Quasi-Zenith Satellite System

Sarobetsu

Koganei

Okinawa

Chichijima

Hawaii

Guam

Bangkok

Bangalore

Canberra

**Office of National Space Policy,
Cabinet Office, Government of Japan**

System Overview

- ***Functional Capability:***
  - ☐ GNSS Complementary
  - ☐ GNSS Augmentation
  - ☐ Messaging Service

- ***Coverage:*** Asia and Pacific region
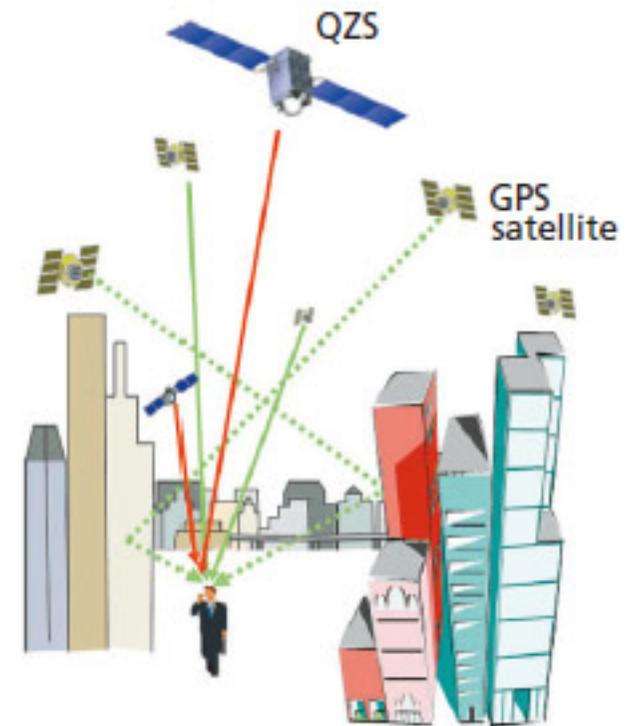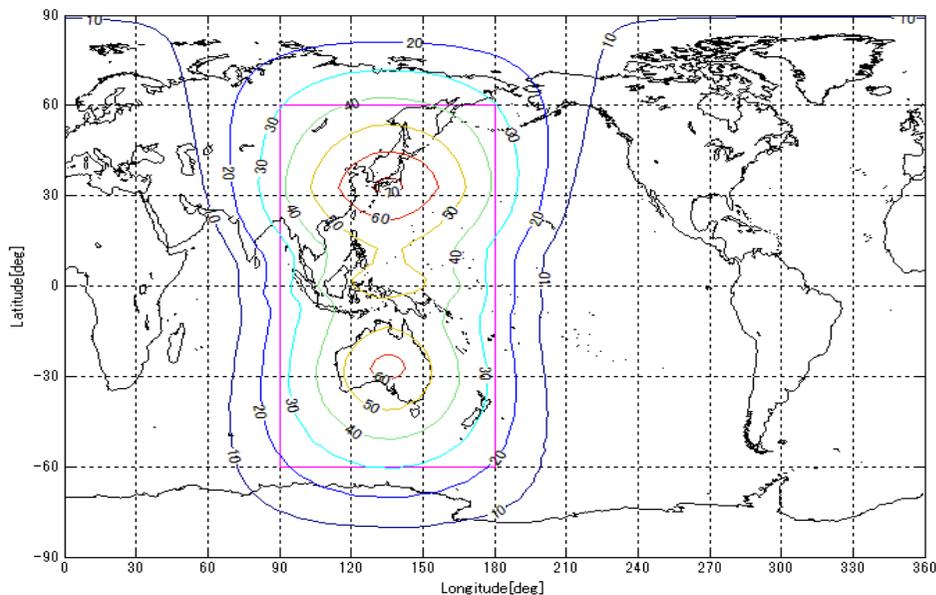
System Overview
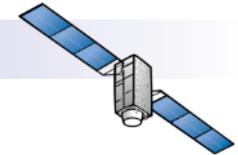
- **Signals:**

Signal	1st Satellite	2nd–4th Satellite		Service		Frequency
	QZO	QZO	GEO			
L1 C/A	○	○	○	Positioning	complement GPS	1575.42 MHz
L1 C	○	○	○	Positioning	complement GPS	
L1 S (L1-SAIF)	○	○	○	Augmentation (Sub-meter) (*)		
L2 C	○	○	○	Positioning	complement GPS	1227.6 MHz
L5	○	○	○	Positioning	complement GPS	1176.45 MHz
L5 S	—	○	○	Augmentation Experimental Use		
L6 (LEX)	○	○	○	Augmentation (Centimeter)		1278.75 MHz
S-band	—	—	○	Message Service (Safty Confirmation)		2 GHz band

＊ : Message service (Satellite Report for Disaster and Crisis Management) is also provided in L1S

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System Overview
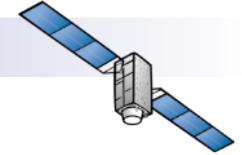
- ## *Constellation:*
  - ☐ 1 GEO Satellite
  - ☐ 3 QZO Satellite
    - ■ *First QZSS satellite "MICHIBIKI" launched in 2010.*

- ## *Ground System*
  - ☐ 2 Master Control Stations
  - ☐ 7 Satellite Control Stations
  - ☐ Over 30 Monitor Stations around the world
   (Including exclusive GPS monitoring use stations)

