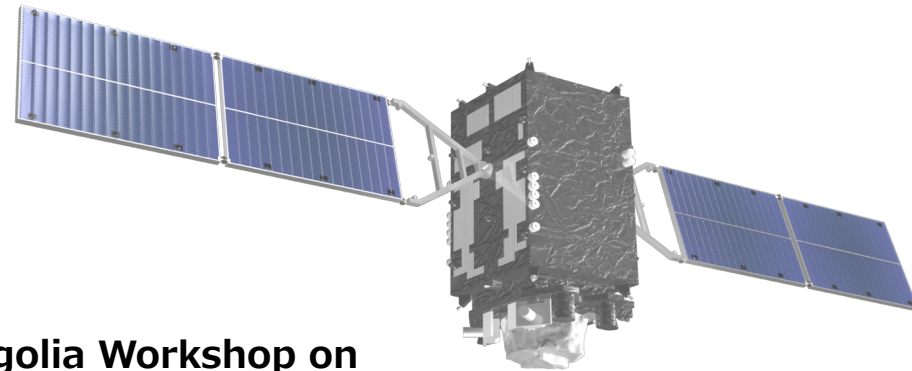


**Session 10 - GNSS Applications:  
Reports from the ICG Working Group B, Application Subgroup**

# Application Status of Quasi-Zenith Satellite System in Japan



**United Nations/Mongolia Workshop on  
the Applications of Global Navigation Satellite Systems ,  
Ulaanbaatar, Mongolia, 25 - 29 October 2021**

**QZSS.go.jp**

**Yasushi Sakurai, Japan Space Systems**

# Contents

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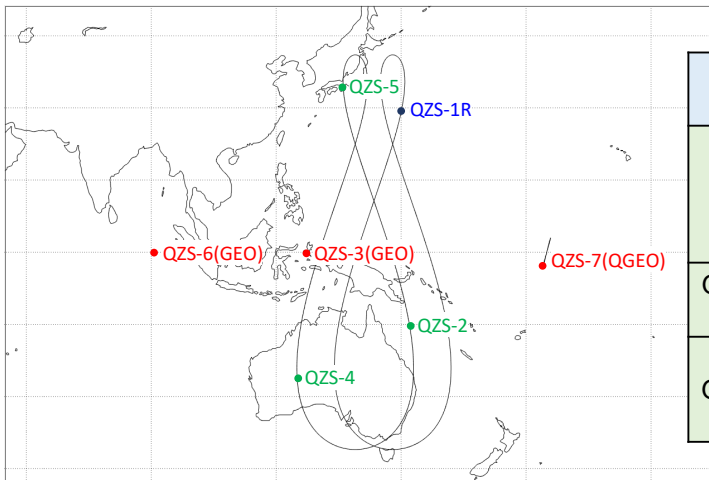
- **QZSS Overview**
  - Overview
  - QZSS Services
  - QZSS Unique Applications
- **User Survey after one year operation**
  - QZSS penetration in the Japanese market
  - Key challenges and issues for the future of QZSS and GNSS
- **The Next Step towards Asia-Pacific region**
  - CM Augmentation for Asia Pacific region from 2024
  - EWS system enhancement to Asia Pacific region in 2024-2025.
- **Summary**

# QZSS Overview

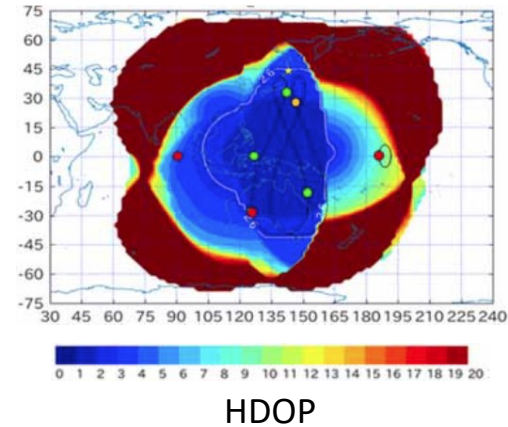
QZSS : Quasi-Zenith Satellite System

## ➤ QZSS Overview ; Japanese Satellite Positioning System

QZS & GEO : How ensure service capability.



Satellite orbit	Satellite Number	Orbital Position
Inclined Geosynchronous Orbit (4 satellites)	QZS-1R	148 deg E
	QZS-2	139 deg E
	QZS-4	139 deg E
	QZS-5	139 deg E
Geostationary Orbit (2 satellites)	QZS-3	127 deg E
	QZS-6	90.5 deg E
Quasi Geostationary Orbit (1 satellite)	QZS-7	175 deg W



