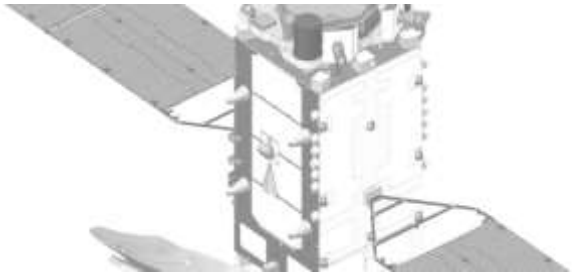
Cabinet Office
National Space Policy Secretariat



ICG WG-S 3PITF Workshop

QZSS PPP/PPP-RTK Updates

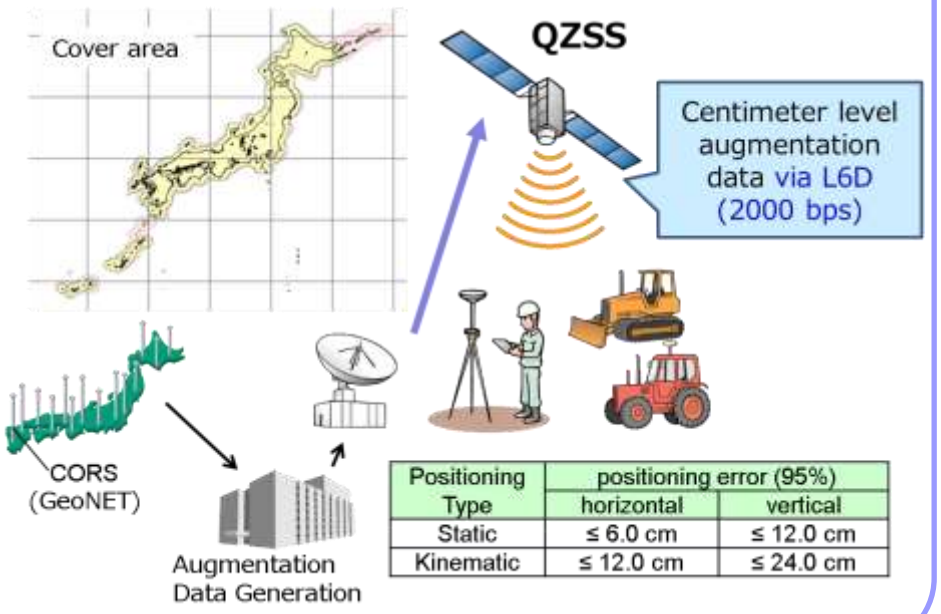
January 30, 2024

National Space Policy Secretariat
Cabinet Office, Government of Japan
Yoko SAKAI

Status of CLAS/MADOCA-PPP

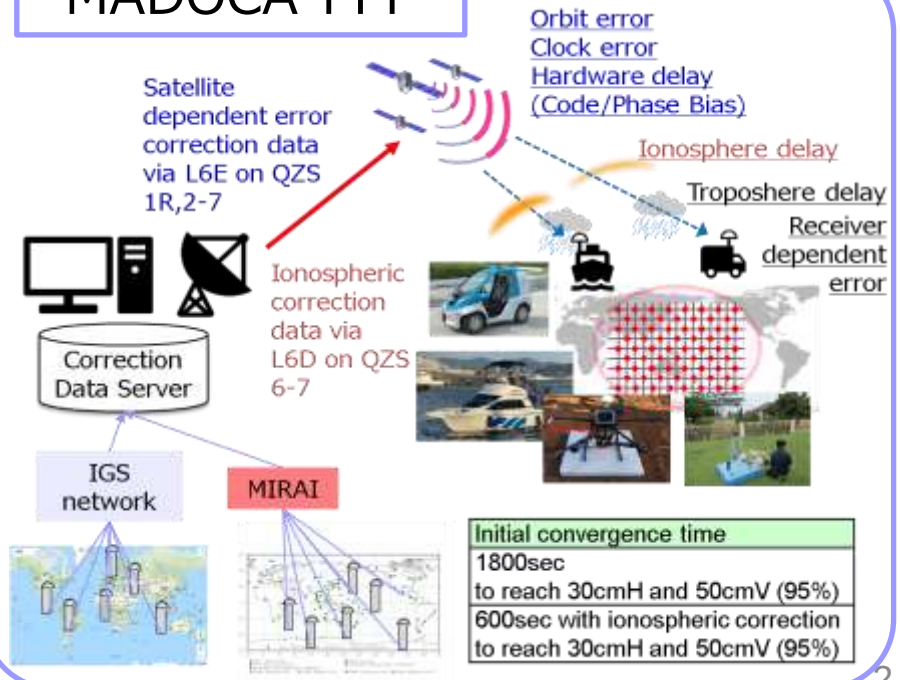
- CAO has been stably operating CLAS and trial service of MADOCA-PPP.
- CLAS message authentication is under development and an evaluation of ionospheric correction for MADOCA-PPP is underway for the experimental transmission from QZS 6 and 7 to be launched.
- CAO is working for utilization expansion such as publicly solicited demonstration, leading to price down of L6 receivers.
- CAO will open source CLASLIB and MADOCALIB, which were developed as user test libraries for CLAS and MADOCA-PPP, respectively.

