

Introduction to Michibiki and EWS

**GNSS Applications for Policy and Decision Makers in the
Context of Nepal**

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1. QZSS, “Michibiki” Overview
 - System
 - Services and Performances
 - Program schedule
2. Future Expansion to 7SV constellation
 - Service expansion into Asia Pacific region
3. Summary

1. QZSS Overview -System-

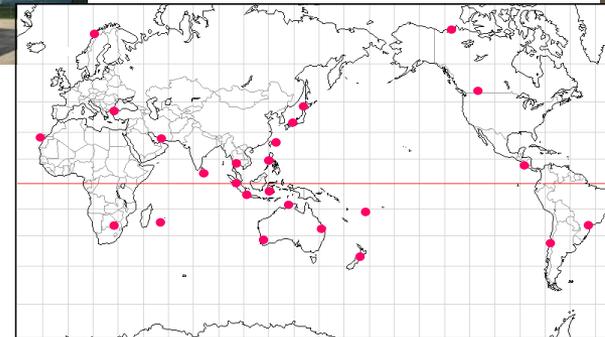


■ Constellation:

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

■ Ground System

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



1. QZSS Overview -Current Services-

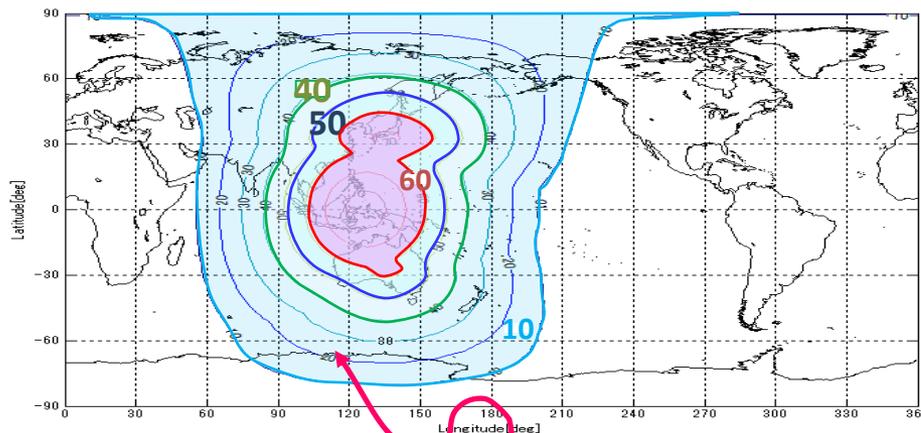
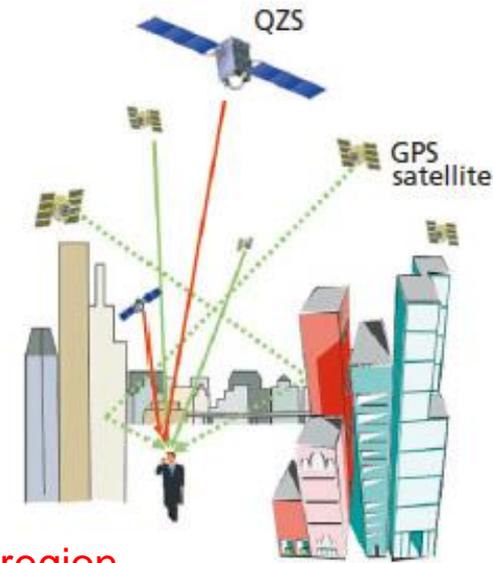


■ **Functional Capabilities:**

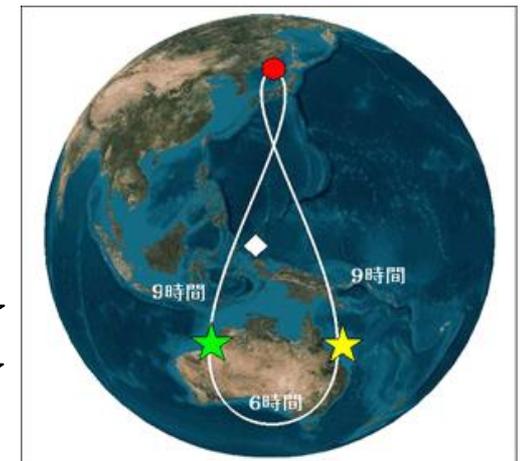
- GPS Complementary (Ranging signals)
- GNSS Augmentation (Error corrections)
- Messaging Service (Disaster relief, management)

■ **Coverage:** Asia and Pacific region

- Augmentation service covers only Japan
 - Experimental service provides error corrections in Asia Pacific region



- QZSS-1 ●
- QZSS-2 ★
- QZSS-4 ★
- QZSS-3 (127E) ◇

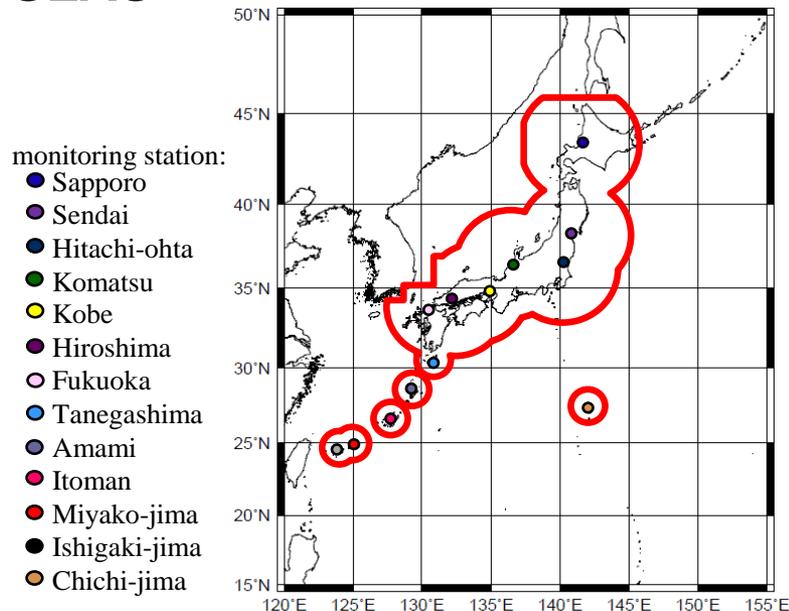


One or more QZSS SVs over 10 degrees elevation angle

1. QZSS Overview -Current Services-



Service Area of SLAS



Service Area is the area surrounded by the red line.
The left-axis is latitude, and lower-axis is longitude.