準天頂軌道
Quasi-zenith orbit

Equator
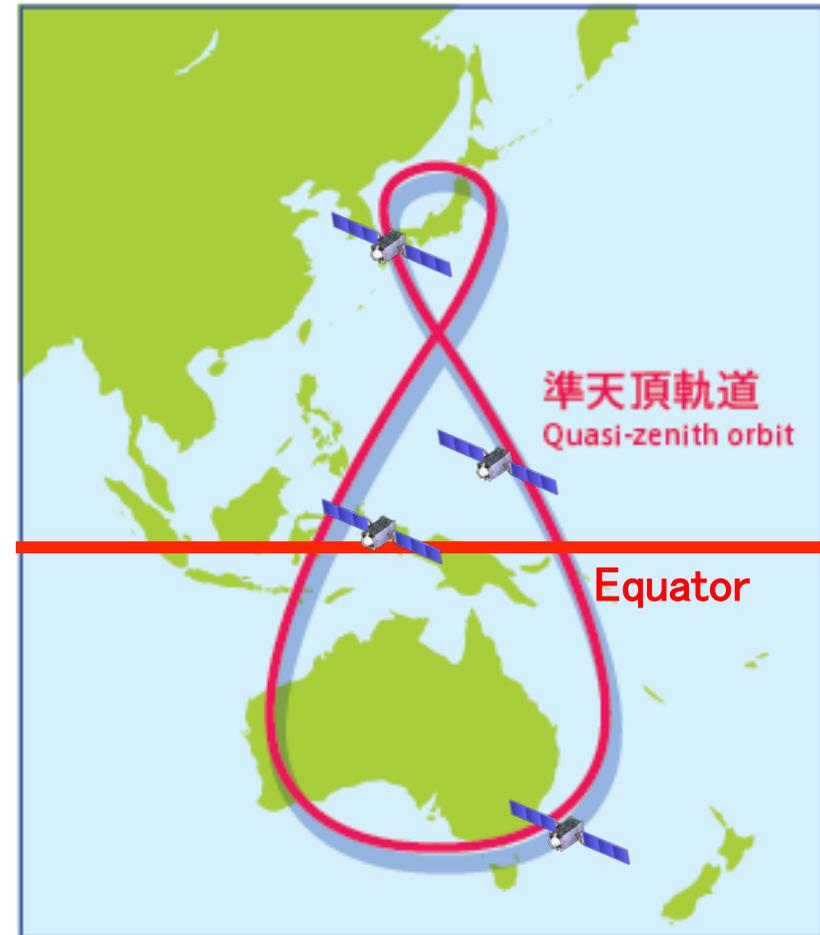
Basic policy on the implementation of the operational QZSS project (1)
Cabinet Decision on September 30, 2011
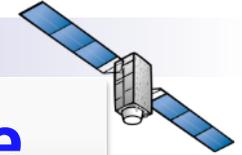
The QZSS will contribute to

- Welfare of the Asia and Pacific region

- Broad range of security including the improvement of the capacity to respond to natural disasters
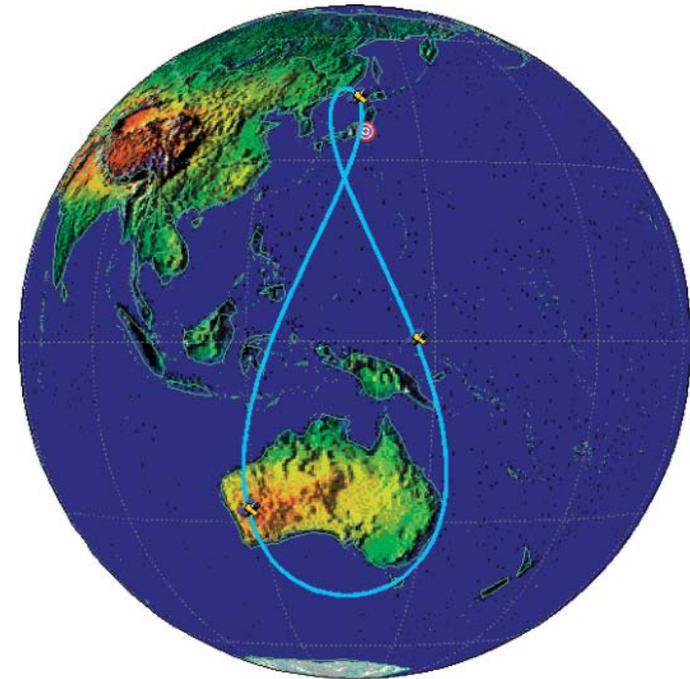

QZSS Satellite Ground Track

Basic policy on the implementation of the operational QZSS project (2)
Cabinet Decision on September 30, 2011

- **GOJ has decided to accelerate the deployment of the operational QZSS as expeditiously as possible.**

- **Four satellites constellation shall be established by the late 2010s.**

- **In the future, seven satellites constellation shall be completed to enable sustainable positioning.**