CLAS (PPP-RTK)



Positioning Type	positioning error (95%)	
	horizontal	vertical
Static	≤ 6.0 cm	≤ 12.0 cm
Kinematic	≤ 12.0 cm	≤ 24.0 cm

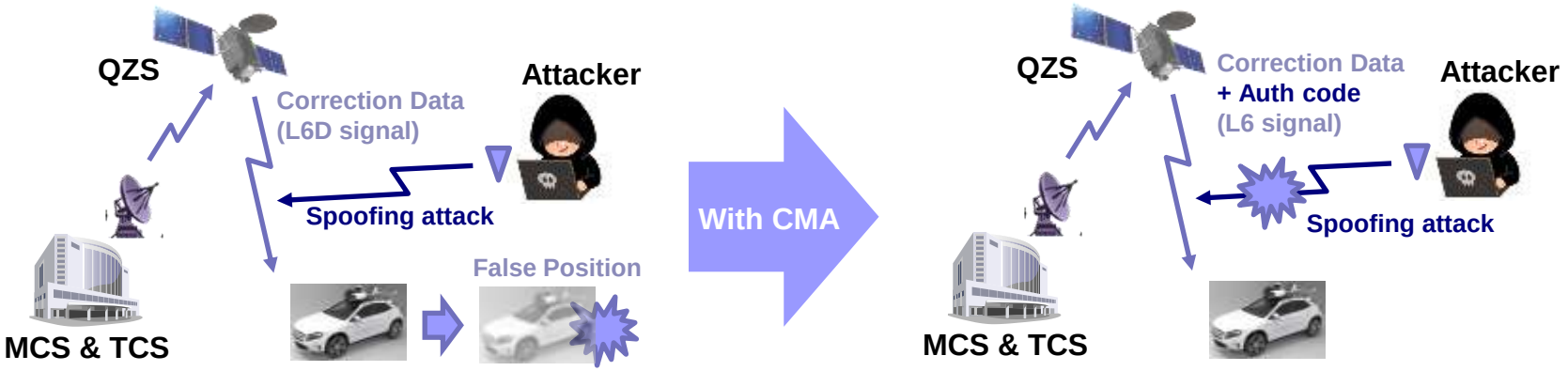
MADOCA-PPP

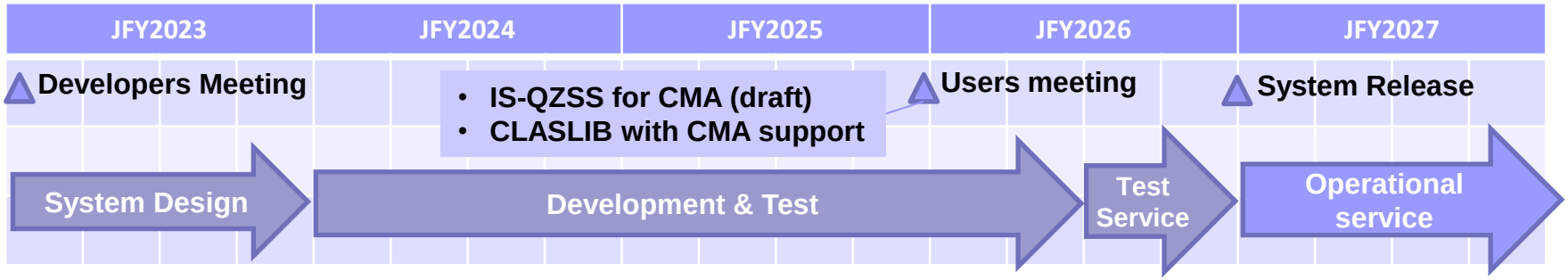


Initial convergence time
1800sec to reach 30cmH and 50cmV (95%)
600sec with ionospheric correction to reach 30cmH and 50cmV (95%)

