Ministry of Land, Infrastructure, Transport and Tourism

Civil Aviation Bureau of Japan

MSAS (Michibiki Satellite-based Augmentation Service)

EGNOS Workshop 2025

Berlin, Germany

Oct. 1-2, 2025

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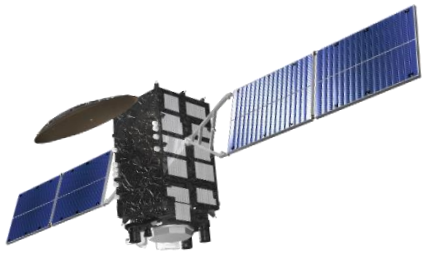
JCAB JAPAN CIVIL AVIATION BUREAU

国土交通省

JRANSA 一般財団法人 航空保安無線システム協会 Japan Radio Air Navigation Systems Association



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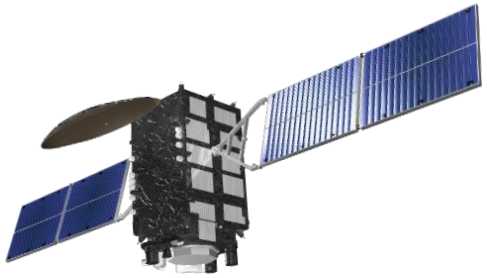
- Introduction of MSAS
- MSAS Version 3 Status
- MSAS R&D Activity Status
- MSAS Performance Assessment
- Conclusion

Introduction of MSAS

FY	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	～
MSAS Ver.	MSAS Ver.1													MSAS Ver.2					MSAS Ver.3			
GEO Satellite	**MSAS**: **M**ultifunction Transport Satellite（MTSAT） **S**atellite-based **A**ugmentation **S**ystem													**MSAS**: **M**ichibiki **S**atellite based Augmentation Service								



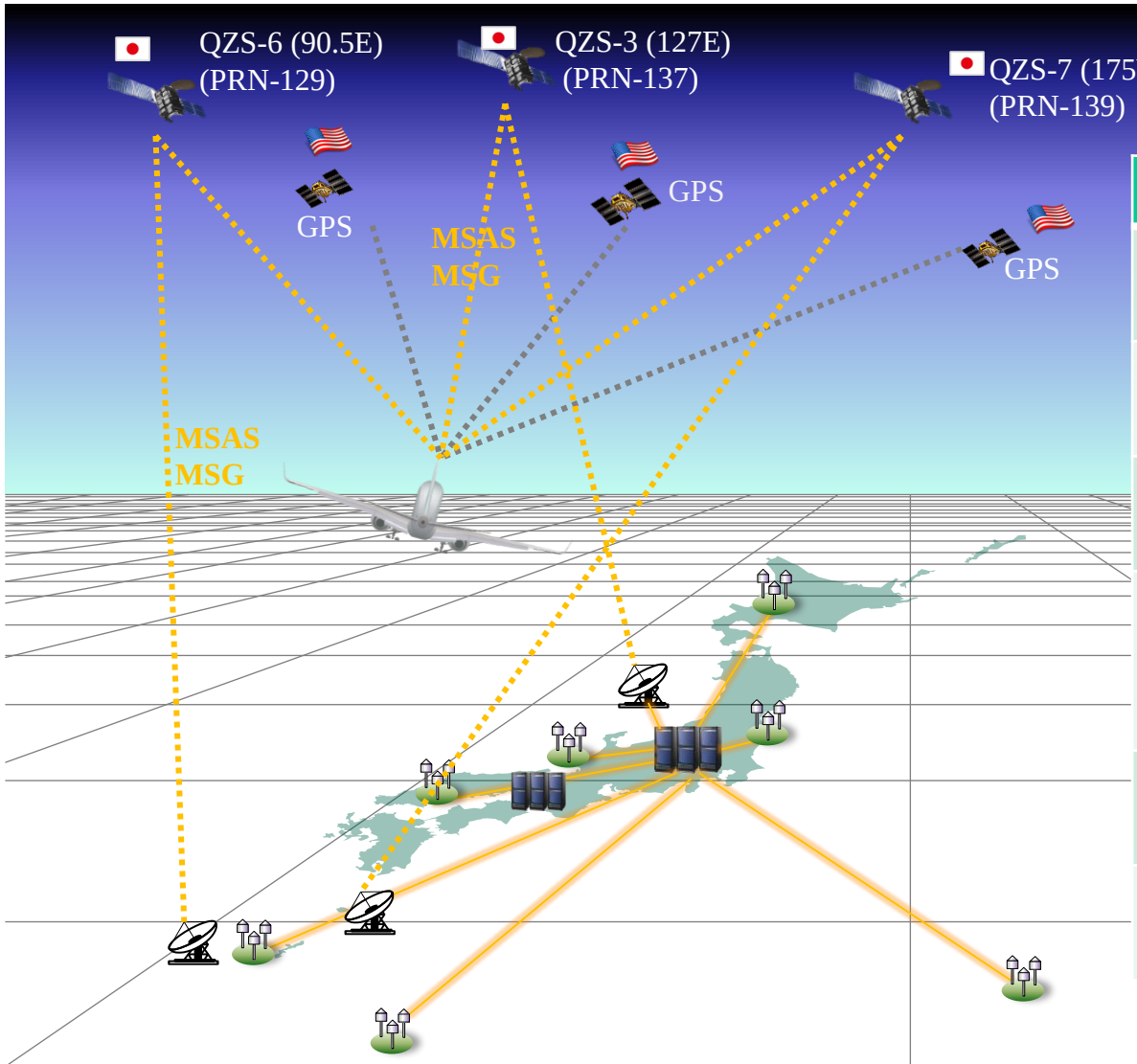
ICAO SARPs ANNEX 10 Volume I 7th Edition, Attachment D of Amendment 92 ～

6.2.2 Satellite-based augmentation services are provided by the Wide Area Augmentation System (WAAS) (North America), the European Geostationary Navigation Overlay Service (EGNOS) (Europe and Africa), the Michibiki Satellitebased Augmentation Service (MSAS) (Japan) and the GPS-aided Geo-augmented Navigation (GAGAN) (India). The System for Differential Correction and Monitoring (SDCM) (Russia), the BeiDou Satellite-based Augmentation System (BDSBAS) (China), the Korea Augmentation Satellite System (KASS) (Republic of Korea), the Augmented Navigation for Africa (ANGA) (ASECNA) and the Southern Positioning Augmentation Network (SouthPAN) (Australia and New Zealand) are also under development to provide these services.

