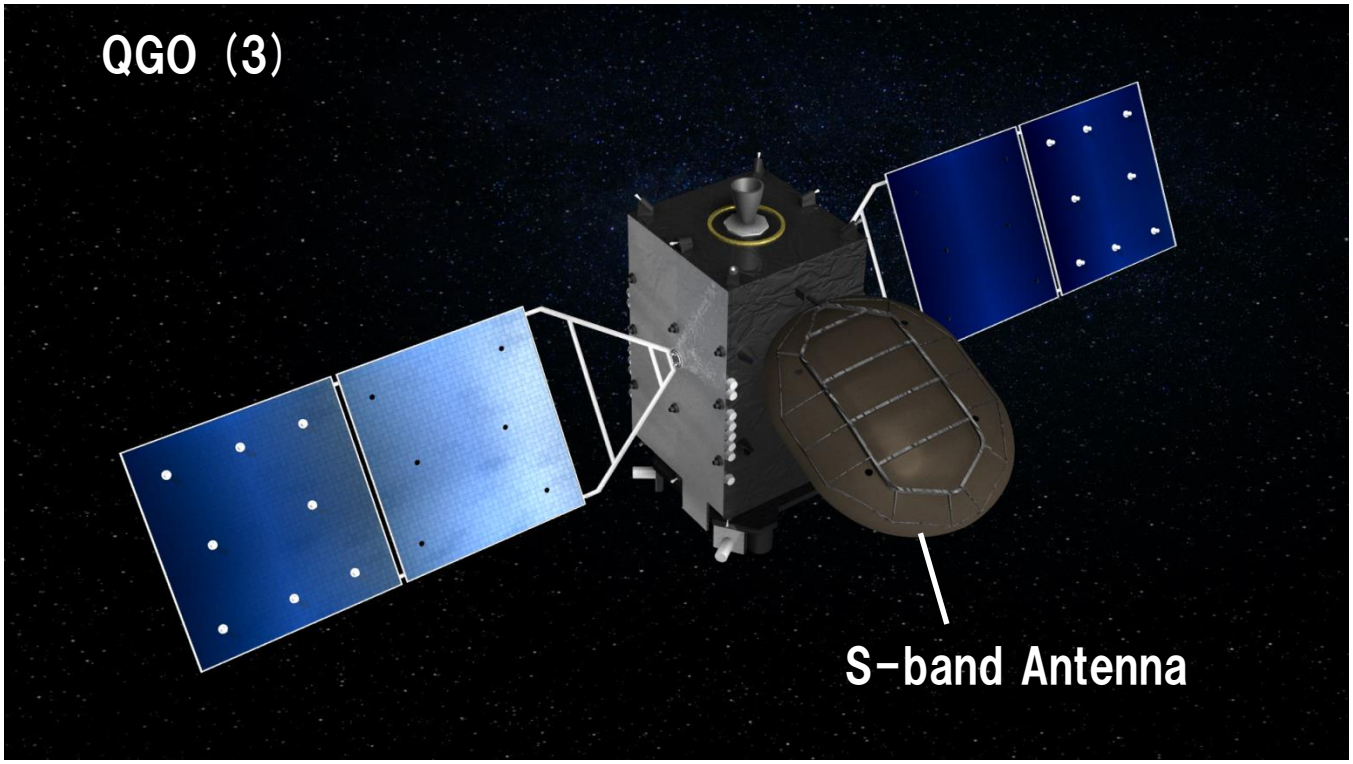


Launch Vehicle : H-IIA
Mass Dry/Launch : 1.6t/4.0t
Lifetime : 15years+

Orbit Parameter	Nominal Allocation
Semimajor Axis (A)	42164km
Eccentricity(e)	0.075
Inclination (i)	41 degree
Argument of Perigee (w)	270 degree
RAAN (Ω)	Block I_Q: 117 degree Block II_Q: 117±130 degree
Central Longitude (λ)	136 degree

RAAN: Right Ascension of the Ascending Node

QZSS Satellite (s) Overview



Launch Vehicle : H-IIA
Mass Dry/Launch : 1.8t/4.7t
Lifetime : 15years+

Orbit Parameter	Nominal Allocation
Longitude	E 127
Latitude	0

QZSS Master Ground Station

QZSS Control Center
Kobe,

- ✓ Two-Ground Station (Control Center) will be available in the end of 2016.
- ✓ Initial Operation will be started from 2018.

