



Status Update on the Quasi-Zenith Satellite System



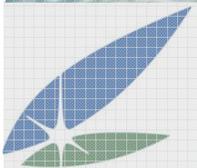
Presented by : Dinesh Manandhar, The University of Tokyo

On behalf of Satoshi KOGURE

National Space Policy Secretariat

**UN-Nepal GNSS Workshop on the Applications of Global
Navigation Satellite Systems**

12-16 DEC 2016, Kathmandu, Nepal



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2. Mission of the QZSS
3. The QZSS Expansion Activities for Asia-Oceania Countries
4. Summary

1. System Overview



Functional Capability:

GPS Complementary

GNSS Augmentation

Messaging Service

Coverage: Asia and Pacific region

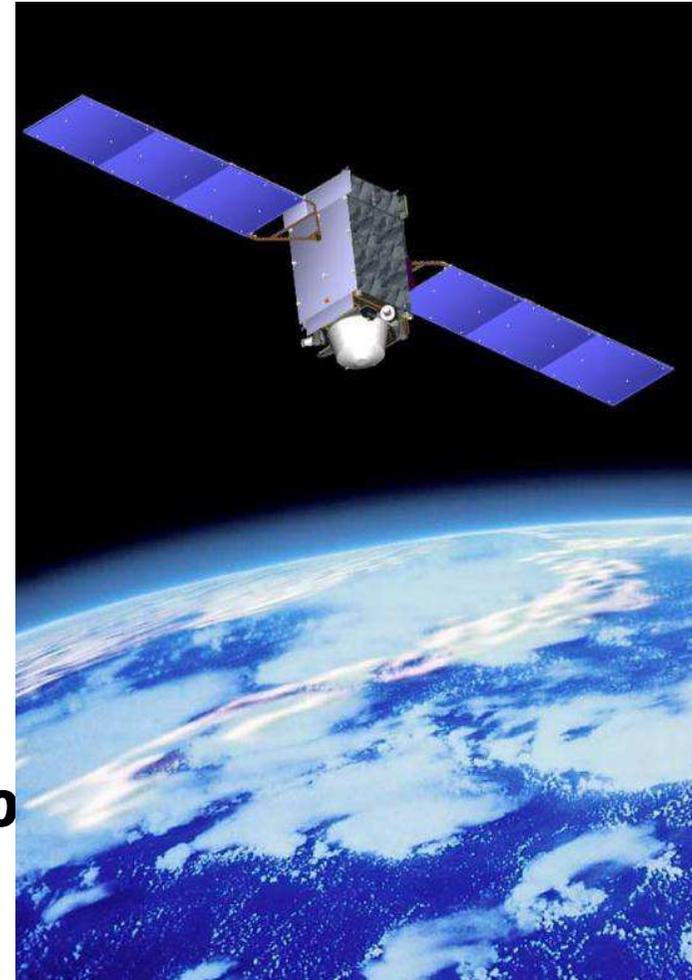
Signals(QZS-1):

L1C/A, L1C, L2C and L5

L1S (L1-SAIF) on 1575.42 MHz

L6 (LEX) on 1278.75MHz

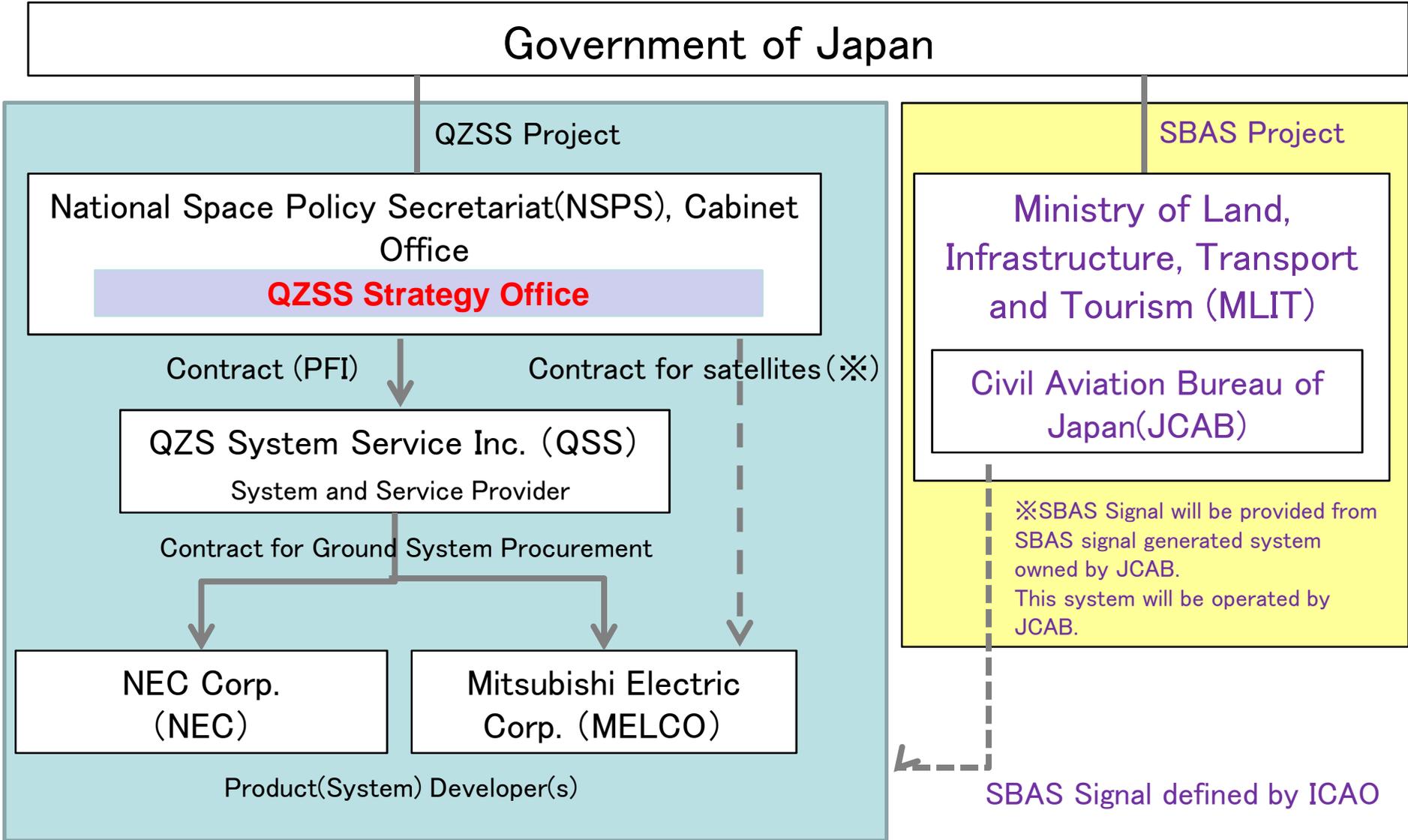
L1Sb will be added as SBAS from 2020



(Today) 1st QZSS satellite "MICHIBIKI"

