

Japanese Regional Navigation Satellite System

QZSS

NCSR6

Jan.18, 2019

IMO/London

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

Contents

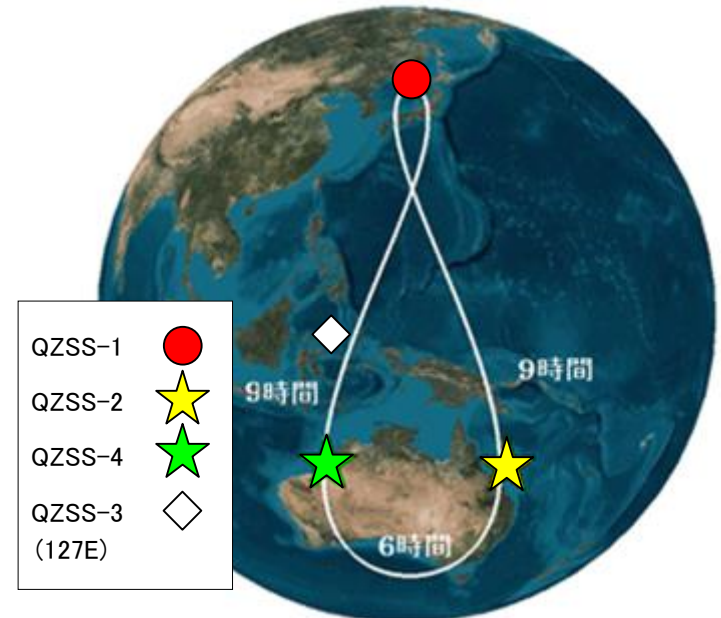
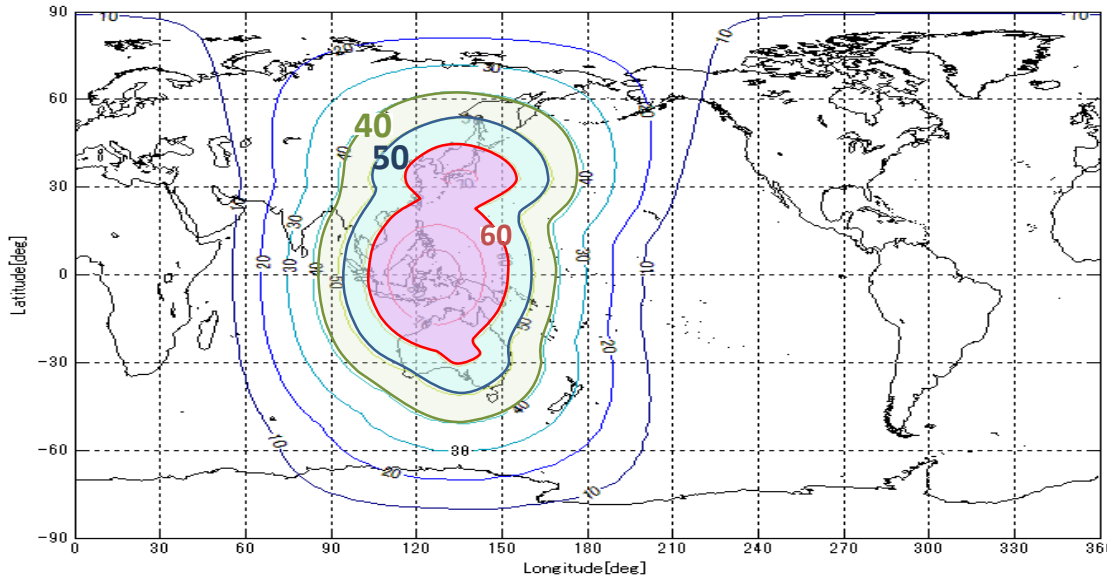
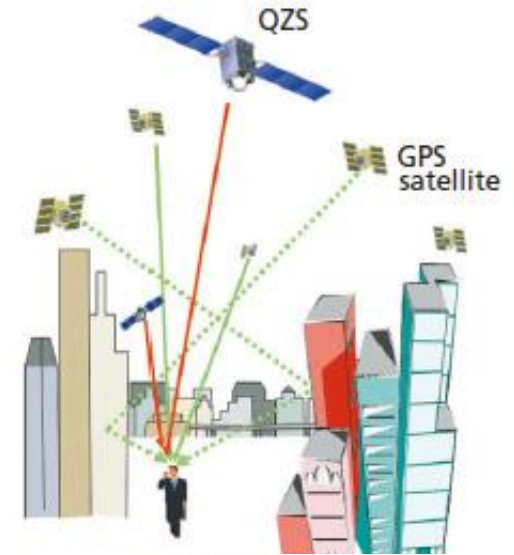


1. QZSS Overview
 - Services
 - System Architecture
 - Development Status
2. Recent Development
 - QZSS Performance
 - Vessel Tracking in the Maritime Field
3. Summary

