



Project Overview of The Quasi-Zenith Satellite System

31 October 2015

QZS System Services Inc. (QSS)



- 1. Project/System Overview and Program Status**
- 2. Mission of the QZSS**
- 3. Demonstration Results of the QZSS**

Project Overview

National undertaking, “Quasi-Zenith Satellite System (QZSS)” operated by the Cabinet Office of Japan was divided to 2 divisions since end of 2012 : Satellite System (project under ministerial jurisdiction), and Operation System (PFI).

	Operation System project of QZSS (QSS/PFI project)	Satellite System project of QZSS
Term	2012~2032	2012~2016
Outline	<ul style="list-style-type: none"> ①Design and examination of Total System. ②Promotion of QZSS Utilization ③Improvement, maintenance, and management of Ground System. ④Accomplishment of the Total System operation. <p>Total 4 satellites (MICHIBIKI and 3 QZSS) will be operated.</p> <ul style="list-style-type: none"> ⑤Promotion of the QZSS Utilization 	<p>Development of 3 QZSS (2 QZSS/1 geostationary orbit satellite and simulator) (project under ministerial jurisdiction)</p>

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)



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)】:

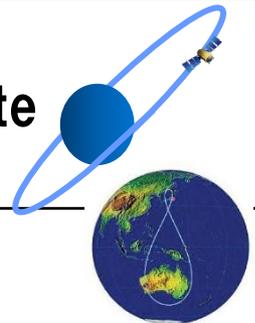
Prepare the 4 satellites constellation (3 QZ orbit + 1 Geostationary orbit) by the end of the 2010s. In the future, 7 satellites constellation shall be completed to enable continuous and more sustainable positioning.

【Current Status】:

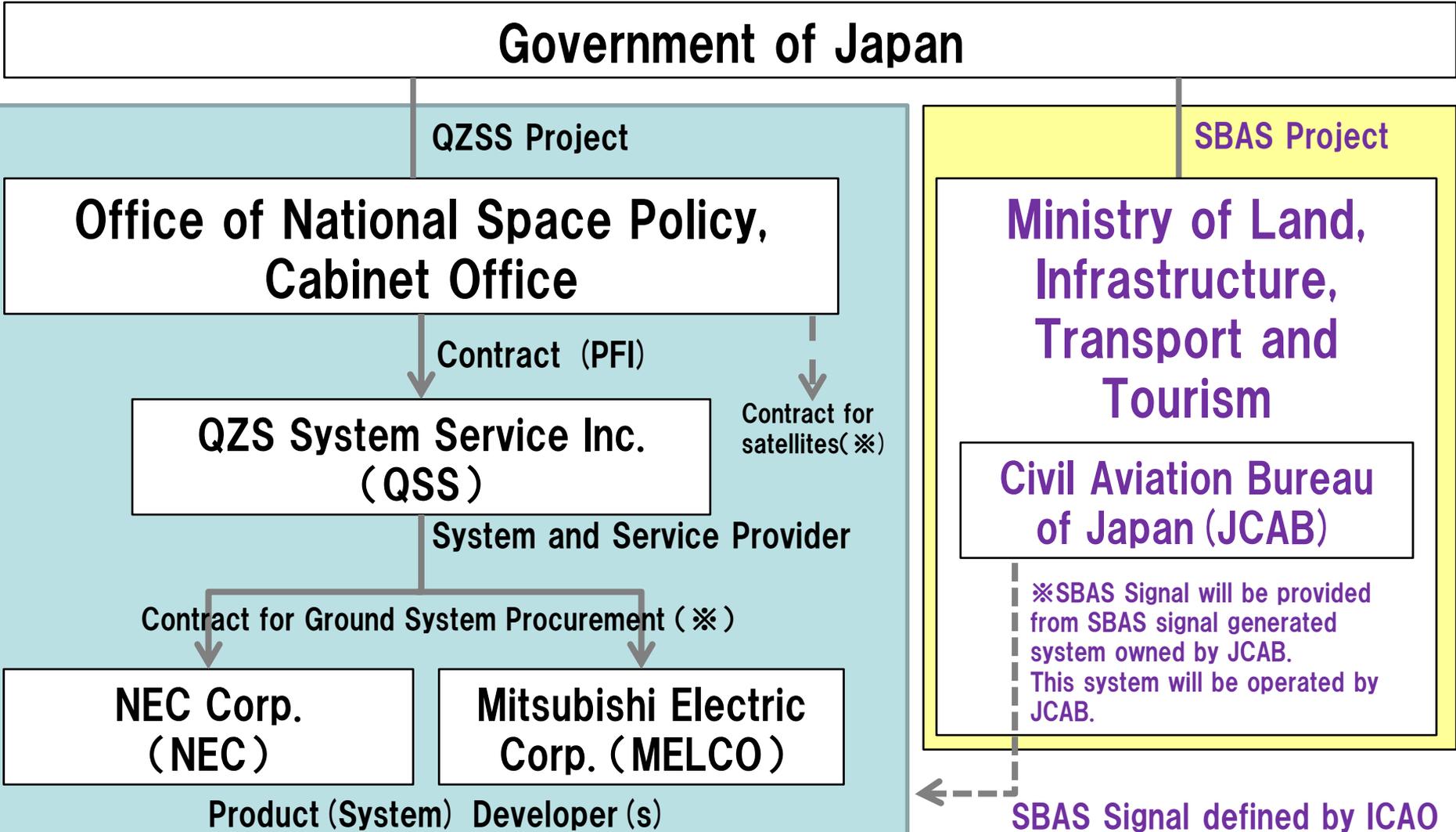
System and application verification by using the first satellite, MICHIBIKI.

【Number of Satellites】(as of the beginning of 2018JFY)