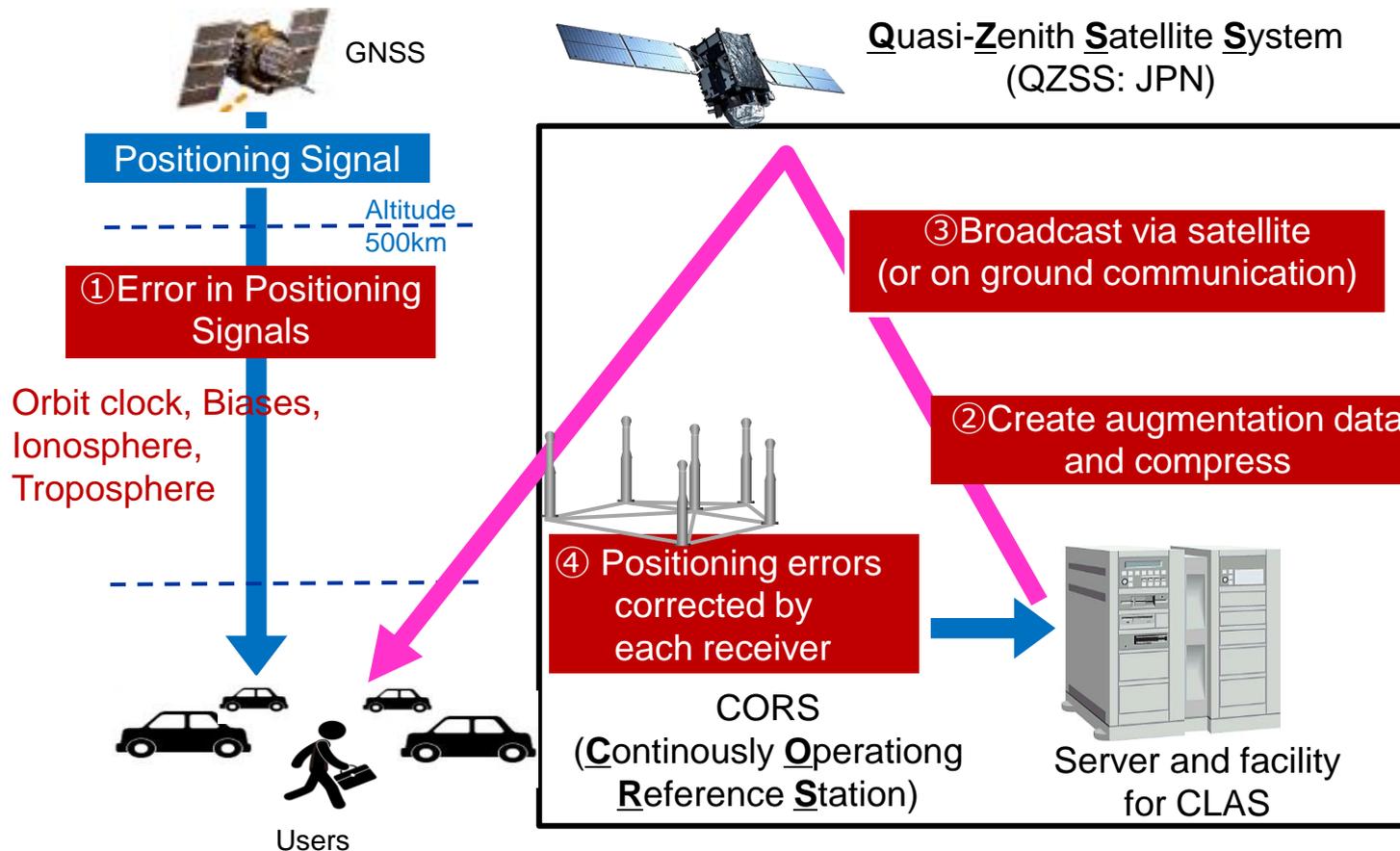
Accuracy of SLAS

positioning error(95%)		Remarks
horizontal	vertical	
≤ 1.0 m	≤ 2.0 m	EL mask : 10° User range error caused by user's receivers and user's situation : 0.87 m(95%)

1. QZSS Overview -Current Services-



Overview of CLAS (Centimeter Level Augmentation Service)



Specification on positioning accuracy

$H \leq 6.0$ cm (95%), $V \leq 12.0$ cm (95%) (Static)