Constellation plan



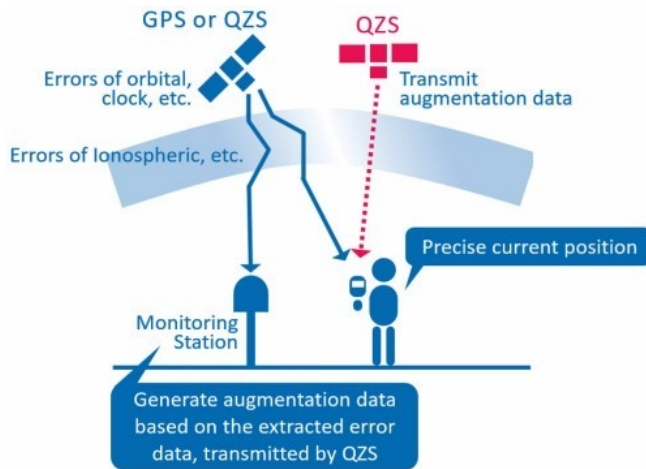
“Status Update on the Quasi-Zenith Satellite System (QZSS)” , Hongo Nobuo, National Space Policy Secretariat Cabinet Office, Japan , ICG-15, Sept. 2021

# QZSS Overview

QZSS : Quasi-Zenith Satellite System

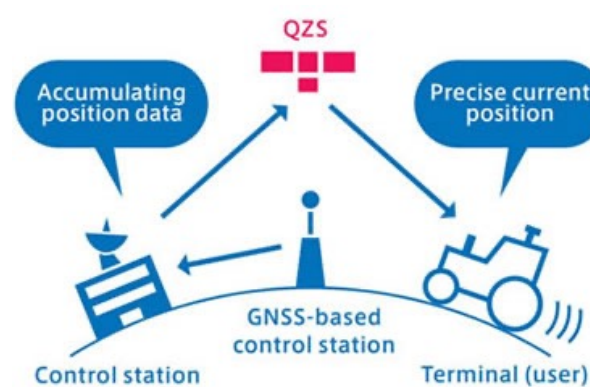
## ➤ QZSS Services;

- Satellite Positioning, Navigation and Timing Service (PNT)
- Sub-meter Level Augmentation Service (SLAS)
- Centimeter Level Augmentation Service (CLAS)
- Satellite Report for Disaster and Crisis Management (DC Report)



### SLAS

[https://qzss.go.jp/en/overview/services/sv05\\_slas.html](https://qzss.go.jp/en/overview/services/sv05_slas.html)



### CLAS

[https://qzss.go.jp/en/overview/services/sv06\\_clas.html](https://qzss.go.jp/en/overview/services/sv06_clas.html)



### DC Report

[https://qzss.go.jp/en/overview/service/s/sv08\\_dc-report.html](https://qzss.go.jp/en/overview/service/s/sv08_dc-report.html)

QZSS Website : <https://qzss.go.jp/en/index.html>

## ➤ QZSS Unique Applications ; Autonomous Driving Level 3, Robot Farming, Early Warning Service



[https://qzss.go.jp/info/archive/honda\\_210517.html](https://qzss.go.jp/info/archive/honda_210517.html)





## ➤ QZSS Unique Applications ; Augmentation Services

### Augmentation Service

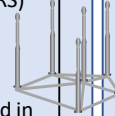
#### SLAS : sub m segmentation

Augmentation	Augment 13 satellites (GPS L1C / A, QZS L1C / A) to utilize 13 monitor station.	
	Disaster reports could broadcast at 4-second intervals using SLAS slots.	
Accuracy 5%		
	Horizontal	Vertical
	Narrow	1.0m
Wide	2.0m	3.0m

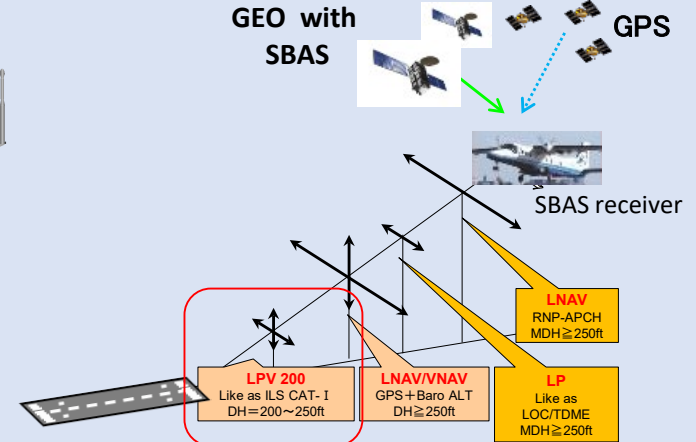


#### CLAS : cm augmentation

Augmentation	Utilize real-time Continuously Operating Reference System (CORS) data.	
	Ionosphere and troposphere correction information is provided in 13 block units.	
Accuracy 95%		
	Horizontal	Vertical
	Fixed	6cm
Mobile	12cm	24cm