QZ Orbit: 3 satellites constellation, Geostationary Orbit: 1 satellite

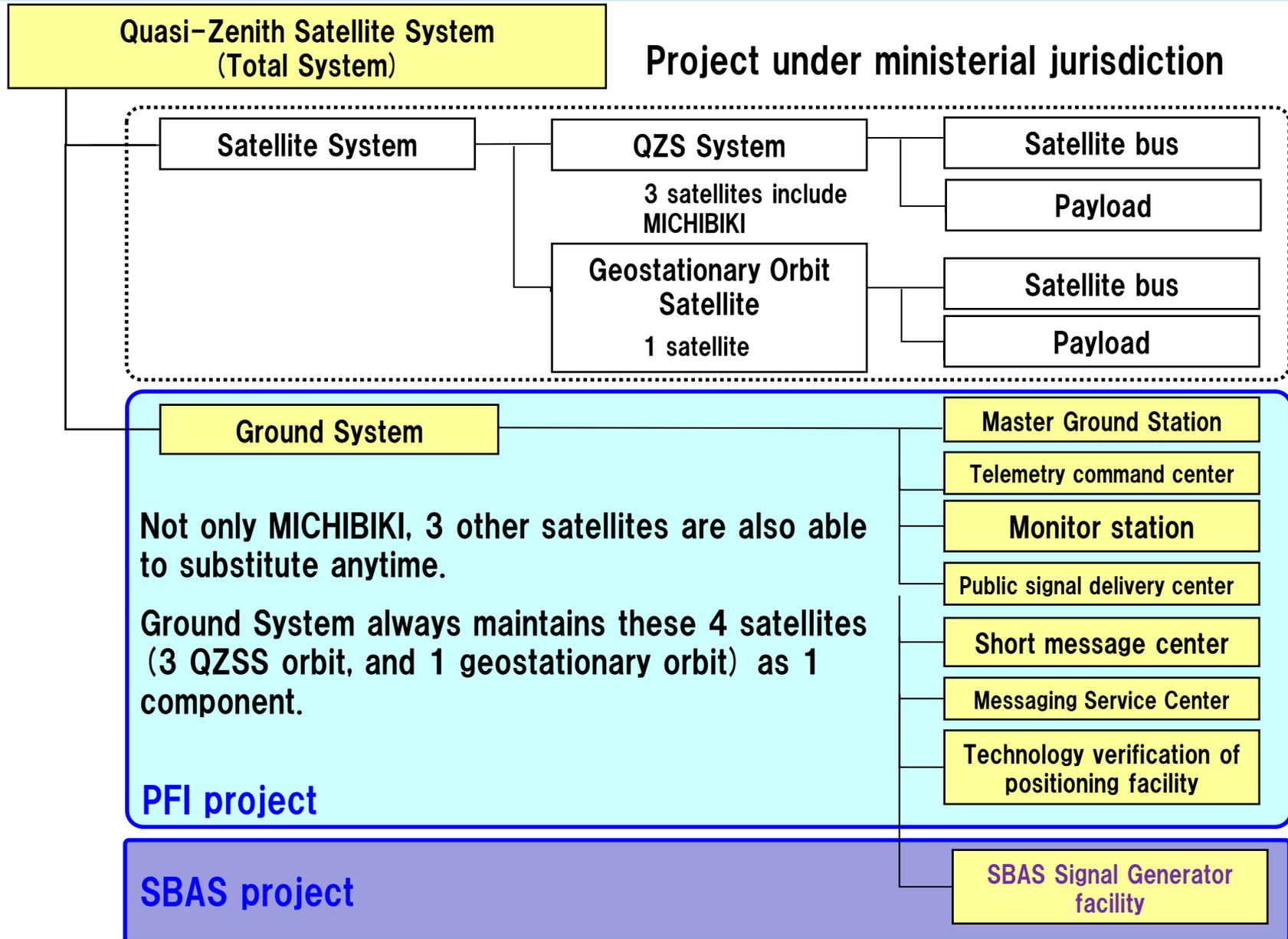


Organization and Contractual Frameworks

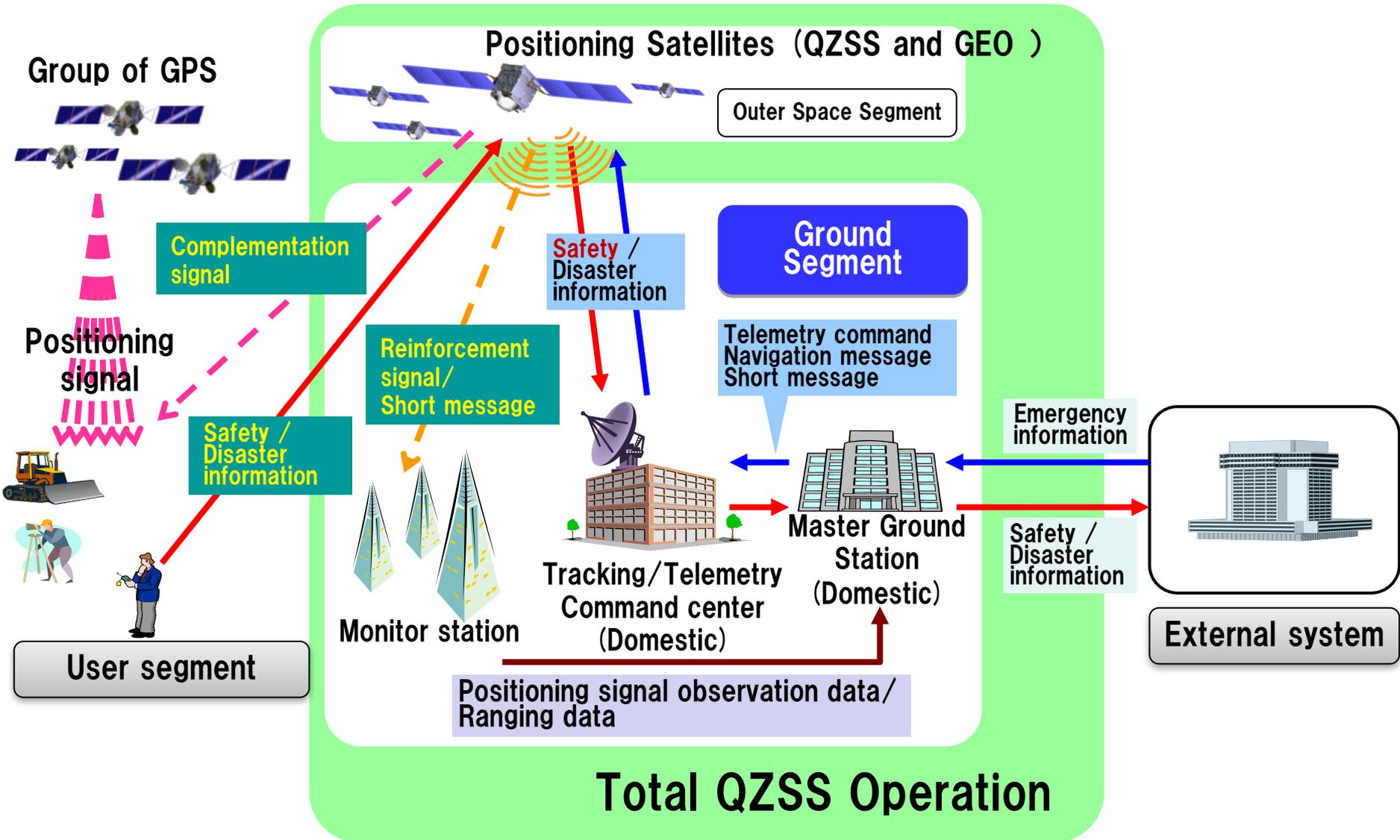


*The contract for QZSS Satellites procurement has been concluded between Cabinet Office and MELCO.