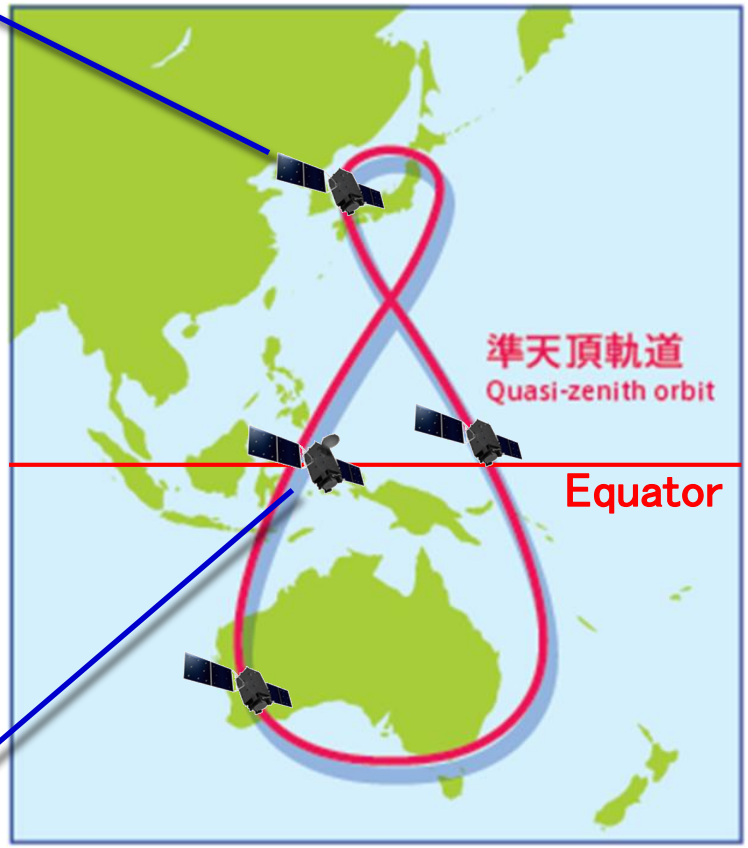
QZSS Control Center
Hitachi-Ohta,

QZSS TTC & Monitor Station

- ✓ All of TTC monitor stations will be founded by the end of 2016.
- ✓ Initial Operation will be started from 2018.

1. QZSS Overview

Japan Region
- Over 20 degrees elevation
  More than 2-QZS are available
- Over 60 degrees elevation
  1 QZS is available



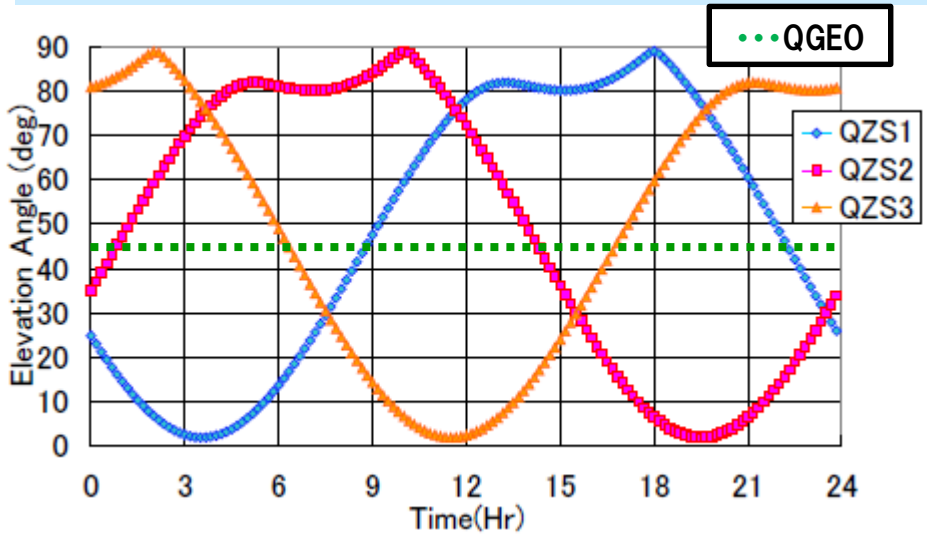
Functional Capability:
- GPS Complementary
- GNSS Augmentation
- Messaging Service