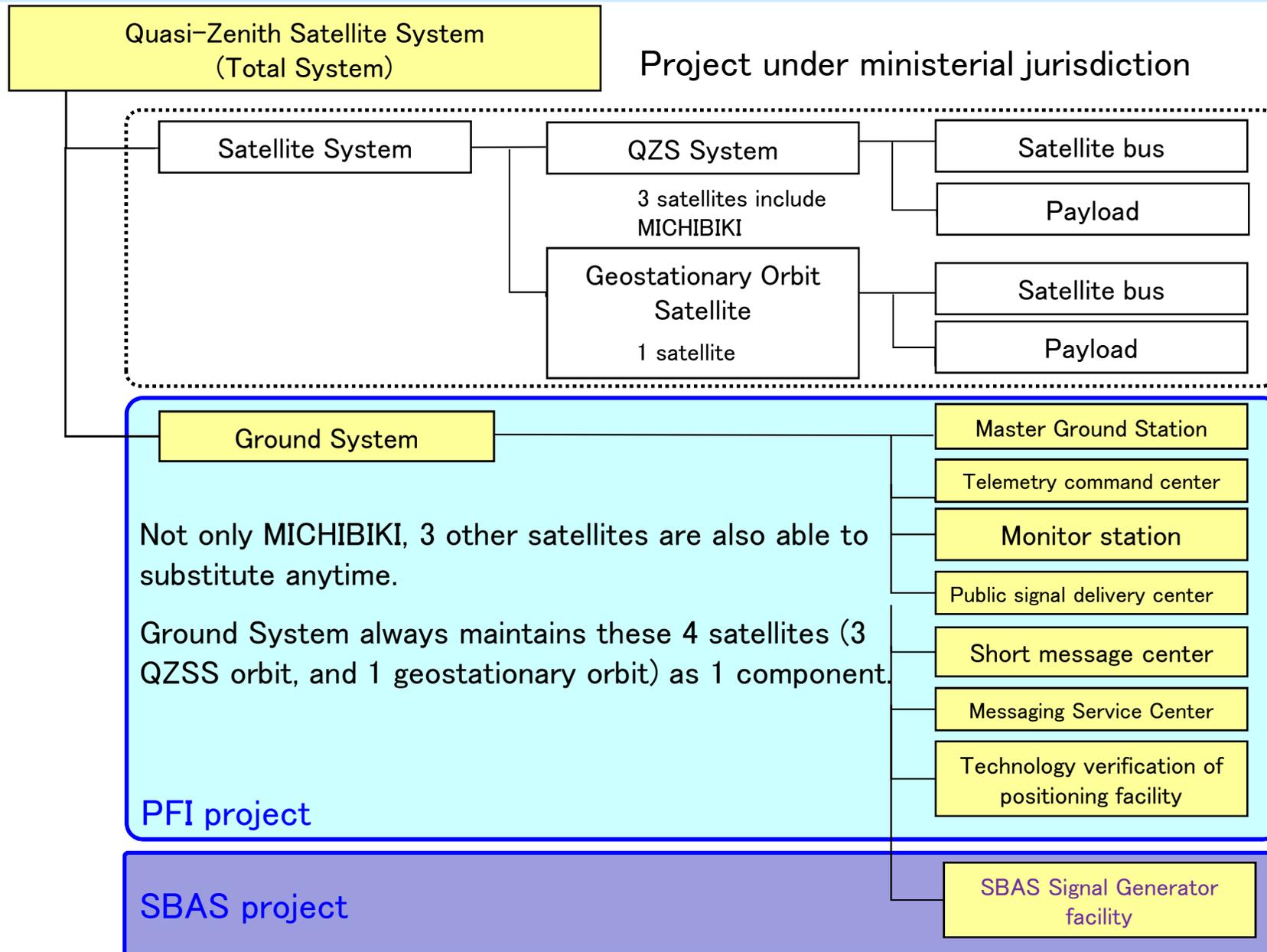
Four satellites constellation will be established and the service will start in 2018.

Organization and Contractual Frameworks (renewed)



※The contract for QZSS Satellites procurement has been concluded between Cabinet Office and MELCO.