System Configuration of QZSS



Conceptual Scheme of QZSS Operation



Orbit (s) of QZSS



4-Satellite Constellation:

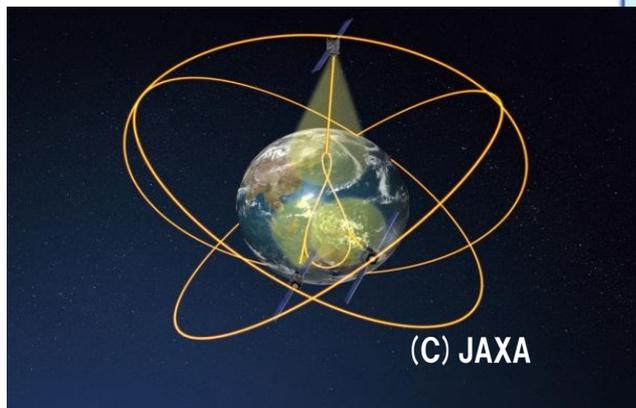
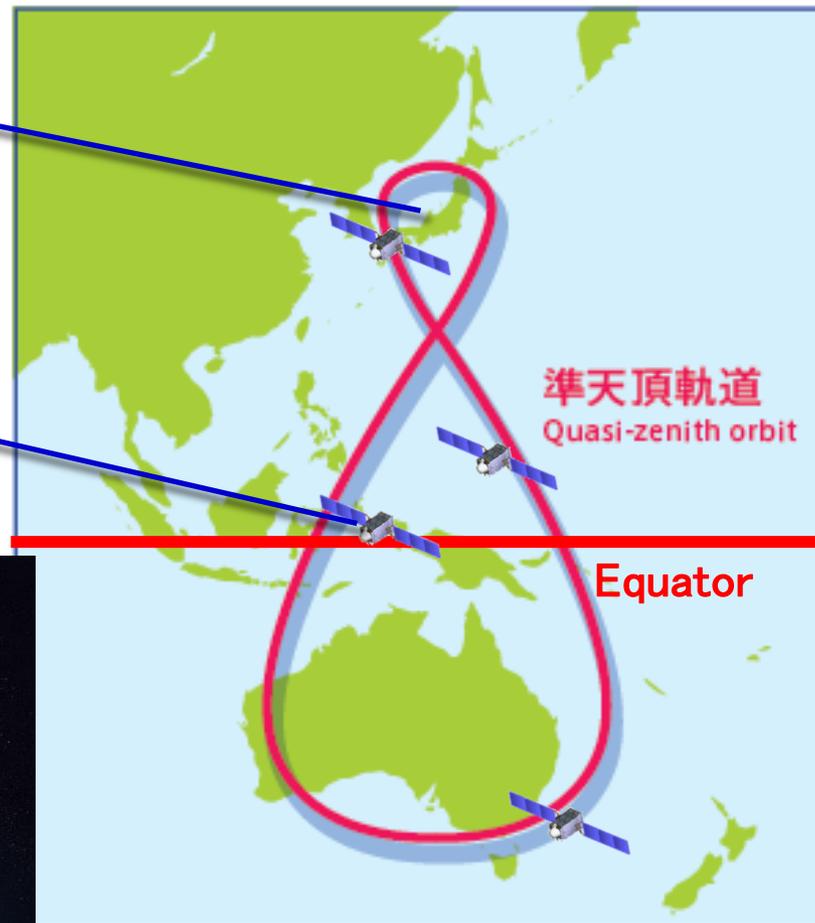
1st QZS (launched in 2010) plus

3 additional satellites (2 QZ Orbit, 1 Geostationary Orbit)

Japan Region

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

1 Geostationary satellite



(C) JAXA

Orbit (s) of QZSS



Q-Z Orbit Parameter and Tracking Range

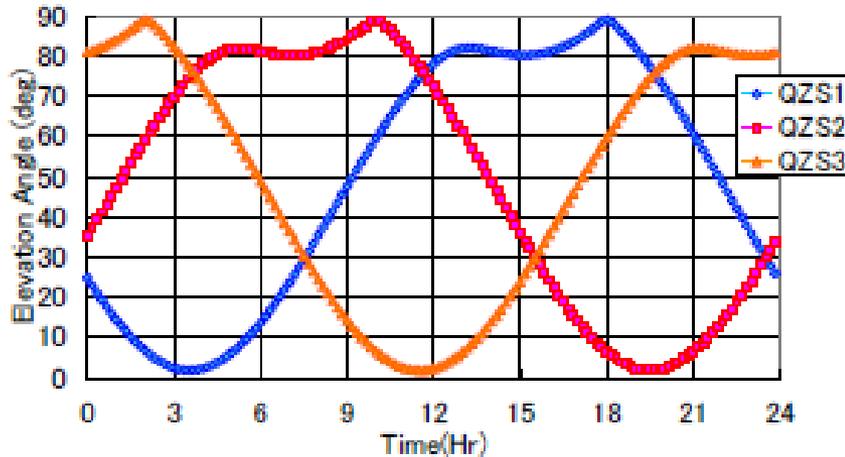
Orbit Parameter	Nominal Allocation	Tracking Range
Semimajor Axis (A)	42164km	-
Eccentricity(e)	0.075	0.075 ± 0.015
Inclination (i)	40 degree	36 ~ 45 degree
Argument of Perigee (w)	270 degree	270 ± 2.5 degree
RAAN (Ω)	Block I_Q: 117 degree Block II_Q: 117 ± 130 degree	-
Central Longitude (λ)	136 degree	130~140 degree

RAAN: Right Ascension of the Ascending Node

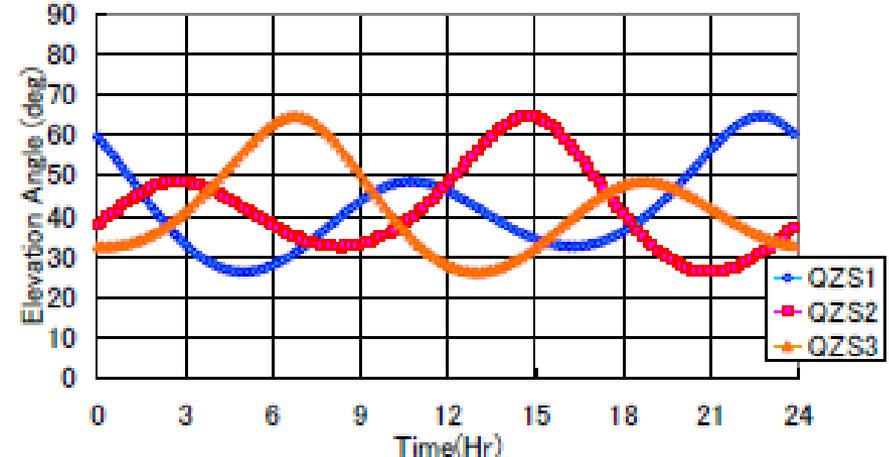
Geosynchronous Orbit Parameter and Tracking Range

Orbit Parameter	Nominal Allocation	Tracking Range
Longitude	E 127	127 ± 0.1 degree
Latitude	0	0 ± 0.1 degree