#### SBAS@LPV200

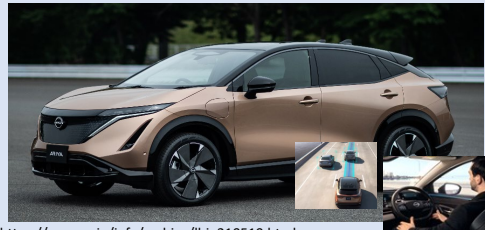


Approach		Horizontal alert limit	Vertical alert limit
NPA Non-Precision Approach	LNAV	556m	—
	LP	40m	—
APV Approach with vertical guidance	LNAV/VNAV	556m	—
	LPV	40m	50m
	LPV200	40m	35m
PA Precision Approach	CAT1	16m	35~10m



[https://qzss.go.jp/info/archive/honda\\_210517.html](https://qzss.go.jp/info/archive/honda_210517.html)

Level.3@Honda Legend

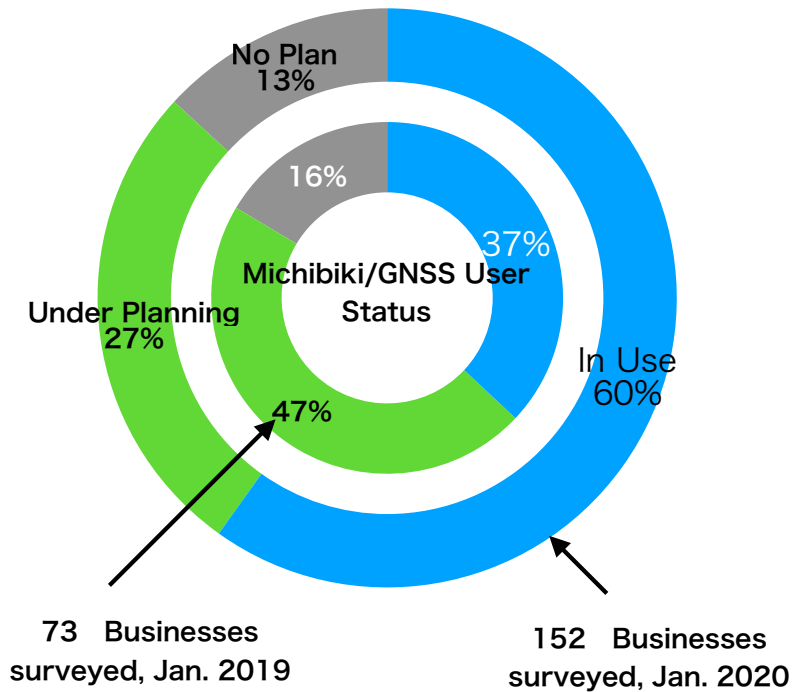


[https://qzss.go.jp/info/archive/lbj\\_210510.html](https://qzss.go.jp/info/archive/lbj_210510.html)

Level.2@Nissan Ariya

# User Survey after one year operation

- A survey was launched in December 2019 to understand how Michibiki has penetrated the Japanese market after one year of operation, and what are the key challenges and issues for the future of QZSS, nicknamed MICHIBIKI.



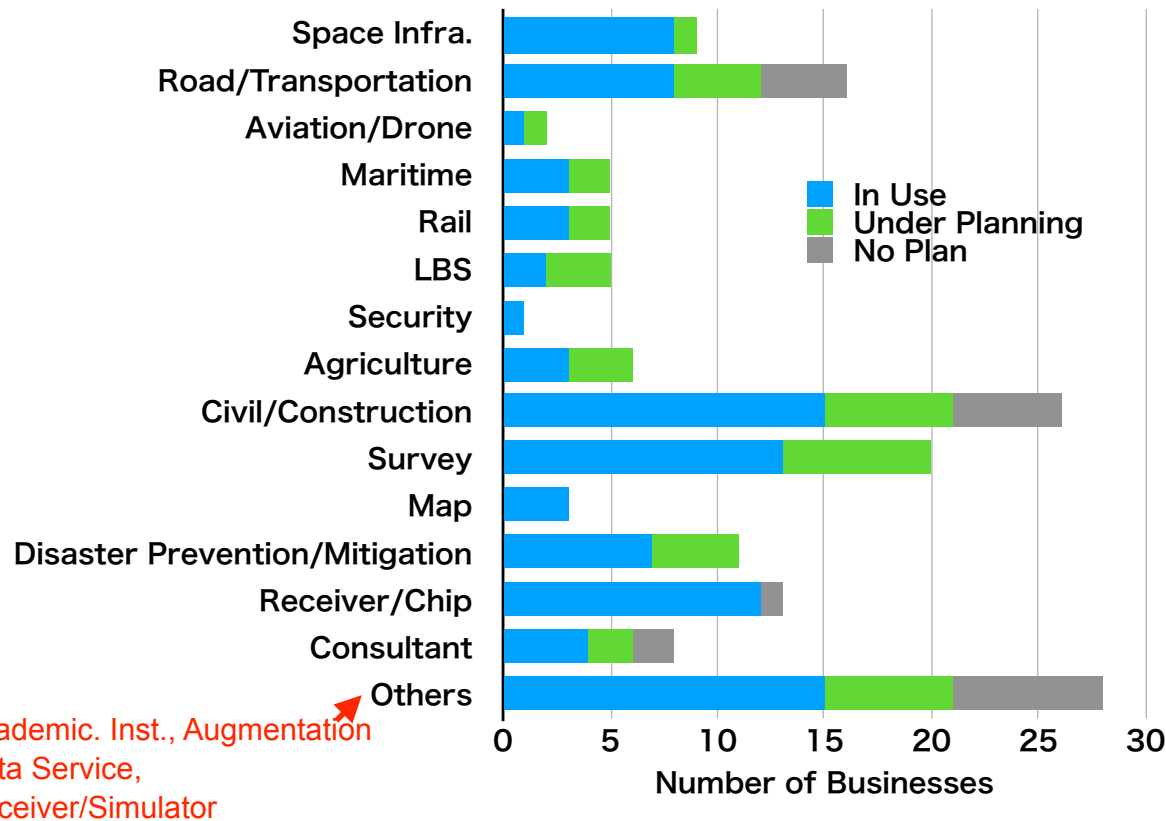
- Michibiki is headed to a good start ; Business users has dramatically increased during the one-year period after the service start in Nov.2018.

