1030/1090MHz Occupancy Monitoring and evaluation project in JAPAN

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ABSTRACT

The 1030/1090 MHz radio frequencies are used for a variety of purposes in aviation world. Recently, not only increase traffic volume but also new era aviator such as e-VTOL, moreover invite new technology such as ADS-B, Downlink Aircraft Parameters (DAPS), there is concern that the signal environment may deteriorate in the skies.

For this thing, The Japan Civil Aviation Bureau (JCAB), as an air navigation service provider develop the project which grasp the situation by which monitors and analyzes the signal environment at 1030/1090 MHz.

INTRODUCTION

As the responsibility of civil aviation, The Flight Inspection Center (FIC) conducts 3 responsibilities which are the flight inspections, the flight validation and flight surveys by utilizing flight inspection aircrafts. The flight inspections check air navigation facilities are operating correctly, the flight validation vilify flight procedures to be flyable as appropriate by aircraft operation, and the flight survey conducts surveys to implementation air navigation facilities or systems and new technologies.

The Technical Management Center (TMC) provides lifecycle management from the formulation of functional requirements for air navigation facilities to technical support for operation work. It works to ensure the safety and security of air traffic and to carry out appropriate response to user needs through the introduction of new systems and new technologies as well as smooth decommissioning of existing systems.

The mission of Network Performance Assessment Center (NPAC) are centrally monitoring, analyzing and assessing service levels as Communication Navigation and Surveillance (CNS) performance, this is an important key to realize PBO Performance Based Operation (PBO) such as Performance Based Navigation (PBN) and Performance Based Communication and Surveillance (PBCS) which are future air navigation service promoted by The Global Air Navigation Plan (GANP) developed by ICAO.

Regarding to ensuring the suitable management air navigation service, JCAB conduct and harmonize these 3 centers as PDCA manner which could work smoothly and effectively for variety of scene depending on the responsibility. (Figure 1)

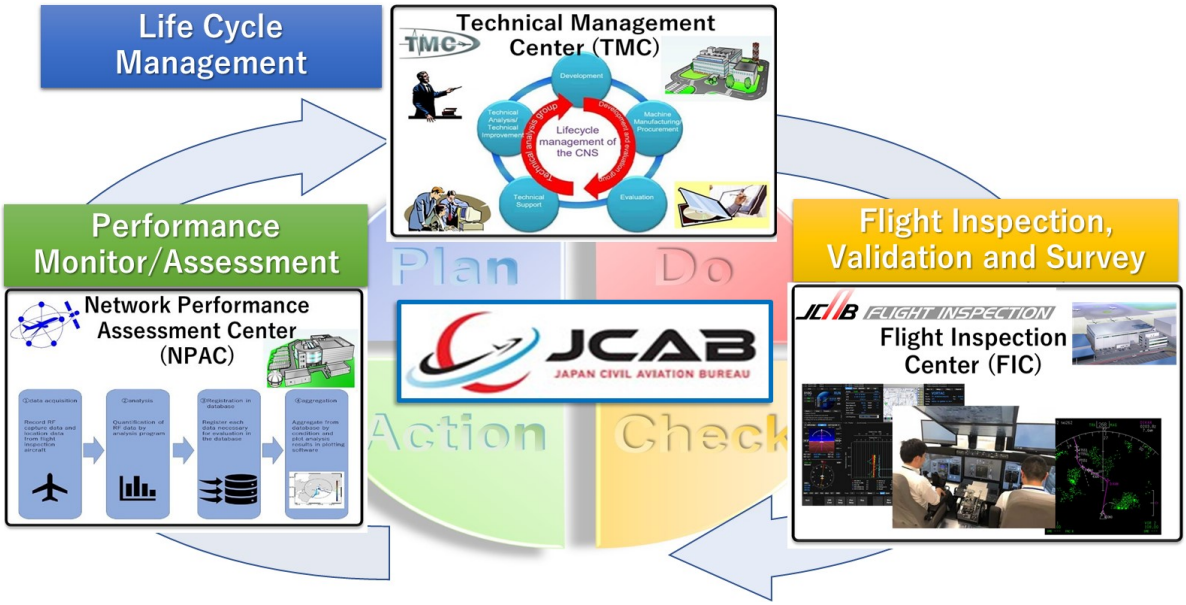

Figure 1. The frame work of PDCA for Air Navigation by JCAB

Besides, from the perspective of research and development, Electronic Navigation Research Institute (ENRI) is responsible for research and development in the field of electronic navigation in Japan.

