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THIRTEENTH AIR NAVIGATION CONFERENCE

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COMMITTEE A

Agenda Item 2: Enabling the global air navigation system
2.2: Integrated CNS and spectrum strategy

MSAS STATUS AND FUTURE PLAN

(Presented by Japan)

EXECUTIVE SUMMARY

This paper informs current multi-functional transport satellite-based augmentation system (MSAS) status and future MSAS plan, and also reports a study result of the possibility and condition to use MSAS in other flight information regions (FIR).

1. INTRODUCTION

1.1 MSAS has started operation with MTSAT as a satellite-based augmentation system (SBAS) for Japan's FIR on 27 September 2007. In preparation for the coming decommission of MTSAT-2, works for the transition of MSAS operation from MTSAT to QZSS GEOs is on-going. QZS3(GEO) have been launched successfully on 19 August 2017. A decision of MSAS LPV implementation was made on 13 March 2018.

2. DISCUSSION

2.1 Current MSAS status

a) MTSAT-2 is currently broadcasting two (2) PRN codes (Dual PRN mode:129 and 137) as an MSAS GEO;

b) MSAS is providing GPS Augmentation Information for RNAV, from En-route through NPA (RNP 0.3); and

c) decision of LPV implementation was made on 13 March 2018 based on the agreement with stakeholders.

2.2 MSAS future plan

a) MTSAT-2 will be decommissioned in 2020.

b) Cabinet Office of Japan (CAO) is under deployment of Quasi-Zenith Satellite System (QZSS).

c) QZSS will start operation from 2018 with four satellites consisting of one GEO and three QZOs (Quasi-zenith orbit satellites).

d) JCAB has started the development of the next stage SBAS of Japan and will conduct functional tests and performance evaluations with QZSS (GEO) satellite from 2018.

e) The next stage SBAS will start operation with single QZSS (GEO) satellite configuration in 2020.

f) PRN129 and PRN137 will be transferred from MTSAT to QZS (GEO) satellites.

g) L1 SBAS compatible signal will be transmitted using PRN187 from QZSS GEO in pre-operational testing period.

h) QZSS seven satellites configuration is expected in 2023 including at least 2(two) GEOs.

i) L5 augmentation signal with PRN196 (QZS2:QZO) for DFMC SBAS validation became available on 23 September 2017.

j) Additional L5 augmentation signals are planned using PRN197 (QZS3:GEO) and PRN200 (QZS4:QZO).

k) JCAB will start a process to change current L5 PRN (PRN197, PRN196 and PRN200) to SBAS PRN at a suitable moment.

l) PRN assignment for SBAS IGSO satellites is under discussion in DS2

2.3 MSAS configuration

2.3.1 MSAS configuration for each operational step is explained with the following table:

MSAS Version	**Topics**
MSAS V1: Initial Performance Phase (2007 ～ 2020) (Fig. 1)	- Operation with a MTSAT, 2 Master Control Station (MCS) and 6 Ground Monitor Stations (GMS) by 2020
MSAS V2: System Update Phase (2020 ～ 2023) (Fig. 2)	- Operational takeover to new GEO (QZS-3) - Full replacement of SBAS ground system - 2 MCS, 13 GMS and 3 Uplink Station in domestic - Performance equal or higher than the current MSAS V1
MSAS V3: LPV Performance Phase (2023 ～) (Fig. 3)	- Vertical guidance: LPV operation by two or more GEOs - Need development of high performance IONO software for low latitude magnetic equatorial region based on the research outcome from ENRI
MSAS V4: DFMC Validation Phase (2017 ～) (Fig. 4)	- In support of ICAO SARPs validation activity, the initial performance starts with LPV 200 - ENRI has started DFMC SBAS experiment in 2017 with QZS2 -QZS3 and QZS4 will be used for DFMC SBAS validation