System Configuration of QZSS



QZSS Satellite(s) Overview

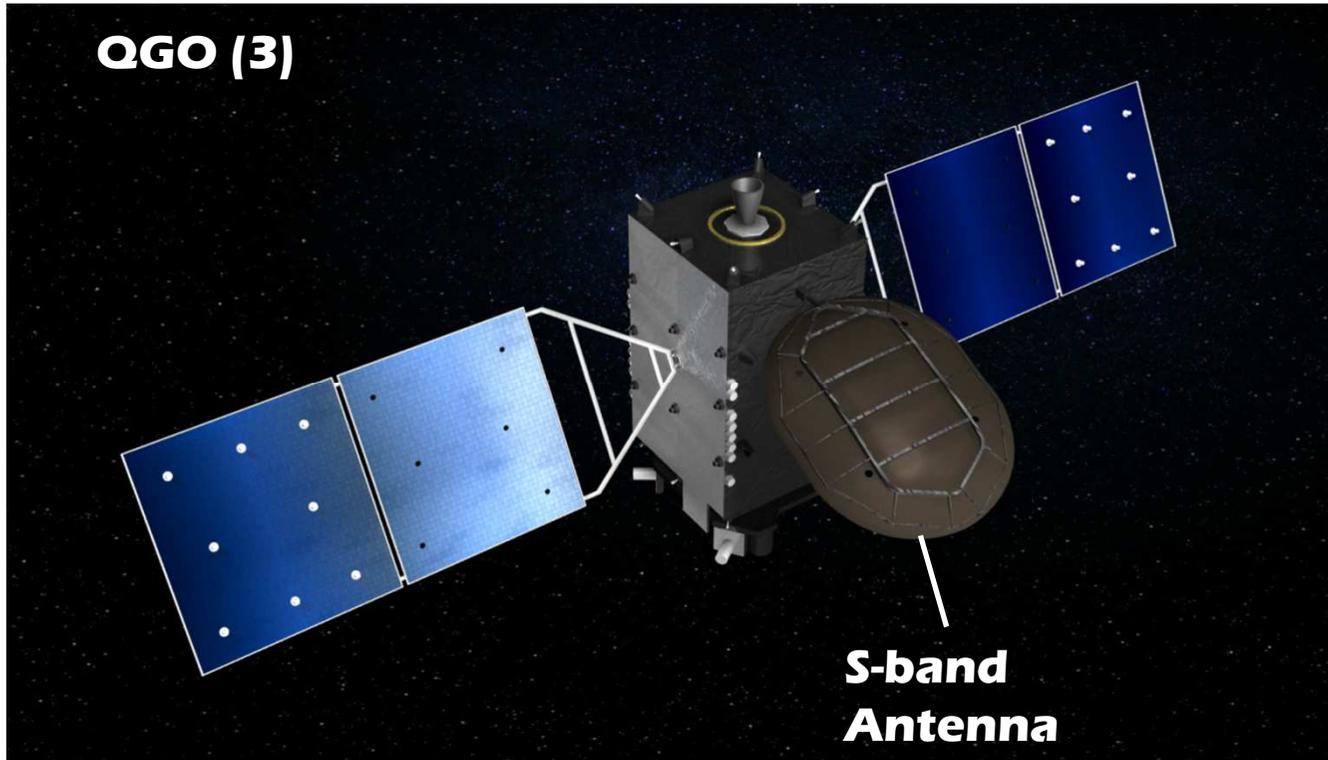


Launch Vehicle : H- II A
Mass Dry/Launch : 1.6t/4.0t
Lifetime : 15years+

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- II A
Mass Dry/Launch : 1.8t/4.7t
Lifetime : 15years+

Orbit Parameter	Nominal Allocation
Longitude	E 127
Latitude	0

QZSS Master Ground Station

http://www.mlit.go.jp/koku/15_bf_000367.html



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,



http://www.mlit.go.jp/koku/15_bf_000367.html

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:

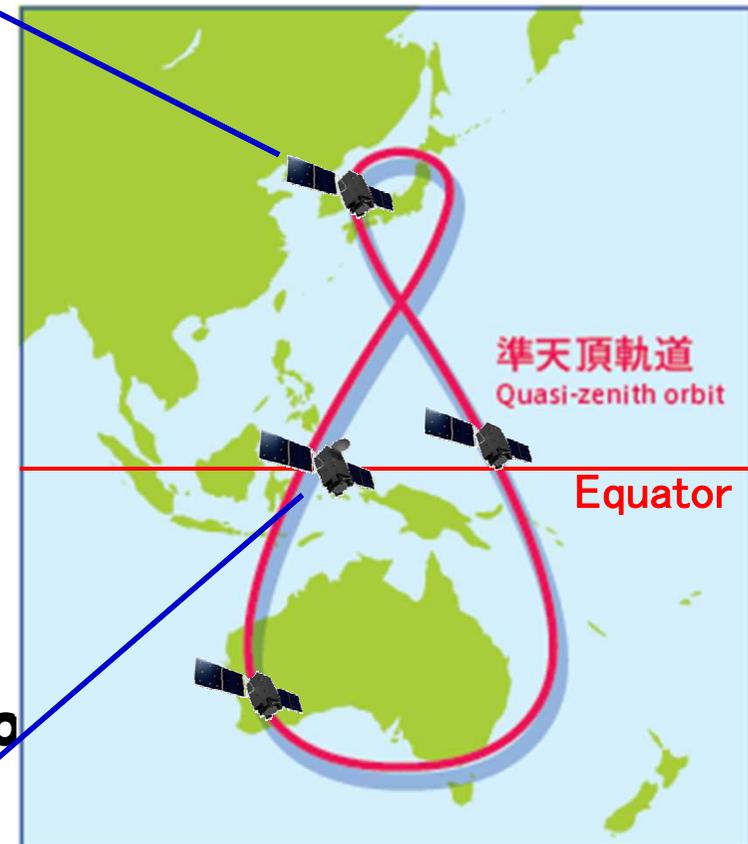
GPS Complementary

GNSS Augmentation

Messaging Service

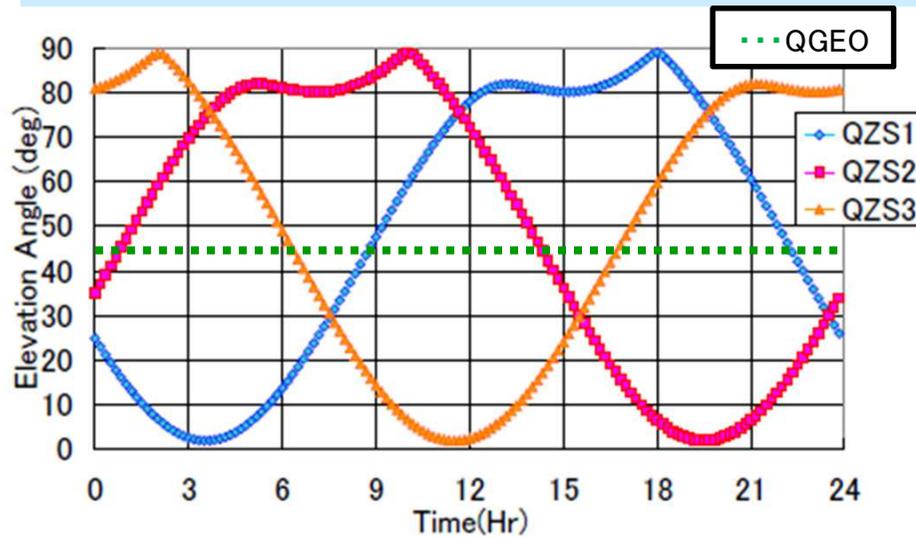
Coverage: Asia and Pacific region

1 Geostationary satellite

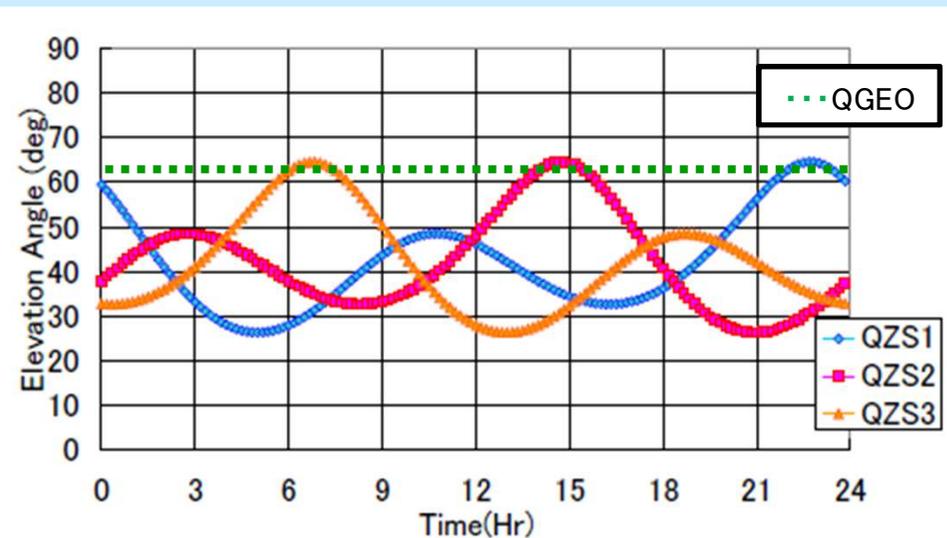


Four satellites constellation will be established and the service will start in 2018.