QZSS Overview -Services-



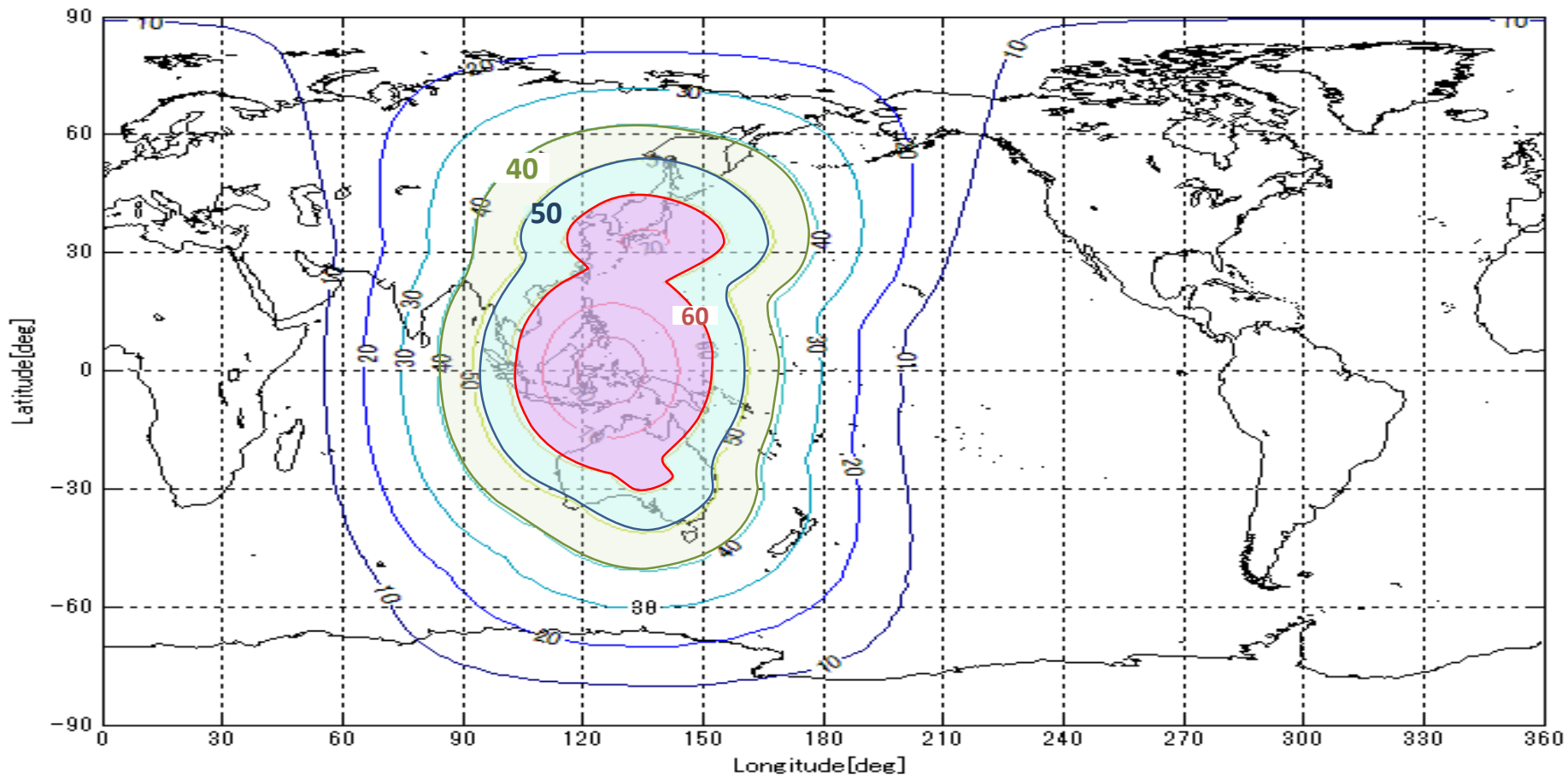
- **Functional Capability:**
 - GPS Complementary Service
 - GNSS Augmentation Service
 - Messaging Service
- **Coverage:** Asia and Pacific region



QZSS Overview -Services-



- **Coverage:** Asia and Pacific region



Minimum Largest Elevation Angle Contour in the QZSS 4SV Constellation

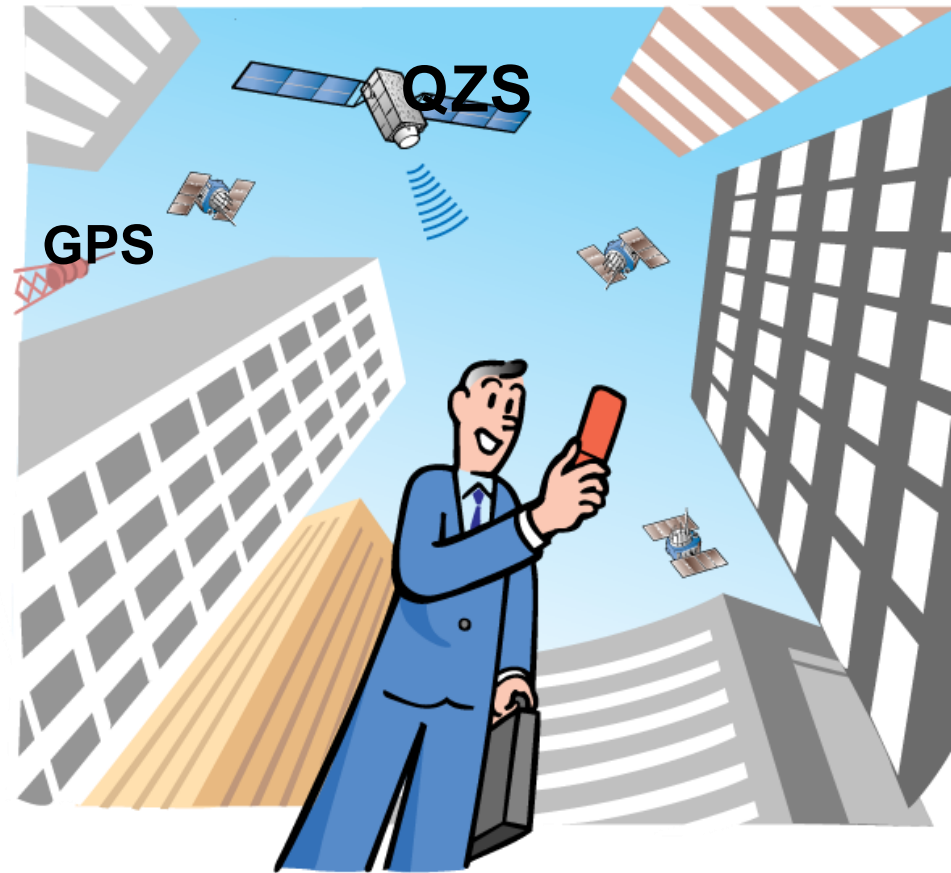
QZSS Overview -Services-



Functional Capability 1 GPS Complementary Service

QZSS improves positioning availability

- Navigation signals L1-C/A, L1C, L2C, and L5 coming from high elevation (near zenith) improve PNT availability.
- QZSS is the first L1C and L5 signals provider offering interoperability among other GNSS.
- SIS-URE: 2.6m (95%)