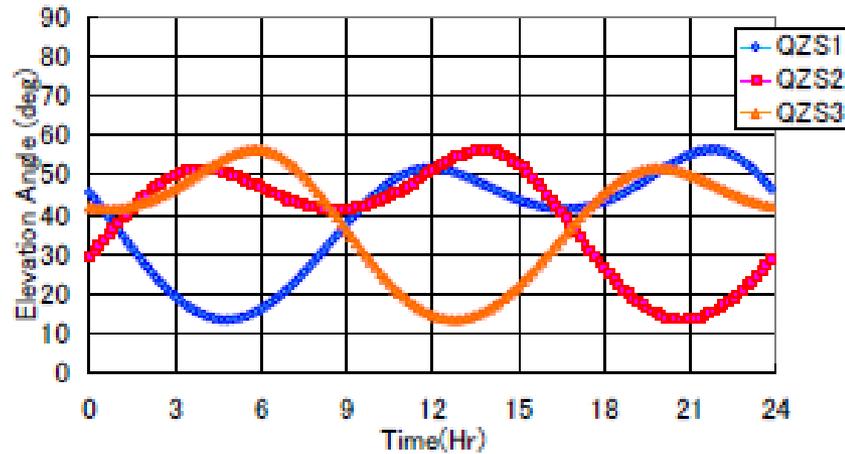
QZSS Visibility Time



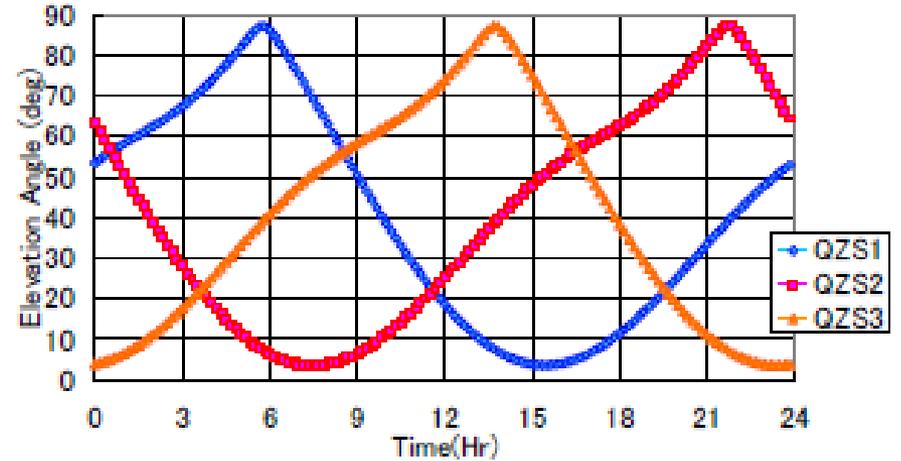
TOKYO



SINGAPORE



BANGKOK



SYDNEY

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.						
				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 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.**

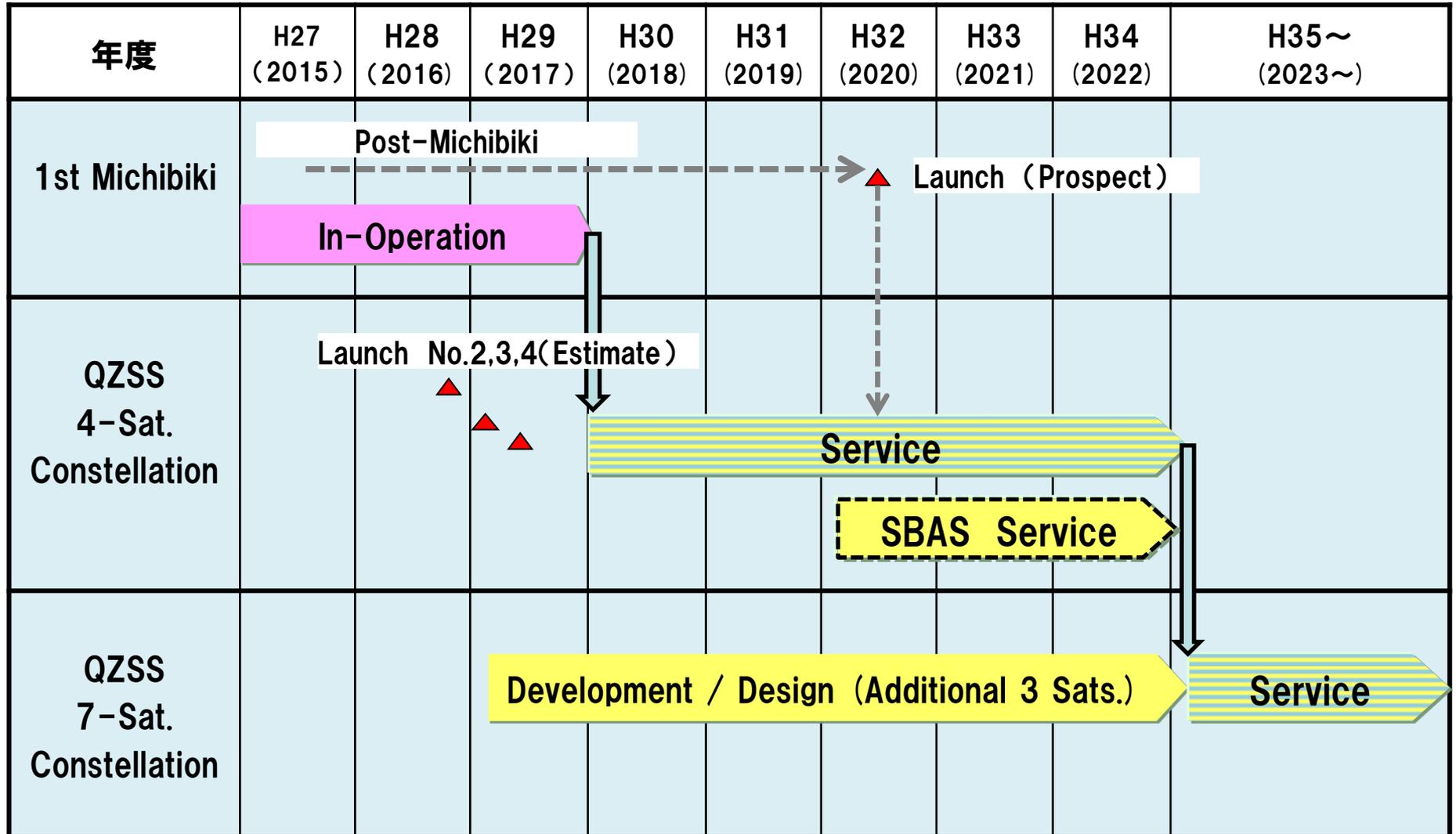
QZSS Program Status

- **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.

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.