2010
1 QZO
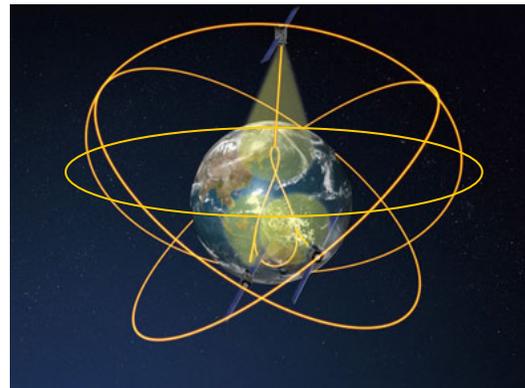
2018
1 GEO, 3 QZOs
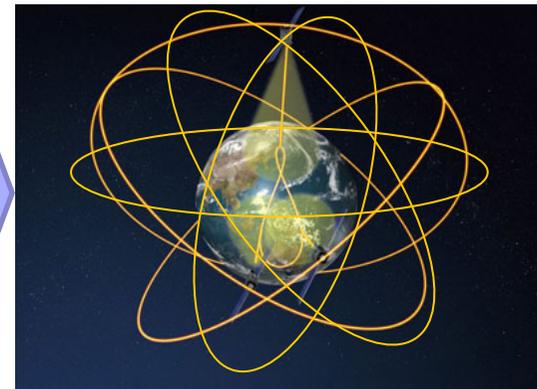
in the future
7 satellites constellation
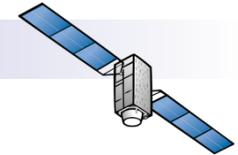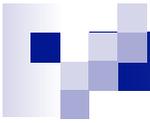
Schedule
(Planned)

FY	2012	2013	2014	2015	2016	2017	2018	------	2032
Over All		**Development** (QZS-2,3,4 & Ground System) (~6 years)				Evaluation	**Operation (15 years)**		
	QZS-1 In-Operation by JAXA					Operation by QSS			
Satellite System (QZS-2,3,4)		Design	Manufacturing		Test	Launch			
Ground System (Next generation)		Design	Manufacturing		Test				
Specification Documents			Interface Specification/ Performance Standard						

△ We are here

■ *Four satellites constellation shall be established & the service will start in 2018.*

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# *GNSS Complementary*

QZSS improves positioning availability time

Navigation signals L1-C/A, L1C, L2C, and L5 sent from high elevation will improve the time percentage of positioning availability.


QZS

GPS

Accuracy : Signal-in-space User Range Error (SIS-URE)

MICHIBIKI SIS-URE meets its specification, within +/- 2.6m (95%).
Its SIS-URE(RMS) is about 40cm & less than that of GPS's target, about 90cm*.

Average	−0.0303	[m]
RMS	0.4003	[m]
Percentage of Time (│ URE │ ≦2.6[m])	99.998	[%]

(Spec: ≧95[%])

(GSIC 2011)

© JAXA.

SIS-URE (June 2011 ～ April 2013)

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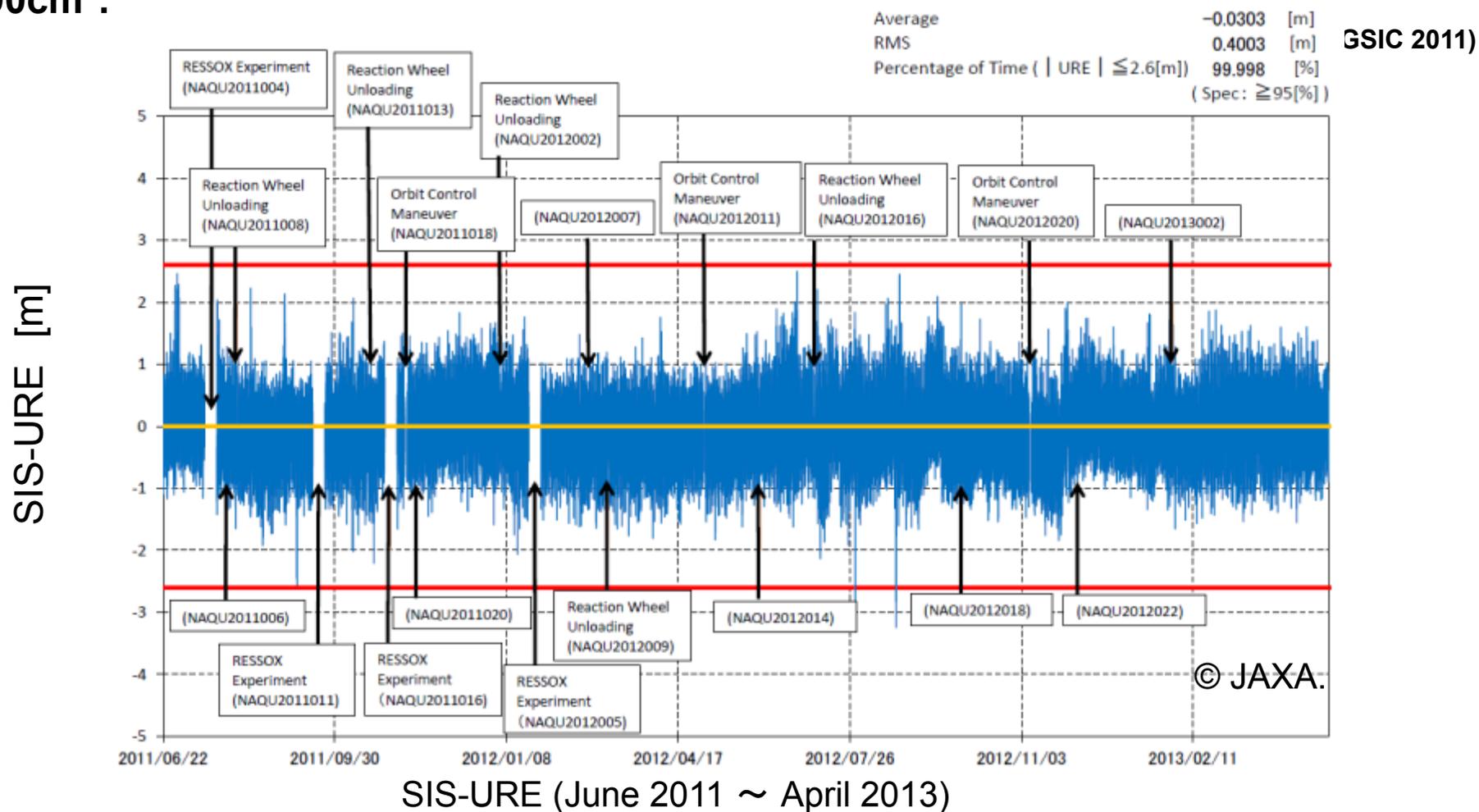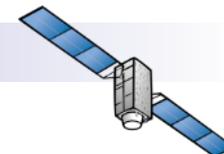
QZSS Technical Verification of QZS-1 MICHIBIKI