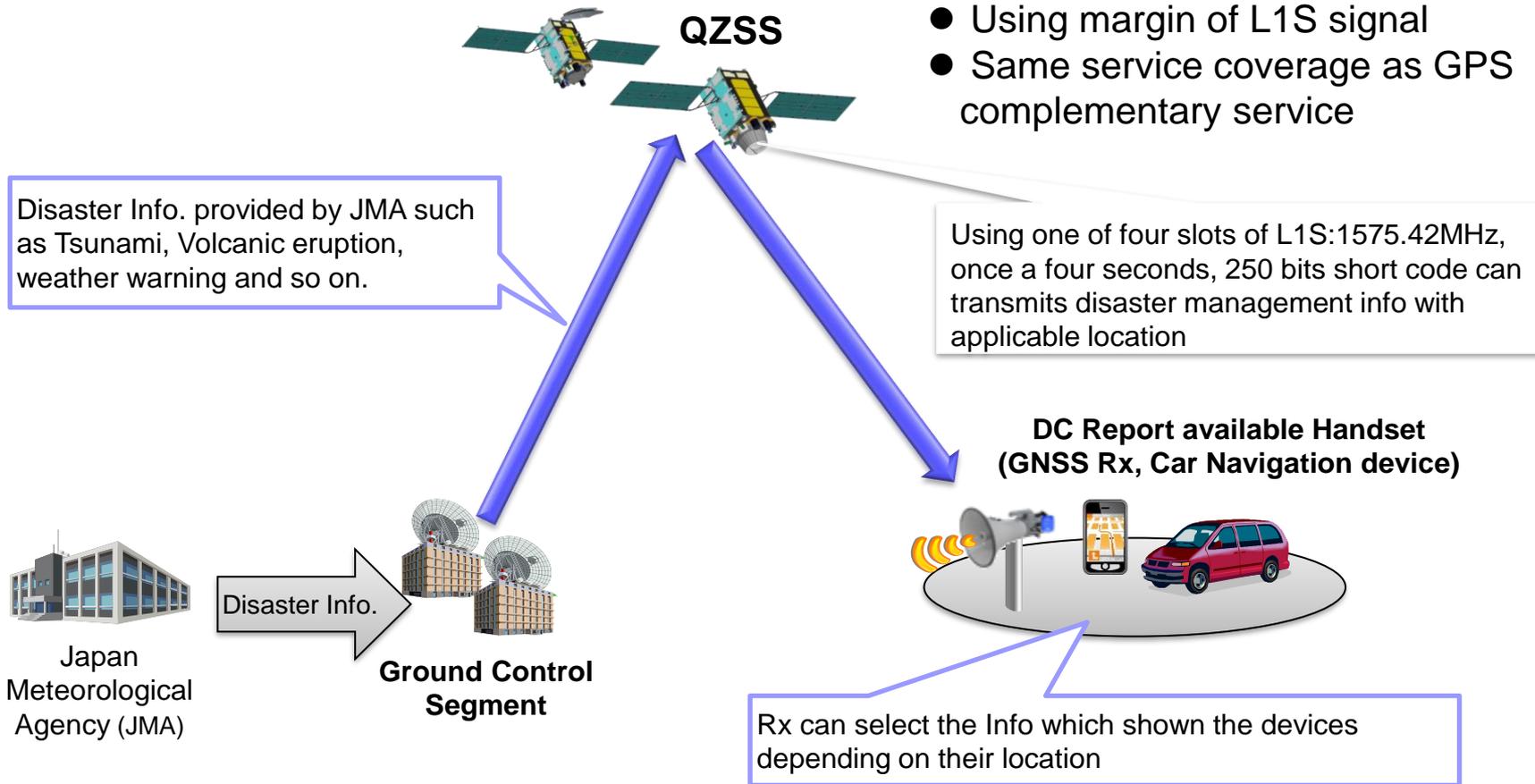
$H \leq 12.0$ cm (95%), $V \leq 24.0$ cm (95%) (Kinematic)



1. QZSS Overview -Current Services-

Functional Capability 3 Messaging Services

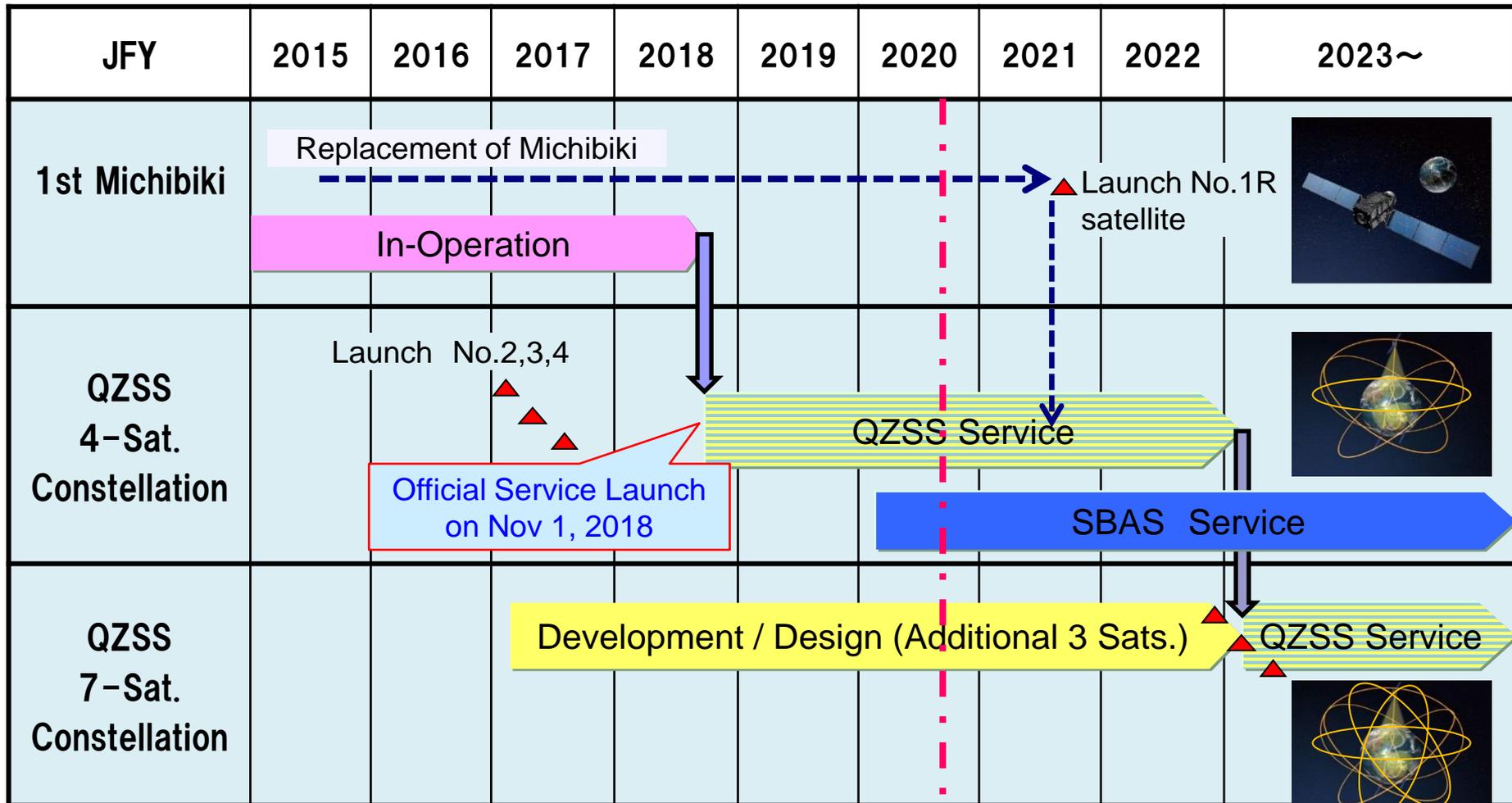
Satellite Report for Disaster and Crisis Management (DC Report)