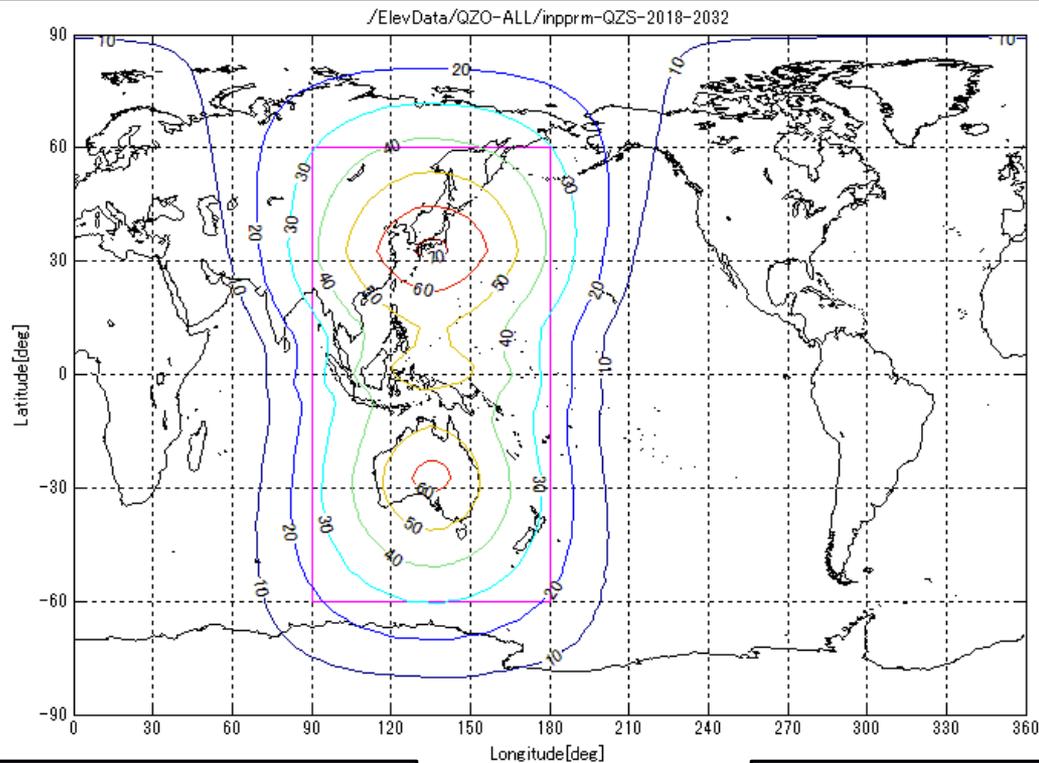
QZSS Service: Positioning related Service



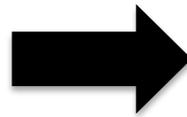
① Satellite Positioning Service

【Coverage Range】

More than 10 degrees elevation to QZS constellation



**High compatibility with
the GPS satellite**

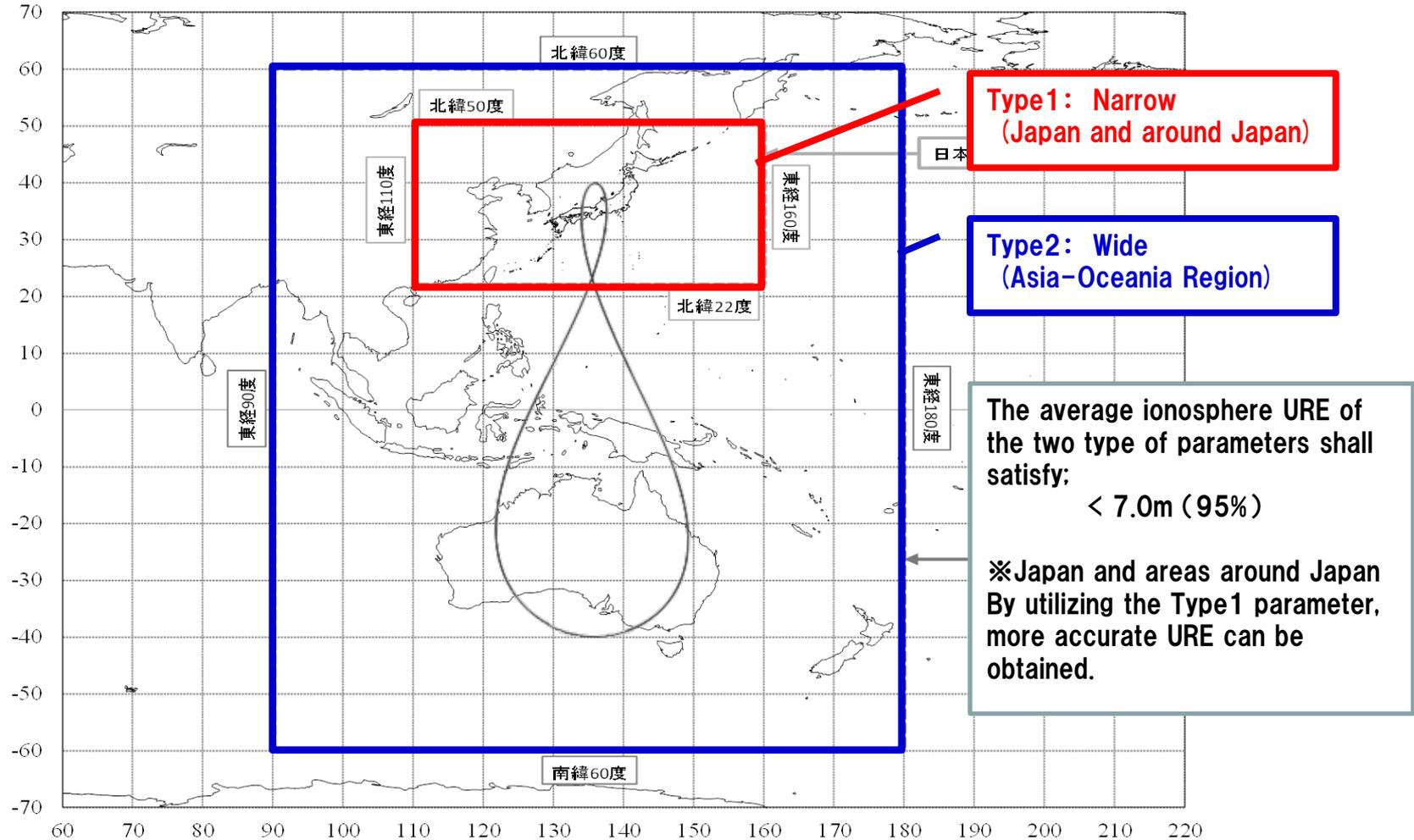


**Contributing to the reduction
of positioning error**

① Satellite Positioning Service



- Ionosphere Parameter for L1C/A (Two types of parameters)



② Sub-meter Level Augmentation Service



Sub-meter Level Augmentation Signal

Transmit 「L1S」 signal which has the same frequency modulation with 「L1C/A」, in order to augment positioning.