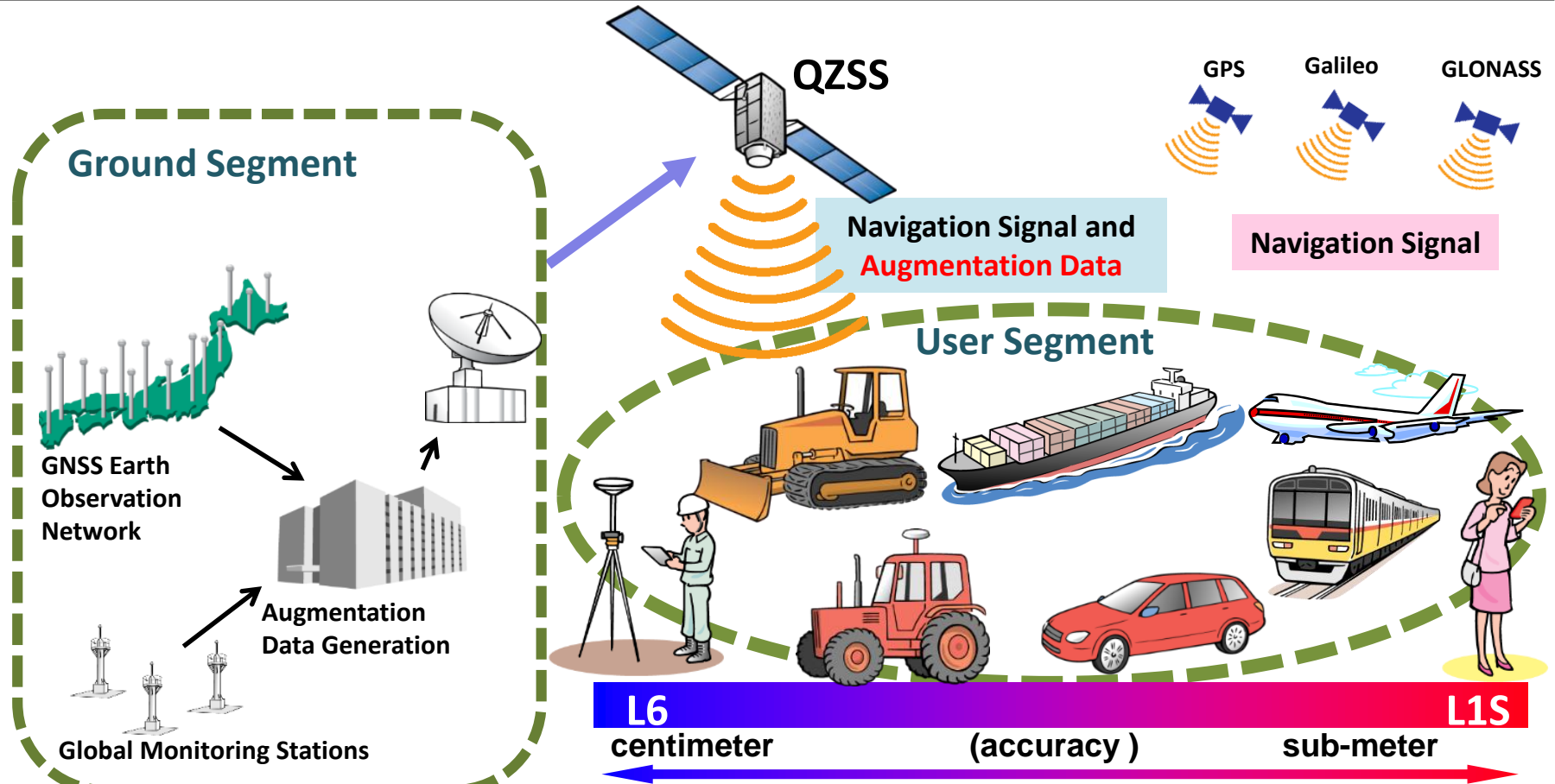


QZSS Overview -Services-



Functional Capability 2 GNSS Augmentation Service

QZSS improves **positioning accuracy and reliability**



QZSS Overview -Services-



Functional Capability 3 Messaging Service

Satellite Report for Disaster and Crisis Management (DC Report)



QZSS

- Using margin of L1S signal
- Same service coverage as GPS complementary service

Disaster Info. provided by JMA such as Tsunami, Volcanic eruption, weather warning and so on.

Using one of four slots of L1S:1575.42MHz, once a four seconds, 250 bits short code can transmits disaster management info with applicable location

DC Report available Handset
(GNSS Rx, Car Navigation device)

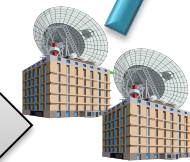


Rx can select the Info which shown the devices depending on their location



Japan Meteorological Agency (JMA)

Disaster Info.



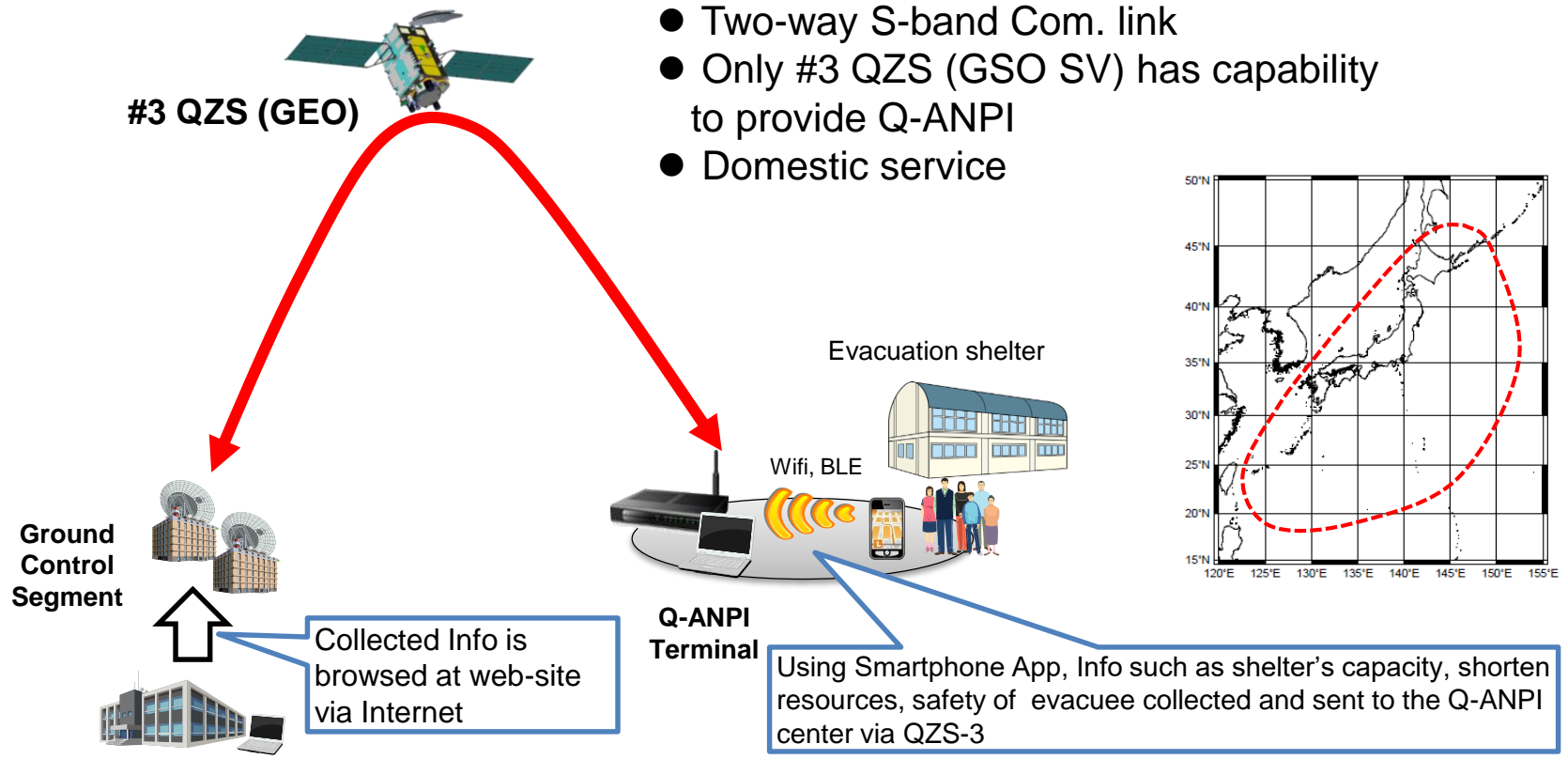
Ground Control Segment

QZSS Overview -Services-



Functional Capability 3 Messaging Service

QZSS Safety Confirmation Service (Q-ANPI)



Disaster organization, Municipal government

This service is available on S-band devices that support Q-ANPI, Q-ANPI terminal.