QZSS CLAS Authentication

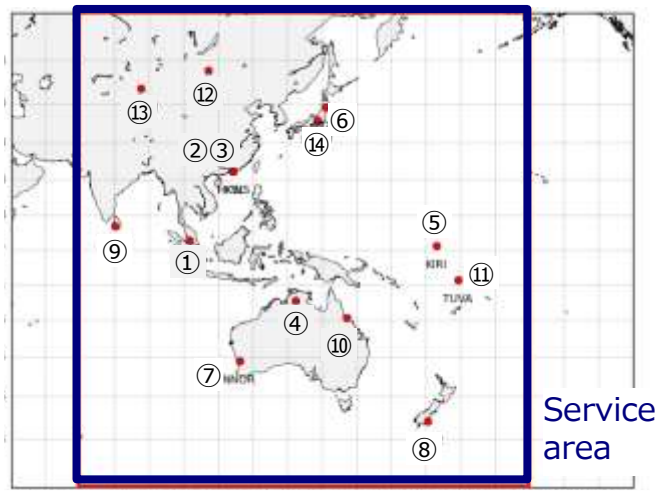
- Correction Message Authentication (CMA) will be provided for QZSS CLAS.
- It increases the resilience of high-accuracy positioning against spoofing.



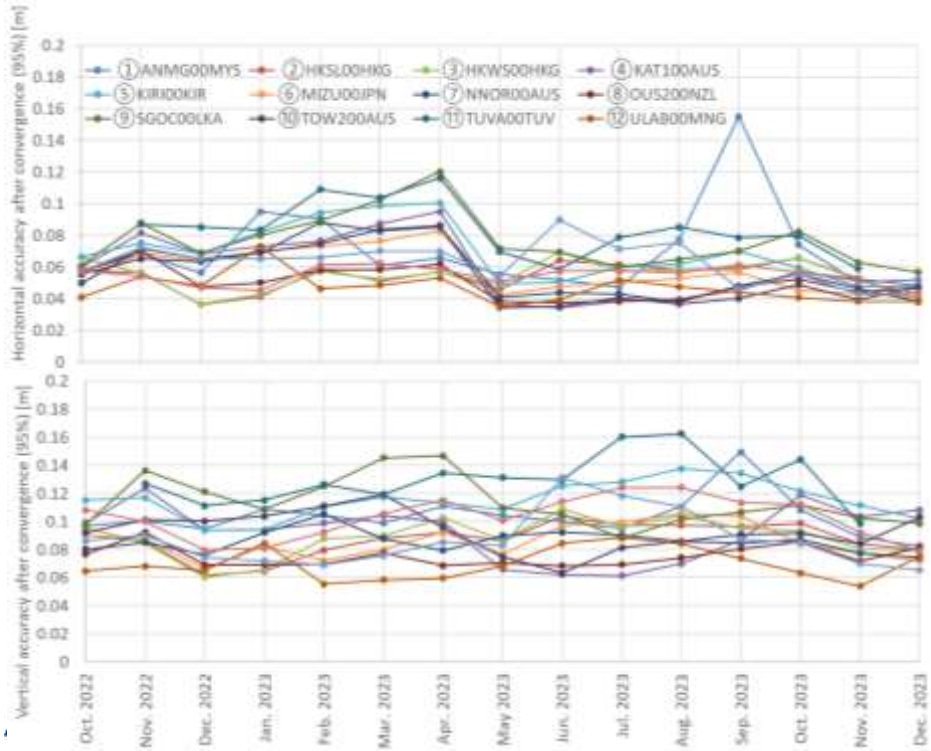


MADOCA-PPP Performance

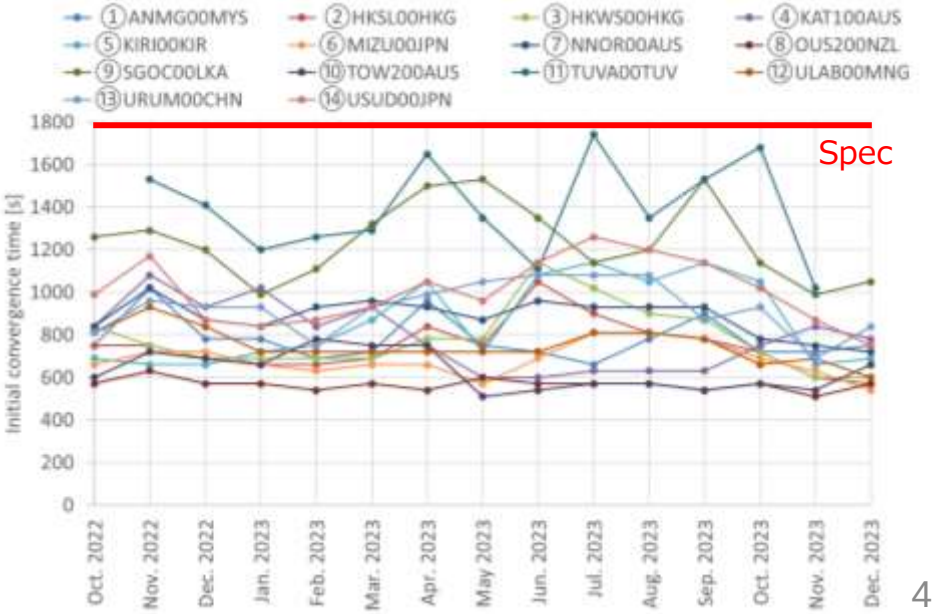
PPP results trends using IGS monitoring stations are as shown below.
Better initial convergence time than the defined specification and approximately 10 cm of accuracy has been confirmed.