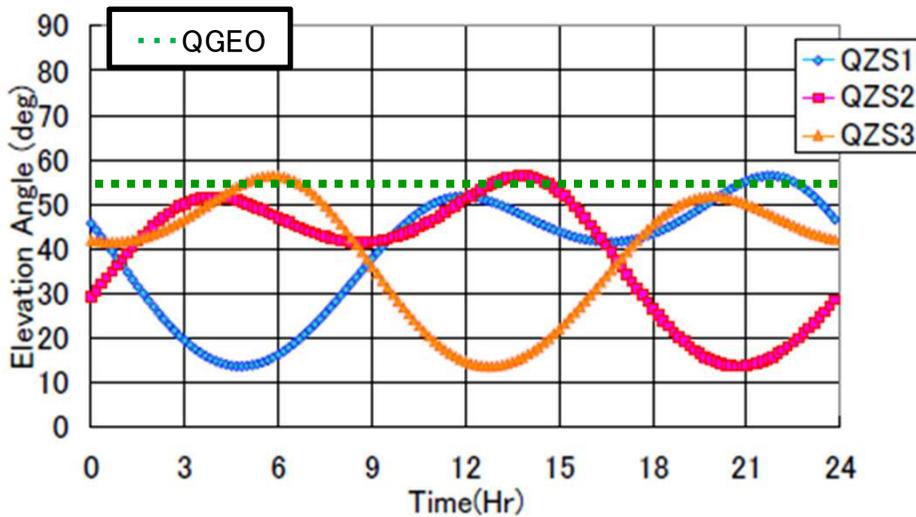
QZSS Visibility Time



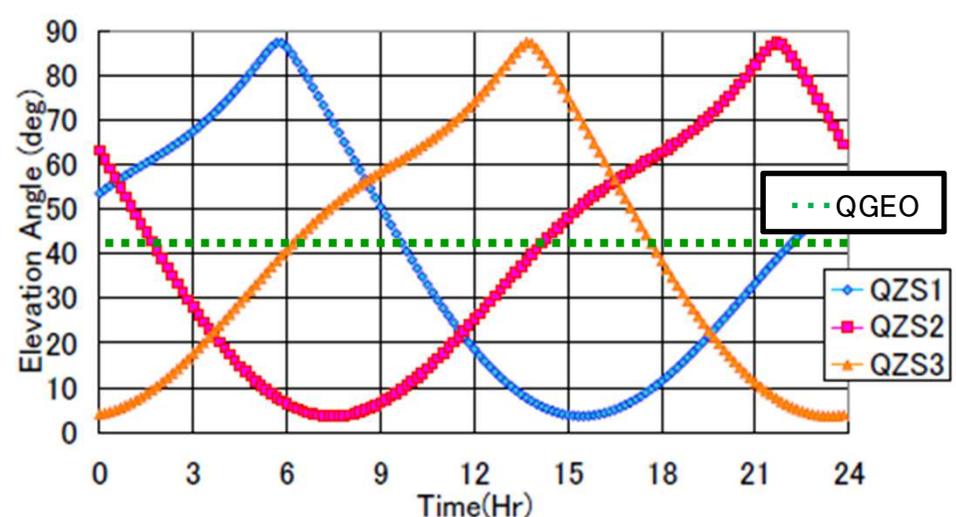
TOKYO



SINGAPORE



BANGKOK



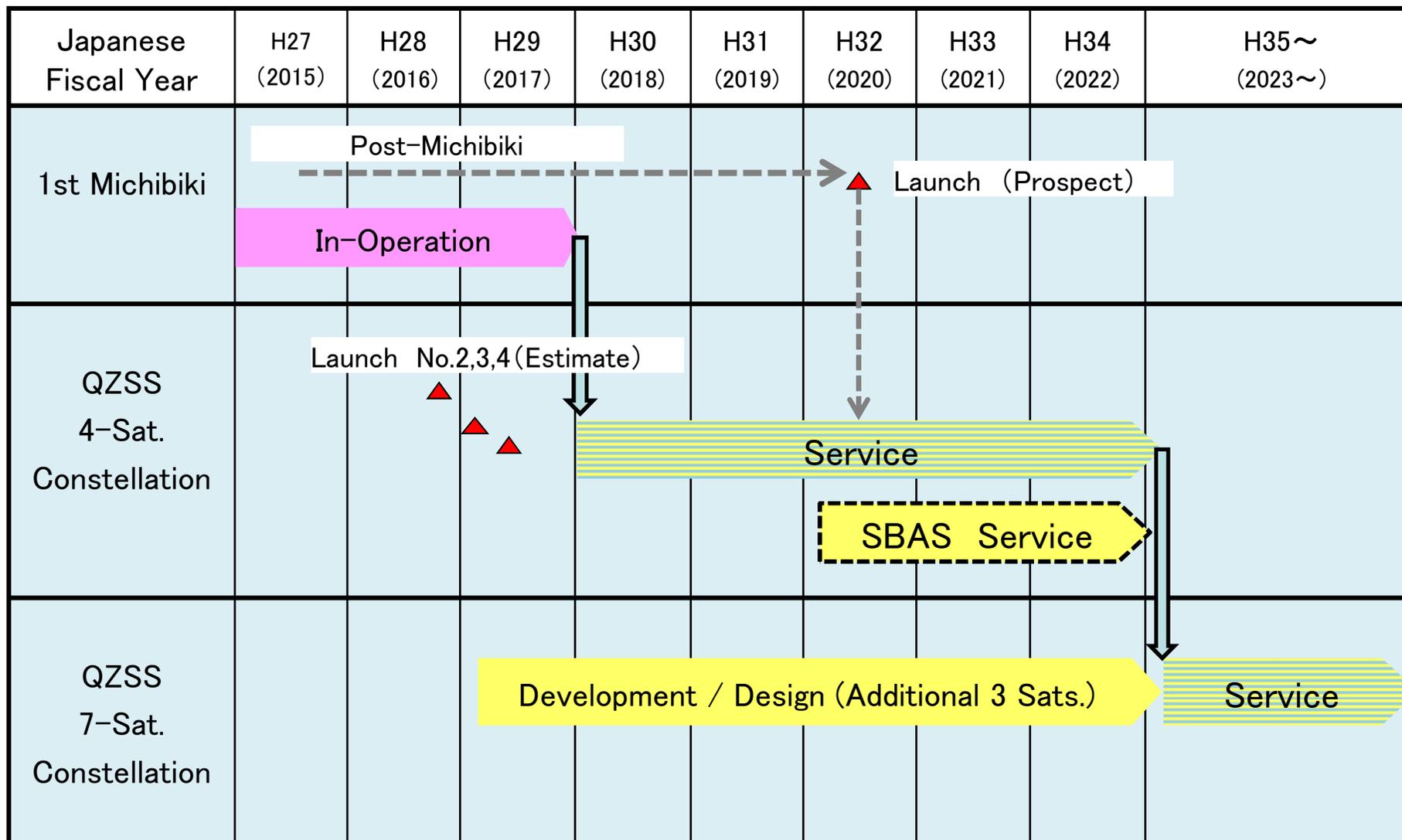
SYDNEY

Positioning Signal of QZSS (as of Nov. 2019)

Positioning Signal of QZSS						
Not only positioning complementation signal, but satellite orbit, time, and ionosphere correction information will be also transmitted as augment information.						
				1 st Satellite	2 nd -4 th 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		—	○	○
L1Sb		1575.42 MHz	Experimental Use Augmentation	SBAS	—	—
L6	1278.75 MHz	Augmentation		○	○	○

the beginning of 2020's.

QZSS Program Schedule (Update)



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



2. Mission of the QZSS

2. Mission of QZSS



QZSS provides positioning- related service and messaging service.

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 .

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

2. Mission of QZSS



	Performance Standard	Interface Specification
Satellite Positioning, Navigation and Timing Service	PS-QZSS-001 (in preparation)	IS-QZSS-PNT-001 (Draft, July 12, 2016 / PDF: 2,200KB)
Sub-meter Level Augmentation Service (SLAS) / Satellite Report for Disaster and Crisis Management (DC Report)		IS-QZSS-L1S-001 (in preparation)
Centimeter Level Augmentation Service (CLAS)		IS-QZSS-L6-001 (Draft, July 12, 2016 / PDF: 1,389KB)
Positioning Technology Verification Service		IS-QZSS-TV-001 (Draft, July 12, 2016 / PDF: 637KB)

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>



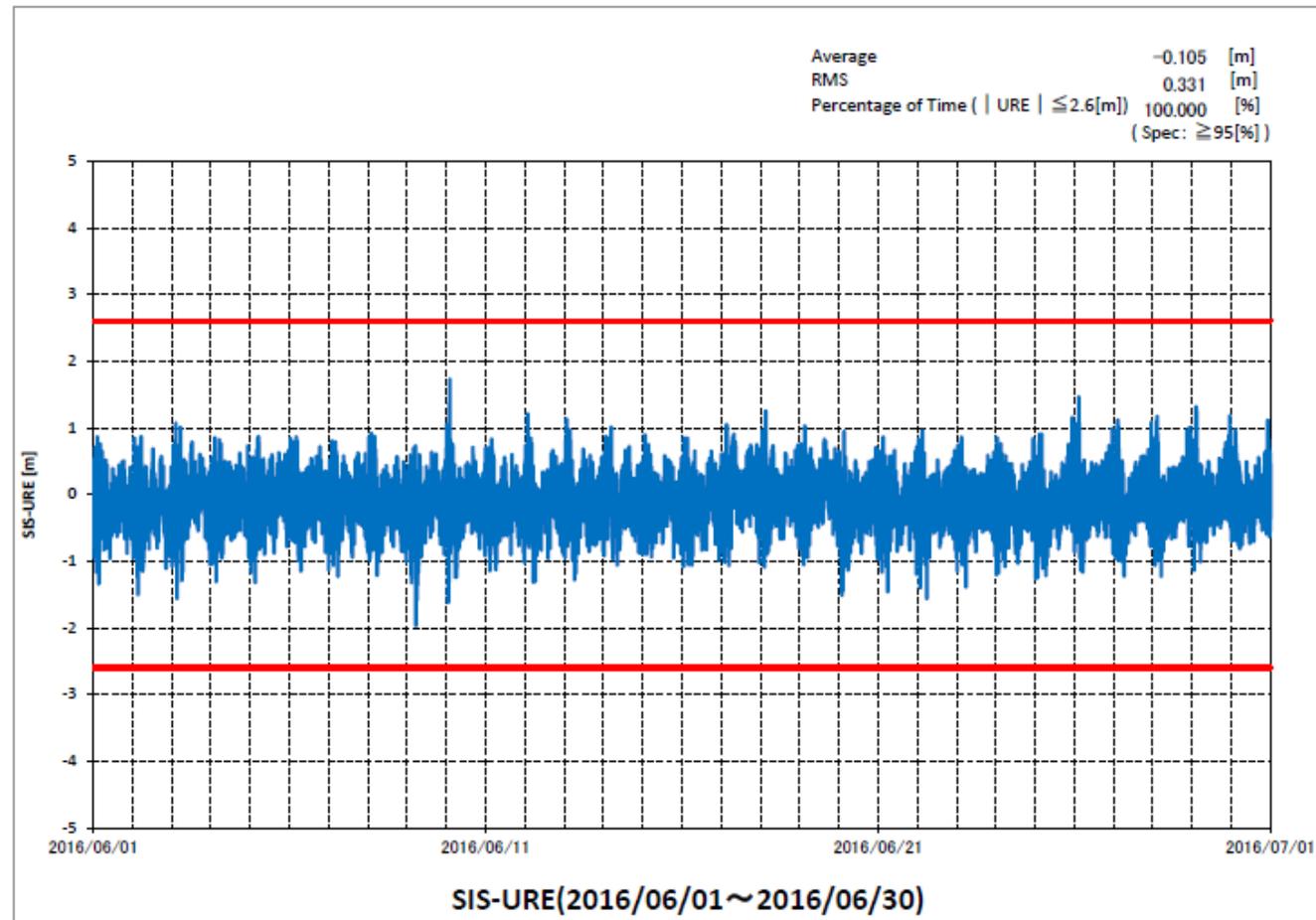
3. Recent Demonstration results of the QZSS