Contents



1. QZSS Overview

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- System Architecture
- Development Status

2. Recent Development

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3. Summary

QZSS Overview -System Architecture-

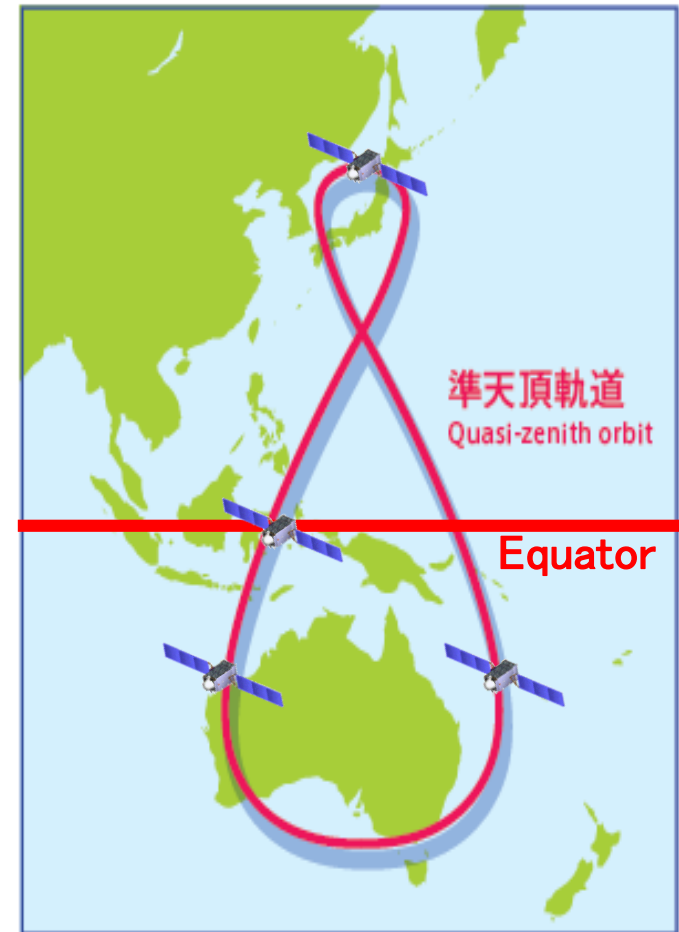


- **Constellation:**

- 1 GEO Satellite, 127E
- 3 QZO Satellite (IGSO)

- **Ground System**

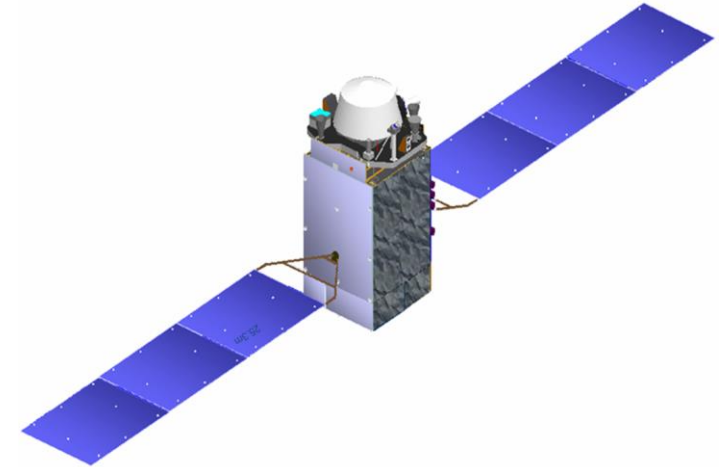
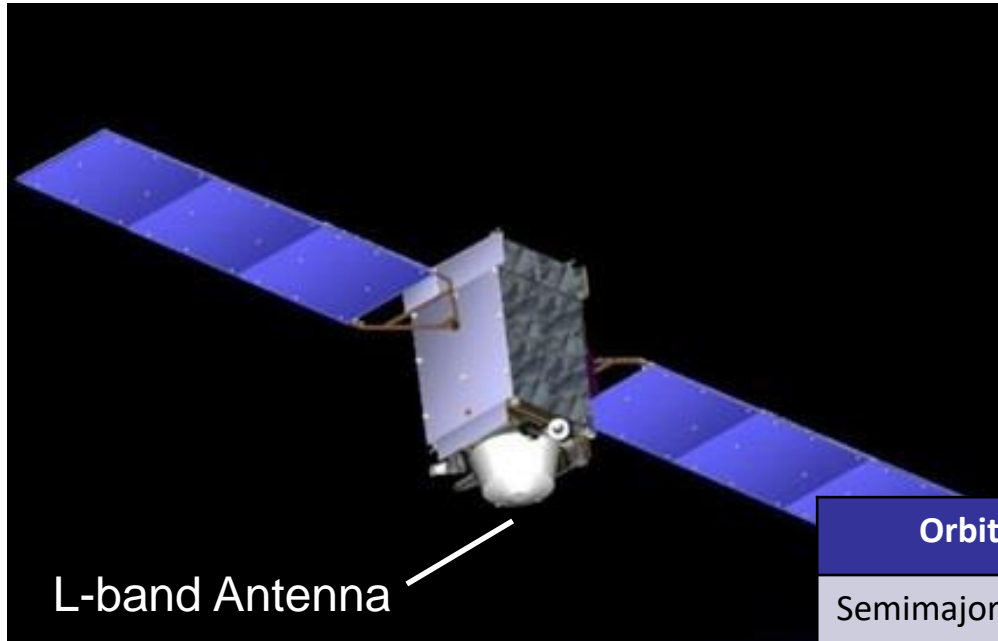
- 2 Master Control Stations
 - Hitachi-Ota and Kobe
- 7 Satellite Control Stations
 - Located south-western islands
- Over 30 Monitor Stations around the world



QZSS Overview -System Architecture-



QZSS Satellite (#1)