Accuracy after convergence

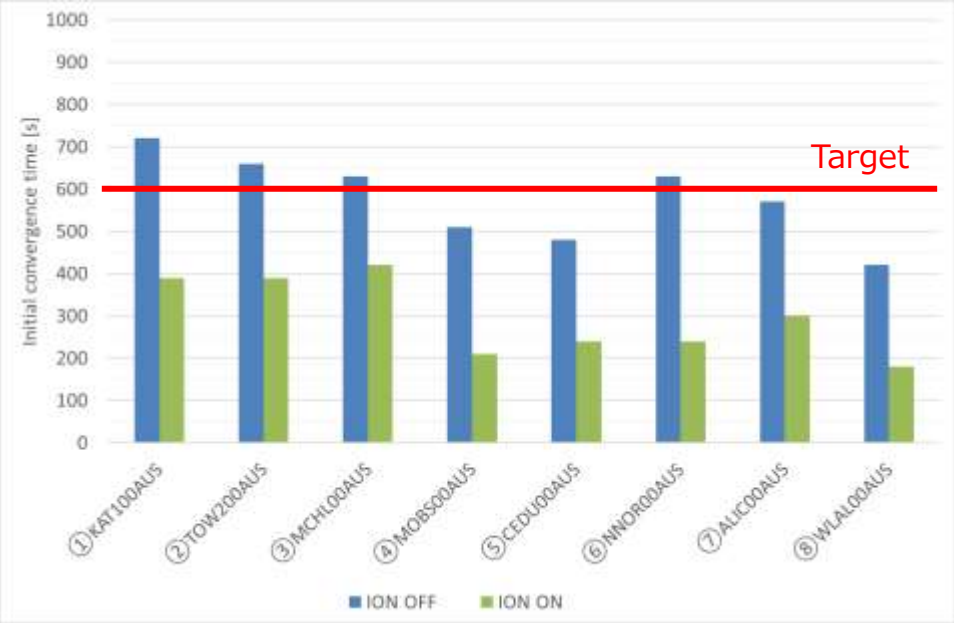


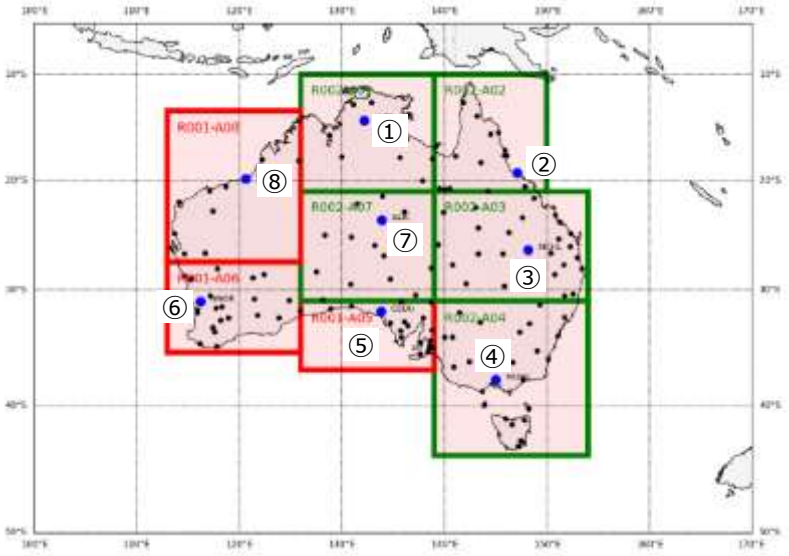
Initial convergence time



Demonstration of MADOCA-PPP initial convergence time with ionospheric correction

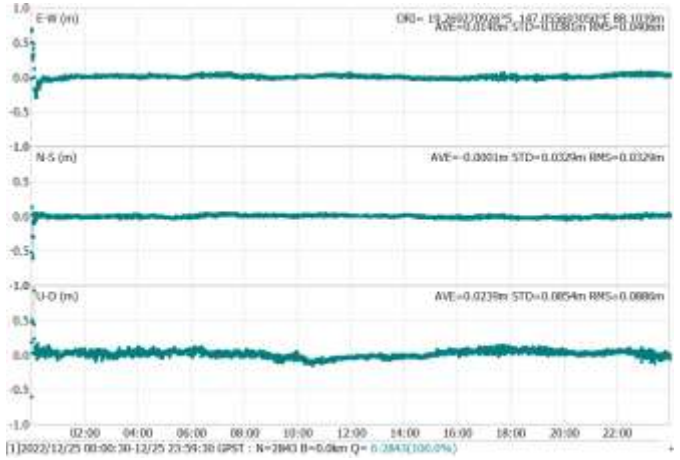
- Thanks to Geoscience Australia, CAO got a good prospect that the convergence time reduction will meet the target specification, 600s.
- CAO also cooperates with BIG in Indonesia and NAMRIA in the Philippines for the similar evaluation.