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)



Demonstration 2 : Dual-Frequency Positioning

- Verify the validity of the ionosphere correction by dual-frequency positioning

- RNSS(Radio Navigation Satellite System)

 - : QZSS, GPS, GLONASS

 - GPS(Ⅱ R(M), Ⅱ F)/QZSS (L1 + L2, L1+L5 in the future)

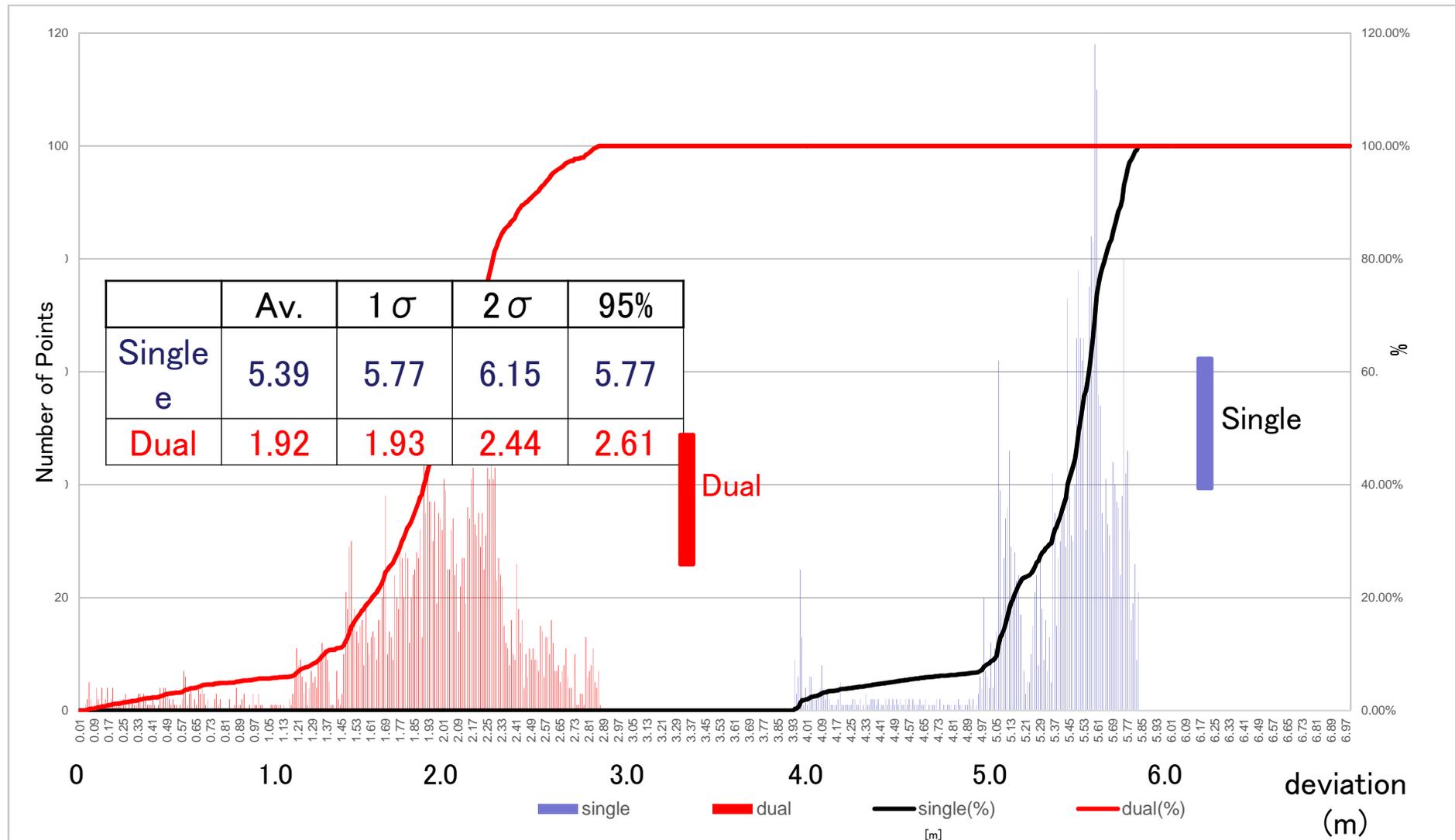
 - GLONASS (L1 + L2)

- Demonstration Area

 - Japan : OKINAWA (GPS and QZSS)

 - Asia : MANILA, Philippine (GPS/QZSS, GLONASS)

② Demonstration of Dual-Frequency Positioning in Philippine





4. The QZSS Expansion Activities for Asia-Oceania Countries

QZSS Expansion Activities



QZSS Round Table
(2014.12.1)

Quasi-Zenith Satellite System

QZSS Utilization Workshop In Thailand

January 22nd, 2016
Friday
at
Chulalongkorn University
Faculty of Engineering
(100 Years Memorial Buildings)

MGA/AOR Workshop (2016.11.14-16)

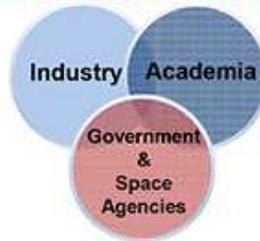
8th Multi-GNSS Asia (MGA) Conference

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 Utilization Workshop
(2016.1.22)

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

VNSC QZSS Positioning in Urban City (Hanoi/Vietnam)