Launch Vehicle : H-IIA
 Mass Dry/Launch : 1.8t/4.0t
 Lifetime : 10years+

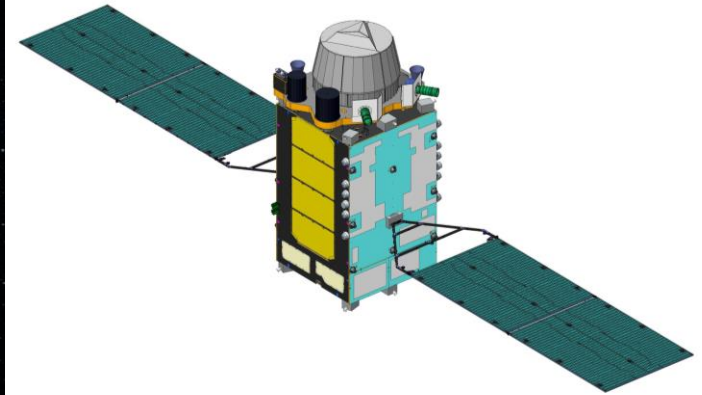
Orbit Parameter	Nominal Allocation
Semimajor Axis(A)	42164km
Eccentricity(e)	0.075
Inclination (i)	41 degree
Argument of Perigee(w)	270 degree
RAAN(Ω) (2019.1.1)	150 degree
Central Longitude (λ)	136 degree

RAAN: Right Ascension of the Ascending Node

QZSS Overview -System Architecture-



QZSS Satellite (#2 and #4)



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

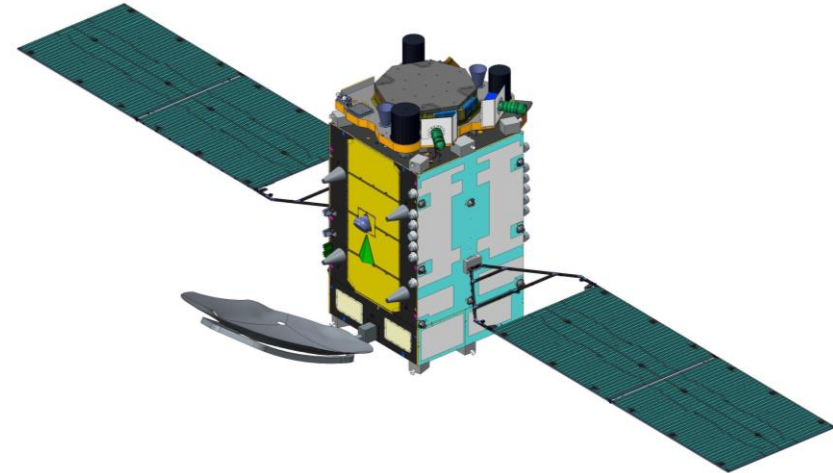
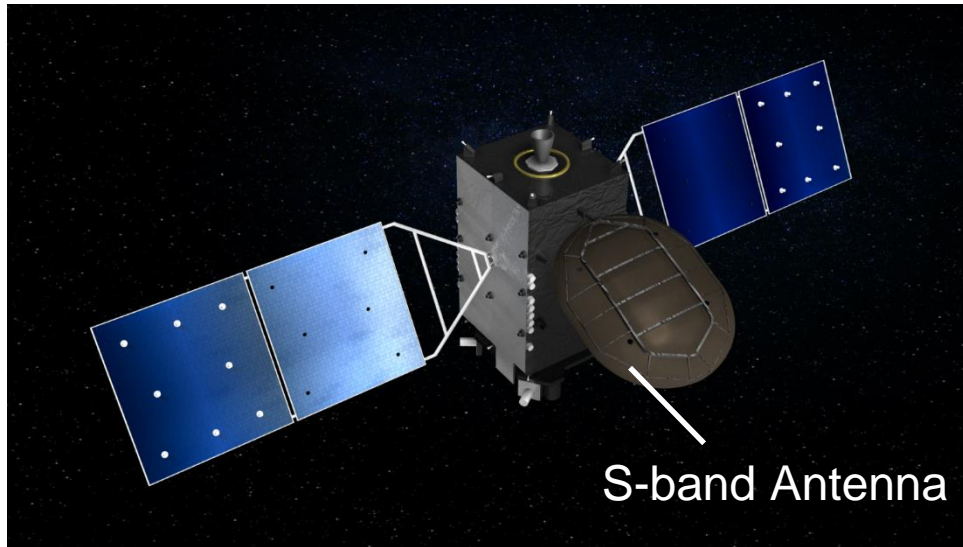
Orbit Parameter	Nominal Allocation
Semimajor Axis(A)	42164km
Eccentricity(e)	0.075
Inclination (i)	41 degree
Argument of Perigee(w)	270 degree
RAAN(Ω) (2019.1.1)	#2 : 281 degree #4 : 18 degree
Central Longitude (λ)	136 degree

RAAN: Right Ascension of the Ascending Node

QZSS Overview -System Architecture-



QZSS Satellite (#3 GEO)



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

Orbit Parameter	Nominal Allocation
Longitude	E 127
Latitude	0

- Additional S-band antenna for two-way communication for emergency safety report (Q-ANPI service).
- L1Sb signal for SBAS service.

QZSS Overview -System Architecture-



Ranging Signals of QZSS

Signal	Frequency MHz	Service	Compatibility	QZS-1	QZS-2/4	QZS-3
				IGSO	IGSO	GEO
L1C/A	1575.42	Positioning	Complement GPS	✓	✓	✓
L1C		Positioning	Complement GPS	✓	✓	✓
L1S		Augmentation(SLAS)	DGPS (Code Phase Positioning)	✓	✓	✓
		Messaging	Short Messaging	✓	✓	✓
L1Sb		Augmentation(SBAS)	SBAS (L1) Service	-	-	✓
L2C		1227.60	Positioning	Complement GPS	✓	✓
L5 I/Q	1176.45	Positioning	Complement GPS	✓	✓	✓
L5S		Experimental(L5 SBAS)	L5 SBAS (DFMC)	-	✓	✓
L6D	1278.75	Augmentation(CLAS)	PPP-RTK (Carrier Phase Positioning)	✓	✓	✓
L6E		Experimental(MADOCA)	PPP, PPP-AR (Carrier Phase Positioning)	-	✓	✓

QZSS Overview -System Architecture-



Interface Documents

	Performance Standard	Interface Specification
Satellite Positioning, Navigation and Timing Service	PS-QZSS-001	IS-QZSS-PNT-001 (March 28, 2017 / PDF: 3748KB)
Sub-meter Level Augmentation Service (SLAS)		IS-QZSS-L15-001 (March 28, 2017 / PDF: 709KB)
		IS-QZSS-I6-001

Performance Standard (PS-QZSS) and Interface Specification (IS-QZSS) are available in our website <http://qzss.go.jp/en/technical/ps-is-qzss/ps-is-qzss.html>



Contents

1. QZSS Overview

- Services
- System Architecture
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2. Recent Development