1. QZSS Overview -Development Plan-



QZSS Program Schedule (latest)

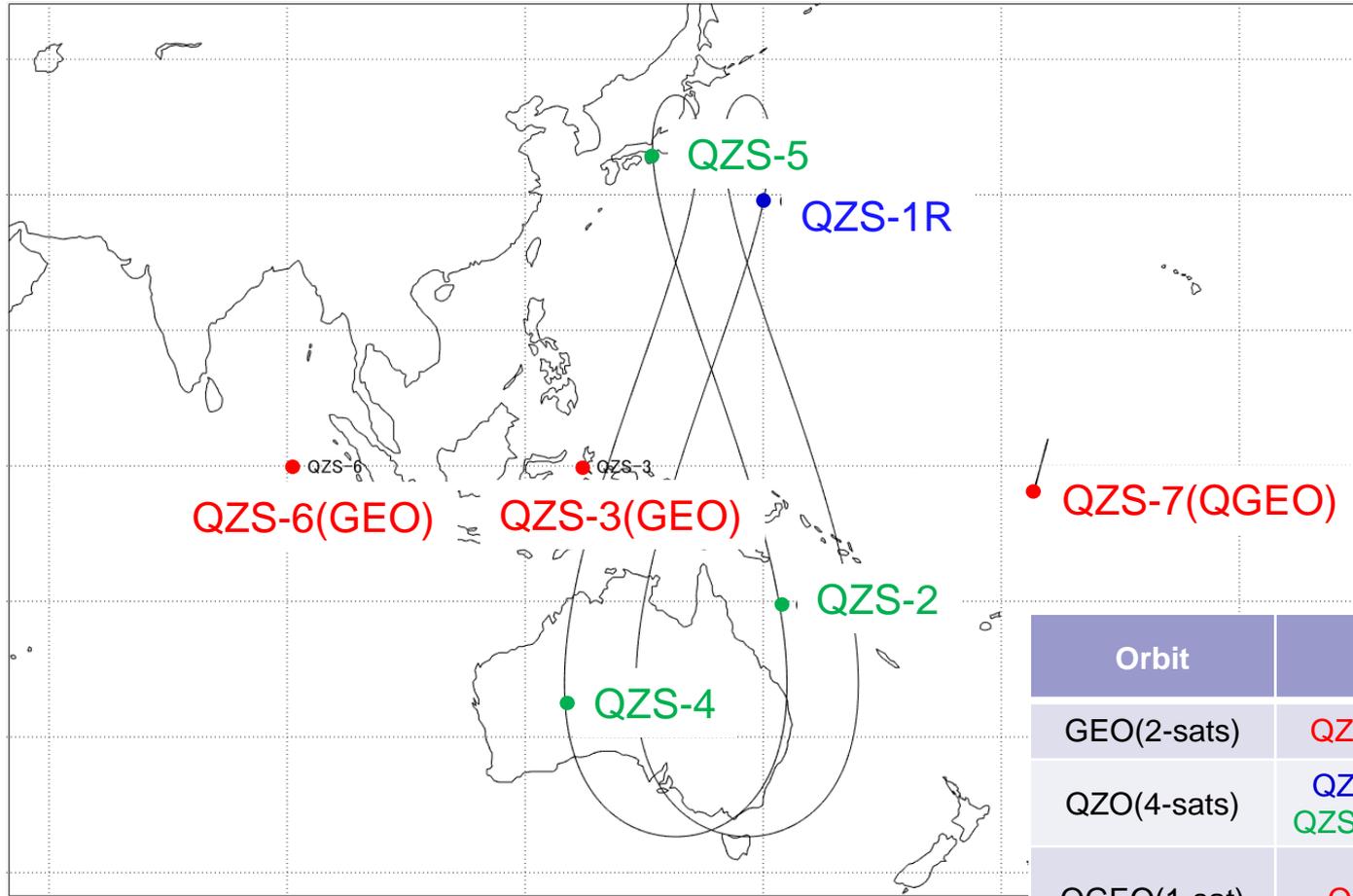


Today

2. QZSS 7SV Constellation Design



QZSS Constellation Plan



7-QZSS Ground Track

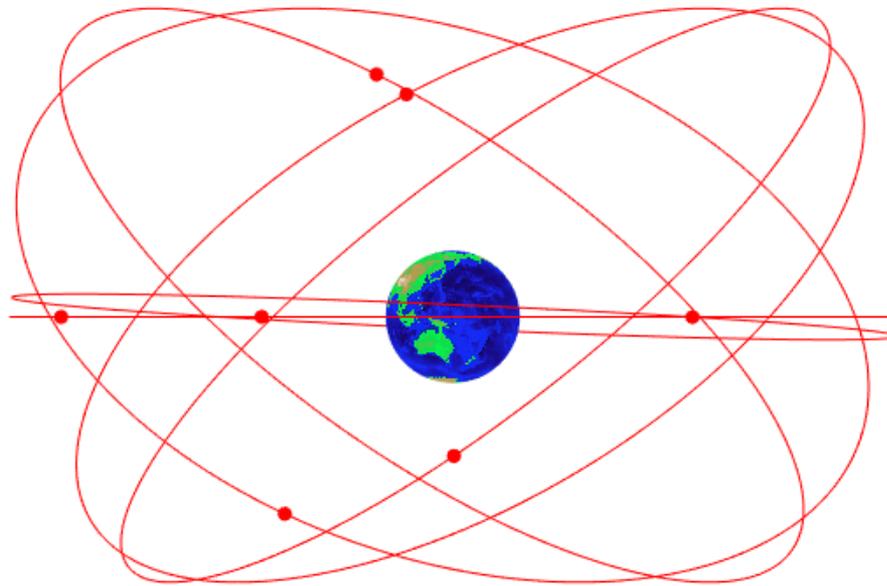
Orbit	SV	Center Longi. (deg.)
GEO(2-sats)	QZS-3, 6	127E, 90.5E
QZO(4-sats)	QZS-1R, QZS-2, 4, 5	148E(nom) 139E(nom)
QGEO(1-sat)	QZS-7	185E(nom)