Availability Improvement in Ginza, Tokyo (Feb. 19, 2011)
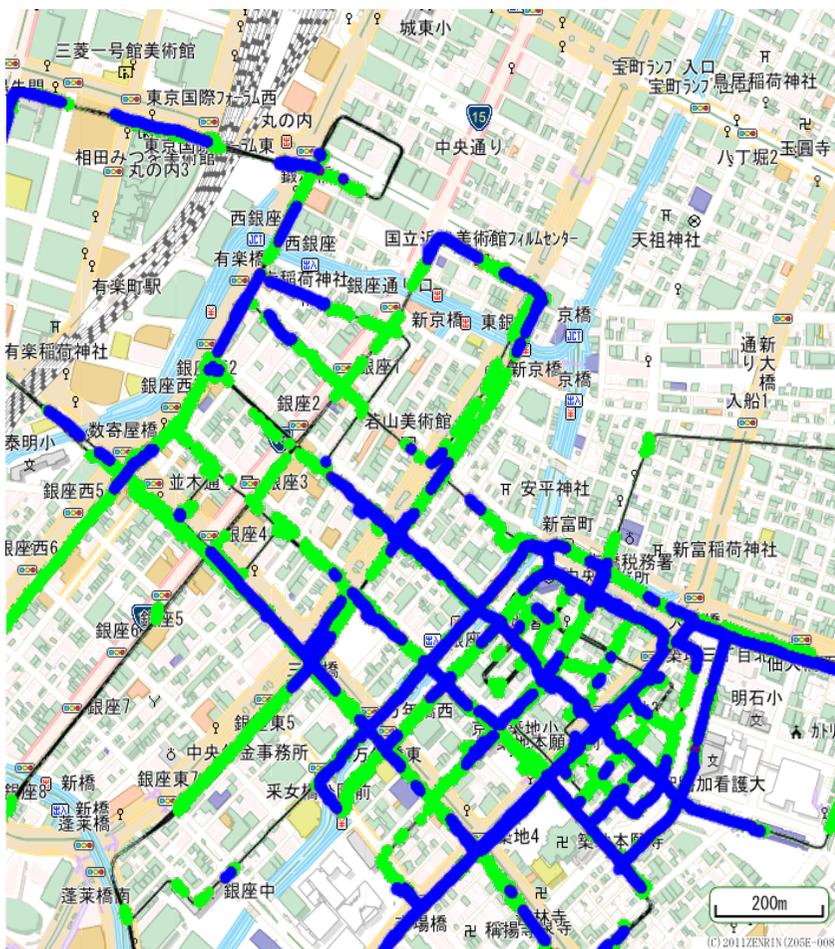
© 2011ZENRIN (Z05E-008)

— **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%**
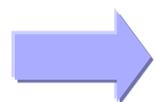
➡ **GPS+QZSS**:**69.1%**
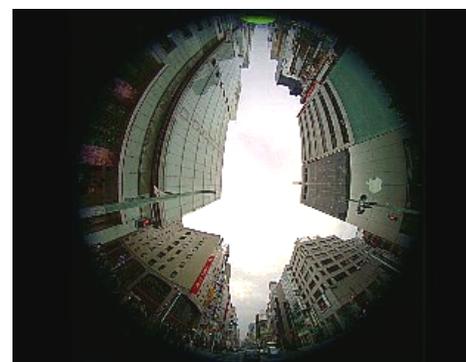
© JAXA.