Michibiki（導き）＝Guidance

Introduction of MSAS

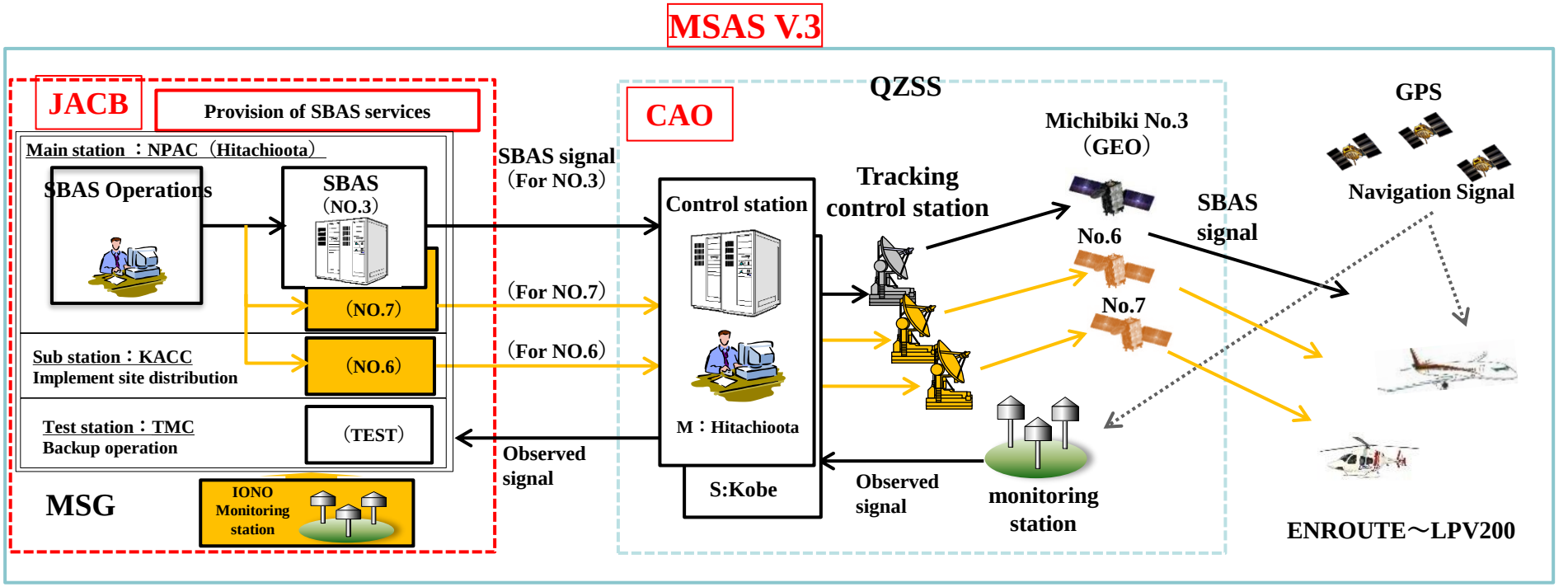
MSAS（Michibiki Satellite-based Augmentation Service）-V3 System Configuration



Subsystem	Q'ty	Remarks
MCS (Master Control Station)	2	@Hitachi-ohta @Kobe
GMS (Ground Monitoring Station)	15	MSAS Reference Station (for GPS augmentation)
IMS (Ionosphere Monitoring Station)	13	Monitoring various Constellations to increase # of IPP
GEO (Geo-stationary Satellite)	3	QZS-3 (in operation) QZS-6(Launched, under test) QZS-7 (Will be launched in 2027)
Uplink Station (Nominal)	3	@Hitachi-ohta @Tanega-shima @Miyako-jima
TES (Test Evaluation System)	1	@Tokorozawa

Introduction of MSAS

Organization aspects to Operate MSAS V.3



- JCAB : MSAS Service Provider
  - NPAC: Operation of MSG and GPM.
    Evaluation/Analysis of MSAS performance
- CAO: QZSS Service Provider

MSG: MSAS Signal Generation Equipment
GPM: GNSS Prediction and Monitoring equipment

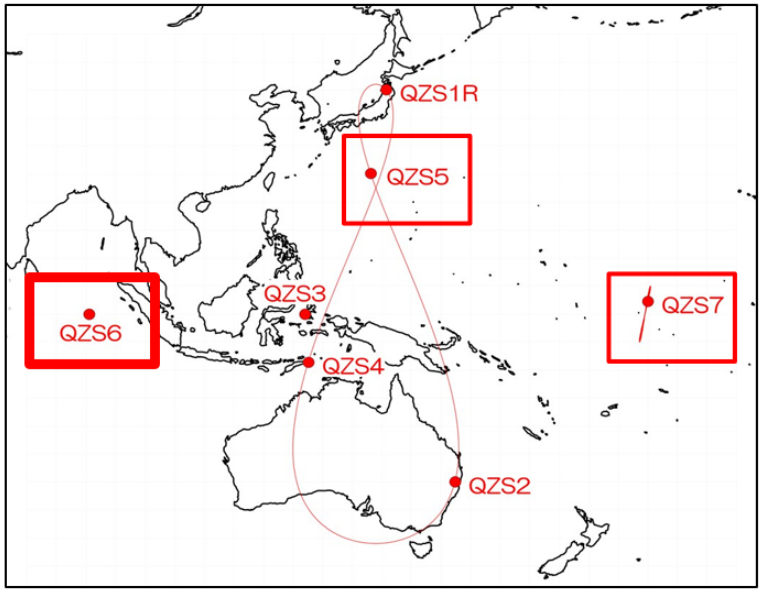
To 7-satellite constellation

Cabinet Office
National Space Policy Secretariat

- **QZS-6 was launched to GEO on 90.5 East Longitude on 2nd Feb, 2025.**
- **Two additional MICHIBIKI(QZS-5,7)** will be placed on an IGSO and a Quasi-Geostationary Orbit on 175 West Longitude, respectively.