\*A survey has been done every year since 2018, targeting QBIC (QZSS Business Innovation Council) members and contributing organizations.

“One year of success for Michibiki in Japan”, QBIC, 22<sup>nd</sup> May 2020  
<https://qbic-gnss.org/wp-content/uploads/2020/10/int-3-01.pdf>

# User Survey after one year operation

- Michibiki penetration starts from professional market segments using centimeter-class, high accuracy service;



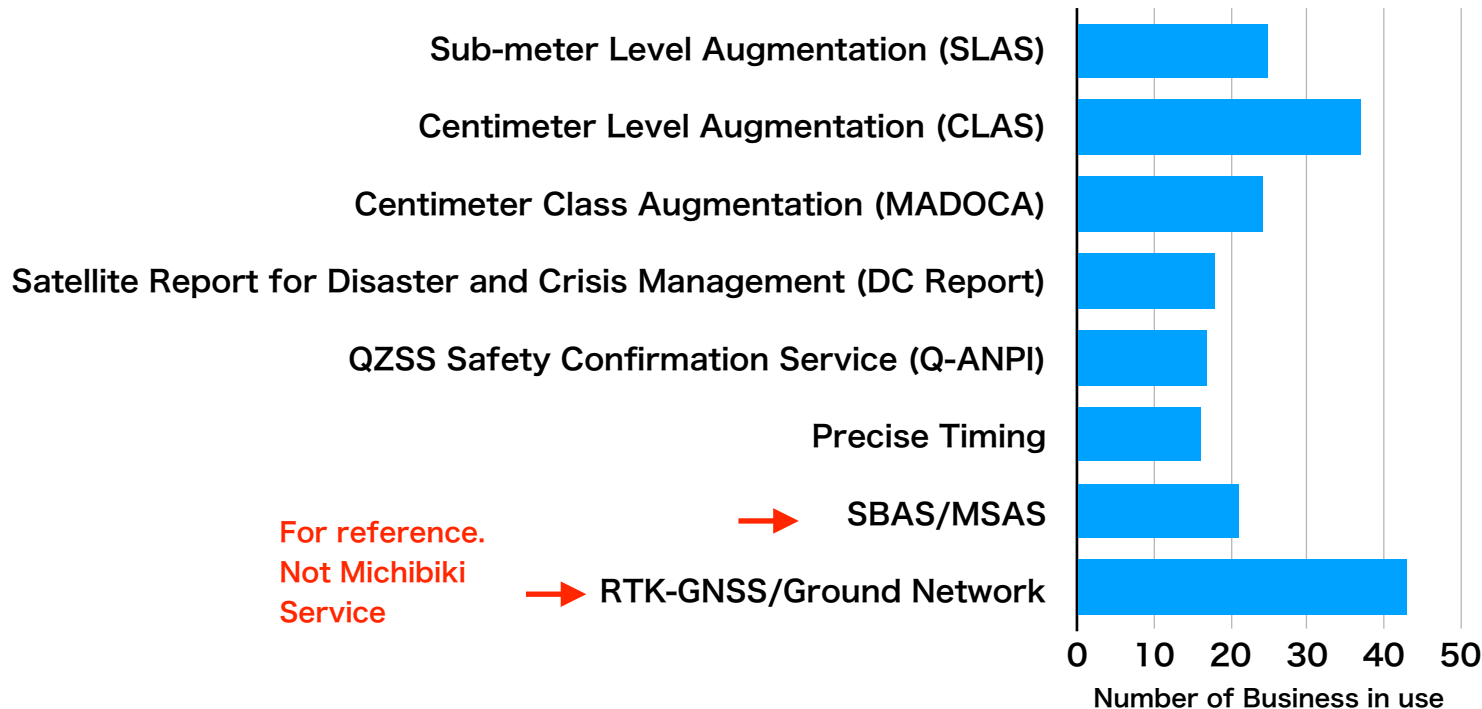
- Leading user segments are; Civil/Construction, Survey, Road/Transportation, Disaster Prevention/Mitigation.
- Michibiki will expand the area of high accuracy service over Asia-Pacific Region from 2024.