*QGEO: Quasi Geostationary Earth Orbit
($i > 1\text{deg}$, $e = 0.008$)

2. QZSS 7SV Constellation Design



QZSS Constellation Plan



7 QZSS orbits viewed from the equatorial plane at eastern hemisphere, with fixed camera view

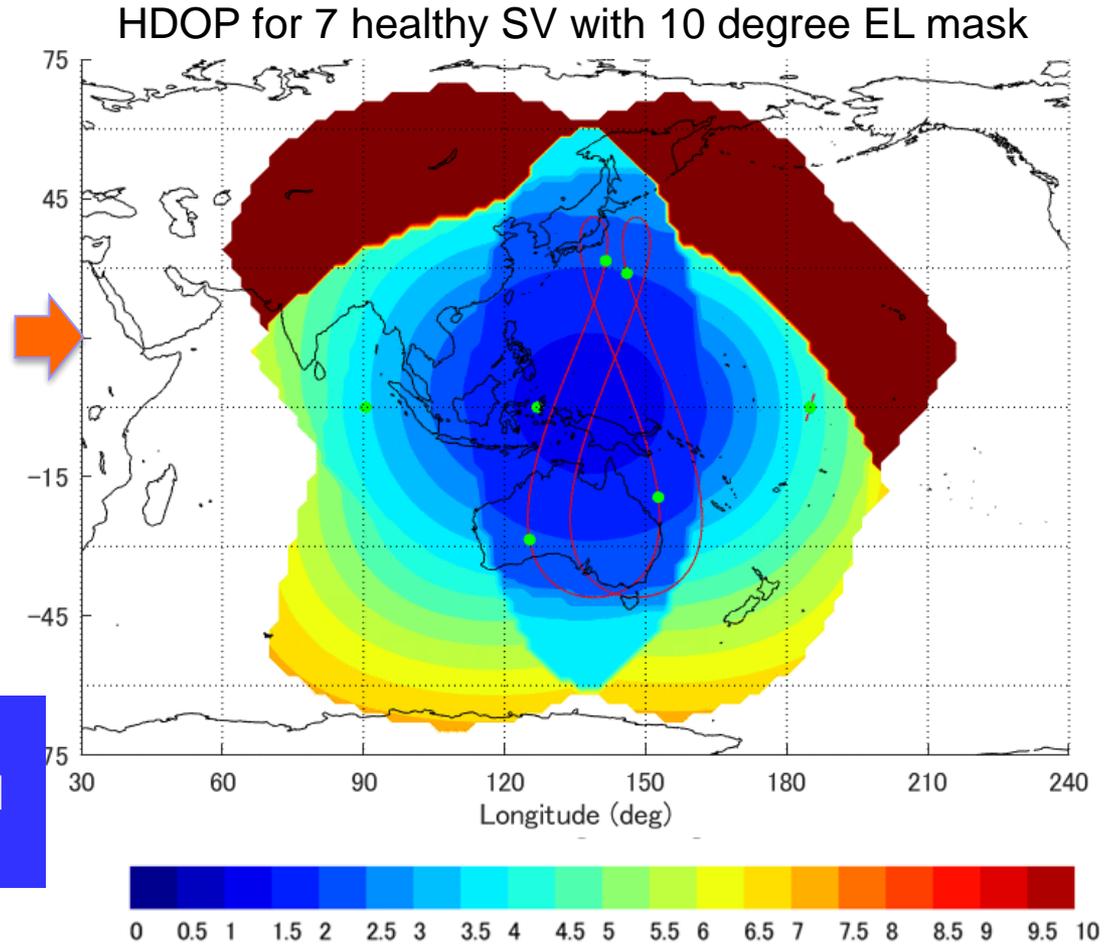


2. QZSS 7SV Constellation Design

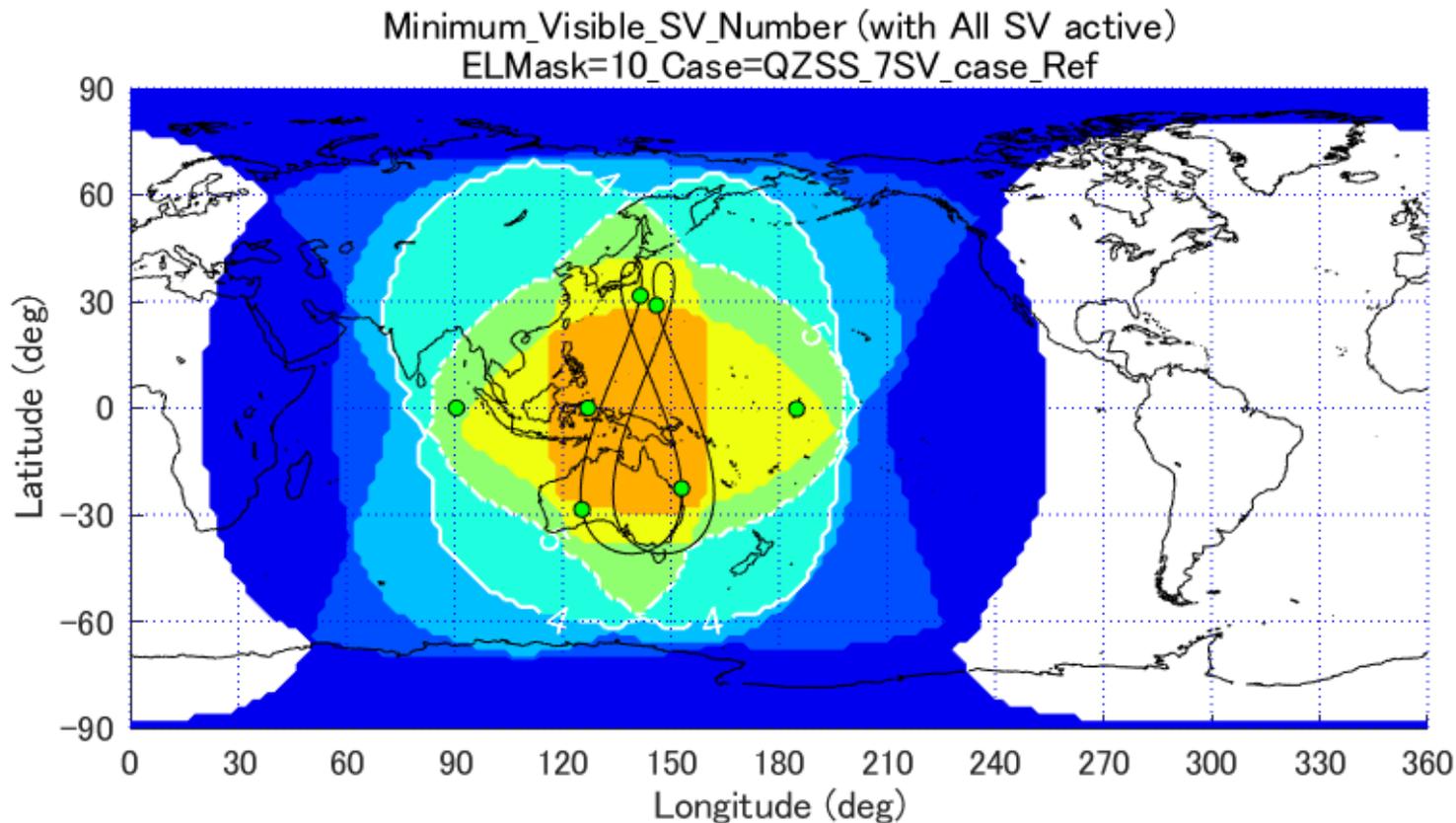
- The highest priority is to provide good geometry (HDOP).
 - Japan and surrounding area should have good HDOP, less than 2.6 on 95 time percentile.
- SBAS user requirements on the number of GSO satellites is satisfied.
 - More than 2 GSO SV for LPV service to be provided by Japanese Civil Aviation Bureau