Coverage: Asia and Pacific region

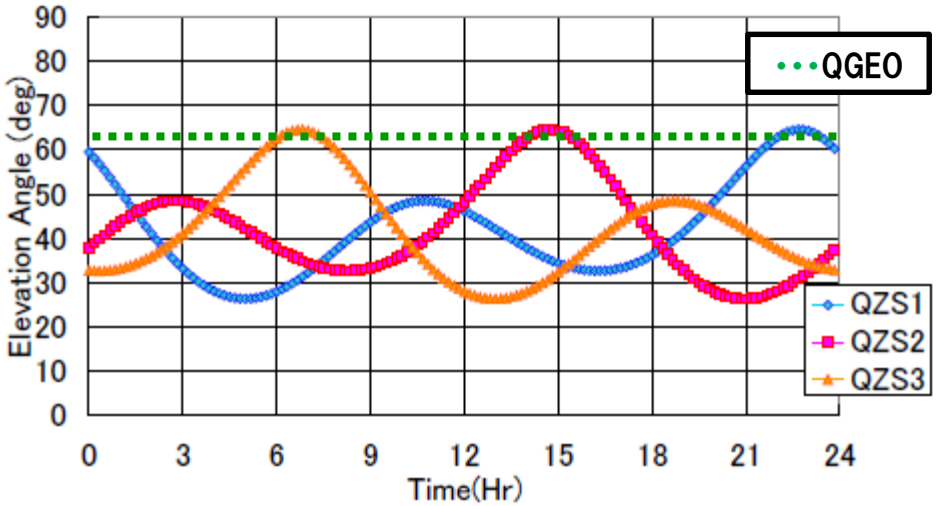
1 Geostationary satellite

Four satellites constellation will be established and the service will start in 2018.