Demonstration Set-up

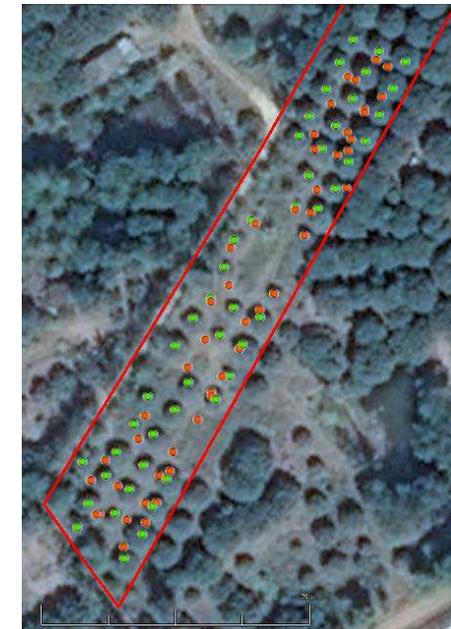


8

Bus Driving (Quezon/Philippine)

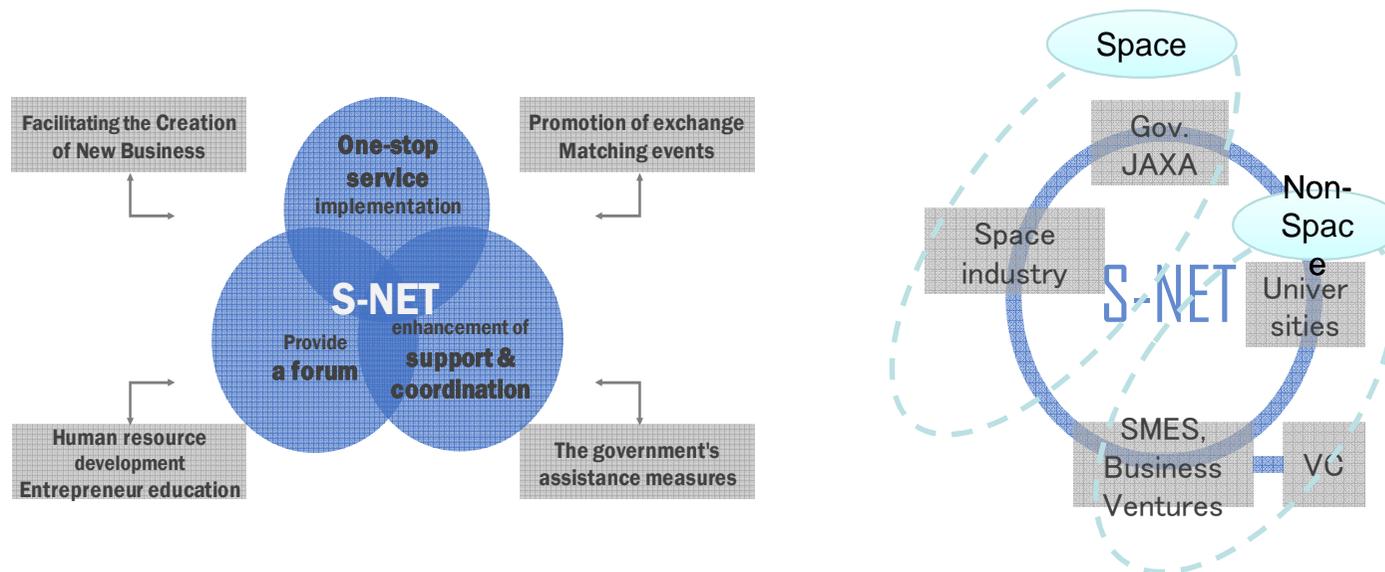


Management of orchards fused with remote sensing technology (AIT/PASCO)



Space New Economy NETWORK (S-NET)

- Created a new network which enables any entities that have interests in utilizing and developing the space to interact with each other.
- The network involves the value-chain, such as start-ups, business ventures and SMEs that wish to utilize the space as potential business tools.
- Executive office is located at National Space Policy Secretariat, Cabinet Office. It will soon function as coordinators and facilitators in collaboration with related Ministries and participants.
- S-NET welcomes International partners regarding space business.



New economic growth utilizing space infrastructure

- Fusion of space infrastructure, big data and IoT -

Automatic Operation of Farm Equipments

Automated Operation of Farm Equipment and Sophisticated Production Management, utilizing space asset, will be introduced to inefficient large-scale farm, in order to improve self-sufficiency in food and to resolve the shortage of farm operators.



Precision Forestry

Precision Forestry will be expanded widely throughout Japan And overseas, combining cloud services with automatic forest assessments and production management skills.



Logistics

A reciprocal unmanned freight transport system will be implemented between the main islands and remote ones.



Source: YAMAHA

Delivery

The delivery service will be capable of making deliveries to non-fixed address, such as locations inside of a park.

Intelligent Transport System (ITS)

Vehicle stability control, like lane keeping and changing, will be possible thanks to QZS high-accuracy positioning information.



Source: denso

Electronic Toll Collection (ETC)

A road pricing system, based on the accurate positioning information from QZSS, will be established in order to achieve a free-flow gateless system.



Disaster Prevention

Disaster information will be provided by a built-in electronic message board for vending machines, utilizing Satellite Reports for Disaster and Crisis Management. In addition, beverages will be offered free of charge through vending machines in the case of a disaster.



Sightseeing

Pilgrimages to tourist hotspots peculiar to Japanese Animation is recently on the rise. That is why, a system will be expanded, in which animation fans will be able to take pictures with a certain character using augmented reality when they go to the particular locations, and obtain limited goods.

Source: khara, Inc.



Watching service for elderly person and kids

An environment, which relatives watch their elderly Parents or children at any time of night or day, will be provided by the fusion of QZS high-accuracy positioning technology and geospatial information.



Source: MHLW

Society's infrastructure

The operation and maintenance services for society's infrastructure including bridges and expressways will be provided by utilizing QZS high-accuracy positioning technology.



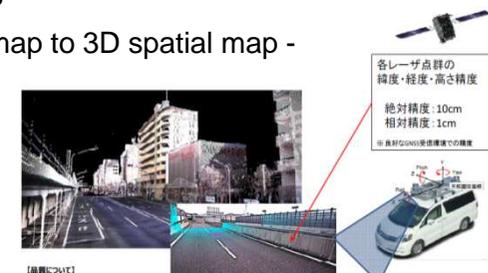
Railway

QZSS will be applied to operation support systems, security systems, such as car-body tilting and radio-based train controls, through high-accuracy positioning technology in the railway sector.