4 IGSO + 2 GSO + 1 QGSO* constellation will be completed around 2023

*: QGSO Quasi-Geo Synchronous Orbit
Geosynchronous orbit with small eccentricity and inclination



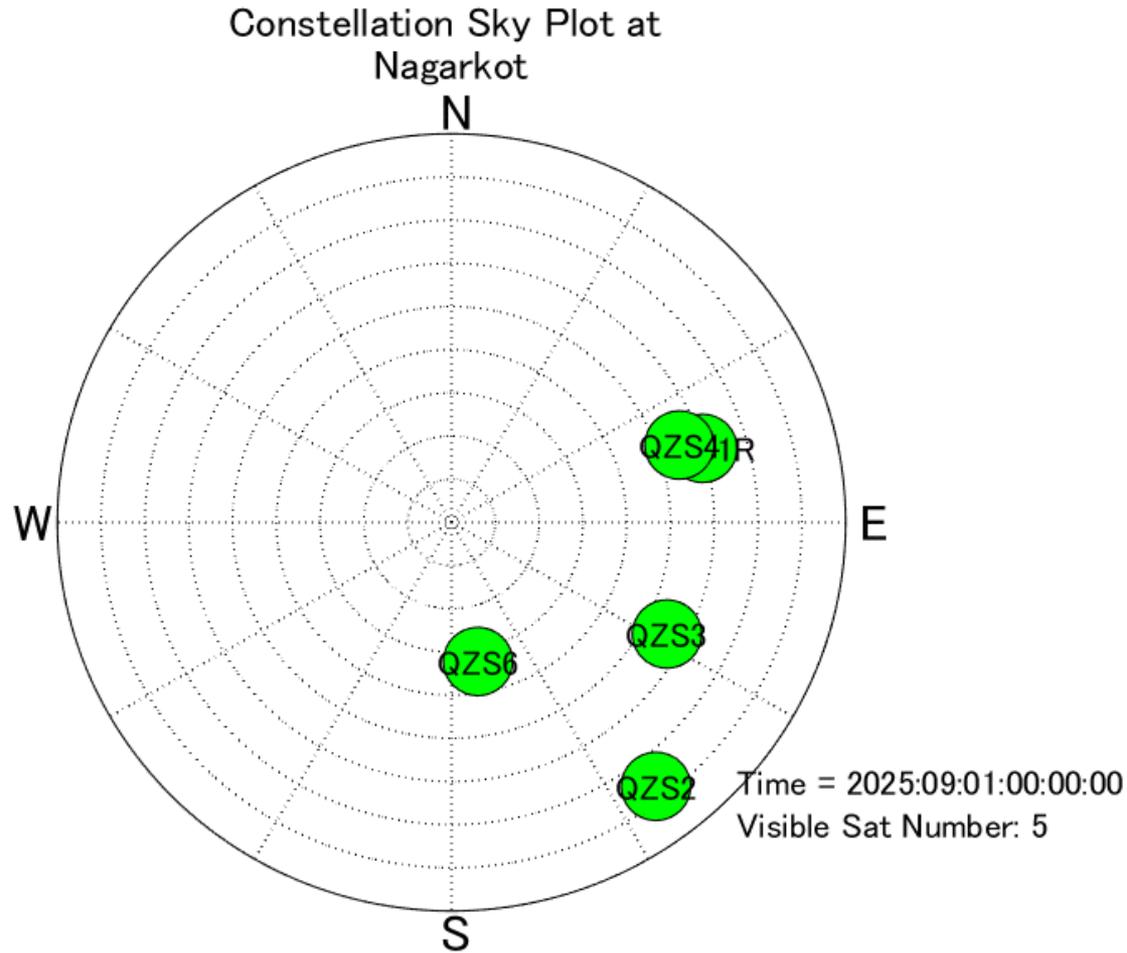
2. QZSS 7SV Constellation Design



2. QZSS 7SV Constellation Design



Visibility in Nagarkot, Nepal

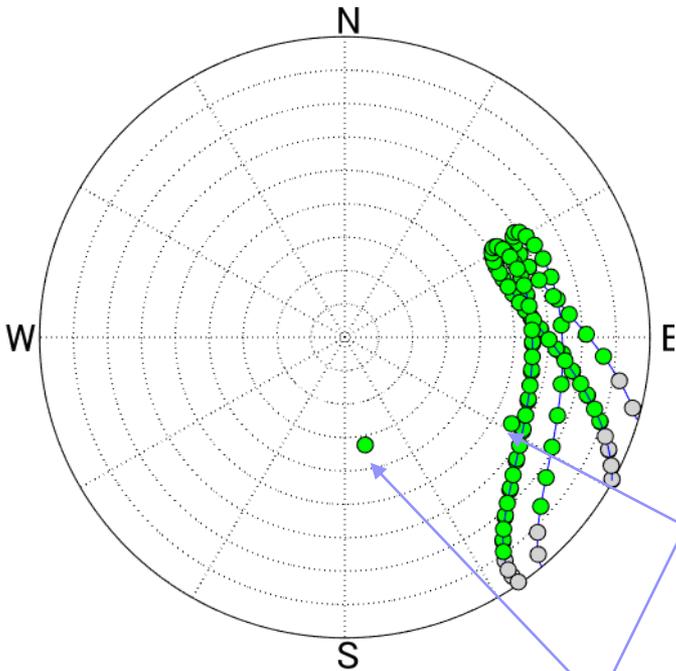


2. QZSS 7SV Constellation Design

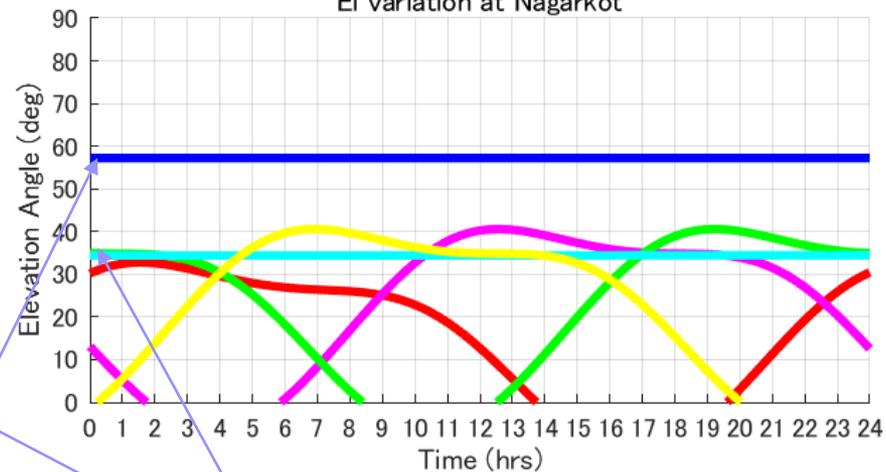


Visibility in Nagarkot, Nepal

Constellation Sky Plot at Nagarkot



EI variation at Nagarkot



QZS-6 Elevation 57 deg

QZS-3 Elevation 34 deg

2. Future Expansion to 7SV constellation



Service Requirement for future 7SV constellation (2/2)

2. Augmentation services

- Both existing services, Sub meter Level Augmentation Service (SLAS) and Centi-meter Level Augmentation Service (CLAS) are to be provided in domestic area via current four SVs with same specifications.
- MADOCA based PPP augmentation service will cover Asia Pacific region.

3. Messaging services

- Disaster and Crisis management Report (DCR) service, a kind of Early Warning Service (EWS) will be expanded to Asia Pacific region.