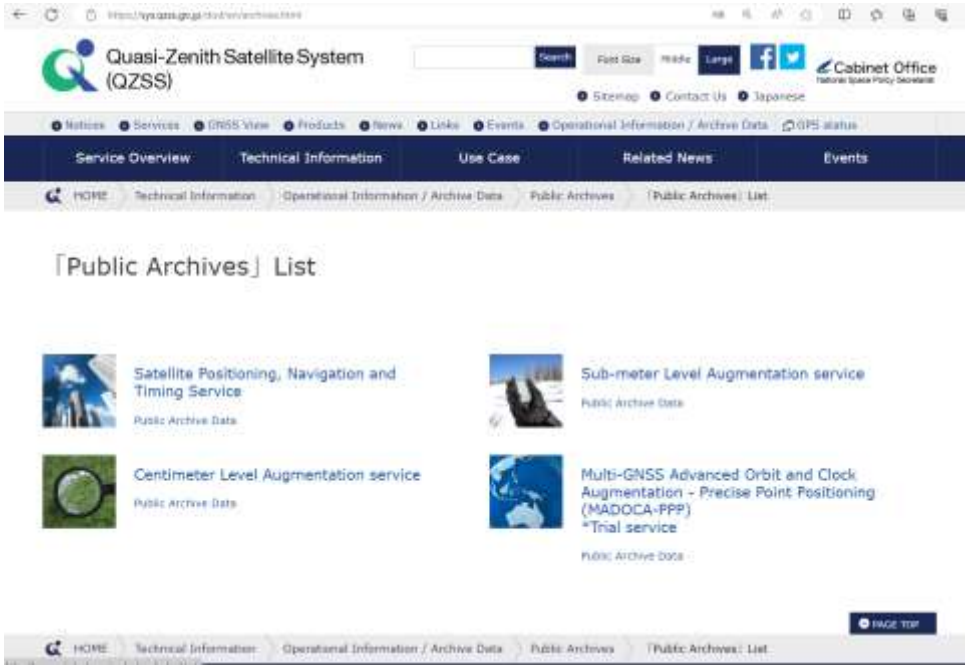


CLASLIB and MADOCALIB

- CAO provides user test libraries, CLASLIB and MADOCALIB for CLAS and MADOCA-PPP, respectively. They will be provided as open-source software soon.
- User can conduct PPP/PPP-RTK by those test libraries with L6 message archive data on the QZSS web and observation data obtained by receivers or from public web site such as CAO's MIRAI and IGS, which will promote the QZSS utilization.



Example of PPP results by MADOCALIB



Archive data of CLAS/MADOCA-PPP can be downloaded.
https://sys.qzss.go.jp/dod/en/archives.html

Receivers for CLAS/MADOCA-PPP

- The more CLAS-compatible receiver products on the market, the more prices are coming down. The range of applications is expanding as receiver prices drop.