Accuracy of positioning : a few meters

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

Private consumers are suitable user since dual frequencies receivers are overpriced and have short battery life

For Private Navigation

- Sightseeing, shopping information
- Emergency point report (#110/#119)

For Public Transportation Navigation

- Management of ship/vessel and bus/taxi operation

For Disaster/Crisis Management

- Searching activity, local security

② Sub-meter Level Augmentation Service



【SLAS Service】

DGPS correction data will be provided in L1S signal

MSG Type 50 (in L1S) : DGPS correction data

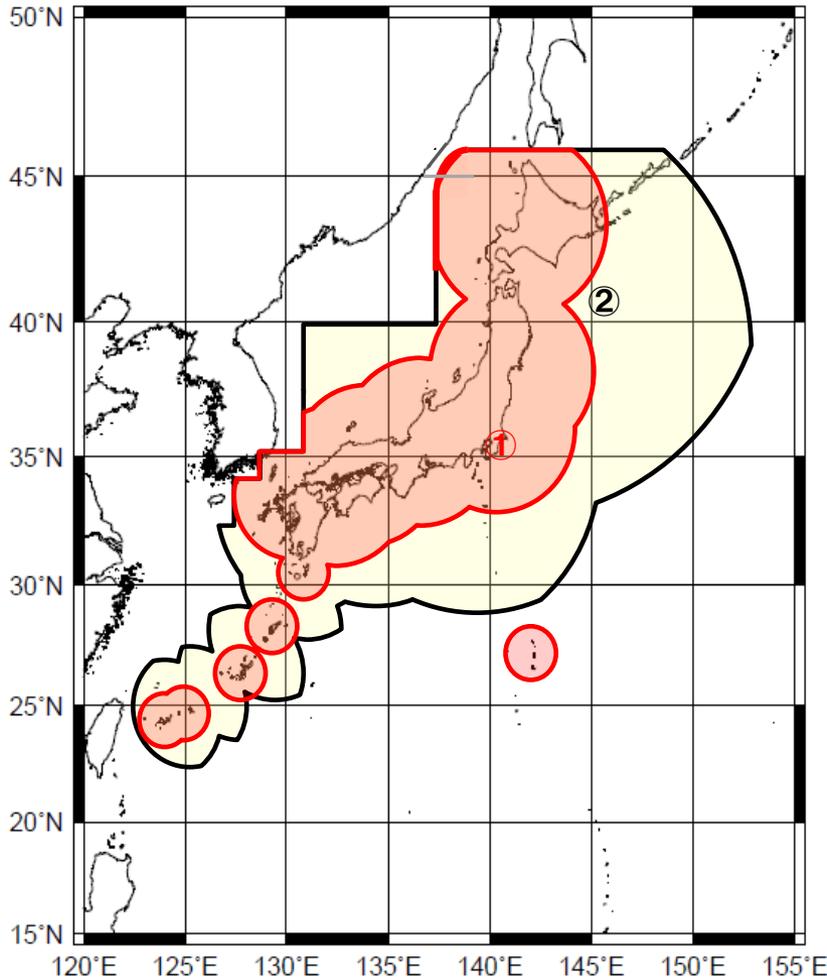
【Service Range】

- Japan and around Japan area
(at the start of the service, 2018)**

② Sub-meter Level Augmentation Service



Positioning accuracy and its range



	Accuracy (95%) [m]	
	H	V
Range①	1.0	2.0
Range②	2.0	3.0

➔ The DGPS corrections, more accurate positioning can be realized

③ Centimeter Level Augmentation Service



Centimeter Level Augmentation Signal

Peculiar signal (frequency) which GPS satellite dose not support.
This signal, 「L6」, will be transmitted for positioning augmentation.

※ GEO-NET (Reference stations) is necessary.

Accuracy of positioning : Around ten-centimeter level
(Reference stations are necessary)

Target user are professionals who require high precision positioning

For Driving
Navigation

- Computer aided construction by automatic construction machine (IT Construction)
- Automatic agriculture machine (IT-Agriculture)

For Land
Survey

- Precise Land Survey

③ Centimeter Level Augmentation Service



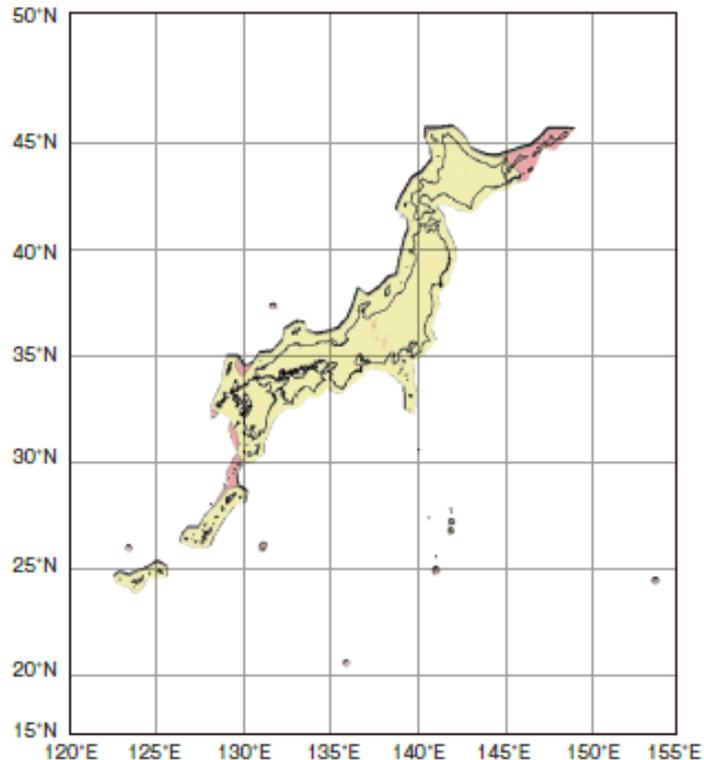
< Centimeter Level Augmentation Service >

【Coverage Area】

Within 20km radius from GNSS-based station(Reference point) which are placed all over Japan

Up to 2000m of altitude direction is available

(Service for Asia-Pacific region is under consideration)



 Area in which precision is achieved

 Area in which precision will be achieved after establishing GNSS-based control stations