■This 7 Satellite constellation aims:

- To be visible more than four satellites and get better DOP.(PNT)
- To be visible more than one satellite at high elevation angle.(Augmentation)

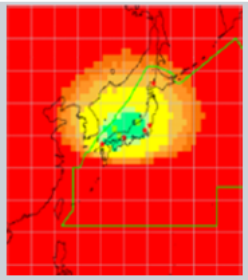
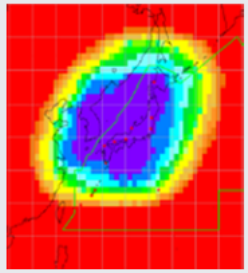
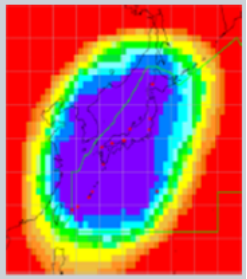


Seven-QZS Ground Track

Satellite orbit	Satellite Number	Orbital Position
IGSO（4 satellites）	QZS-1R	133 deg E
	QZS-2	139 deg E
	QZS-4	139 deg E
	QZS-5	139 deg E
GEO（2 satellites）	QZS-3	127 deg E
	QZS-6	90.5 deg E
QGEO（1 satellite）	QZS-7	175 deg W

7 Satellite constellation (4 IGSO + 2 GEO +1 QGEO) will be completed within Japanese FY2025. QZS-5 and 7 will be launched respectively in Late FY2025.

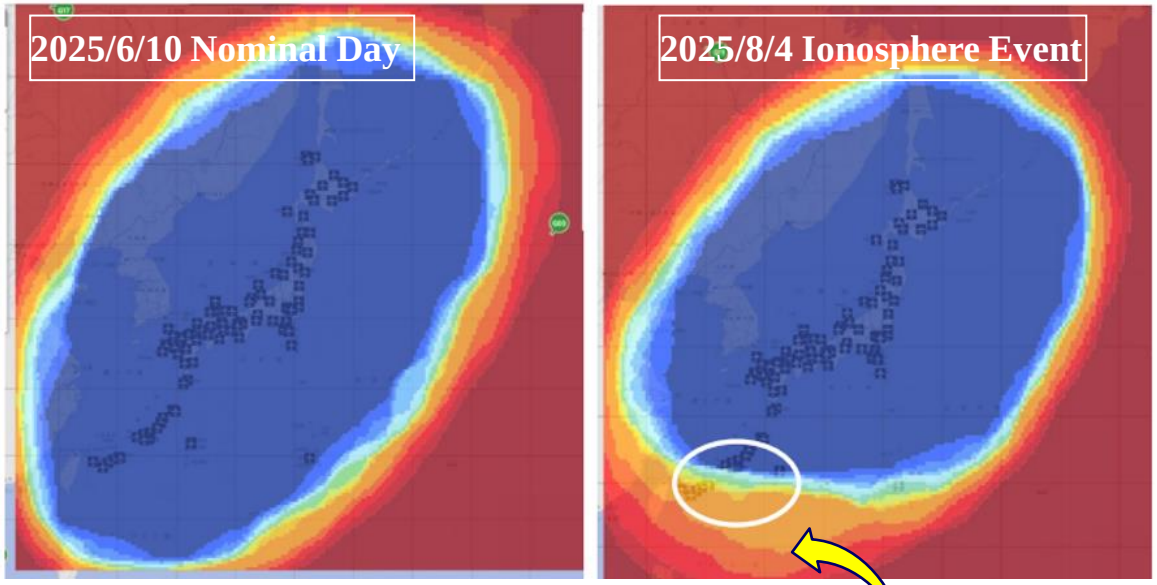
MSAS Version 3 Status

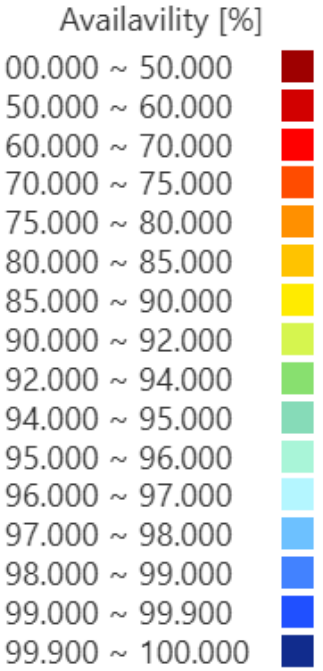
Version	Overview	Feature	Service Level	LPV200 Performance
MSAS-v1	L1 SBAS Operational Period 2007 – 2020 Two MTSAT (PRN129/137) Eight reference stations	Eliminate RAIM check requirement	ENROUTE ~ NPA	
MSAS-v2	L1 SBAS Operational Period 2020 – present Quasi-Zenith Satellites System GEO (PRN137) Thirteen reference stations (G-III) Cutover planned Mar 2025	Eliminate RAIM check requirement LPV250 procedures with LPV250 prediction NOTAM	ENROUTE ~ NPA	
MSAS-v3	L1 SBAS Operational Period 2025 – v4 Quasi-Zenith Satellites Systems GEO (PRN129/137/139) Fifteen GMS (G-III) Thirteen IMS (GT7800) Dual MCS	Eliminate RAIM check requirement LPV200 procedures with or without LPV2050 prediction NOTAM	ENROUTE ~ LPV200	