- MADOCA-PPP is in trial service, but its compatible receivers are also now available.
- The following receivers are compatible with both CLAS and MADOCA-PPP. Both services are via L6 signal, and their message formats are CSSR.
- CAO expected the market of application using high accuracy service will expand in not only in Japan but Asia-Oceania with such common receivers.

RWS.DC (BizStation Corp.)
[50×51.5×13.1mm, 49g]

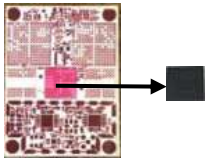
Choac∞ Ten+ (CORE Corp.)
[150×210×55mm, 650g]

MJ-3021-GM4-QZS-EVK (Magellan Systems Japan, Inc. (MSJ))
[130×90×42mm. 340g]

Chronosphere-L6 (CORE Corp.)
[200×140×60 mm, 1100g]

MJ-3008-GM4-QZS (MSJ)
[206.2×155×86㎜, 1500g]

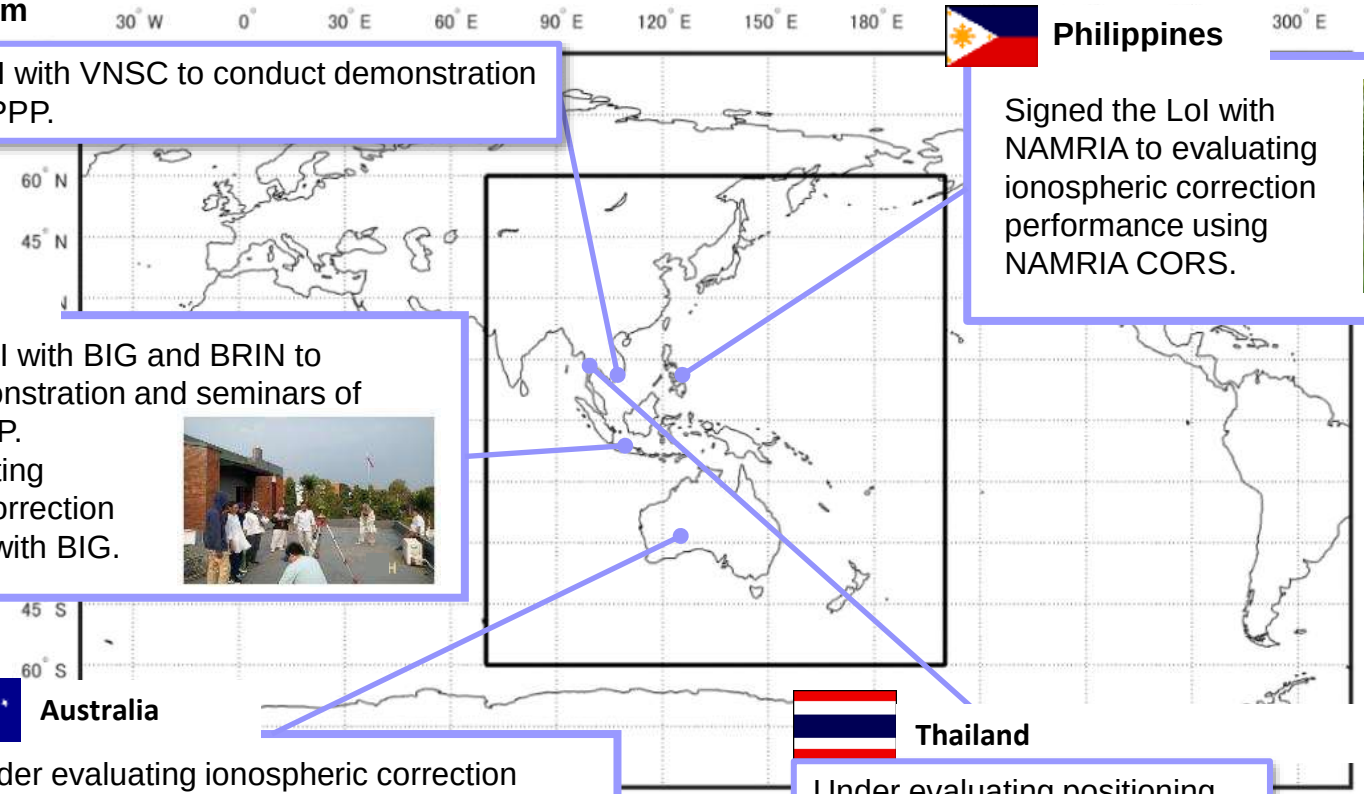
MJ-2014-GM4 (MSJ)
[43×59×10mm, 20g]