“One year of success for Michibiki in Japan”, QBIC, 22<sup>nd</sup> May 2020  
<https://qbic-gnss.org/wp-content/uploads/2020/10/int-3-01.pdf>



# User Survey after one year operation

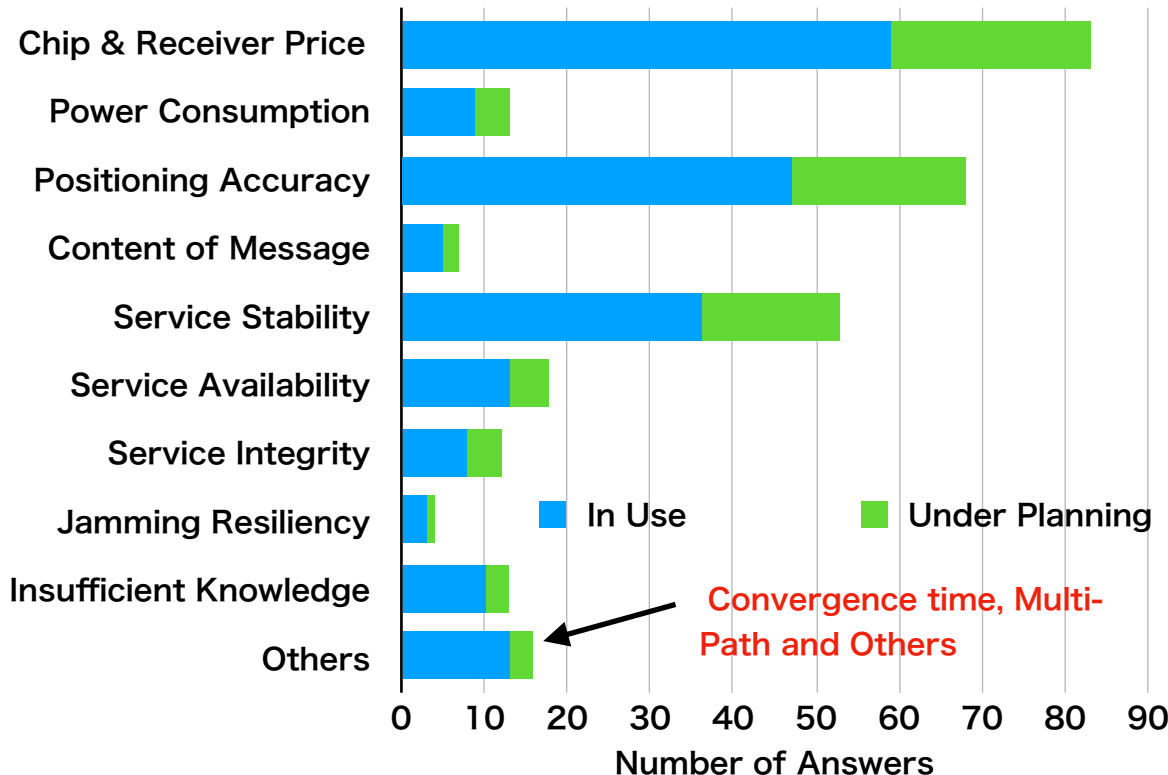
- All Michibiki Unique Services are gaining ground
  - RTK-GNSS using Ground Network seems still attractive for professionals.( CLAS performance improvement has been done Oct.2020.)



“One year of success for Michibiki in Japan”, QBIC, 22<sup>nd</sup> May 2020  
<https://qbic-gnss.org/wp-content/uploads/2020/10/int-3-01.pdf>

# User Survey after one year operation

- **Cheaper receiver of Michibiki unique services is the key for Michibiki penetration;**