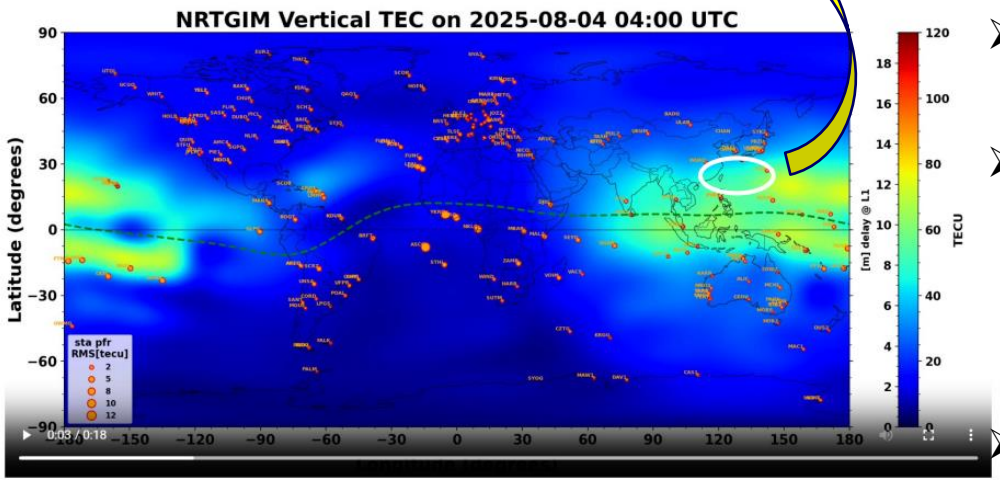
- **MSAS Ver3 is designed for LPV200.**
- **At present, LPV250 is provided at 25 airports with 1 GEO.**
- **From October 1st, LPV250 will be provided with 2 GEOs (PRN137 service-in)**
- **Data collections/evaluations continue for Certification taking Peak of Solar Cycle 25 into account.**

MSAS Version 3 Status

LPV250 Performance





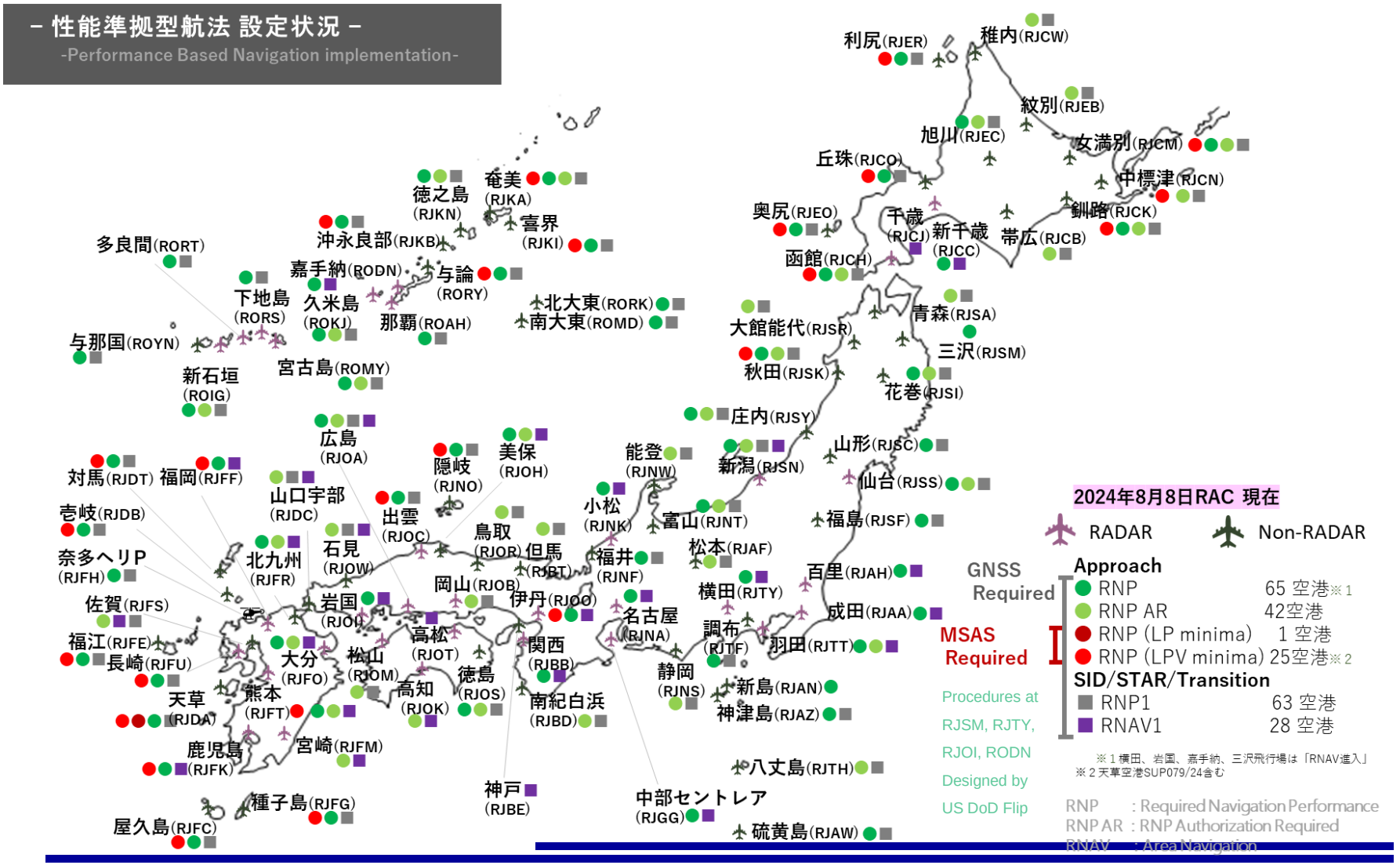


[Summary | MSAS/RAIM Prediction information of JAPAN]

- Some of south-eastern regions of Japan are on the magnetic equation.
- Residual vertical position error would be marginal against LPV200 requirement Annex10 ATT-D 3.3.9.3. if strong regional Iono.event happened.
- Measure is under consideration technically and/or operationally.

MSAS Version 3 Status

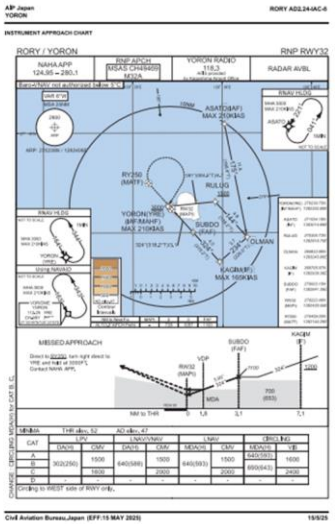
MSAS-based Approach Procedures for 25 Airports are officially published(RNP Approach LP/LPV minima) . Expansion in progress in sequence.