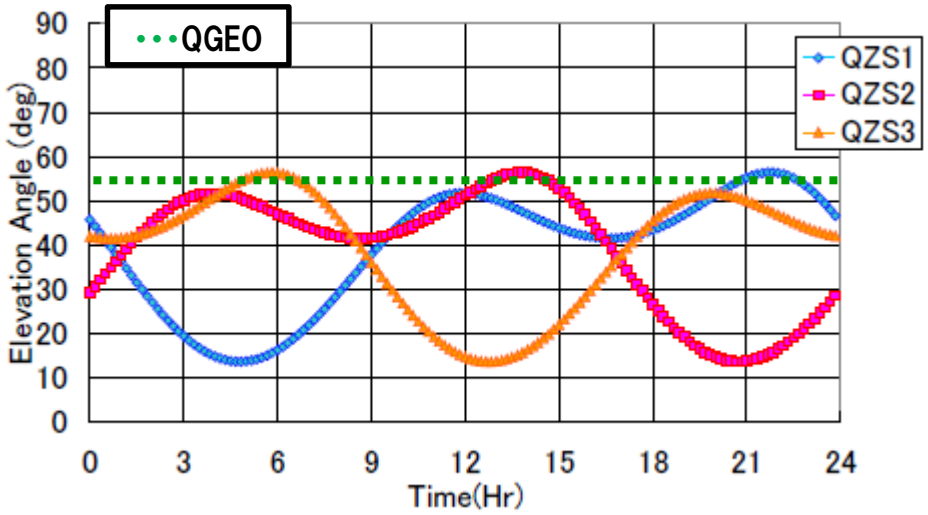
QZSS Visibility Time



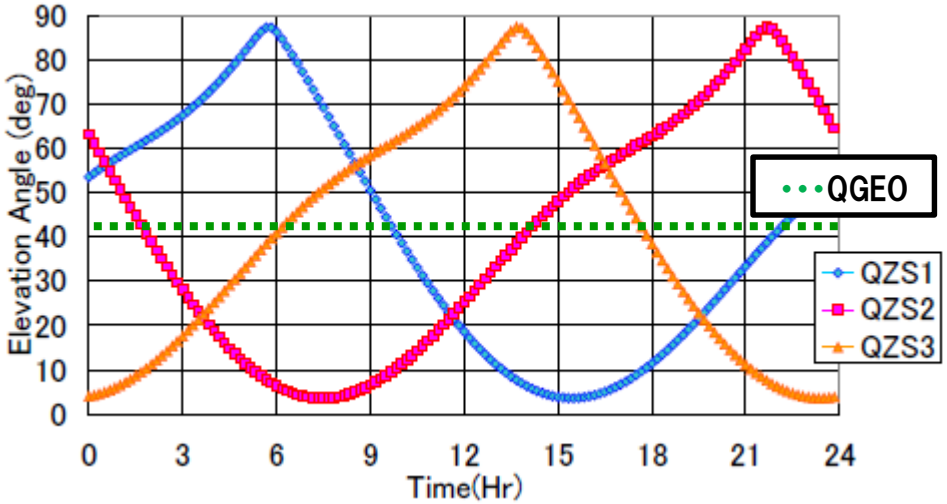
TOKYO



SINGAPORE



BANGKOK



SYDNEY

Ref. : IS-QZSS v1.7, JAXA, 7 Jul. 2016

Positioning Signal of QZSS (as of Sept. 2015)

Positioning Signal of QZSS						
Not only positioning complementation signal, but satellite orbit, time, and ionosphere correction information will be also transmitted as augment information.						
				1st Satellite	2nd–4th Satellite	
				QZO	QZO	GEO
L1C/A	1575.42 MHz	Positioning	complement GPS	○	○	○
L1C		Positioning	complement GPS	○	○	○
L1S		Augmentation (SLAS)		○	○	○
		Message Service		○	○	○
L2C	1227.60 MHz	Positioning	complement GPS	○	○	○
L5	1176.45 MHz	Positioning	complement GPS	○	○	○
L5S		Augmentation Experimental Use		—	○	○
L6	1278.75 MHz	Augmentation (CLAS)		○	○	○
L1Sb	1575.42	Augmentation	SBAS	—	—	○

SBAS Service will be available from the beginning of 2020's.

QZSS Program Status

- Japan – US Cooperation
  - Sep 22, 1998 : “Joint Statement regarding cooperation in the use of the GPS” was issued.
  - Jan 18, 2012 : Joint Announcement on US-Japan GPS cooperation
    - The United States welcomed Japan’s decision to expand and **upgrade QZSS into an operational and regional system** that, in time, could be composed of as many **as seven satellites** and acknowledged the important contribution such an expanded and upgraded system will make to the space-based **PNT services in the Asia-Pacific region**.

QZSS Program Status

- Japan – US Cooperation
  - July 24, 2013 : Joint Announcement on US-Japan GPS cooperation
    - Both Governments reaffirmed that continued close cooperation in the area of GNSS will contribute to the peaceful development of the Asia-Pacific region and promote global economic growth. Both Governments reaffirmed the importance of providing open access to basic GNSS services for peaceful purposes, free of direct user fees.

QZSS Program Status

- ***Basic policy on the implementation of the operational QZSS project*** *(Cabinet Decision on September 30, 2011)*
  - The Government of Japan has decided to accelerate the deployment of the operational QZSS as expeditiously as possible.
  - Four satellites constellation shall be established by the 2018JFY.
  - This year (Jan. 2015), the Japanese government has decided to up-grade the QZSS to 7 satellites constellation in 2023 (around) JFY.
- ***Verification of QZS-1 MICHIBIKI***
  - Technical Verification by JAXA.
  - Application Verification by private companies.

2. Mission of the QZSS

2. Mission of QZSS

Positioning- related service

① Satellite Positioning Service

The service to provide the same as GPS satellites in spite of urban area or mountain area.

② Sub-meter Level Augmentation Service

The service to provide accurate positioning around 2-3 meters.(※)

③ Centimeter Level Augmentation Service

The service to provide highly accurate positioning around 10 centimeters.(※)

※ Ionosphere disturbance (fluctuations), multipath and others will affect the accuracy.