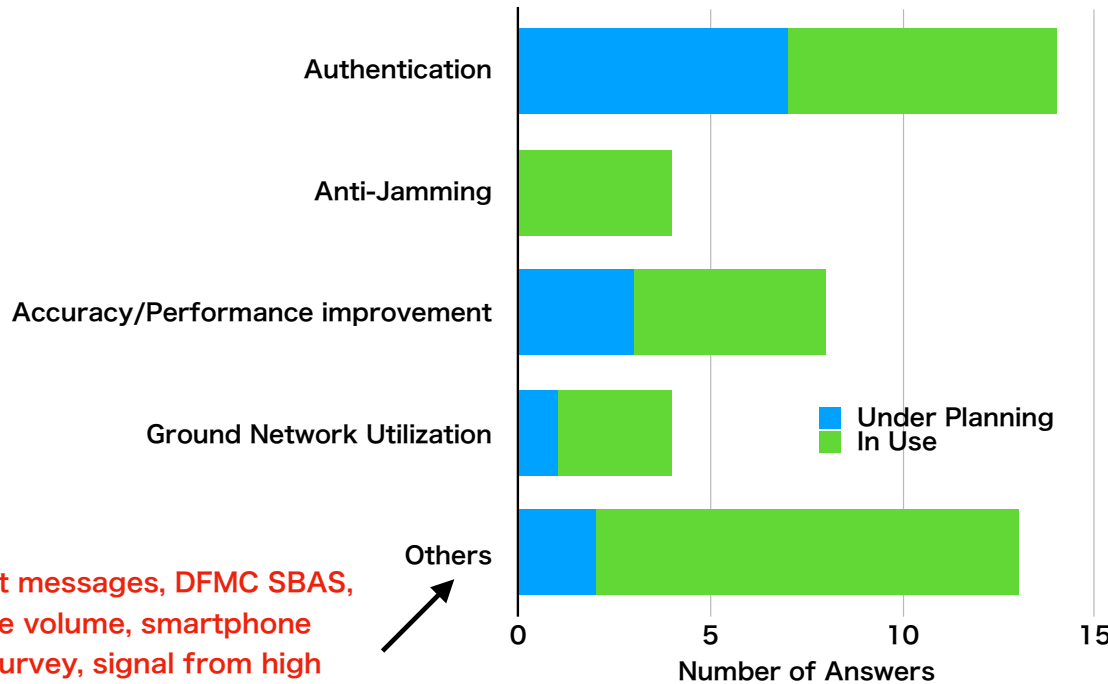
- The price of CLAS receiver was high, but, has been getting cheaper and cheaper as penetrated.
- Interoperability of GNSS-PPP, now promoted under ICG taskforce, is expected to contribute the penetration over the world.

**What is the issue for Michibiki Application?**

“One year of success for Michibiki in Japan”, QBIC, 22<sup>nd</sup> May 2020  
<https://qbic-gnss.org/wp-content/uploads/2020/10/int-3-01.pdf>

# User Survey after one year operation

➤ Service reliability is the top priority for business application;



Short messages, DFMC SBAS, space volume, smartphone for survey, signal from high elevation

- Michibiki seven satellite constellation will start from 2023 to ensure the service capability.
- Signal authentication of Michibiki is planned to start in 2024, promising penetration into business.

What do you expect for future GNSS?

“One year of success for Michibiki in Japan”, QBIC, 22<sup>nd</sup> May 2020  
<https://qbic-gnss.org/wp-content/uploads/2020/10/int-3-01.pdf>

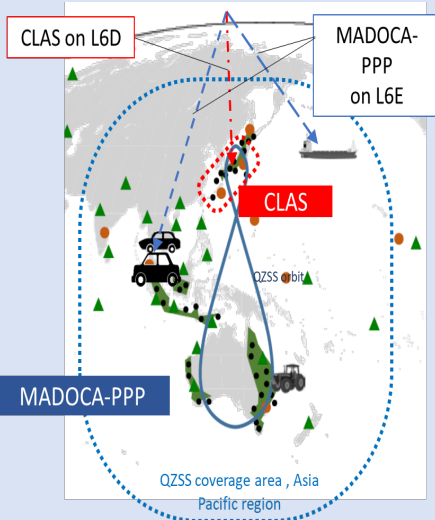
- **QZSS Services expand towards Asia-Pacific region by 2024**
  - **Centimeter Class Augmentation Service(MADOCA-PPP)**

## Augmentation Service

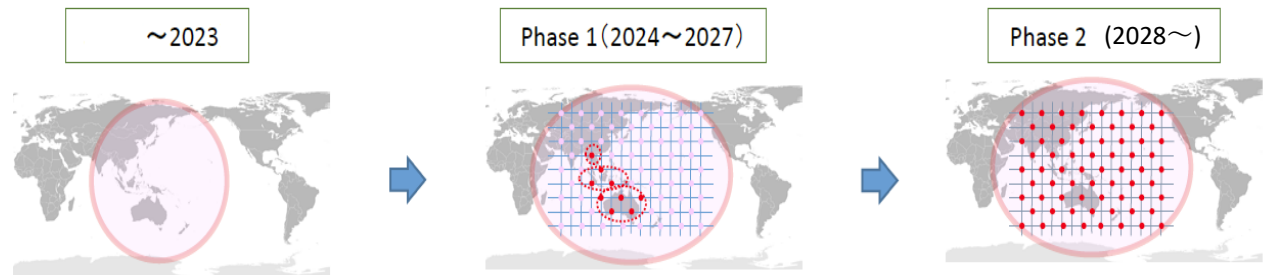
MADOCA PPP : cm augmentation for Asia pacific region

MADOCA : Multi-GNSS Advanced Demonstration tool for Orbit and Clock Analysis

PPP : Precision Point Positioning



- Augmentation on PPP with MADOCA has been provided via L6E signal on QZS-2/3/4.
- MADOCA: Multi-GNSS Advanced Demonstration tool for Orbit and Clock Analysis is a precise POD engine developed by JAXA.