GNSS Augmentation

QZSS improves positioning accuracy and reliability

QZSS

Navigation Signal

GPS   Galileo   GLONASS

Navigation Signal and Augmentation Data

Ground Segment

GNSS Earth Observation Network

Augmentation Data Generation

Global Monitoring Stations

User Segment

L6 **centimeter** (accuracy) **sub-meter** L1S

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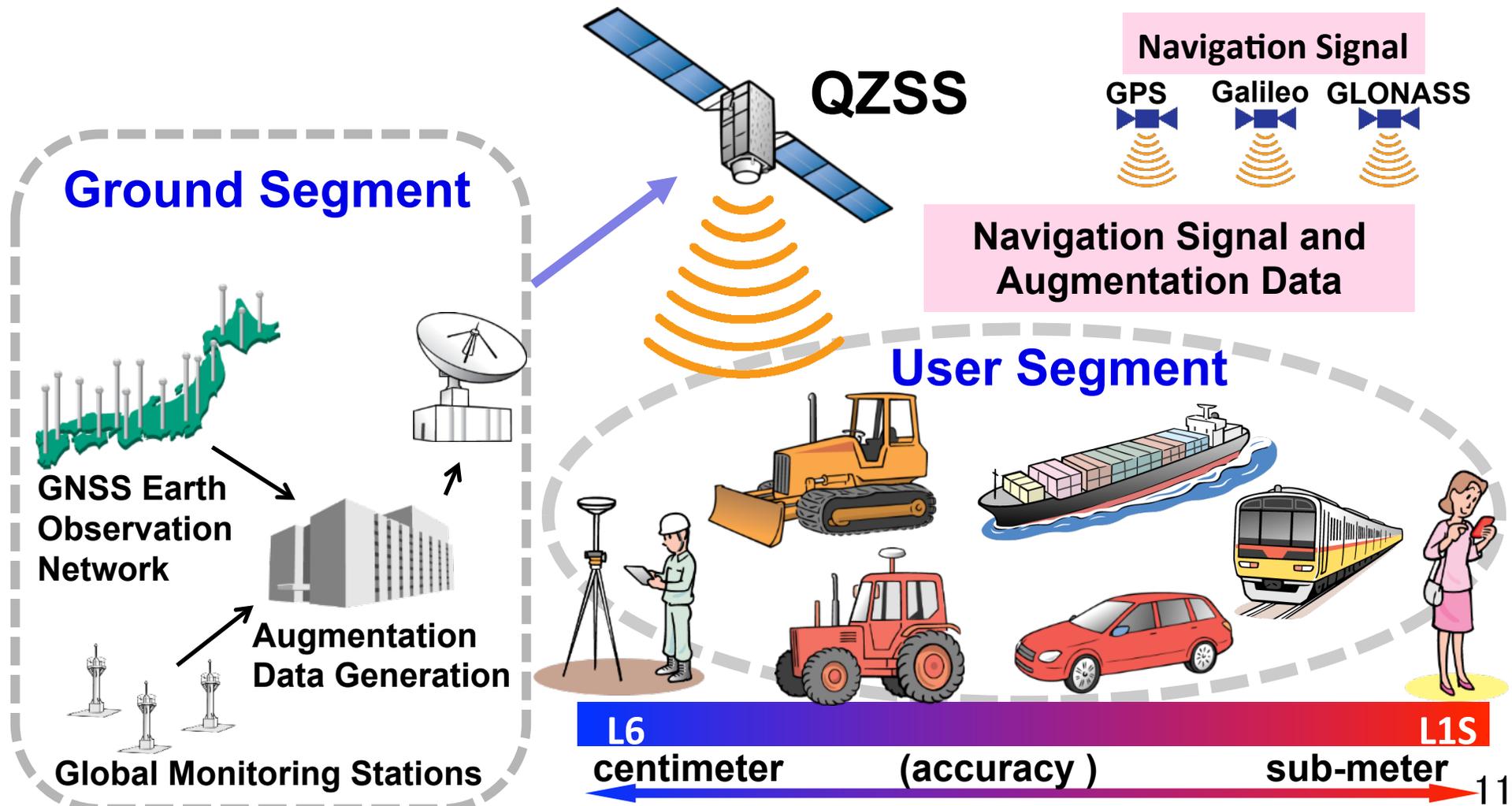
Functional Capability 2 *GNSS Augmentation*

Sub-meter Class Augmentation

QZSS

Ground Segment

GNSS Earth Observation Network

Augmentation Data Generation

Global Monitoring Stations

Sub-meter class Augmentation Data L1S (250 bps)

Using QZSS Augmentation Signal ~ 2m

Using GPS only ~ 10m
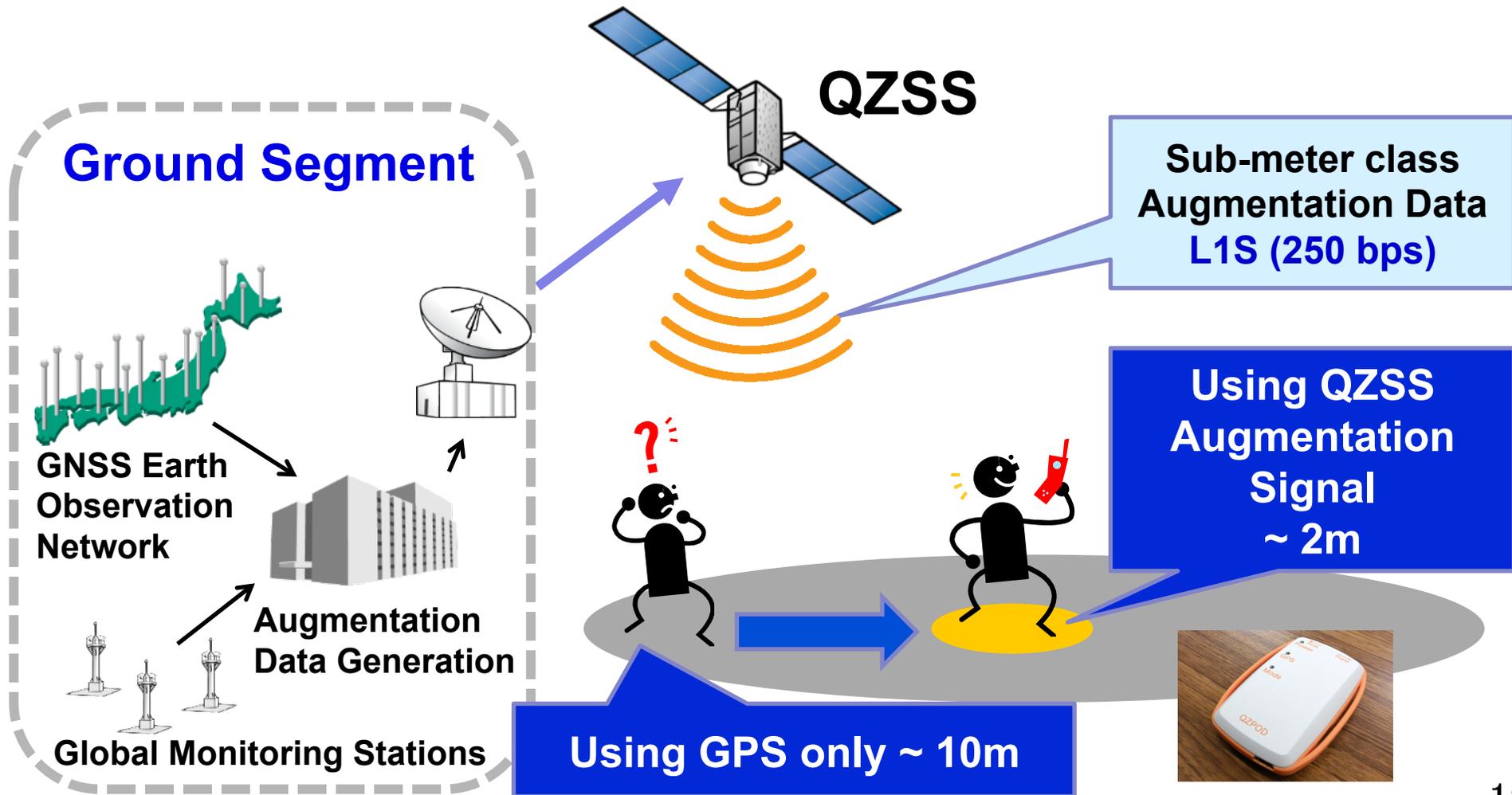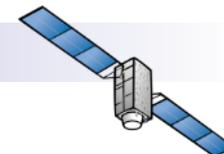
QZSS Technical Verification of QZS-1 MICHIBIKI