④ Positioning Technology Verification Service

The service to provide an application demonstration for new positioning technology.

Messaging Service

⑤ Satellite Report for Disaster and Crisis Management (DC Report)

The service to provide users in the field with disaster management and rescue .

⑥ QZSS Safety Confirmation Service

The service to transmit safety confirmation information via QZS.

②, ③, ⑤ :These services are under investigation for overseas users.

⑥ : This service is only for Japan domestic user.

2. Mission of QZSS

Positioning- related service

① Satellite Positioning Service

Performance Standard (PS-QZSS) and Interface Specification (IS-QZSS) will be released in the website

http://qzss.go.jp/en/technical/ps-is-qzss/ps-is-qzss.html

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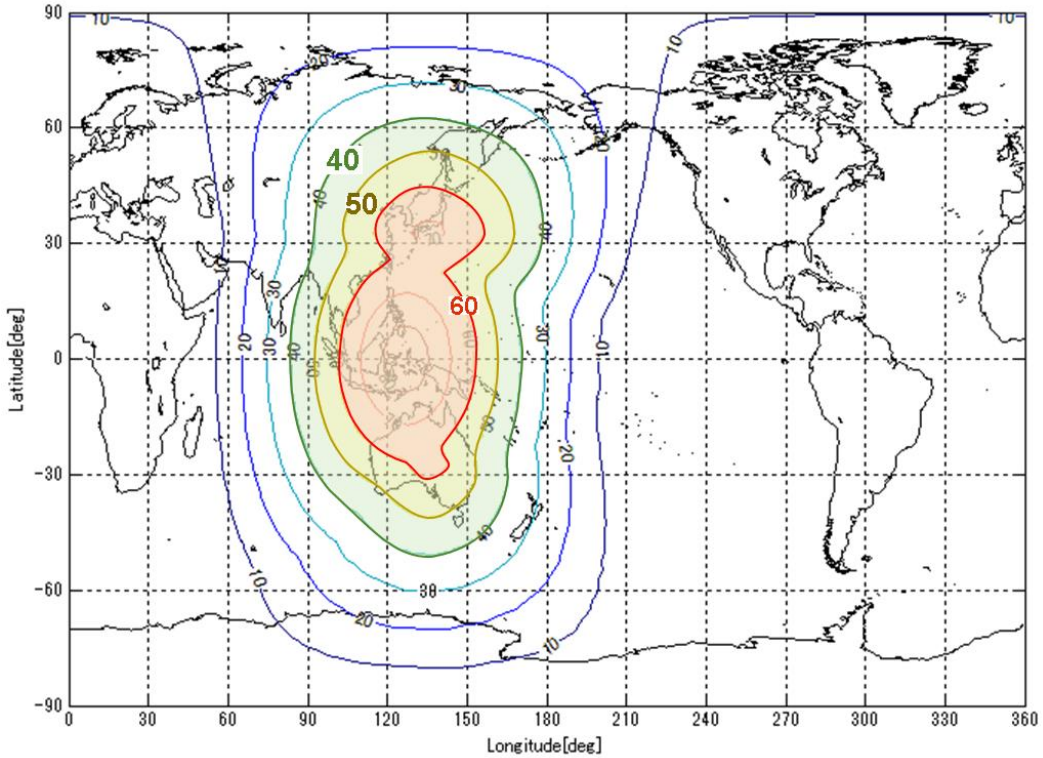
The service to transmit safety confirmation information via QZS.

②, ③, ⑤ :These services are under investigation for overseas users.
⑥ : This service is only for Japan domestic user.