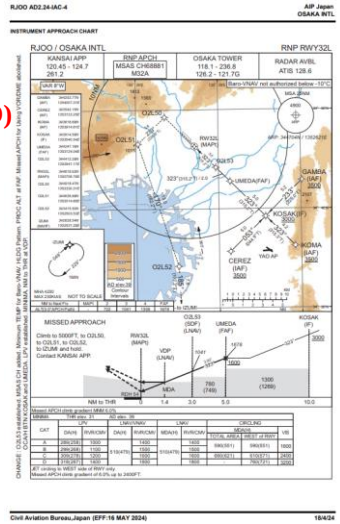
MSAS Version 3 Status

- LPV250 operational evaluation by 5 airlines at 25 airports / 83airpots.
- JCAB analyze feedbacks from airlines using LPV minima from the perspectives as follows.
  - Usability of LPV vertical guidance
  - Signals In Space (performance and anomaly)
  - RFI event and loss of signal
  - On-board equipment failure
- After official publication of AIP, airlines continue to collect data for operational evaluation for further feedback to JCAB.

(RORY)



(RJ OO)



JAL
A350

http://press.jal.co.jp/ja/release/201310/001842.html

AHX (Regional)
ATR42-600

https://www.amx.co.jp/dash/

ORC (Regional)
ATR42-600

https://www.orc-air.co.jp/service/seat/

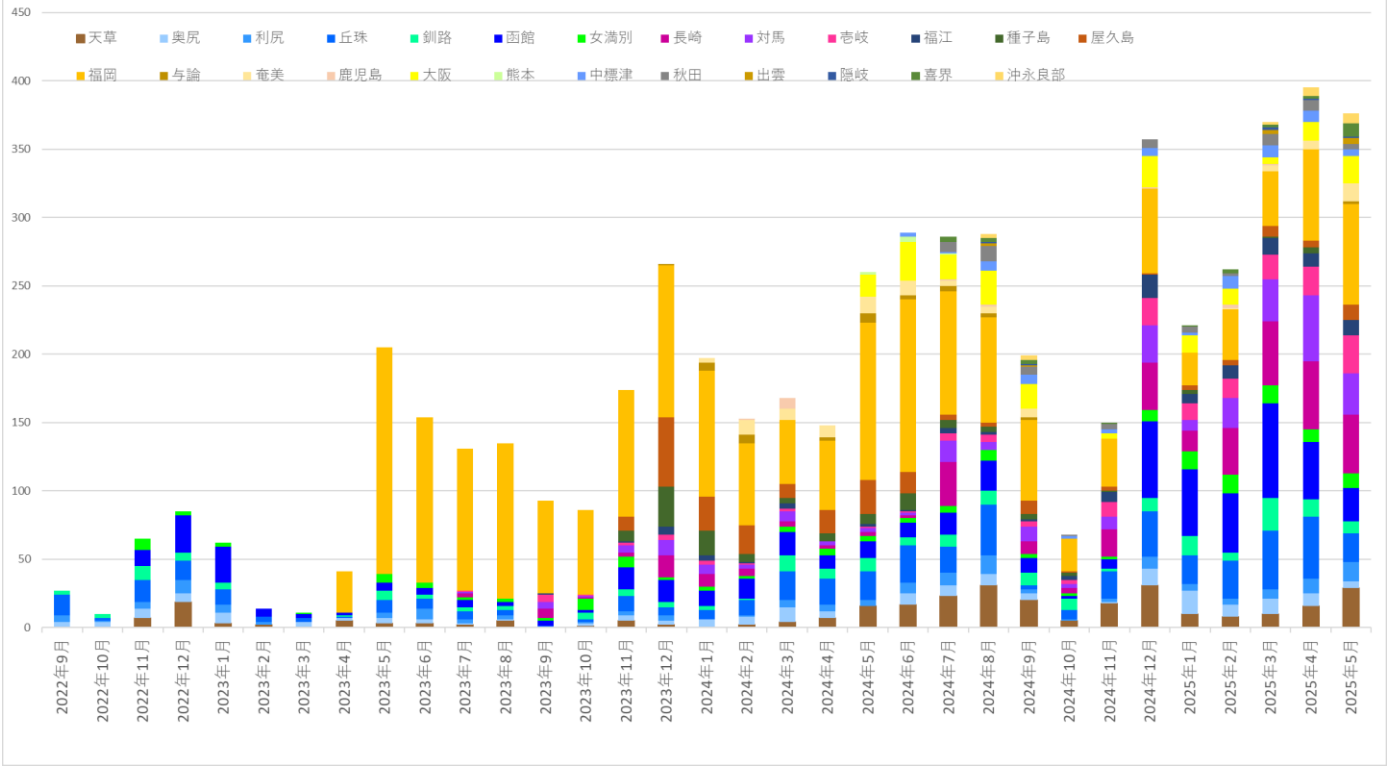
NTH (Regional) JAL Group
ATR42-600

https://www.info.hac-air.co.jp/wp-content/uploads/2018/07/HAC_ATR_FNL_.pdf

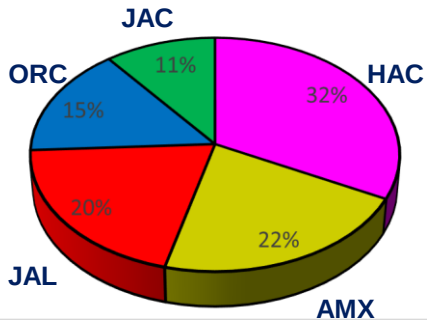
JAC (Regional) JAL Group
ATR42-600

MSAS Version 3 Status

LP/LPV Actual Achievement per month



Per Airline



