International Civil Aviation Organization

ADS-B Study and Implementation Task Force Meeting

Brisbane, Australia, 24-26 March 2003

Agenda Item 2: Review of ADS-B Activities

d) Review activities by Asia/Pacific States in trials and demonstration of ADS-B

STATUS OF ADS-B ACTIVITY IN JAPAN

SUMMARY

This paper introduces ADS-B related activities in Japan and also gives a consideration to the appropriate ADS-B technical link for ADS-B.

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(Presented by Japan)

1. Introduction

ADS-B Planning and Implementation Working Group (ADS-B WG in Japan) was organized in July 2000. ADS-B WG consists of following members.

JCAB (Japan Civil Aviation Bureau)
ENRI (Electronic Navigation Research Institute)
JAL (Japan Airlines)
ANA (All Nippon Airways)
JAS (Japan Air System)
JRANSA (Japan Radio Air Navigation Systems Association)
Data Link Service Providers
ATC automation system vendors
ATC related consultants

This ADS-B WG has been focusing to survey on the trend of ADS-B in the world to consider how to implement ADS-B in Japan from both operational and technical perspective. And also this WG has been discussing future implementation plan of ADS-B in Japan.

2. ADS-B Activities of WG

Main object of this WG activity at this moment is to clarify the benefit derived from ADS-B based on Japanese environment. Examples of Japanese environment are as follows.

1) Current ASDE (Airport Surface Detection Equipment) has some undetected radar areas due to complex terminal buildings. We have to enhance radar coverage in high traffic density areas (e.g. near gates) and also have to enhance safety and ground operations.
2) Most of the areas are covered by mountains in Japan. We have to enhance situational awareness of General Aviation aircraft in the blind area of ground surveillance stations.

In Japanese FY2001, ADS-B WG began to develop a roadmap to implement ADS-B, and also to develop the concept of OCS (Operational Case Study) and the template of OED (Operational Environment Definition). Figure 1 shows the roadmap which was developed by this WG. This WG plans to go forward the ADS-B project according to this roadmap. Concrete plans for implementation have not been fixed yet.

Figure 2 shows the steps for development of OCS/OED. Also Figure 3 shows draft OCSs which were developed by WG.