QZSS Service: Positioning related Service
①Satellite Positioning Service

【Coverage Range】
More than 10 degrees elevation to QZS constellation



High compatibility with the GPS satellite

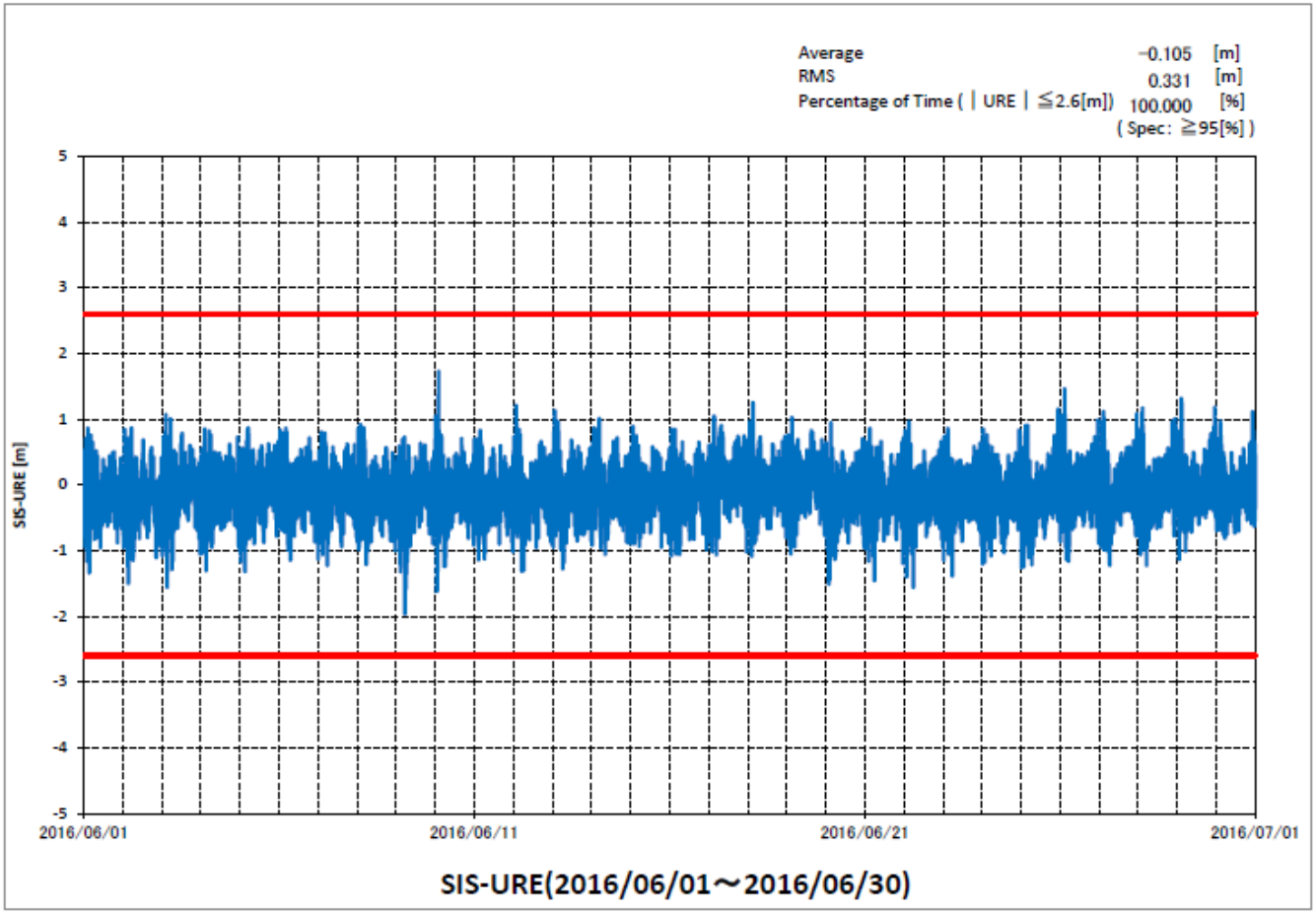
→

Contributing to the reduction of positioning error

QZSS Technical Verification of QZS-1 MICHIBIKI

Since June, 2011, QZSS have provided navigation signals with good qualities, satisfying with their performance specifications, continuously.