 - Common format is now being investigated with EC and other providers under ICG correspondence group.

High accuracy augmentation (MADOCA-PPP) and Early Warning Service into wider area in Asia Pacific region will be operational after 2023



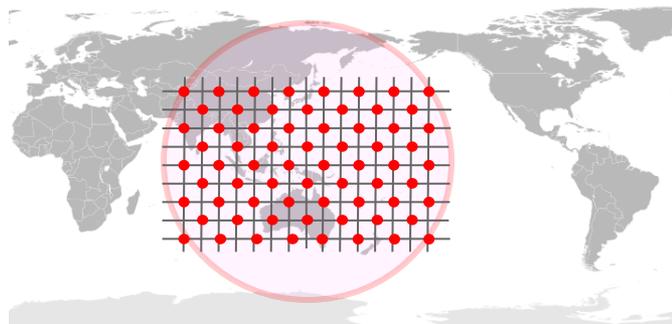
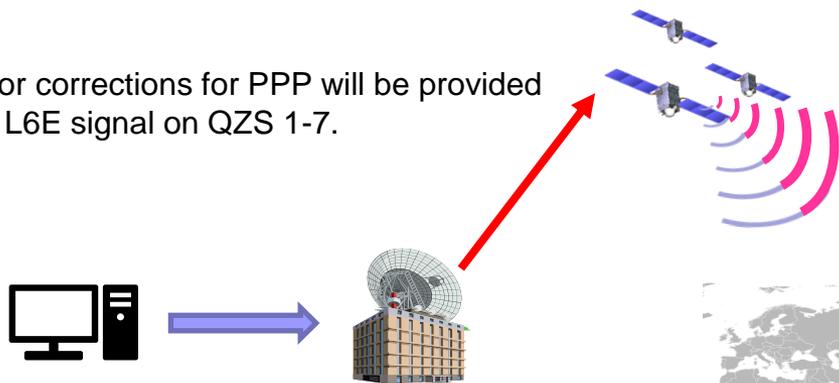
2. QZSS 7SV Constellation Design

-Practical PPP correction service in Asia Pacific region-

- Experimental augmentation signal of MADOCA-PPP is now available for Asia-Pacific region.
- Operational service will start no later than 2024.
- For reduction of initial convergence period in PPP, QZS will provide the ionospheric correction data for some areas from 2024 as an experiment for future practical operation.

Error corrections for PPP will be provided via L6E signal on QZS 1-7.

Ionospheric correction data will be provided via L6D signal on QZS 5-7.



	QZS#1-4 L6D: CLAS	QZS#1-7 L6E: PPP corr.	QZS#5-7 L6D: Fast-PPP Ex
SV orbit error	✓	✓	
Clock error	✓	✓	
Code /phase Bias	✓	✓	
Ionospheric delay	✓		✓
Tropospheric delay	✓		

Fast PPP convergence time can be achieved with QZSS wide area ionospheric correction.