2.3.2 MSAS V1,V2,V3 and V4 are shown in figures for better understanding by visual aids:

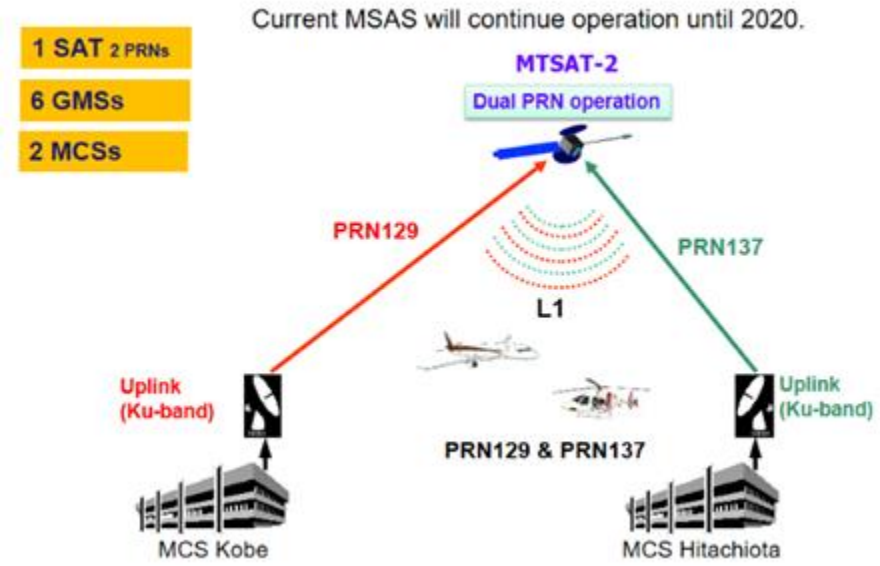


Figure 1. MSAS V1

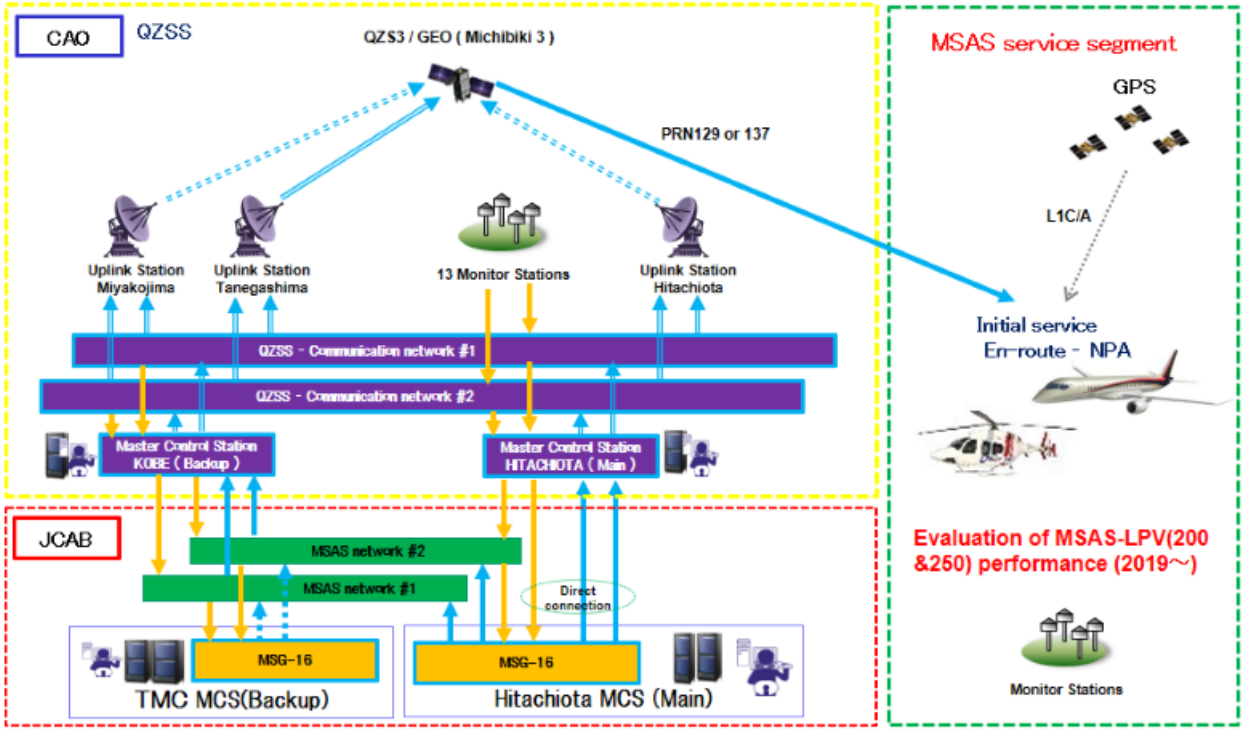


Figure 2. MSAS V2

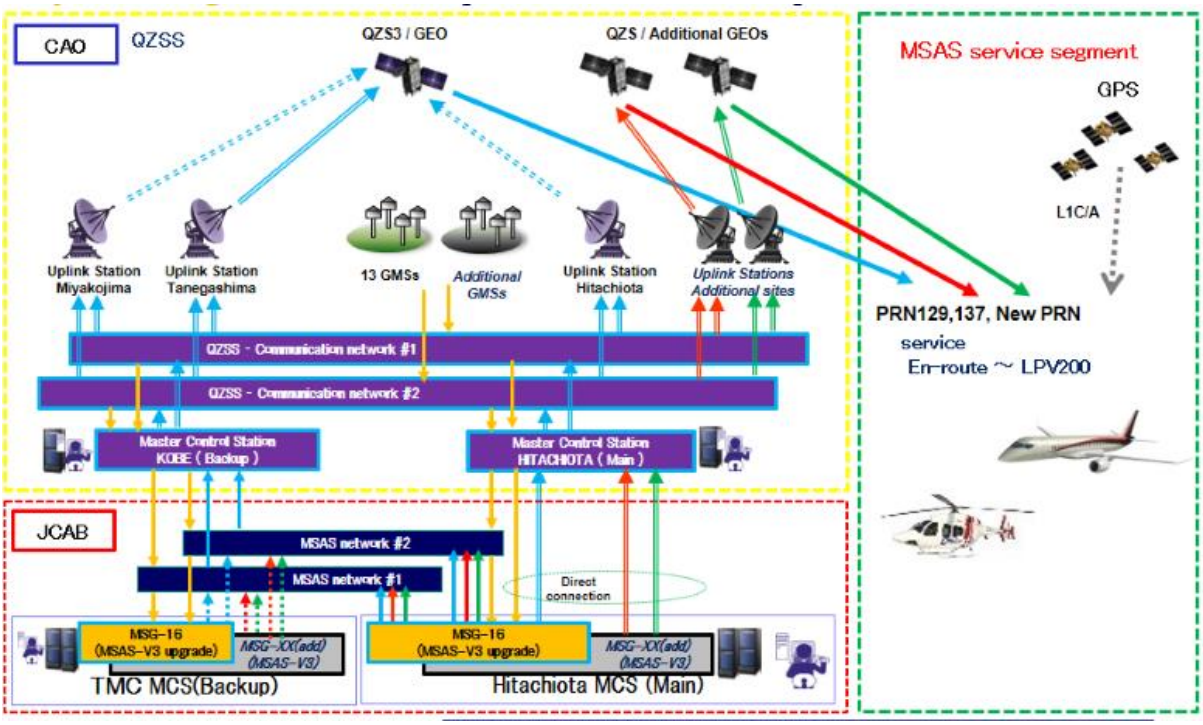


Figure 3. MSAS V3

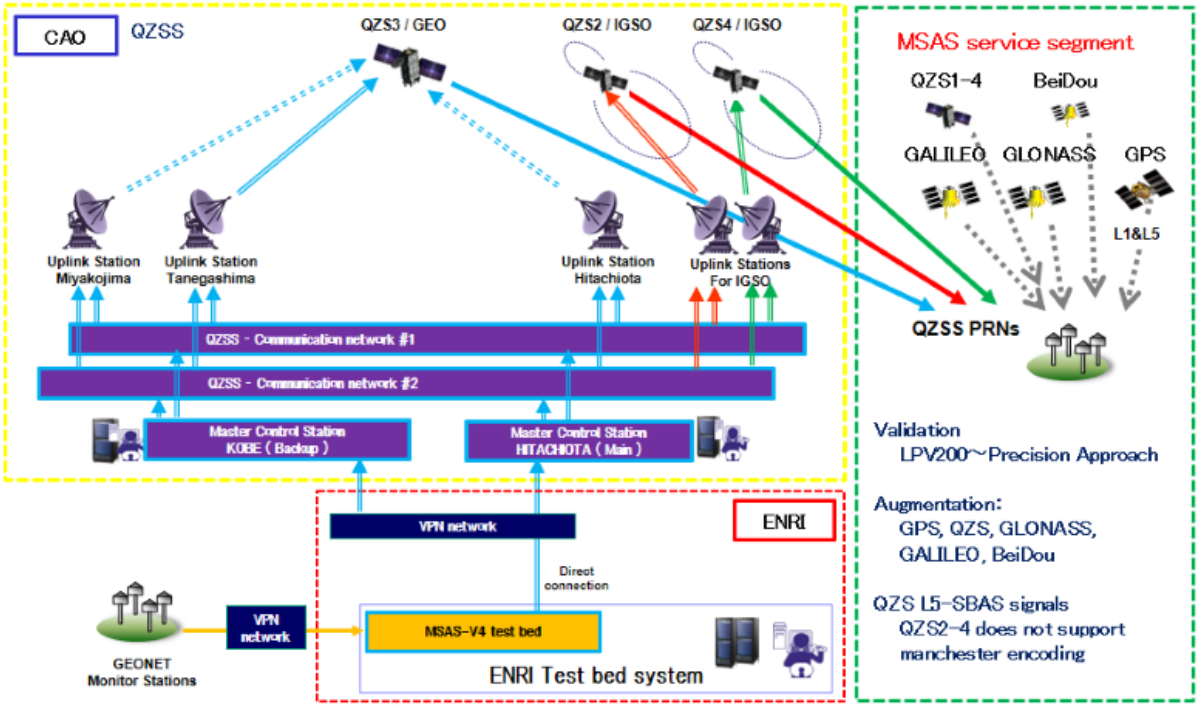


Figure 4. MSAS V4

2.4 Study result of the possibility and condition to use MSAS in other FIR

2.4.1 NAVCANADA, air navigation services provider (ANSP) in Canada, provides SBAS service in their FIR by signing agreement with the Federal Aviation Administration (FAA). And each ANSPs in the European Organisation for the Safety of Air Navigation (EUROCONTROL) provides European Geostationary Navigation Overlay Service (EGNOS) service in their FIR by signing agreement with ESSP, EGNOS service provider.

2.4.2 The footprint of MSAS covers wide area in Southeast Asia, Pacific island country, and Oceania Region. Here is the study result of condition to use MSAS in other FIR.

2.5 Analysis result

2.5.1 Analysis of NPA service was conducted. In GPS RAIM there are airspaces and time where accuracy cannot meet NPA level (Figure 5). In the analysis case to use MSAS augmentation signal, all footprint area can meet NPA accuracy (Figure 6).