北海道エアシステム
ATR42-600 HAC

https://www.info.hac-air.co.jp/wp-content/uploads/2018/07/HAC_ATR_FNL_.pdf

天草エアライン
ATR42-600 AMX

https://www.amx.co.jp/dash/

JAL
A350 JAL

http://press.jal.co.jp/ja/release/201310/001842.html

オリエンタルブリッジ
ATR42-600 ORC

https://www.orc-air.co.jp/service/seat/

日本エアーコミューター
ATR42/72-600 JAC

http://www.jac.co.jp/aircraft/atr42-600.html

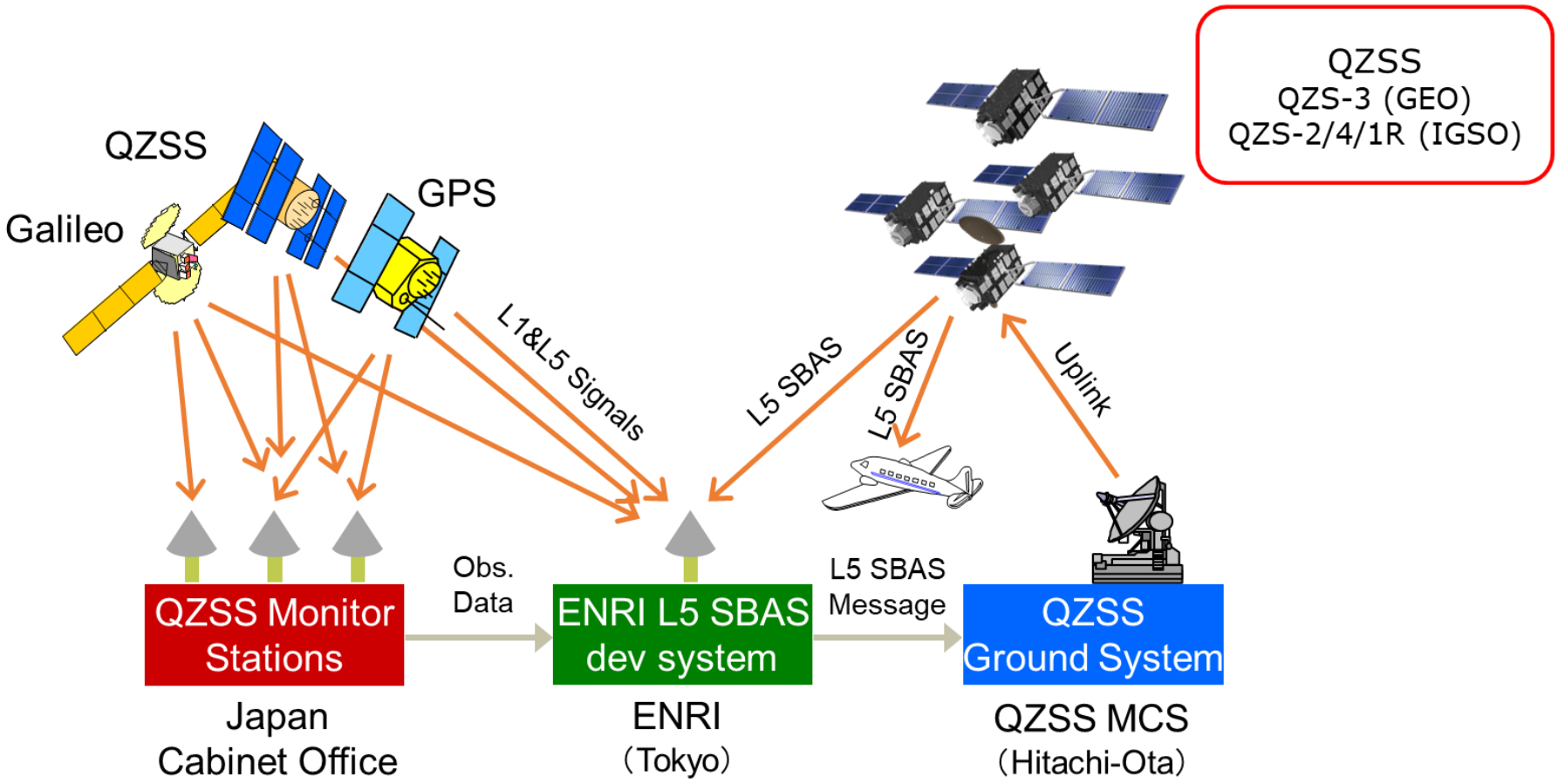
MSAS Version 3 Status

Status of SBAS equipage of national airlines

Airline	Model	SBAS	LPV
Hokkaido Air System , HAC	ATR-42-600	4	4
Amakusa Airlines , AHX	ATR-42-600	1	1
Oriental Air Bridge , ORC	ATR-42-600	2	2
Japan Airlines , JAL	A350-900/1000	24	24
	B777-300ER	12	
Japan Air Commuter , JAC	ATR-42/72-600	11	11
New Central Airservice ,CUK	DO-228	5	1
All Nippon Airways , ANA	DHC-8-Q400	24	
IBEX Airlines , IBX	CRJ-700	9	
Fuji Dream Airlines , FDA	ERJ-175L	8	
Ryukyu Air Commuter , RAC	DHC-8-Q400	5	
ANA	B777F/-300ER	15	
	Total	120	43

MSAS R&D activities

Validation Configuration: DFMC-MSAS proto-type(R&D 2017.8～)