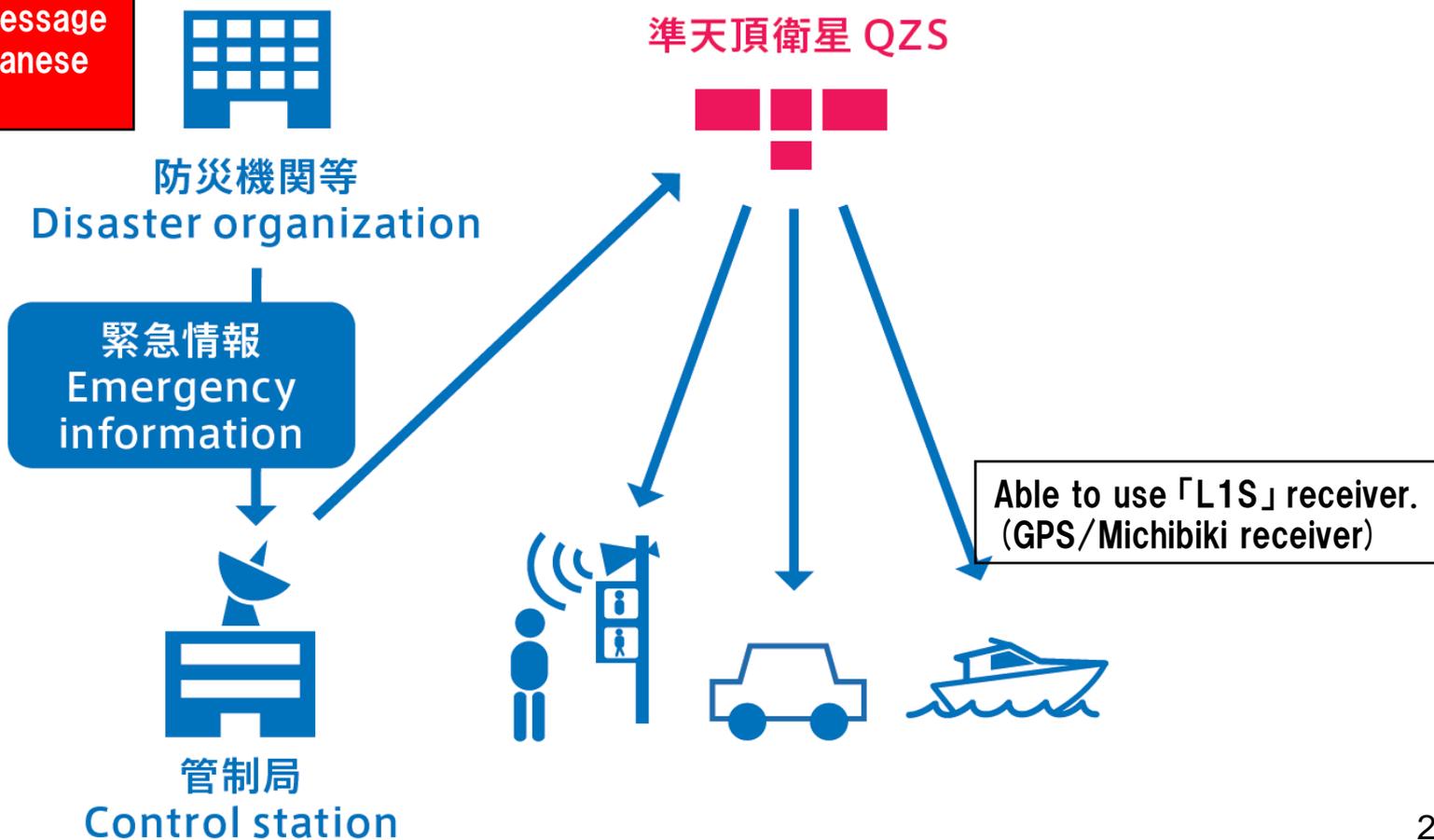
QZSS Service: MSG related Service



④ Satellite Report for Disaster and Crisis Management

By using reserve space of 「L1S」 signal, Short message (Disaster/Risk management report) can be transmitted.

Most promising Message transmitter is Japanese Government.