Sophistication of MAP

- From Conventional 2D map to 3D spatial map -



Source: Mitsubishi Electric Corporation

Summary

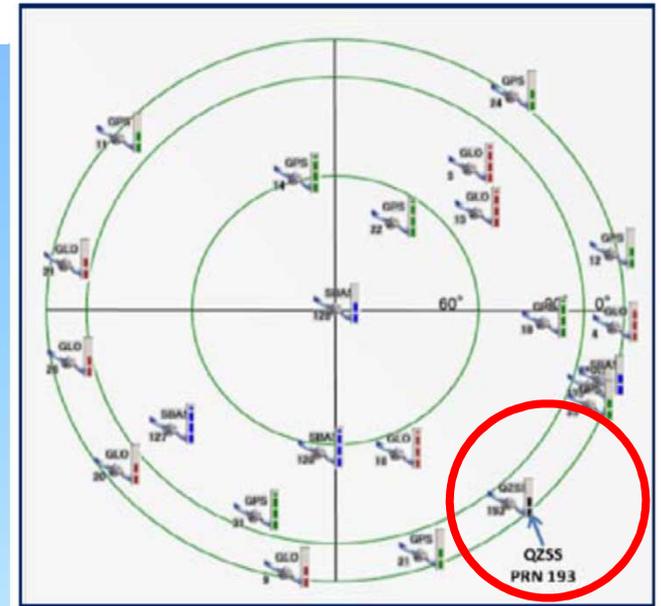
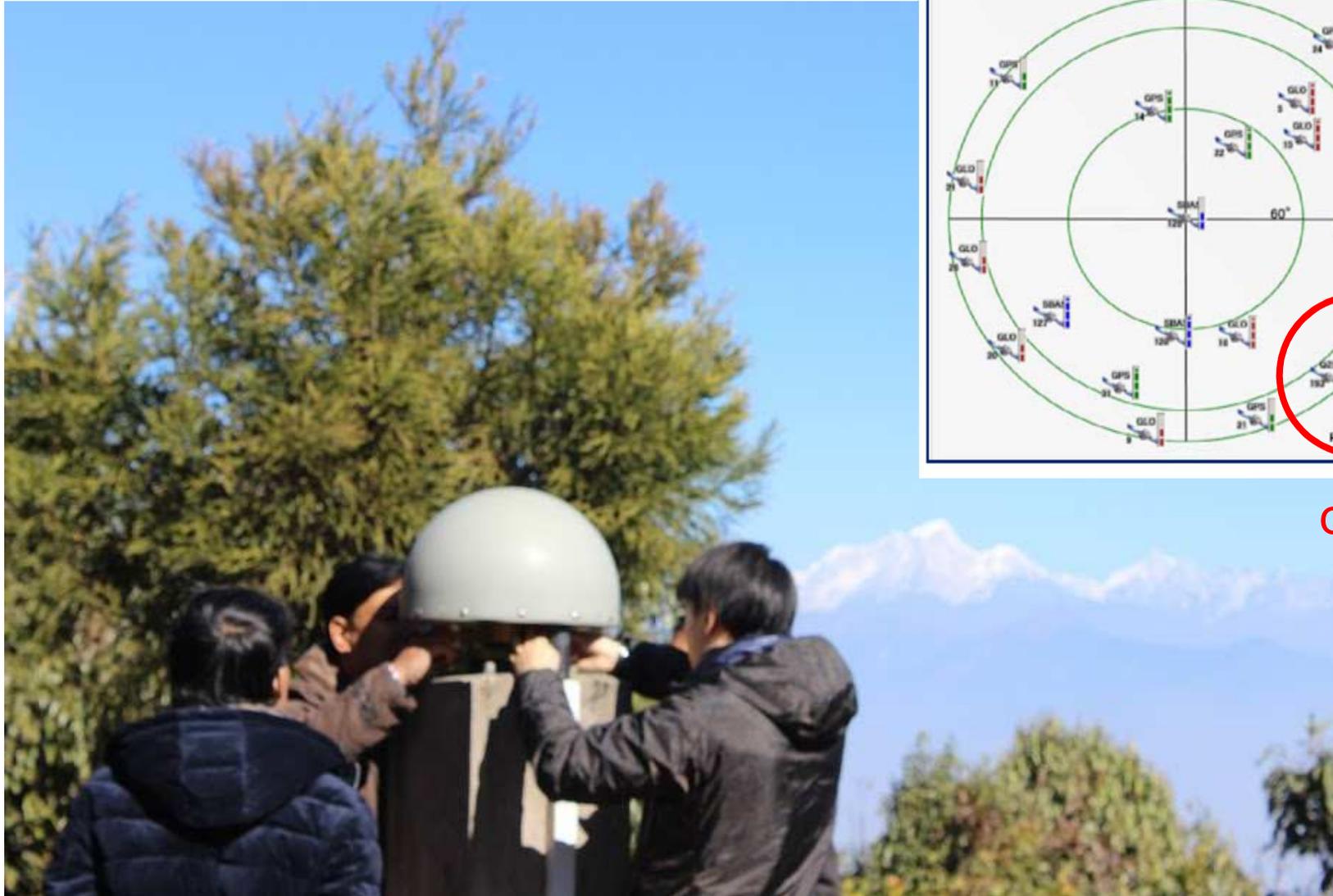


- ✓ Based on the decision of the GOJ, the deployment of the operational QZSS is underway.
 - 4 satellites constellation shall be established by the 2018JFY.
 - Necessary equipment (satellite, ground station and others) are currently in development.
 - GOJ has decided to expand the QZSS to 7-satellite constellation around 2023.

- ✓ Verification, assessment and many demonstrations of the QZSS have been conducted.
 - Dual frequency positioning will be effective in the dense area of Total Electron Content, namely equatorial region.
 - S-Net initiative has been launched. It is an effort to promote space technologies such as Satnav and Remote-sensing into wide variety of applications

JAXA MGA Station in NAGARKOT

Installed on JAN 2013, Operated by Survey Department



QZSS

**Thank you for your
attention.**

**For more information, please visit our web
site**

<http://qzss.go.jp/en/>

Acknowledgment

- Slides in this presentation were provided by Mr. Yoshiyuki Murai, QSS (Quasi-Zenith Satellite System Service Inc.) with some modifications.



- **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**