Their research activities cover the basic technologies of avionics such as electronic navigation, air traffic control and satellite navigation, and the related field supporting governmental needs and social demands. To promote the activity, JCAB Provide operation knowledge, material/data and analyzed reports. On the contrary, ENRI provide technical knowledge and solution. It would be also considering that PDCA as Develop new technology and solution. (Figure 2)

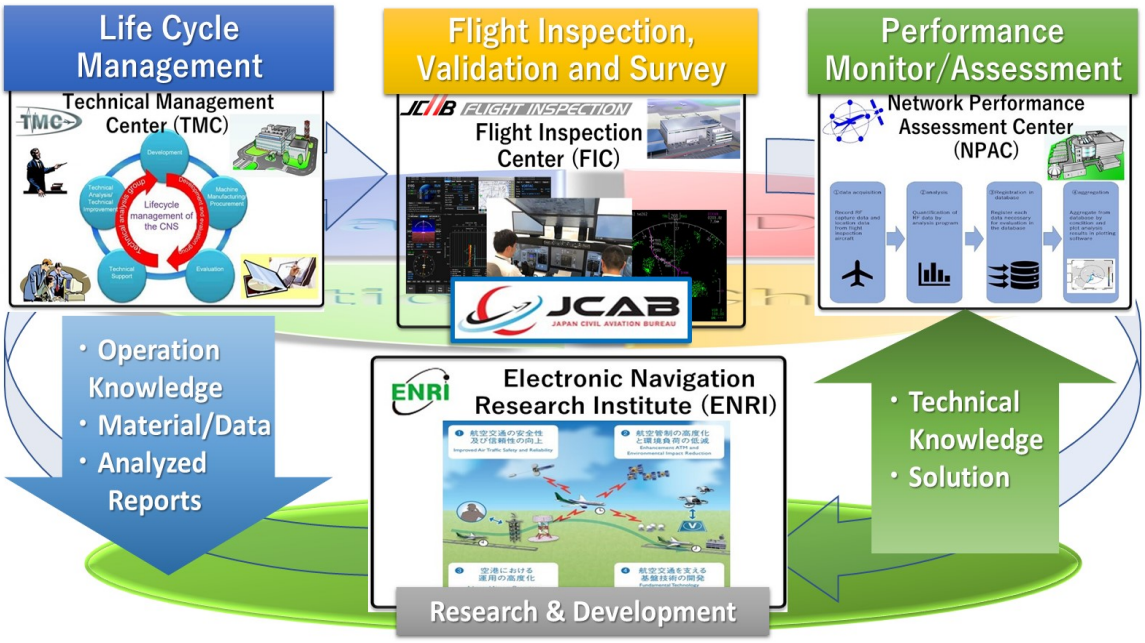

Figure 2. The frame work of PDCA for Air Navigation collaborated with R&D

According to these activities, as one of lesson learn, this paper introduces an activity which has monitored, analyzed and evaluated the performance of surveillance systems.

Challenges a deterioration of the signal environment of 1030/1090MHz

The 1030/1090 MHz frequency band is used by a wide variety of surveillance applications for ATC (RADAR, Multilateration, Airborne Collision Avoidance System (ACAS), etc.), including onboard and ground services. It is important to avoid excess utilization to protect the 1030/1090 MHz spectrum.

However, operating a wide variety of services with a large number of aircraft on the same frequency leads to a deterioration of the signal environment (increased frequency occupancy), and in 2014, there was a problem in Europe where aircraft display was missing from radar screens. It is mentioned that the cause of this event in Europe is said to be an increase in occupancy due to abnormal transponder responses, and there is concern that this event will occur if the threshold (8%) is exceeded.

For this thing, ICAO introduced how to measure and analyze RF at chapter 13 of Appendix M in Doc9924 Aeronautical Surveillance Manual. ENRI had several times evaluated 1030/1090MHz occupancy rate in the Japanese airspace in their research, and the results were reported to JCAB to share the present situation especially in the congested airspace.

There is also concern about the impact on the signal environment in the airspace over Japan due to the future increase in aviation demand. Therefore, since 2022, we decided to establish a scheme to ensure that surveillance service can be used normally in congested airspace by monitoring the frequency occupancy not approaching dangerous levels. NPAC established a monitoring structure of 1030/1090MHz signal environment by the technology transfer from ENRI. The measurement procedure for the monitoring is in accordance with Doc9924 Aeronautical Surveillance Manual and is described in Appendix M 13.3.7.1.1 Method1.