Accuracy Improvement using augmentation signal L1-SAIF from MICHIBIKI
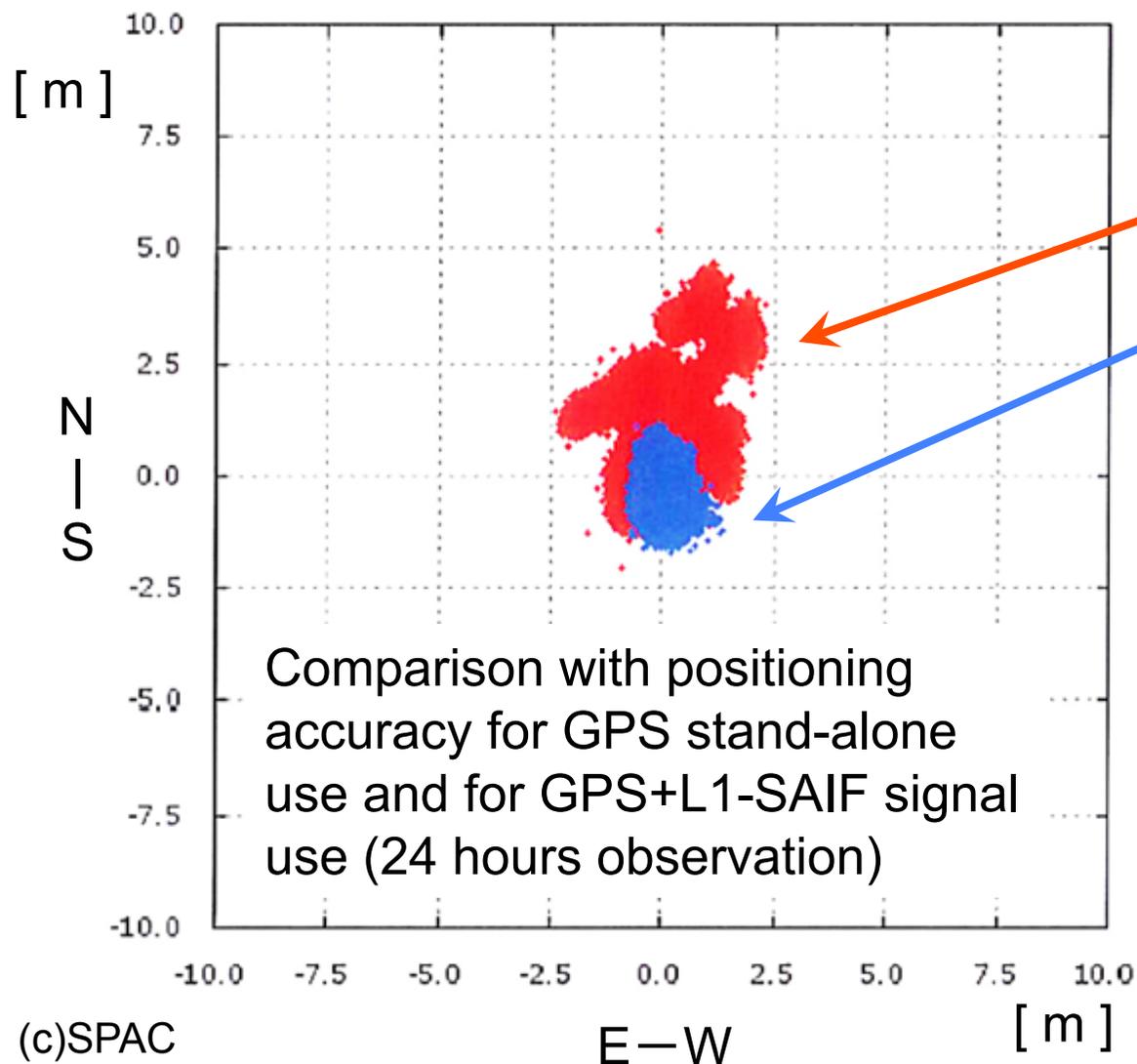
Positioning Error(RMS)