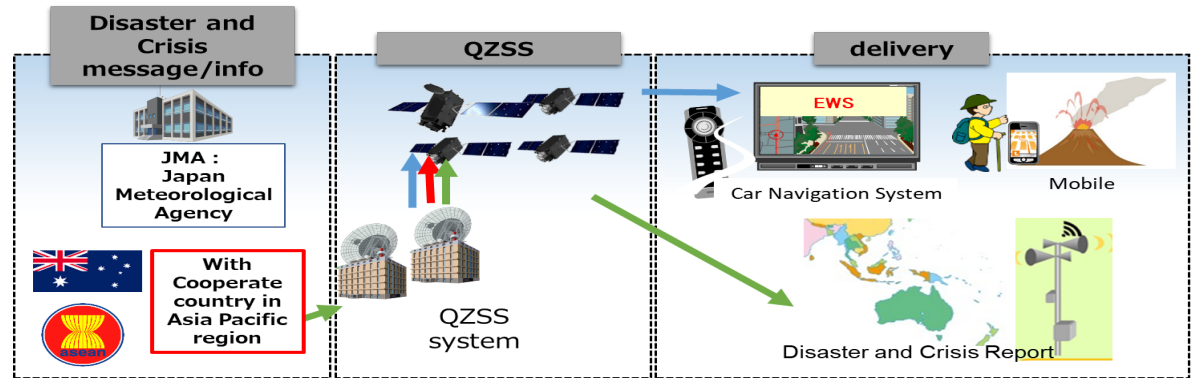


- **QZSS Services expand towards Asia-Pacific region by 2024**
  - **Early Warning Service with cooperate countries in Asia Pacific**

## Messaging services

### Early Warning Service (EWS)

- QZSS L1S signal is sharing 250 bps data stream with SLAS and Disaster and Crisis Report (DCR) service.
- DCR service is currently providing weather information generated by JMA for domestic users in Japan.
- **Common EWS format collaborate with Galileo (EC/EU).**
- QZSS EWS system will enhanced to Asia Pacific region in 2024-2025.
- Demonstration will be conduct for Australia , Thai and Fiji.





# Summary

- **QZSS provides unique services and provides opportunities of innovation for digital transformation in both public and business sectors.**
  - **Level 3 Autonomous driving vehicle, 3D Driving Map**
  - **Application “Show-case development” is ongoing with cm/sub-m class Japan domestic augmentation services**
- **User Survey after one year operation of QZSS shows the penetration in the Japanese market.**
  - **Key challenges and issues became clear for the future of QZSS and GNSS**
- **The Next Step towards Asia-Pacific region has been newly defined Feb.2021.**
  - **CM Augmentation for Asia Pacific region from 2024**
  - **EWS system enhancement to Asia Pacific region in 2024-2025.**

# Thank you for your attention

Please visit for more information;

- QZSS Service Overview

<https://qzss.go.jp/en/overview/services/index.html>

- Use Case-User Guide and Products

<https://qzss.go.jp/en/usage/index.html>

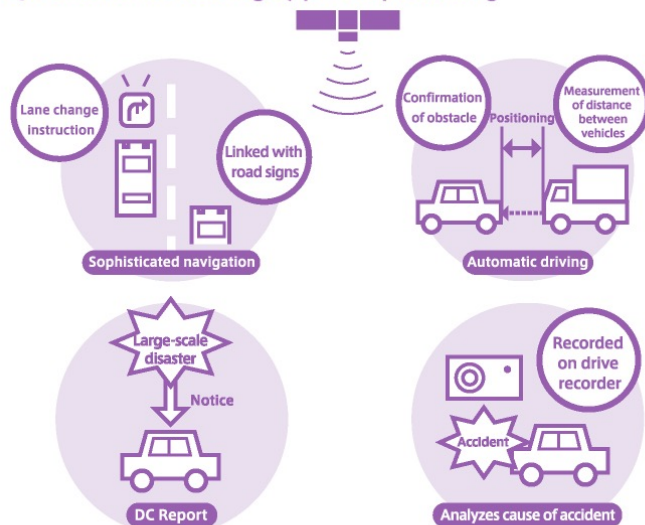
# Backup Slides

➤ **QZSS Service User Guide, <https://qzss.go.jp/en/usage/useimage/index.html>**  
**-Automobiles**