2. QZSS 7SV Constellation Design

Latest Updates -Early Warning Service (EWS)-



- QZSS L1S signal is sharing 250 bps data stream with SLAS and Disaster and Crisis Report service.
- DCR service is currently providing weather information generated by JMA for Japanese domestic users.
- Common EWS format is being investigated in collaboration with EC.
- QZSS ground segment will be upgraded to support EWS in 2024-2025 and distribute EWS once every 4 seconds through QZS-1 to 4 satellites.

Signal	Service Name	Center freq.	Modulation	Bit Rate
L1S	Sub-meter Level Augmentation Service (SLAS)	1575.42MHz	BPSK	250bps
	DC Report Service			

Road Map for QZSS EWS expansion into Asia Pacific region



2. QZSS 7SV Constellation Design

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Signal	Service Name	Center freq.	Modulation	Bit Rate
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Challenges to be solved in advance of practical operation;

Due to narrow bandwidth of satellite transmission through QZSS L1S, effective way to share it among stakeholders in the region, some prioritization scheme will be required.

Ro



(VPN connection)

Available Receiver, chipset for QZSS use



MADOCA-PPP available

GNSS and MADOCA Receiver
L1, L2, ESb, L6
GPS, GLONASS, GALILEO, BEIDOU, QZSS
Size: W: 55 x B: 55 x D: 15

CLAS available

tblox

Cozac

AQLOC

SLAS, EWS available



Dual-band GNSS market moving from insignificant to billions in less than 5 years

December 6, 2018 - By GPS World Staff 0 Comments Est. reading time: 2:30

Most of smart phone can track QZSS

Please check
QZSS.go.jp

Available Receiver, chipset for QZSS use



MADOCA-PPP available

GNSS and MADOCA Receiver
L1, L2, E5b, L6
GPS, GLONASS, GALILEO, BEIDOU, QZSS
Size: W: 55 x B: 55 x D: 15

CLAS available

SLAS, EWS available

List of products that support the QZSS is shown;
<https://qzss.go.jp/en/usage/products/list.html>

Please check
QZSS.go.jp

Dual-band GNSS market moving from insignificant to billions in less than 5 years

December 6, 2018 - By GPS World Staff 0 Comments Est. reading time: 2:30

Most of smart phone can track QZSS



3. Summary

- QZSS is Japanese regional navigation satellite system to improve not only GNSS availability but also accuracy and reliability
 - 4 satellite constellation: Three IGSO and one GEO satellites
 - Providing PNT, augmentation and messaging services
- On Nov 1st 2018, Japanese Government officially launched QZSS service.
 - The service performance has satisfied with the specifications.
 - Application demonstrations were conducted.
- Future expansion to 7 satellite constellation
 - Started procurement process for additional 3 satellites
 - An IGSO, a GSO and a QGSO satellite will be added to the existing constellation
 - Service requirements were established
 - Cover Asia Oceania region for PNT services
 - Extension of High accuracy augmentation (MADOCA-PPP) and Early Warning Service into AP region is being operational services

Rapid Prototype Development Challenge

Put yourself to the test

The Rapid Prototype Development (RPD) Challenge is a Hackathon where teams create a disaster-related application prototype with guidance from Mentors, and participants are encouraged to squeeze their brains to tackle real-life issues through creative solutions.

[How to Participate](#)



**STAY TUNED
AT Multi-GNSS
Asia FACEBOOK!!**

Jul-Aug

Registration

Aug-Sept

Idea Creation

Step 1

Oct-Dec

**System Design &
Develop Prototype**

Step 2&3

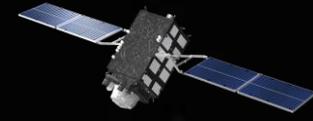
Jan/Feb/Mar

Demonstration

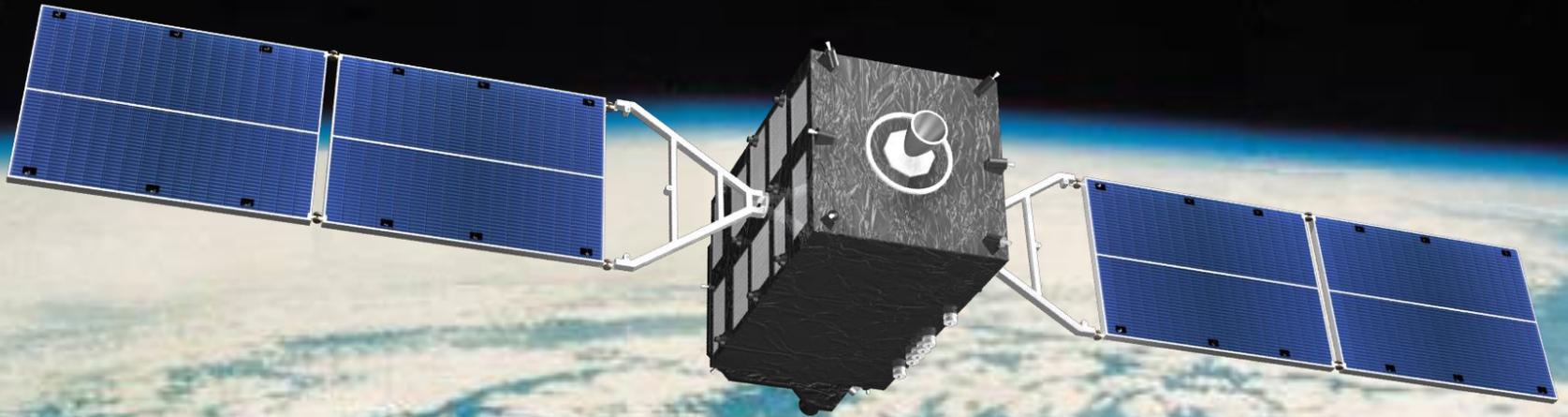
Step 4

Participants can learn how to utilize EWS and PPP positioning through pototype development with their team members.

Check MGA web site <https://www.multignssasia.com/>



Thank you for your attention!



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