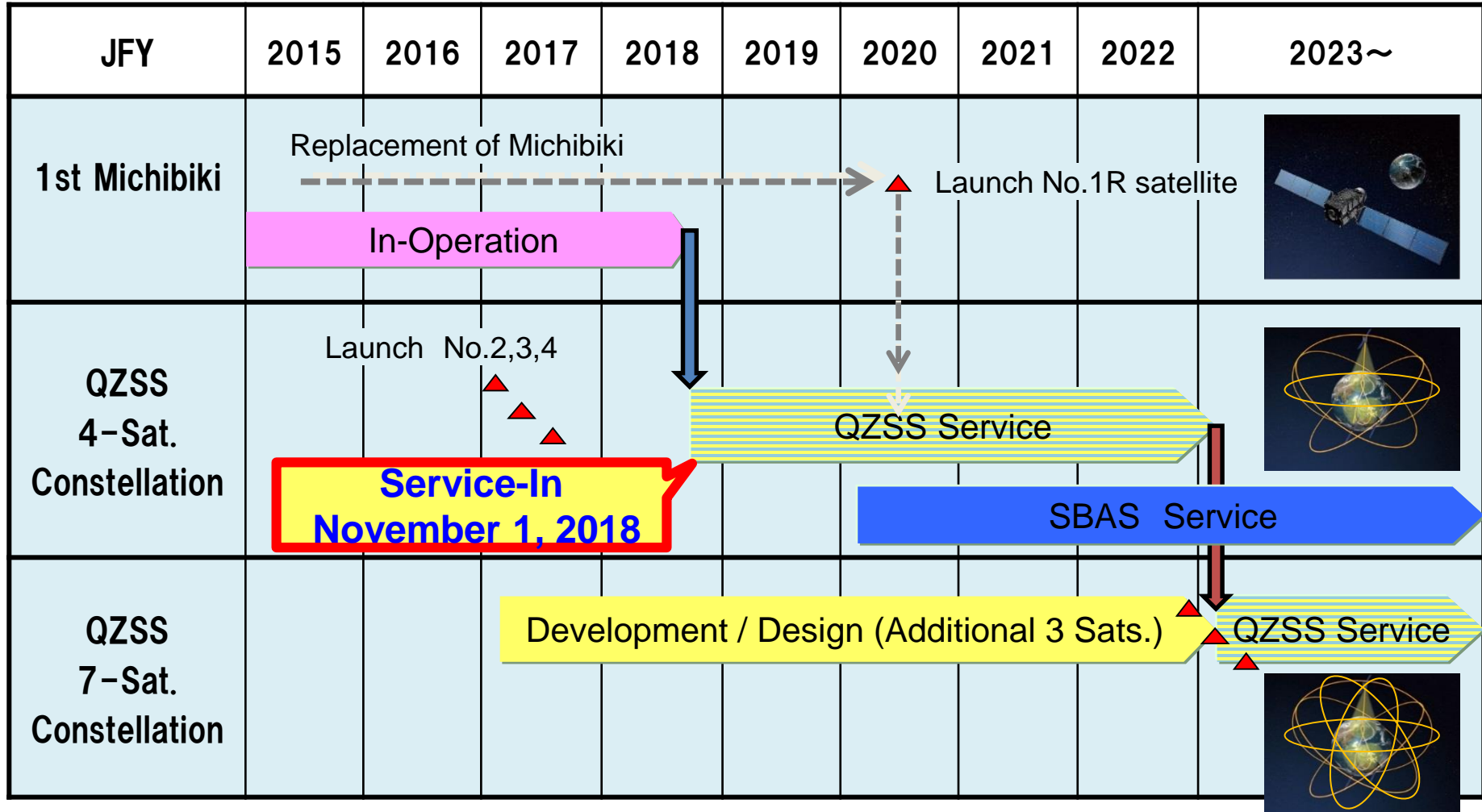
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QZSS Overview -Development Status-



QZSS Program Schedule (latest)



QZSS Overview -Development Status-



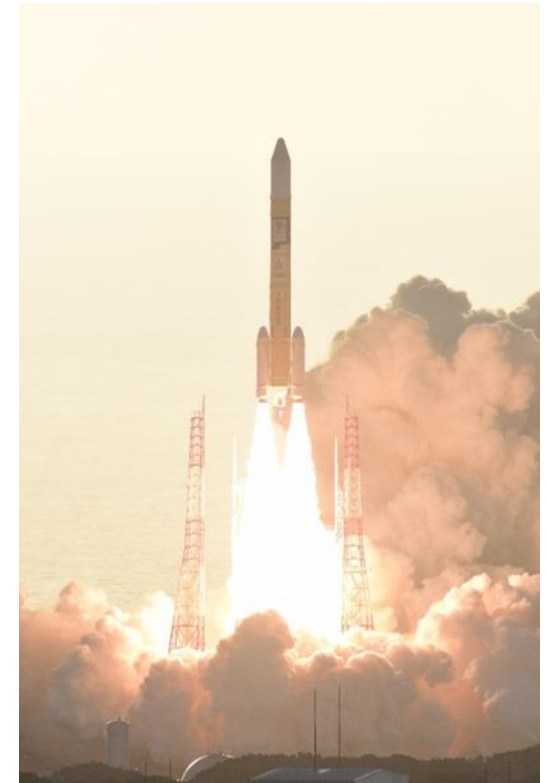
Three consecutive launches have successfully been conducted in 2017.



#2 satellite: Jun. 1, 2017
00:17:46(UCT)



#3 satellite: Aug. 19, 2017
05:29:00(UTC)



#4 satellite: Oct. 9, 2017
22:01:37 (UTC)

©MHI/JAXA

QZSS Overview -Development Status-



QZSS services were started officially on November 1, 2018 !



Prime minister Shinzo Abe (the 2nd from the right) attended the QZSS service-in ceremony on November 1, 2018.



Contents

1. QZSS Overview

- Services
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- Development Status

2. Recent Development

- QZSS Performance
- Vessel Tracking in the Maritime Field

3. Summary

QZSS Performance -PNT Service-



Performance(SIS Accuracy)