1030/1090MHz signal acquisition and analysis

ENRI had conducted measurements using the experimental aircraft. JCAB also used flight inspection aircraft to acquire the data following ENRI's measurement method. The positional information and RF data are acquired by the flight inspection aircraft, and then analyzed and compiled by NPAC. (Figure3) The analysis software is developed on LabVIEW software, which is used measurement. Because the environment for collecting data differs between the ENRI's experimental aircraft and JCAB's flight inspection aircraft, we received the technical transfer necessary to modify the program. The numerical conversion in the analysis software is done by simply accumulating the signal amount from the recorded 1030/1090MHz spectrum data. (Figure4)

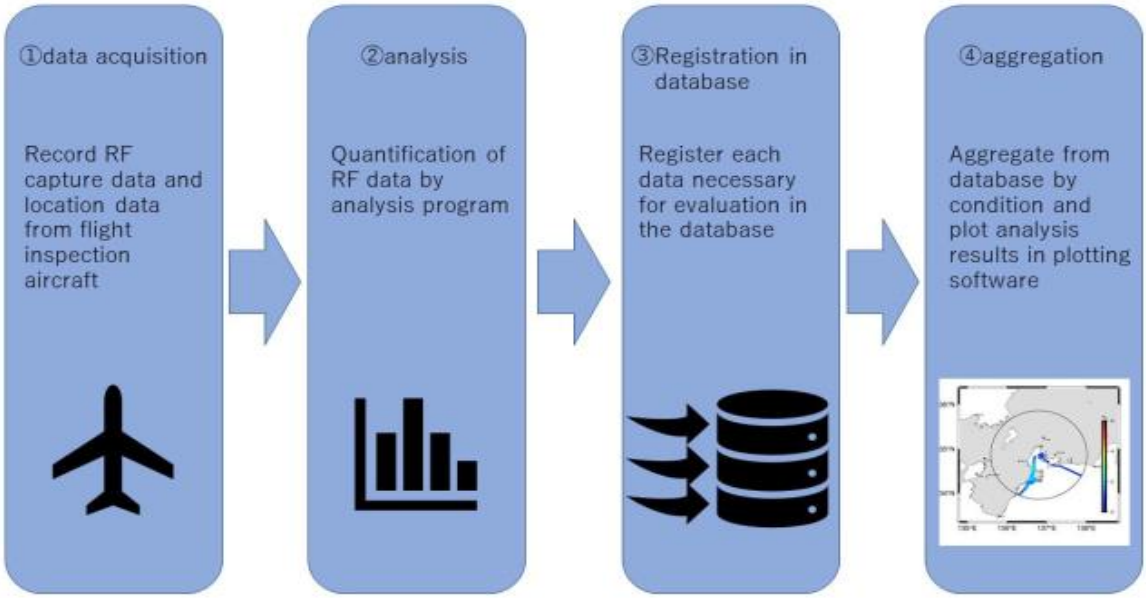

Figure 3. Flow of 1030/1090MHz signal acquisition and analysis

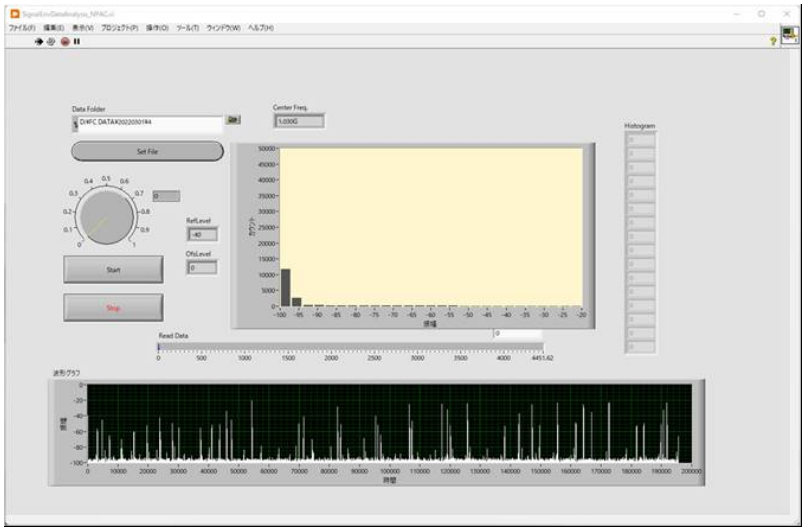

Figure 4. Analysis tool based on LabVIEW

Collection data By Flight inspection aircraft

An RF capture device was installed on the flight inspection aircraft and trial evaluation started in October 2022. Data was collected at several locations in Chubu area. (Figure5, Figure6)

Figure 5. Flight inspection aircraft (C700)