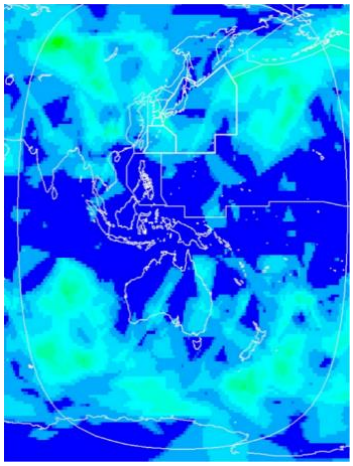


Figure 5. Only GPS RAIM

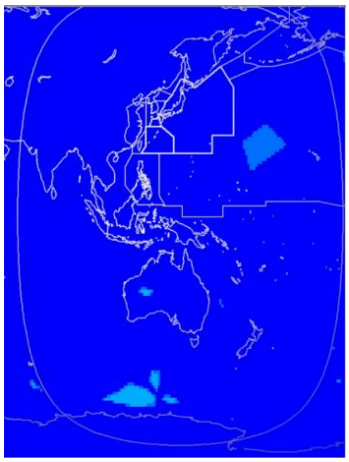
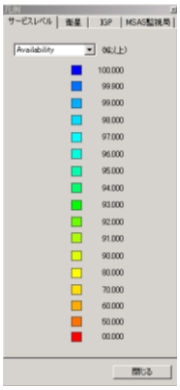


Figure 6. NPA by MSAS(TSO-145,146)



Graph legends

2.5.2 The benefit of NPA for aircraft equipped with SBAS avionics is as follow:

– to provide RNP approach to aircrafts equipped with SBAS avionics without RAIM prediction.

– RAIM prediction service by each FIR is not required and flight planning becomes easily for aircraft operator. This will improve international interoperability and realize seamless ATM.

2.6 The condition to provide MSAS service in other FIR

2.6.1 The condition to provide MSAS service outside Fukuoka FIR is as follows:

a) to make clear the responsibility by signing MOU between SBAS provider, JCAB, and ANSP;

b) to define MSAS as navigation equipment in the State aviation law; and

c) to confirm MSAS signal by using MSAS monitor equipment and establish the framework to inform not to use MSAS by NOTAM when MSAS becomes malfunction (Figure 7).

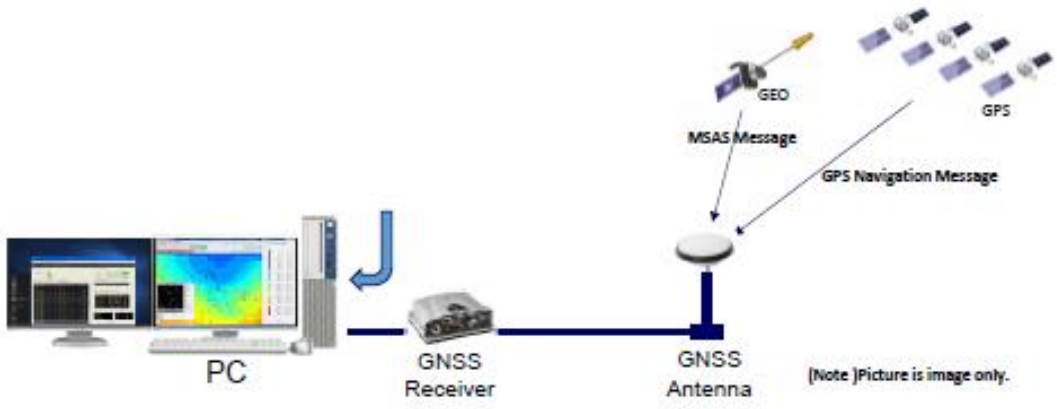


Figure 7. MSAS monitor equipment

2.6.2 If GMS are deployed additionally in the States, LPV will become possible in the States. But it will be a hard road to prepare dedicated lines to Japan and integration work. On the other side, this analysis shows NPA is not so hard to expand the area.

3. CONCLUSION

a) note the information contained in this paper; and

b) discuss any relevant matter as appropriate

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