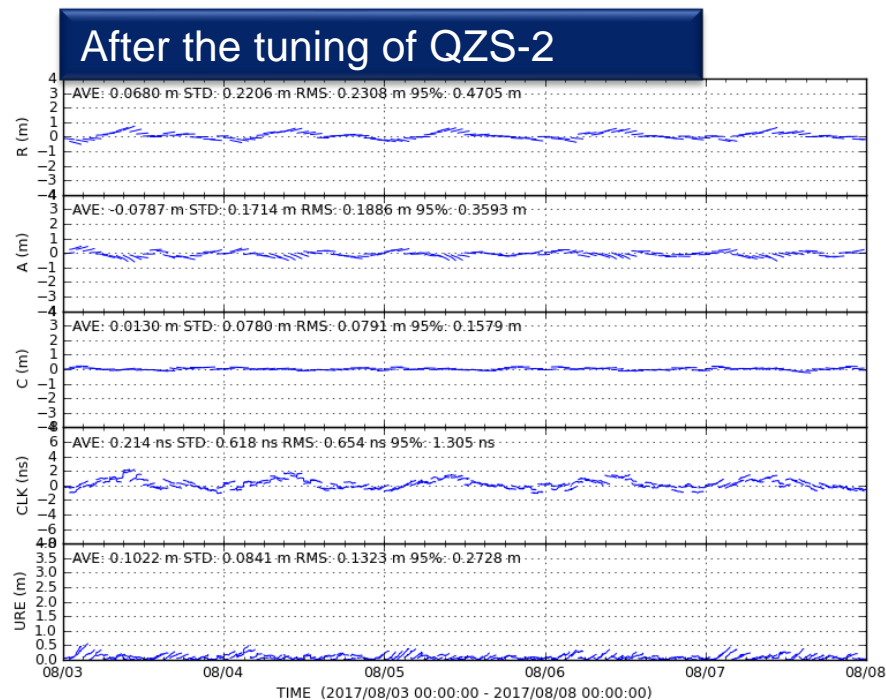
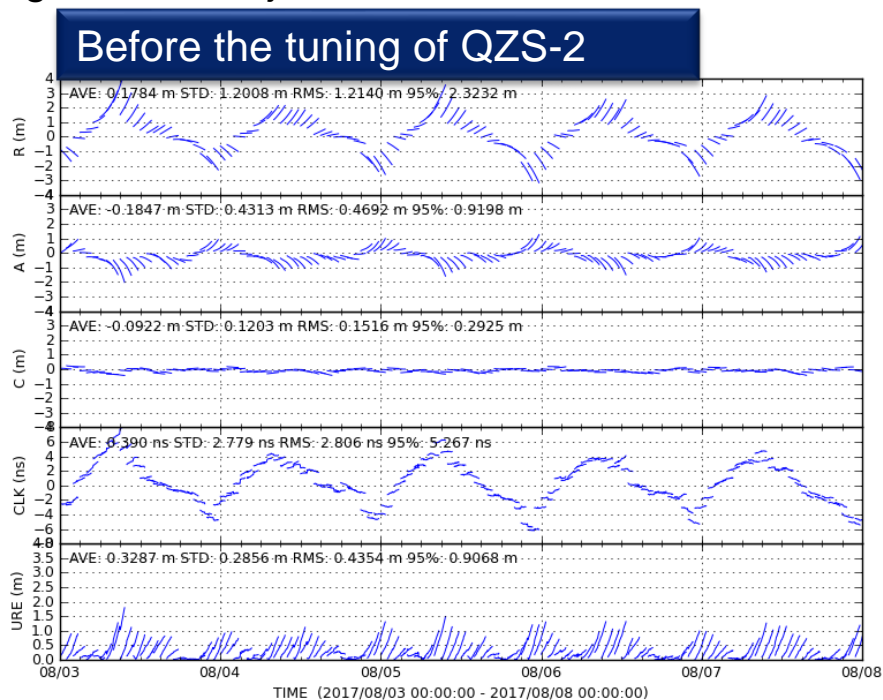
[Specification] less than 2.6m(95%)

[Evaluation (2018/5/11 ~ 2018/5/17)]

QZS-1: 0.61m(95%), QZS-2: 1.11m(95%), QZS-3: 0.96m(95%), QZS-4: 1.01m(95%)

The improvement by the tuning

In order to improve SIS Accuracy (i.e. orbit error and clock error), parameters in our estimation engine were adjusted.





Contents

1. QZSS Overview

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- QZSS Performance
- Vessel Tracking in the Maritime Field

3. Summary



Vessel Tracking in the Maritime Field

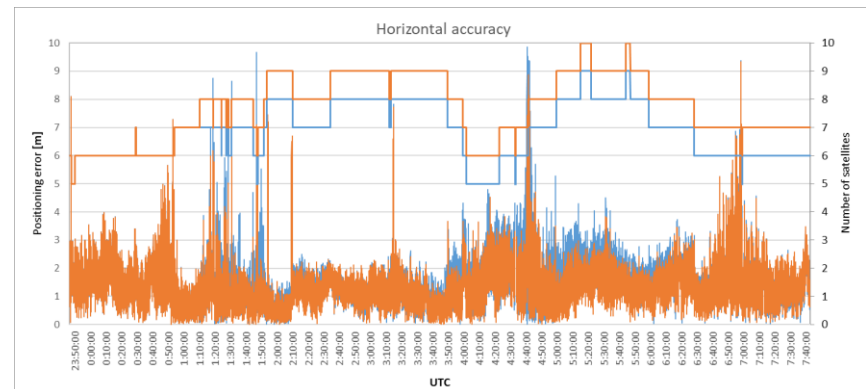
Vessel Tracking in Seto-inland (3days)



• Aug 9, 2017 Data

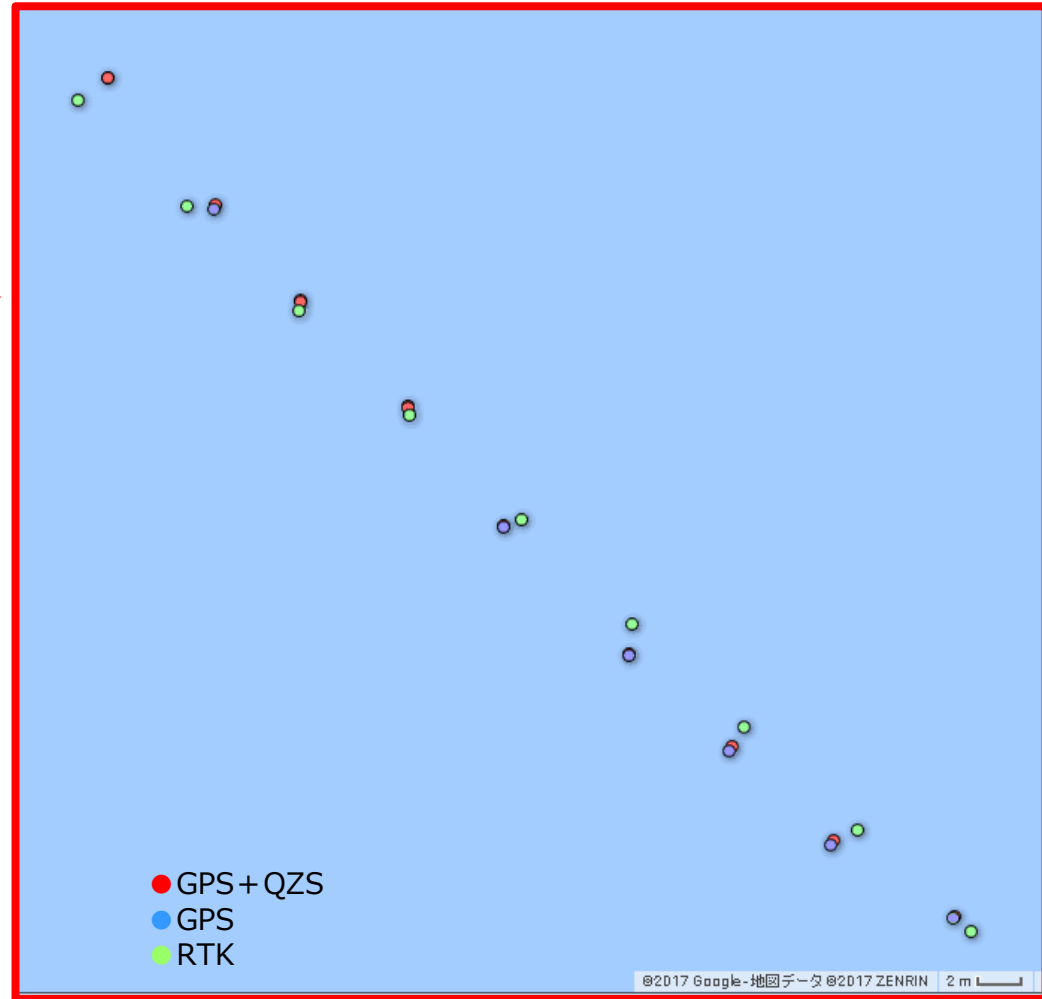
Positioning error : m
(Referenced with RTK result)