Disital ASIC (MSJ)
[30×40mm]
To be release in JFY2023

MADOCA-PPP Collaboration

【MADOCA-PPP Service area】



Vietnam

Signed the LoI with VNSC to conduct demonstration of MADOCA-PPP.

Philippines

Signed the LoI with NAMRIA to evaluating ionospheric correction performance using NAMRIA CORS.

Indonesia

Signed the LoI with BIG and BRIN to conduct demonstration and seminars of MADOCA-PPP.
Under evaluating ionospheric correction performance with BIG.

Australia

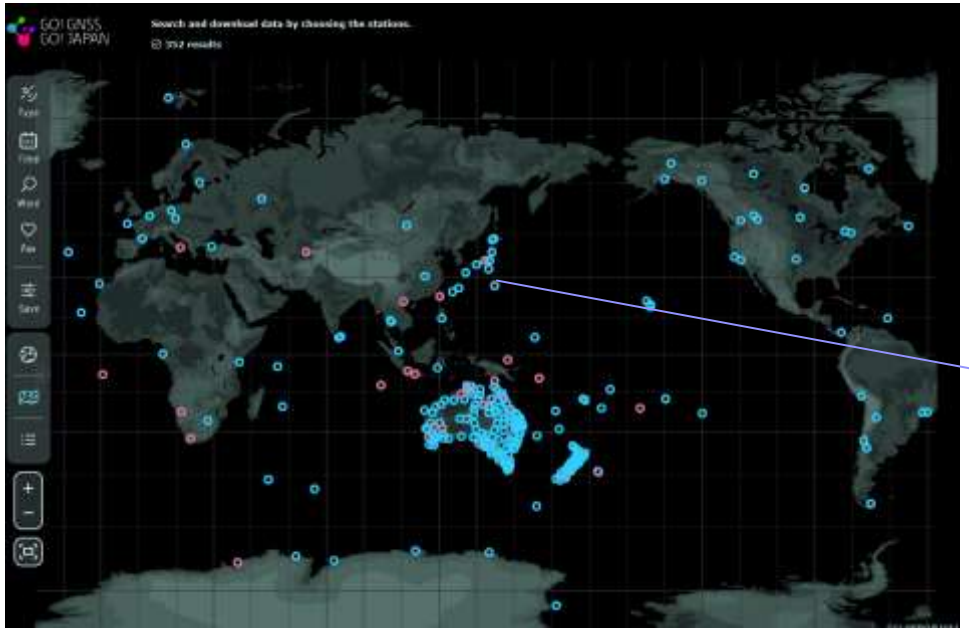
Under evaluating ionospheric correction performance using GA CORS data.