SIS-URE for the first satellite is 40cm (rms) level which is comparable with those for GPS Block IIRm and IIF satellite



During one month in June 2016, 33cm (RMS)

3. The QZSS Expansion Activities for Asia-Oceania Countries

QZSS Expansion Activities

QZSS Round Table
（2014.12.1）

QZSS Utilization Workshop
（2016.1.22）

MGA/AOR Workshop（2016.11.14-16）

PROVIDING THE SOLUTIONS USING MULTI-GNSS AND OTHER SPACE TECHNOLOGY APPLICATIONS IN THE ASIA-PACIFIC REGION

14 November - 16 November 2016

Sofitel Philippine Plaza Manila,
Metro Manila, Philippines

We are pleased to announce that the 8th Multi-GNSS Asia Conference will be held on 14th-16th November 2016 in the Sofitel Philippine Plaza Manila (Metro Manila), Philippines.

QZSS Expansion Activities （in Asian Countries）

Preparation of GNSS reference station（Development of satellite positioning and experiment environment）

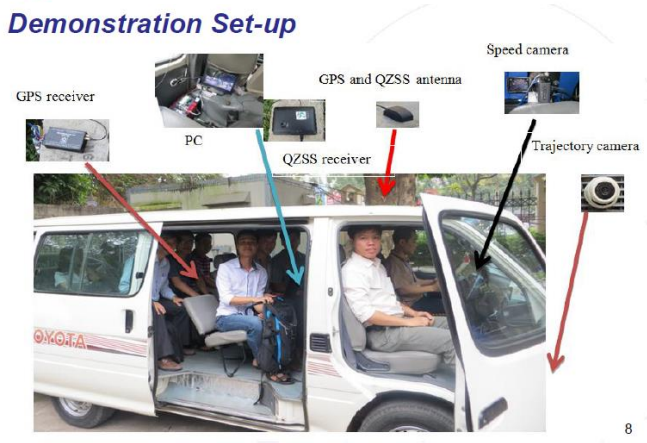
Chulalongkorn Univ（Bangkok）

Univ. of Philippine（Diliman）

Indonesia Univ.（Jakarta）

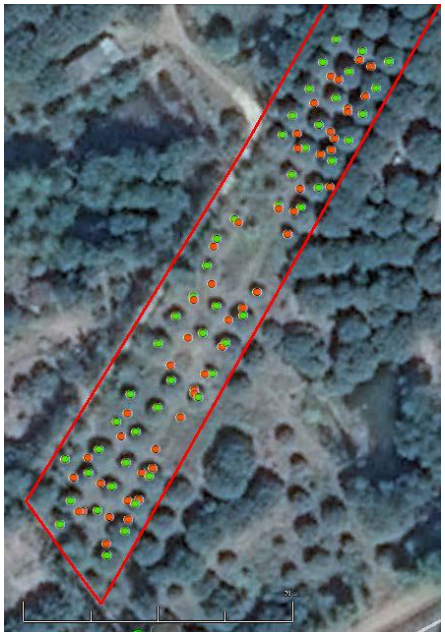
Joint Experiment, Demonstration

QZSS Positioning in Urban City（Hanoi/Vietnam）



Bus Driving（Quezon/Philippine）

Management of orchards fused with remote sensing technology（AIT/PASCO）



Other Receivers and Apps.

Watch (SEIKO:SBXB103)

Sports Watch (CASIO)

Car Navigation System
(Panasonic:CNR300D)

Smart Phone (Covia CP-F03a)

Handy Navigator
(GARMIN GPSMAP62SCJ)

Handy GOLF Navigator
(Yupitel)

Summary

- ✓ Based on the decision of the GOJ, the deployment of the operational QZSS is underway.
  - 4 satellites constellation shall be established by the 2018JFY.
  - Necessary equipment (satellite, ground station and others) are currently in development.
  - GOJ has decided to up-grade the QZSS to 7-satellite constellation in 2020's.

- ✓ Verification, assessment and many demonstration of the QZSS have been conducted.
  - Dual frequency positioning will be effective in the dense area of Total Electron Content, namely equatorial region.

Thank you for your attention.

For more information, please visit our web site
http://qzss.go.jp/en/

- A large circle illustrated “Q” as Quasi-Zenith Satellite System
- Green and blue circle composes 8 shapes; the coverage area of QZSS and they are represented earth and satellite.
- Blue line symbolized precise positioning information as well as enlargement of brand new service to society.
- Color of green stands for environment and safety, and blue stands for space and technology.