Horizontal	
GPS Only	**1.56m**
GPS+ L1-SAIF	**0.46m**

Vertical	
GPS Only	**3.85m**
GPS+ L1-SAIF	**0.57m**

Comparison with positioning accuracy for GPS stand-alone use and for GPS+L1-SAIF signal use (24 hours observation)

* Observation Point
  GPS-based control station
  in Kawagoe, Japan, 5/3/2011

* SAIF : Submeter-class Augmentation with Integrity Function, conformable to SBAS signal

(c)SPAC

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Functional Capability 2 *GNSS Augmentation*

Centimeter Class Augmentation

QZSS

Ground Segment

Centimeter class Augmentation Data L6 (2000 bps)

GNSS Earth Observation Network

Augmentation Data Generation

Global Monitoring Stations

Precise Survey　　**IT Construction**　　**IT Agriculture**

Real-time Users (cm level accuracy)
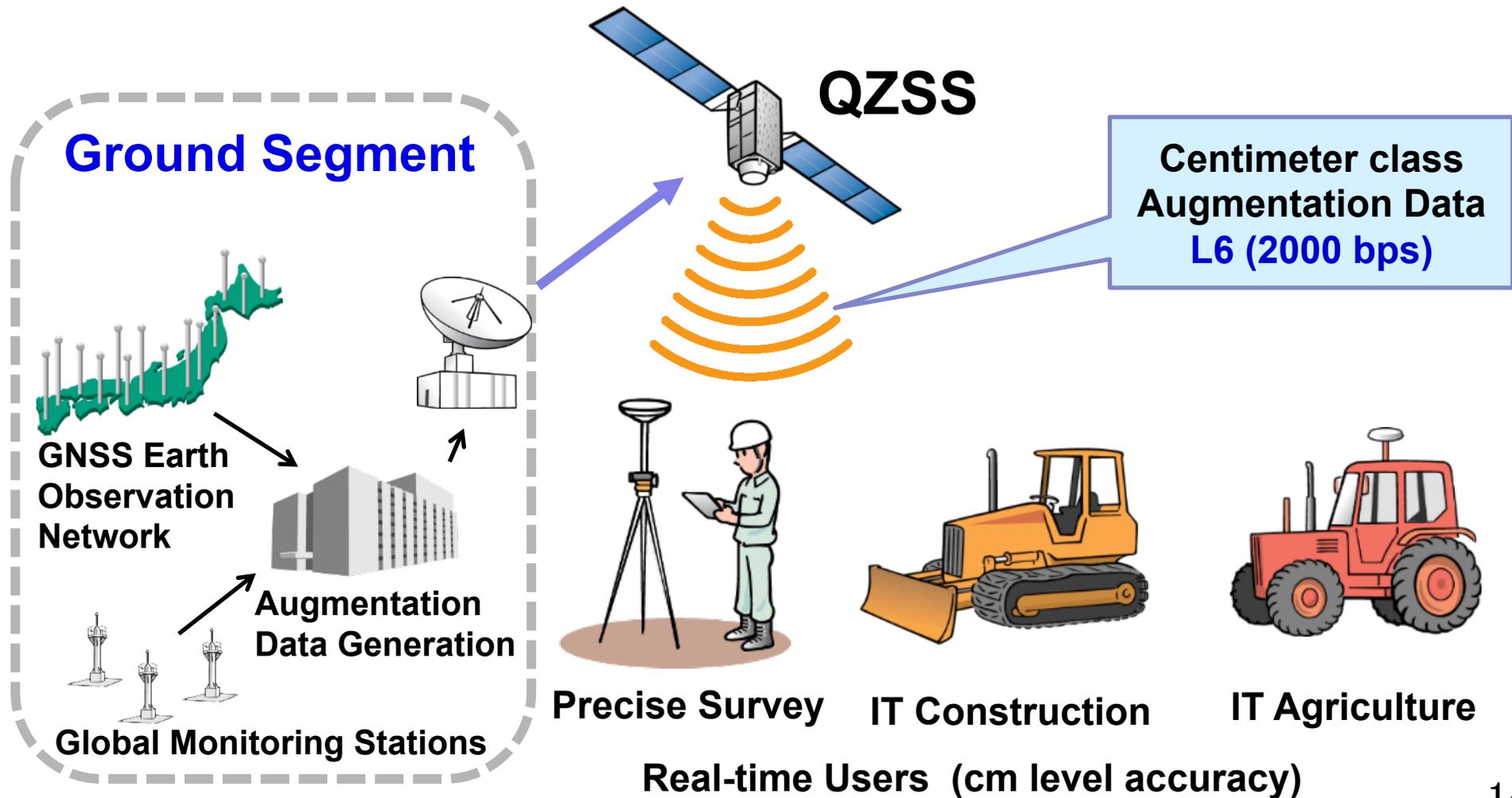
Precision Farming using augmentation LEX signal from QZS-1