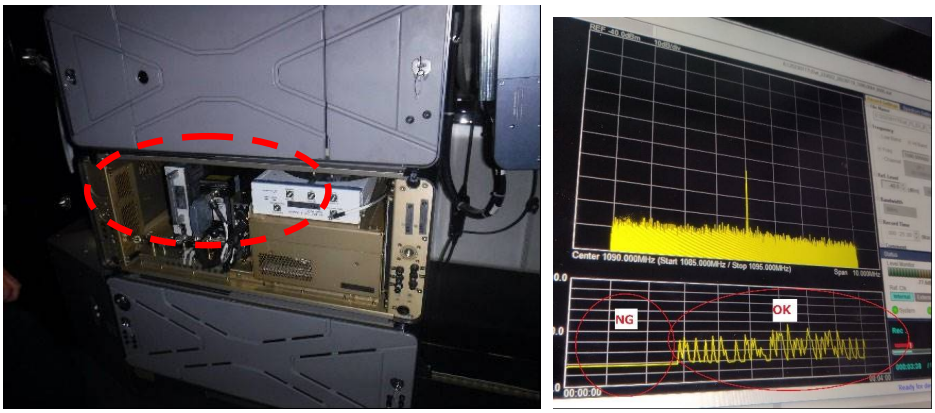

Figure 6. Equipment for data acquisition and an image of RF capture

Evaluation

After the trial evaluation, NPAC started evaluation activity from April 2023. Figure7 shows the actual analysis results in Nagoya area and we can confirm the occupancy rate is about 2%. NPAC is going to coordinate data collection with flight inspection team so that we can evaluate congested airspace such as Tokyo for a long period of time and regularly.

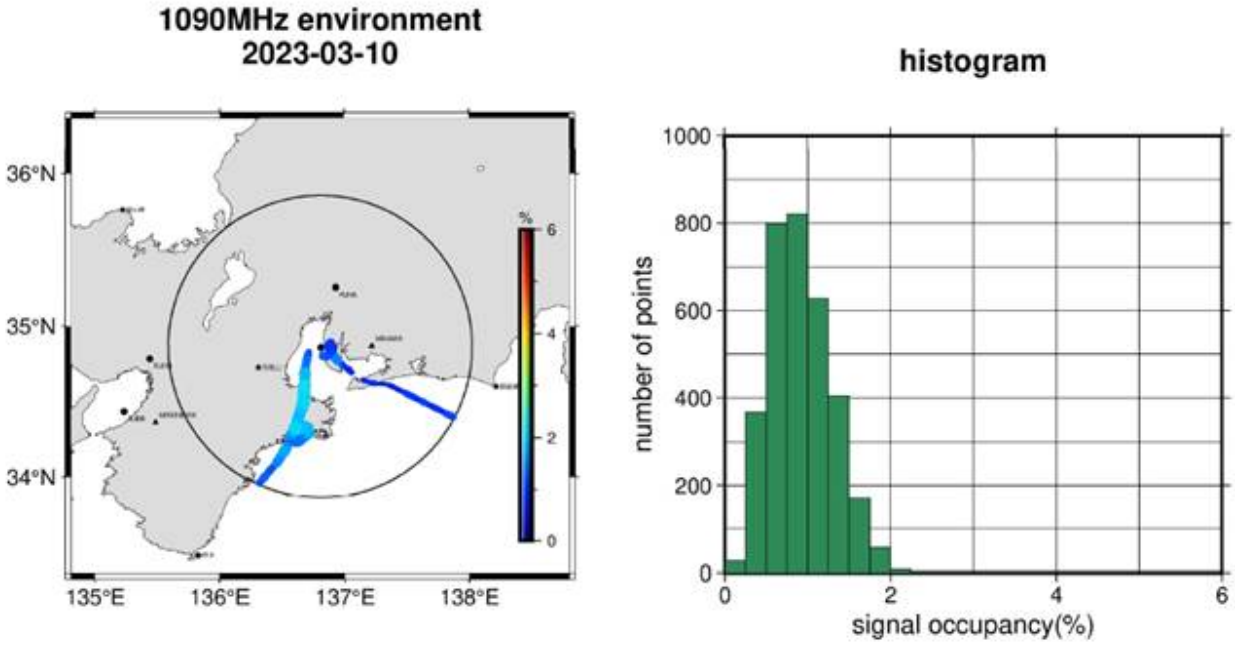

Figure 7. 1090MHz occupancy ratio on the sky around Nagoya

FURTHER CONSIDERATIONS

We have begun monitoring the frequency occupancy rate by analyzing data acquired by flight inspection aircraft, but this method can only identify rising trends and cannot identify aircraft equipped with transponders that respond abnormally.

According this, to solve this issue, it would be suitable to develop a process to detect transponder-equipped aircraft that respond abnormally by analyzing constantly acquired monitoring frequency signals and prevent such situation.

CONCLUSIONS

To concrete above this, we need sufficient lesson learn not only data collection and analysis but also invite any other knowledge for relevant activities.

Therefore, we will request that you provide knowledge regarding this activity and also appreciate to invite lesson learn / practice of relevant activities and shared any relevant matters such as GNSS GPS L1 signal issue.

ACKNOWLEDGMENTS

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REFERENCE

Electronic Navigation Research Institute (ENRI)

URL：https://www.enri.go.jp/en/index.html