		GPS+QZS	GPS
Horizontal	Average	1.32	1.50
	1σ	2.07	2.34
	2σ	3.56	4.00



Vessel Tracking in the Maritime Field

Vessel Tracking in Tokyo Bay (Tokyo-Wan Ferry)



Positioning error : m
(Referenced with RTK result)

		GPS+QZS	GPS
Horizontal	Average	0.76	0.79
	1 σ	1.17	1.22
	2 σ	1.58	1.65

※Number of satellites : 8~10

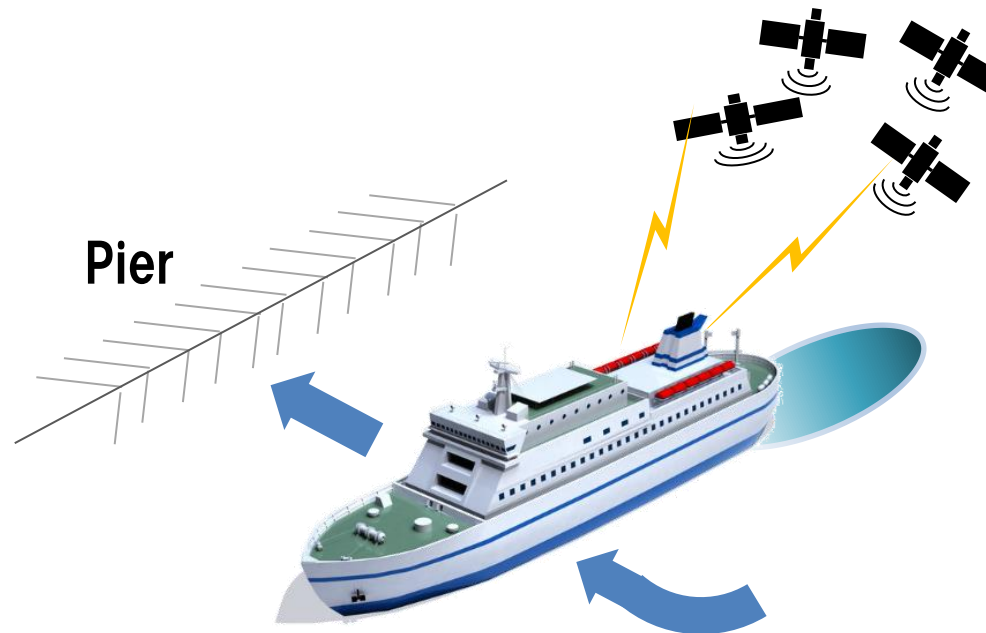


Vessel Tracking in the Maritime Field

Auto Berthing/Un-berthing System with QZSS

High precision positioning is required for berthing/un-berthing.

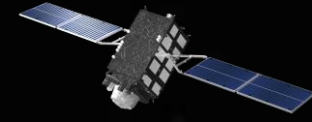
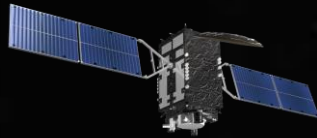
→ **R&D activity on Auto Berthing/Un-berthing system with QZSS is starting.**



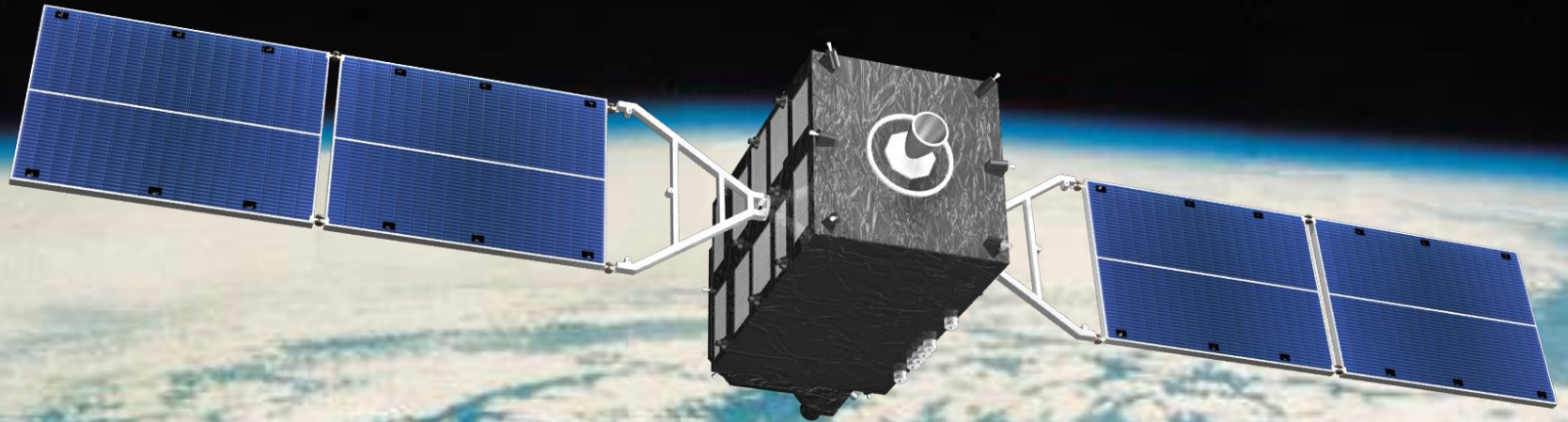
Summary



- **QZSS is Japanese regional satellite navigation system to improve not only GNSS availability but also accuracy and reliability**
 - 4 satellite constellation: Three IGSO and one GEO satellites
 - We are starting development activity in order to establish the 7 satellite constellation of QZSS in FY 2023
 - (7 satellite constellation plan is included in "Basic Plan on Space Policy" of Japanese government)
- **Operational Service begins on November 1, 2018**
 - GPS complement service, GNSS augmentation service, and messaging service
 - Many experiments including vessel tracking are also ongoing
- **QZSS would greatly contribute to maritime users in its coverage area as a part of WWRNS**



Thank you for your attention.



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