Robot Tractor

Robot controller

QZSS receiver

Antenna of QZSS

Soil preparation

Fertilizing and planting

Weeding

Chemical splaying

Puddling

Transplanting

Harvesting

Tillage

Path #	Lateral error (m)
1	0.035
2	0.027
3	0.036
4	0.031

15
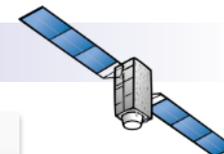
Messaging Service

Satellite Report for Disaster and Crisis Management (DC Report)

- Using L1S signal, QZSS will transmit disaster-related information, such as about earthquakes and tsunamis.
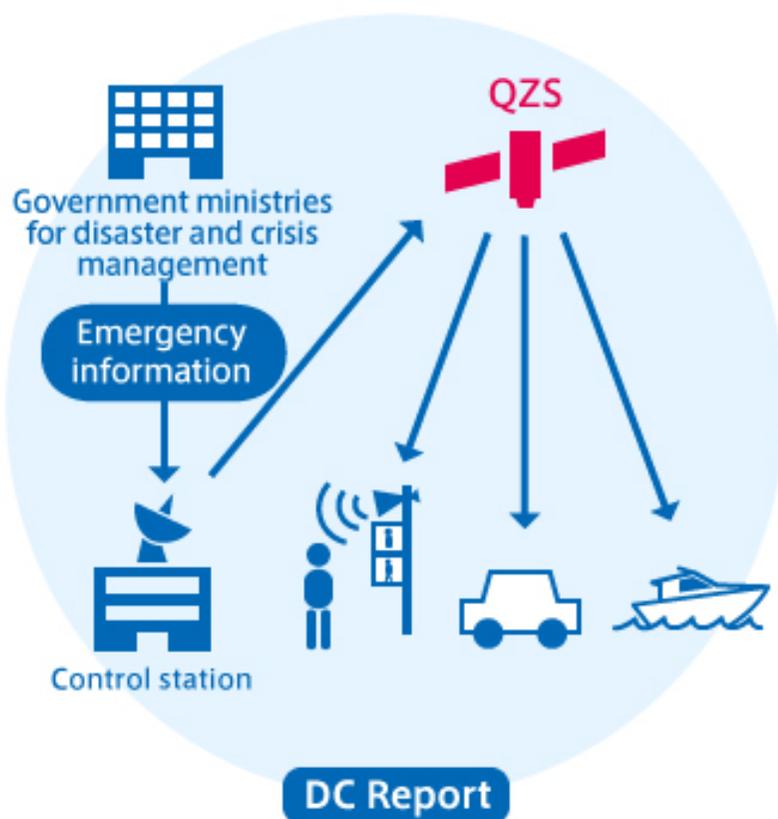


TSUNAMI Evacuation Instruction Go to xxxxxx

Messaging Service

QZSS Safety Confirmation Service

- In cases such as large-scale disasters, safety confirmation information can be sent by e-mail to close relatives who have been registered in advance.

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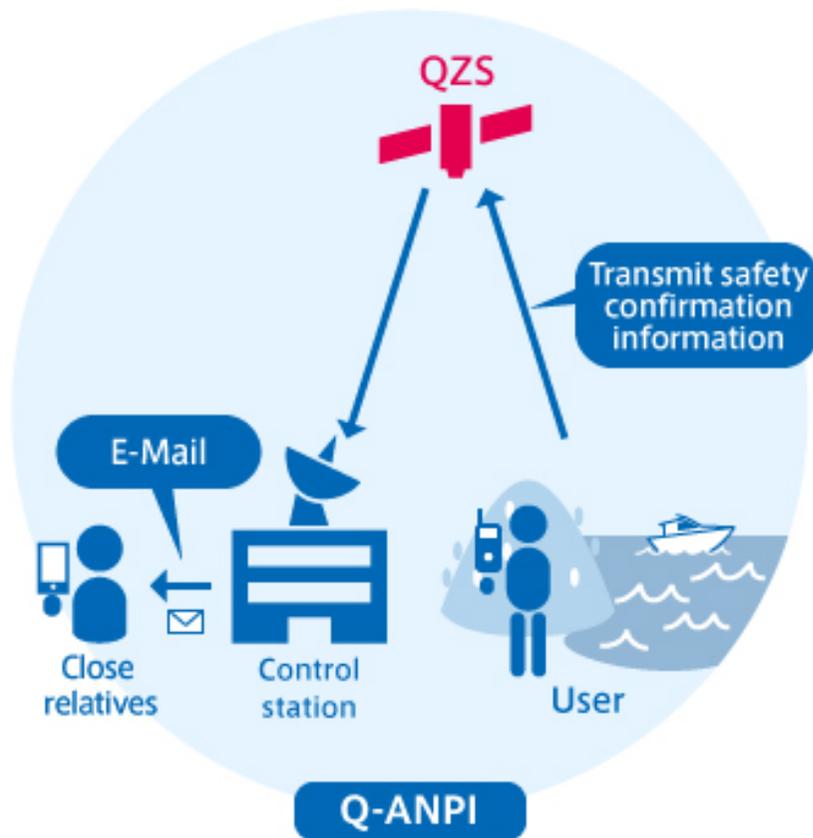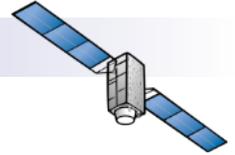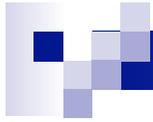
Summary

- **Satellite System: in the process of PDR, Ground System: in the process of PDR**

- **IS/PS-QZSS(Interface Specification/ Performance Standard) in preparation**

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