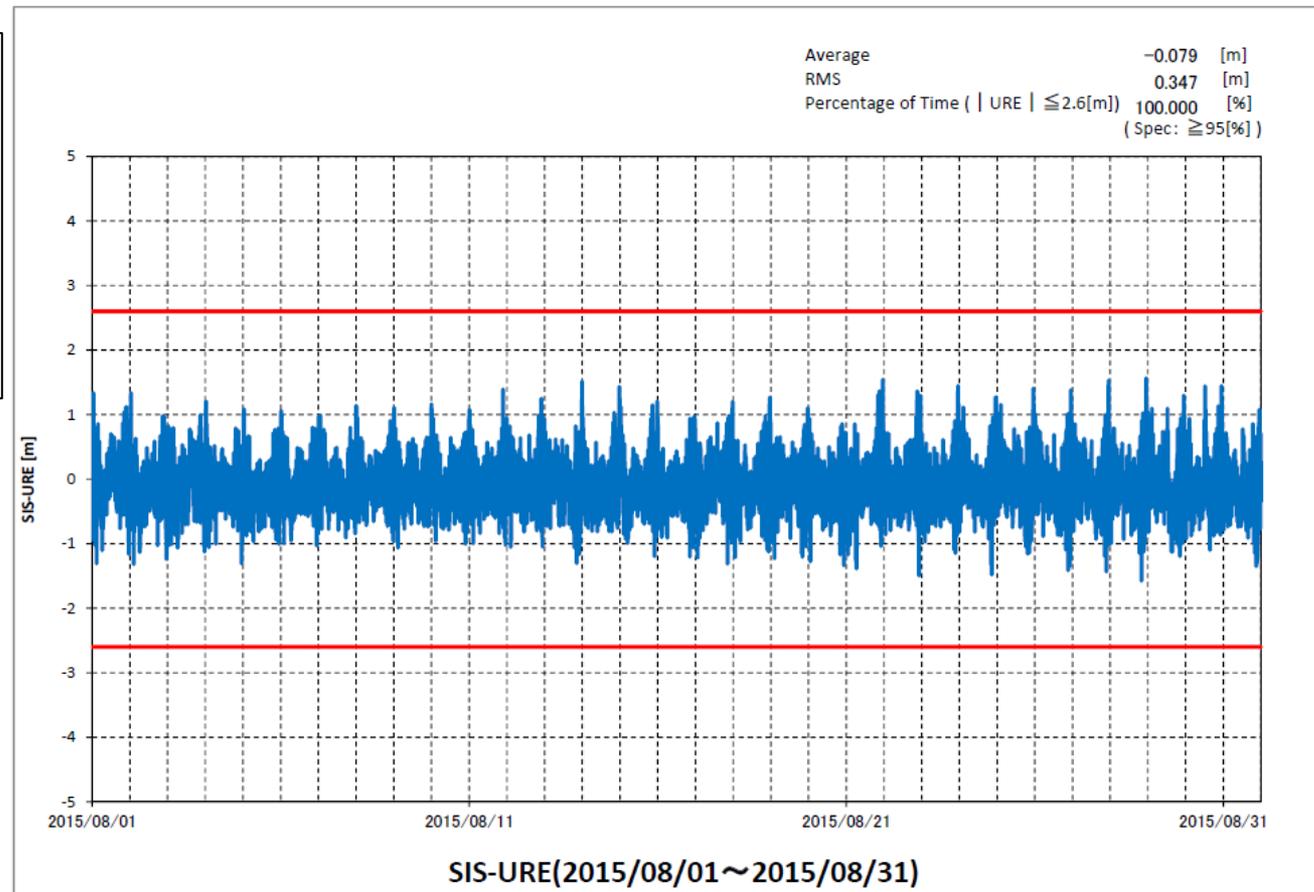
3. Demonstration results of the QZSS

QZSS Technical Verification of QZS-1 MICHIBIKI

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

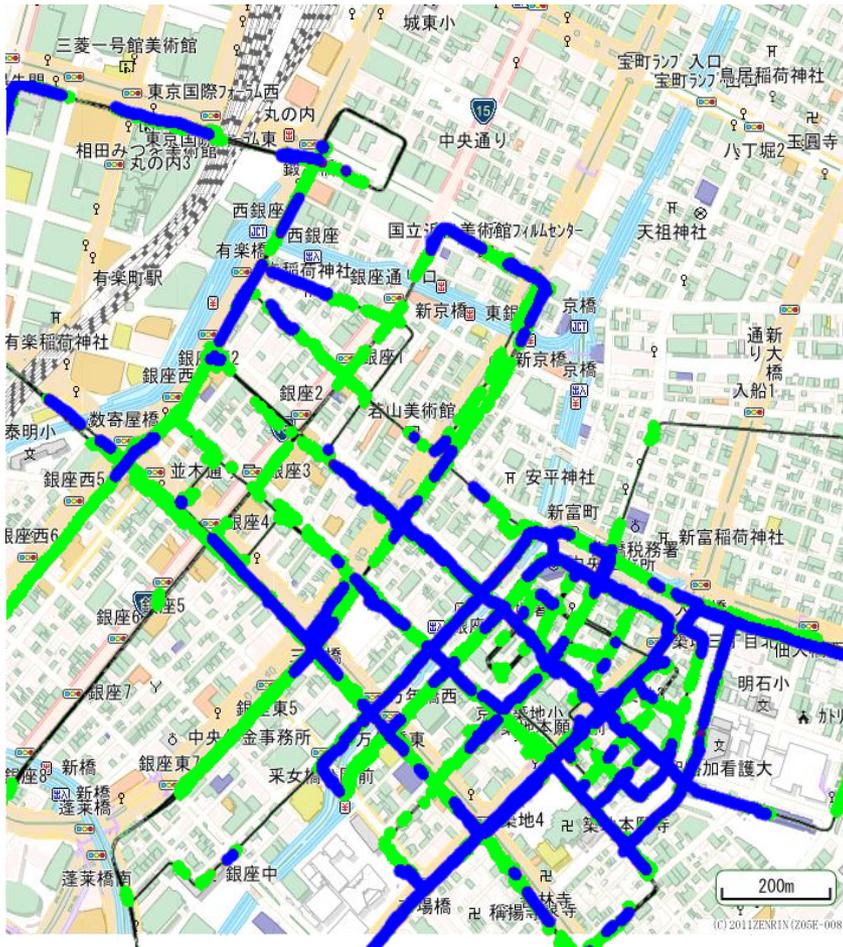
SIS-URE for the first satellite is 40cm (rms) level which is comparable with those for GPS Block IIRm and IIF satellite

During one month in August 2015, 34cm (rms)



QZSS Technical Verification of QZS-1 MICHIBIKI

Availability Improvement in Ginza, Tokyo (Feb. 19, 2011)



© 2011ZENRIN (Z05E-008)

- Reference route
- Positioning result of GPS stand-alone use
- Positioning result of GPS+QZSS combination use

Date of Observation: 2011/2/19

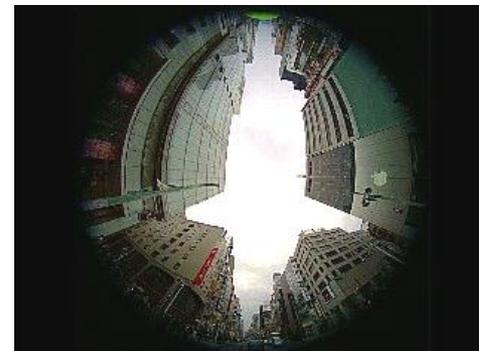
250 minutes driving observation data during 6:00–12:30 obtained under JAXA–Melco joint research experiment

Single Frequency DGPS positioning Availability

GPS: 39.5%



GPS+QZSS: 69.1%



© JAXA.

QZSS Technical Verification of QZS-1 MICHIBIKI

Availability Improvement in Hanoi, Vietnam (Oct. 21-23, 2014)

Receive QZSS signal well and have no missing data



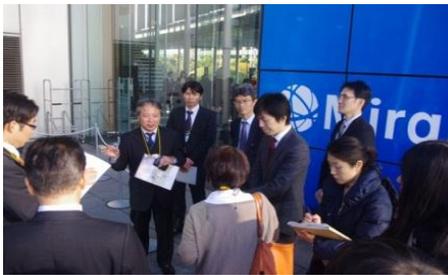
QZSS Service: MSG related Service



④ Satellite Report for Disaster and Crisis Management

Automatically switching vending machines to emergency mode

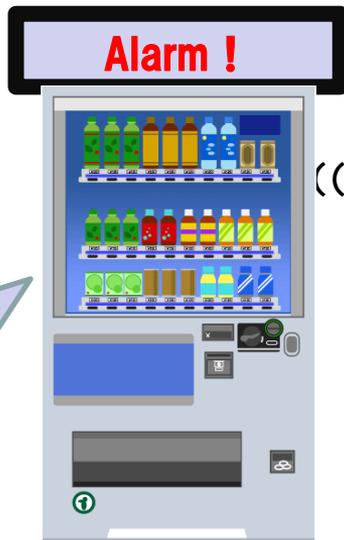
Receive emergency disaster information (Satellite Report for Disaster and Crisis Management Service), ⇒ Alarm display + Free Distribution



Display

Alarm !

Distributed free of charge



QZ1
(Receiver)



Disaster information

QZS



QZSS
Ground Station

Disaster Information Center (ex.)
(Vending Machine Control)



Receivers for Demo.

- Necessary receiver (s) will be loaned to participants for free

For Sub-meter Augmentation and Short Message



QZ1



QZPOD



QZNAV

For Centimeter Augmentation



LEXR
(CMAS)

LPY-10000
(CMAS)

For Multi-frequency/Multi GNSS



ALPHA G3T

Other Receivers and Apps.



Watch (SEIKO:SBXB003)



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.

- ✓ SBAS signal will be provided via QZSS.
 - SBAS Service will be available from 2020' s under Ministry of Land, Infrastructure, Transport and Tourism jurisdiction.

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.