**[Navigation]**  
Highly precise positioning realizes safe and reliable navigation

**[Logistics and Passenger Transport]**  
Highly precise positioning innovates passenger transport and logistics

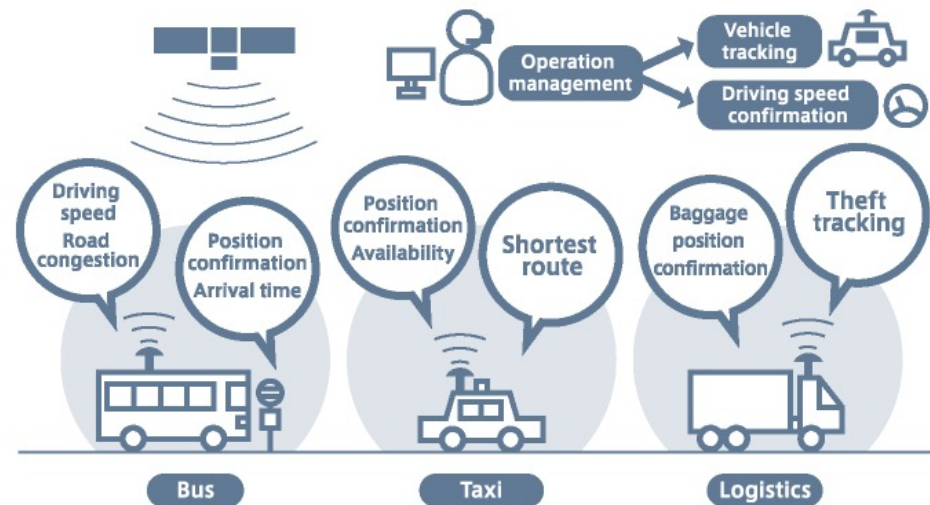
QZSS and traffic with highly precise positioning



Highly precise positioning (at several dozens of centimeters) provides sophisticated driving assistance and supports safe driving. It can also be adopted for automatic driving technologies.

[https://qzss.go.jp/en/usage/useimage/us02\\_auto-navi.html](https://qzss.go.jp/en/usage/useimage/us02_auto-navi.html)

QZSS and buses, taxis, logistics, etc.



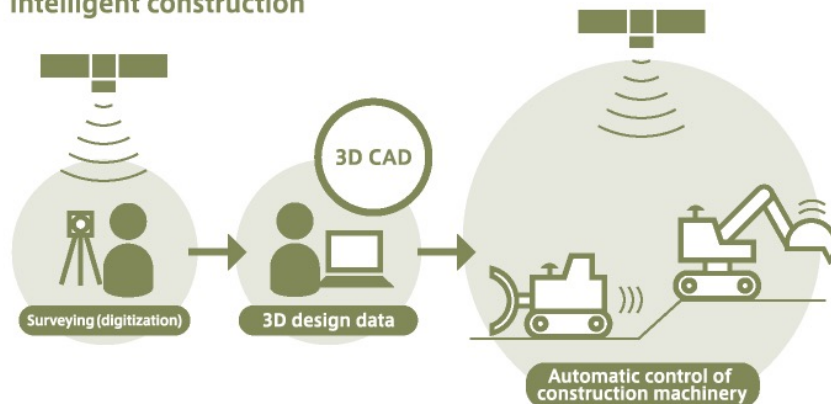
[https://qzss.go.jp/en/usage/useimage/us03\\_auto-logi.html](https://qzss.go.jp/en/usage/useimage/us03_auto-logi.html)

- **QZSS Service User Guide**, <https://qzss.go.jp/en/usage/useimage/index.html>  
**-Construction and Agriculture, Highly precise positioning achieves more efficient work**

**[Construction]**  
**Intelligent construction greatly changes public work processes**

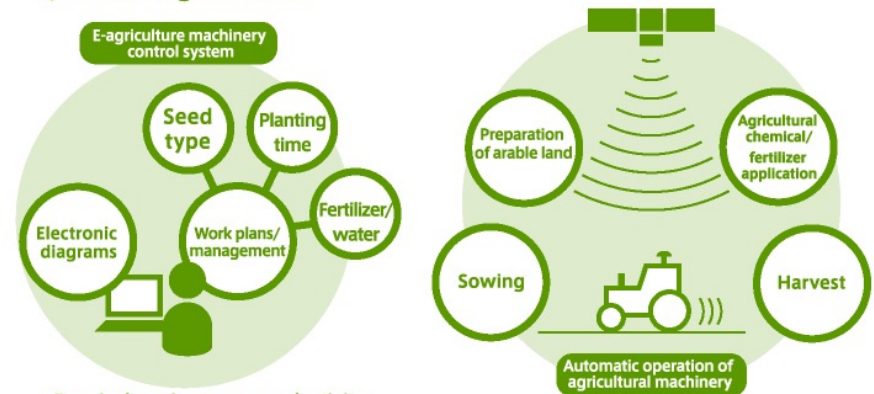
**[Agriculture]**  
**More systematic farming via e-agriculture**

### Intelligent construction



QZSS provides effective support from surveying to actual construction. In this way, it leads to improved efficiency on a dramatic scale via fewer workers and machinery automation.

### QZSS and agriculture



E-agriculture improves productivity through measures such as the application of agricultural chemicals and fertilizer in optimum ways for each type of soil.

[https://qzss.go.jp/en/usage/useimage/us06\\_construct.html](https://qzss.go.jp/en/usage/useimage/us06_construct.html)