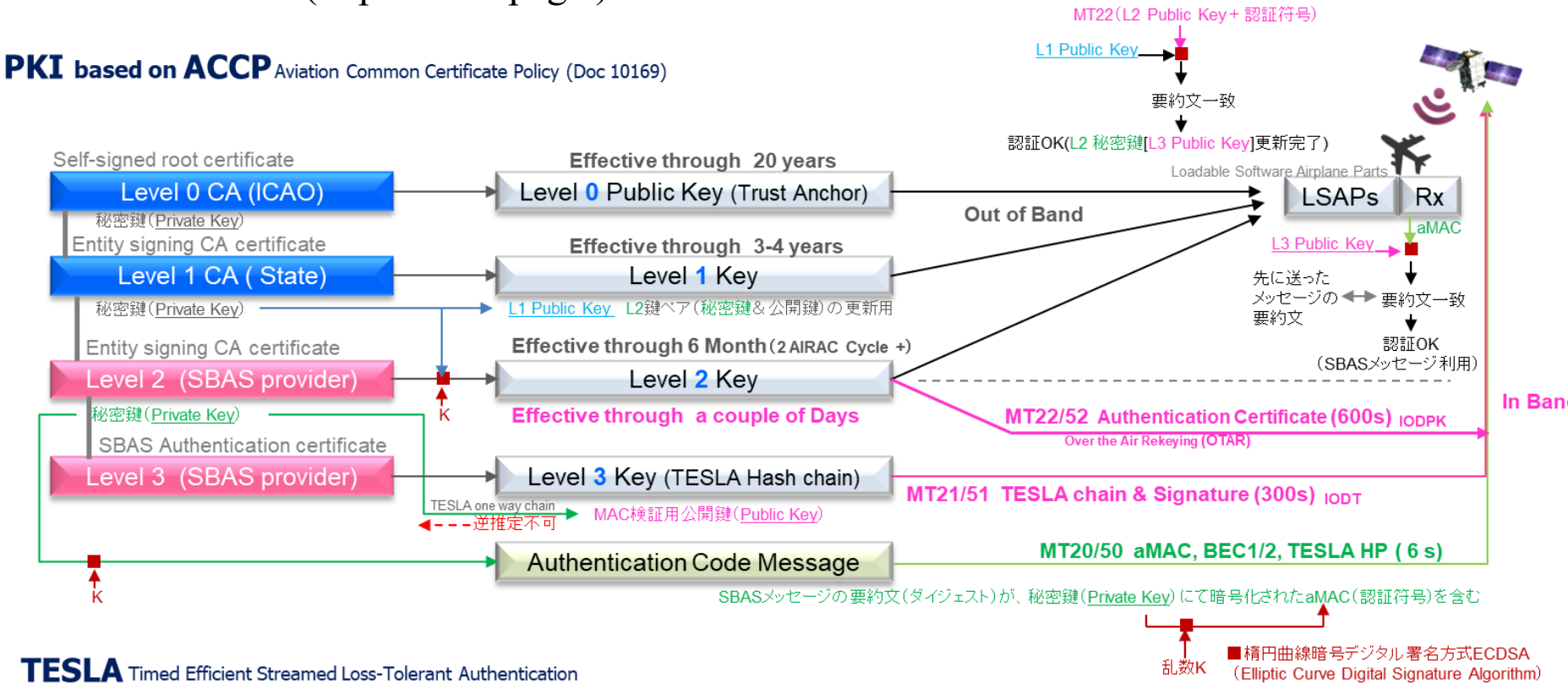
- Real-Time observation

- Real-Time Process
- Augment GPS/Galileo/QZSS
- Generate L5 SBAS Message

- Uplink L5 SBAS Message to QZSS satellites
- Broadcast on L5S signal

MSAS R&D activities

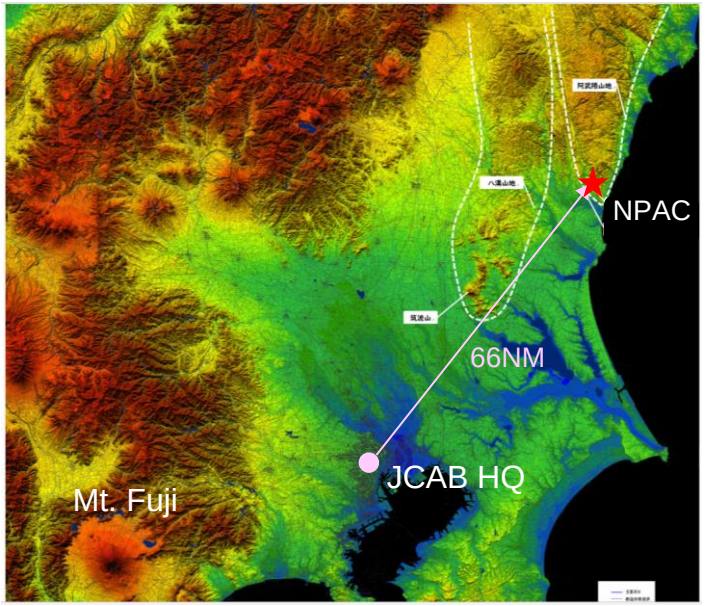
- Authentication is one of the most important subjects in SBAS and Core Constellations.
- JCAB is investigating SBAS Authentication for future MSAS evolution and contributing ICAO standardization activity in this area.
- ENRI's test bed (in previous page) will contribute to validation of ICAO standardization.



Public Key Infrastructure for the Authentication might share with PKI for FF-ICE.