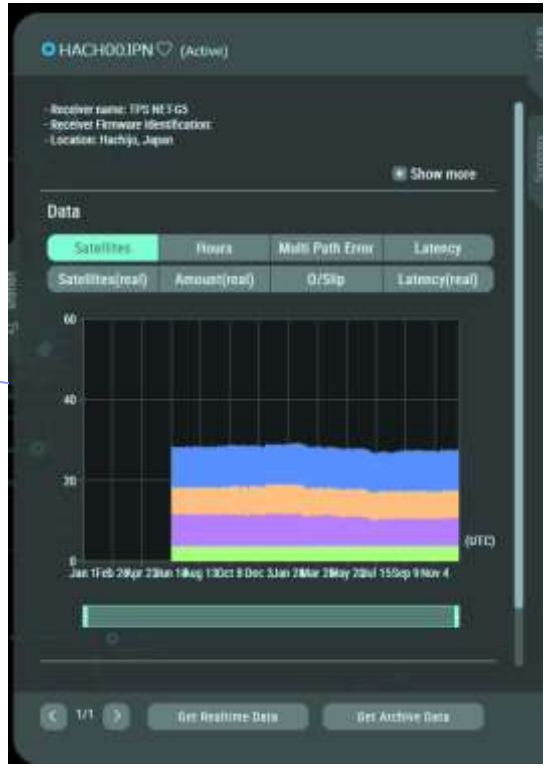
Thailand

Under evaluating positioning performance with GISTDA.

MADOCA-PPP Collaboration

- CAO is operating MultI-GNSS Integrated Real time and Archived Information system (MIRAI) with the intention to be a “redundant” data caster on the existing IGS RT infrastructure for operating MADOCA-PPP and also a source of ionospheric correction generation.
- Partners inside and outside Japan kindly provide their data to MIRAI.
- MIRAI shows both real-time data and archive data, and the MIRAI data are shared openly for the benefit of all scientific, educational, and commercial users for peaceful purposes only.
- QZSS monitoring stations data are provided in MIRAI.





https://go.gnss.go.jp/mirai/

MADOCA Proof of Concept (in progress)

＜Background＞

- The Philippines has 7,600 islands of various sizes, but surveying has not progressed for islands other than those near the borders.
- Currently, the issue is that it is too time-consuming and costly.

＜Overview of PoC＞

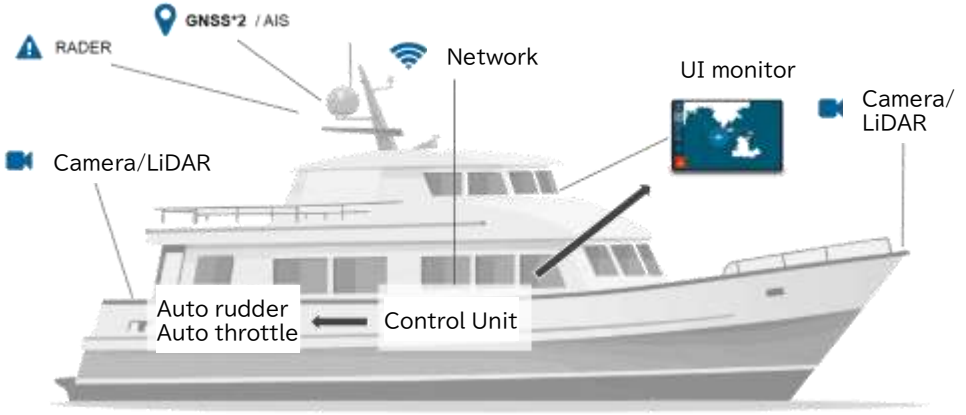
- Created guidelines for surveying remote islands using MADOCA-PPP.
- Evaluate the results (work time, equipment, procedures, accuracy, etc.) of actual surveying according to these guidelines

Demonstration of PPP survey in Balahibongmanoc Island

CLAS Proof of Concept

- Water cab by autonomous EV boat using CLAS on a trial operation
- Flexible operation due to no need for RTK reference stations
- Control system is applicable to a variety of small vessels as retrofit-compatible.

Trial operation of water cab in Hiroshima.



Retrofittable

GNSS antenna × 2
(for heading)

CLAS Receiver
(for moving reference station)

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

Thank you for your attention!