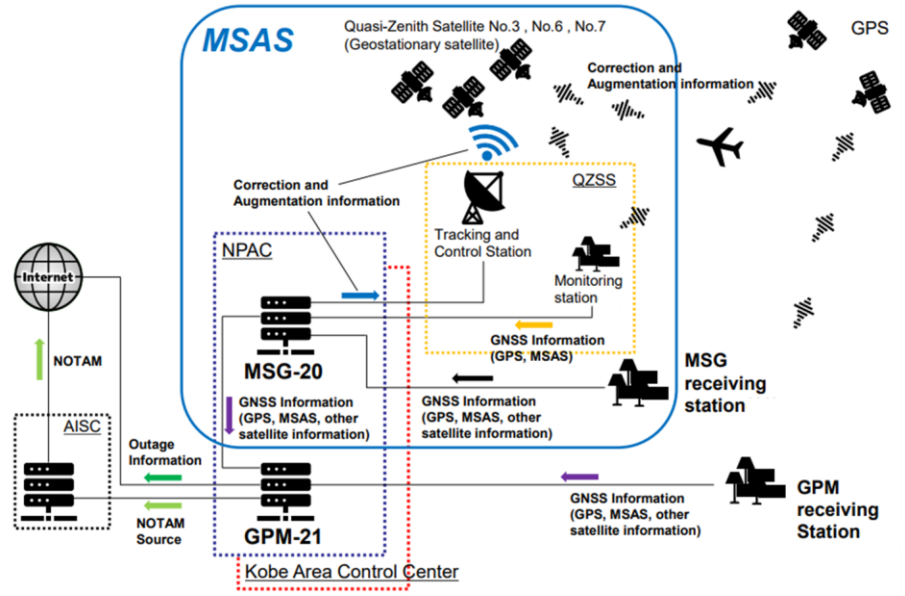
MSAS Performance Assessment

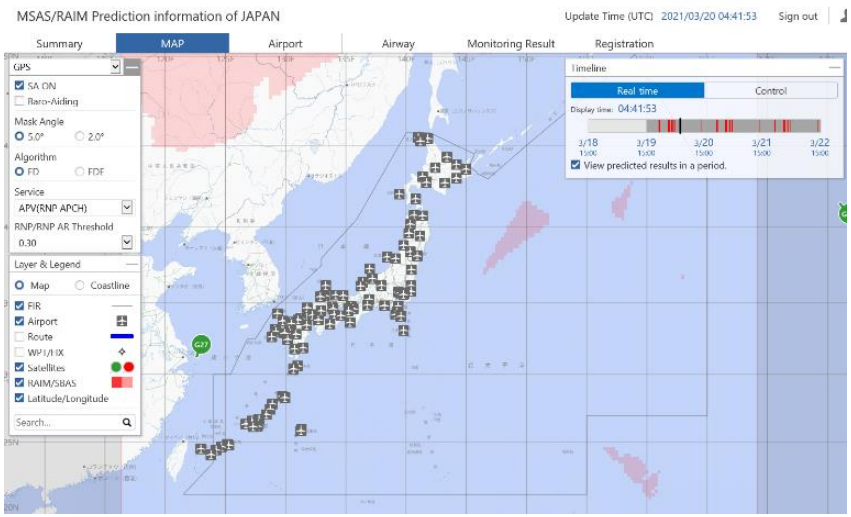
- Network Performance Assessment Center (NPAC) was established in 2020 in response to the fostering “a globally consistent performance-based approach”
- Primary objective is assessing the continued operational safety of advanced CNS services (Datalink, PBN, ATC Surveillance) including frequency spectrum issues in Fukuoka FIR.



Location of NPAC ★

MSAS Performance Assessment





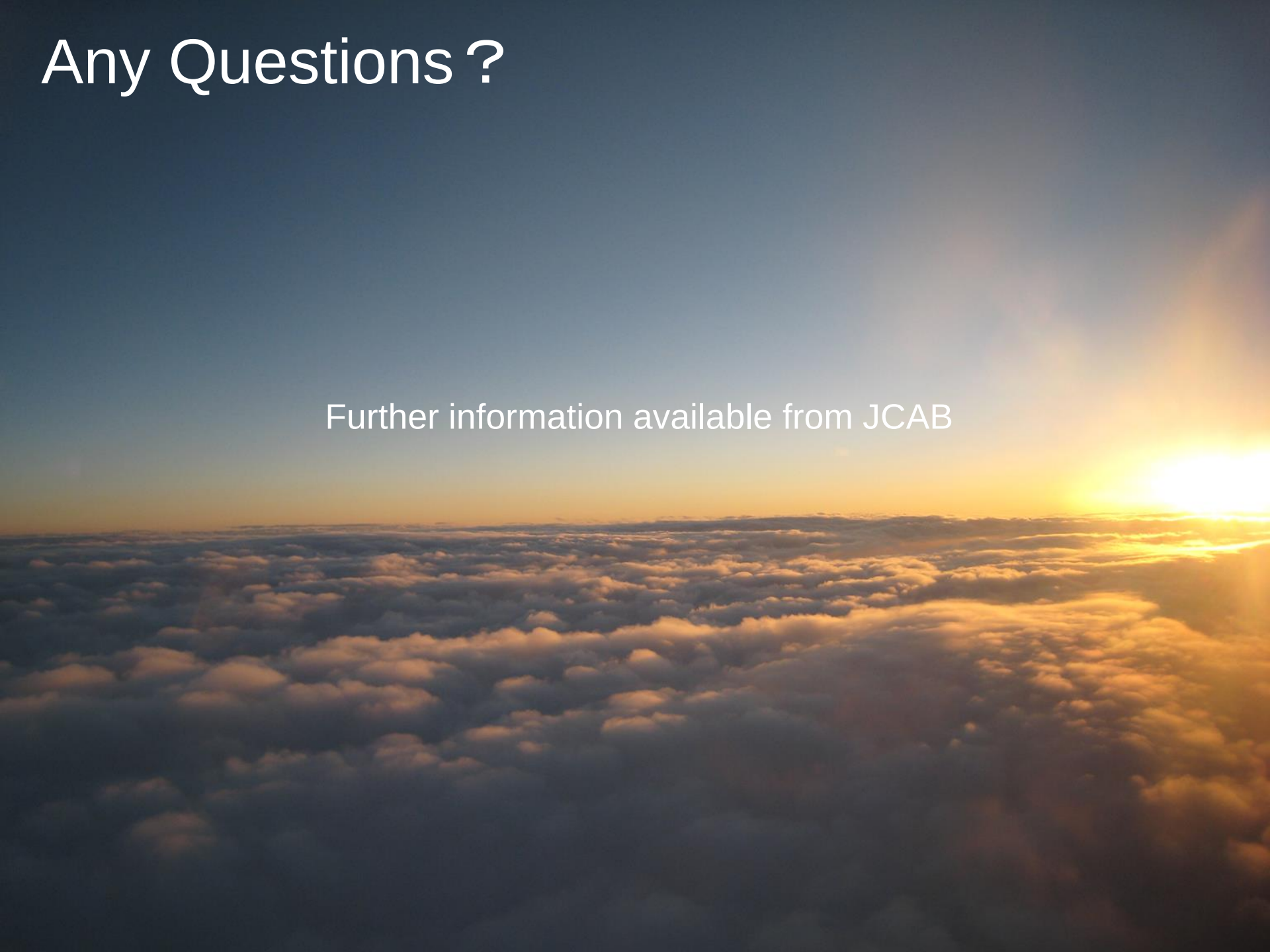
What NPAC is responsible for :

- To conduct continuous MSAS performance monitoring (using GPM: GNSS Performance Monitoring Equipment)
- To detect functional discrepancy against designated RNP (LP/LPV) performance
- To issue NOTAM source data if it is necessary.
- To continue evaluation and to collect data for future evolution of MSAS and Performance Monitoring (DFMC SBAS, Authentication etc.)

Conclusion

- MSAS has been step-by-step phased evolution since 2007.
- MSAS entered into a new phase (Version 3) in April 2025 to pursue full operation of LPV in Japan.
- JCAB is continuing evaluation of MSAS for LPV operation as well as future evolution of MSAS.

Any Questions ?



Further information available from JCAB