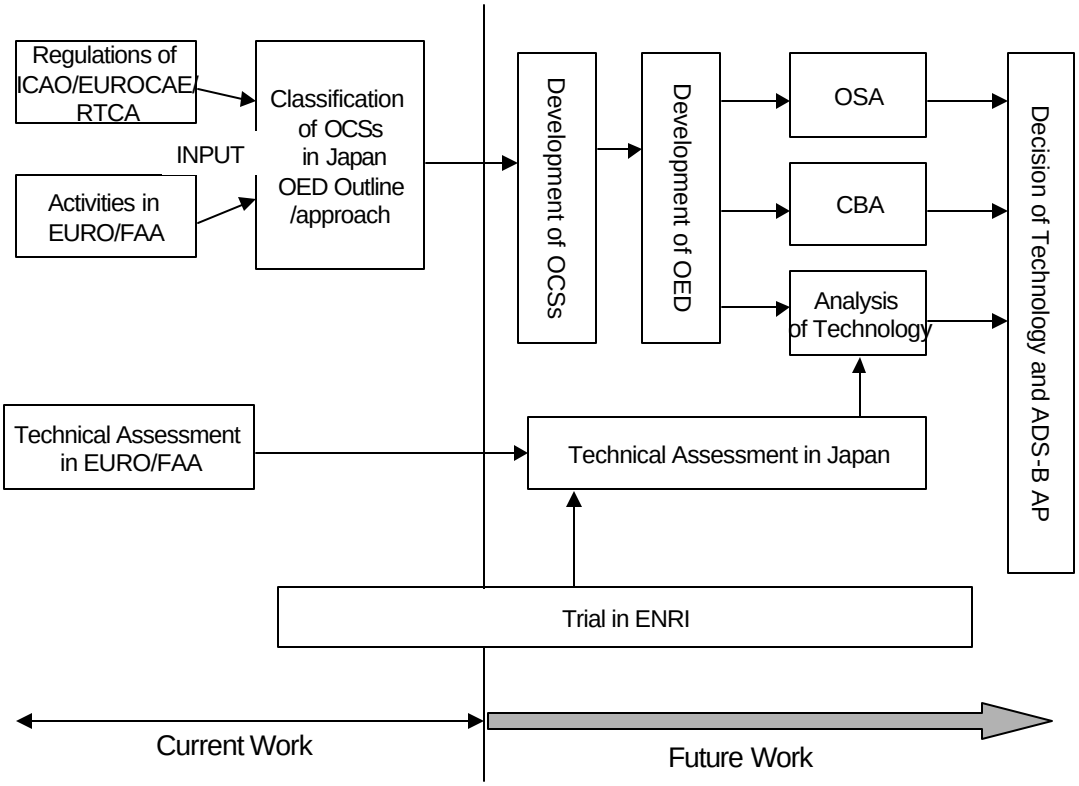

Figure 1. ADS-B Programme to implementation

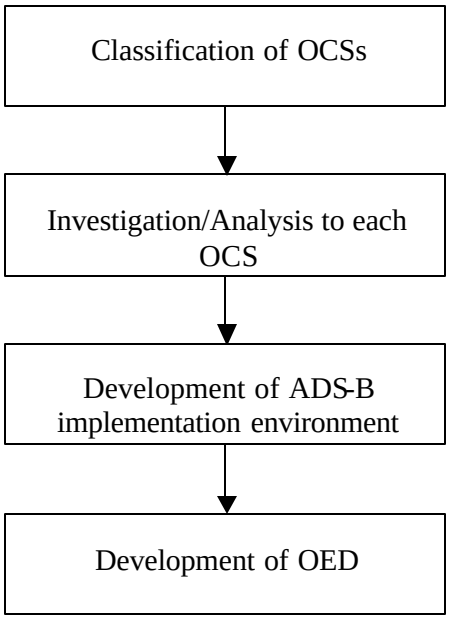

Figure 2. Steps for Development of OCS/OED

OCS No.	Title
OCS1	More efficient use of Oceanic airspace
OCS2	Enhanced En-route capacity by new airborne concepts or aircraft derived data in high density en-route airspace
OCS3	Enhanced operational efficiency in transition airspace from/to oceanic airspace (including over-flights)
OCS4	Enhanced efficiency and safety of airport surface operations
OCS5	Enhanced efficiency and safety of airport arrival/departure operations
OCS6	Increased safety of VFR flight operation, especially low-altitude airspace

Figure 3. OCS classification

We believe that ADS-B will be able to enhance efficiency and safety of airport surface operations in the near future. Therefore we have been concentrating to evaluate OCS4.

Following investigation and analysis for each OCS, we will clarify

1) Application of ADS-B and its Benefits
2) Required Infrastructure including Equipments on vehicles, CDTI for each ADS-B technical link (i.e. SSR Mode S Extended Squitter, UAT or VDL/4)
3) Required operations and procedures including responsibility of controllers and pilots in low visibility and pilot procedure in low visibility
4) Requirements of airborne equipments
5) Alternative method including Multilateration technique

Based on each OCS, we are going to develop OEDs including following items.

1) Description of the purpose of introduction of ADS-B based on Operational Cases
2) Improvement of operations and procedures
3) Definition of environment for operational improvement
4) Definition of services and applications for environment
5) Description of the details of these services and applications in each airspace and operational cases
6) Definition of implementation requirements and equipments

3. ENRI's Activities for ADS-B (SSR Mode S Extended Squitter)

ENRI (Electronic Navigation Research Institute) started an ADS-B development project from Japanese FY2001. ENRI conducts development and evaluation of a 1090MHz extended squitter ADS-B system in this project. The system has multilateration surveillance capability for complementing ADS-B. ENRI plans to evaluate functions and performance of the ADS-B system in airport surface and terminal areas.

As for ENRI's development and evaluation, ENRI plans to carry out their project according to the following schedule. (See Figure 4)

ENRI carried out a design of the experimental system in Japanese FY2001. Figure 5 shows configuration of the experimental system. Also they developed a remote station, a target processor, a monitor equipment and a transponder simulator in this FY. Now they are evaluating performance of the remote station using the transponder simulator.

After this, ENRI is going to complete the experimental system by developing other equipment and to conduct evaluation tests using their experimental aircraft in airport surface and terminal areas. Evaluation items in the tests are Positioning accuracy, Detection probability, Report update rate, Coverage, Processing capacity, and so on. Also they plan to improve receiving and processing techniques of the remote stations in order to overcome interference problems.

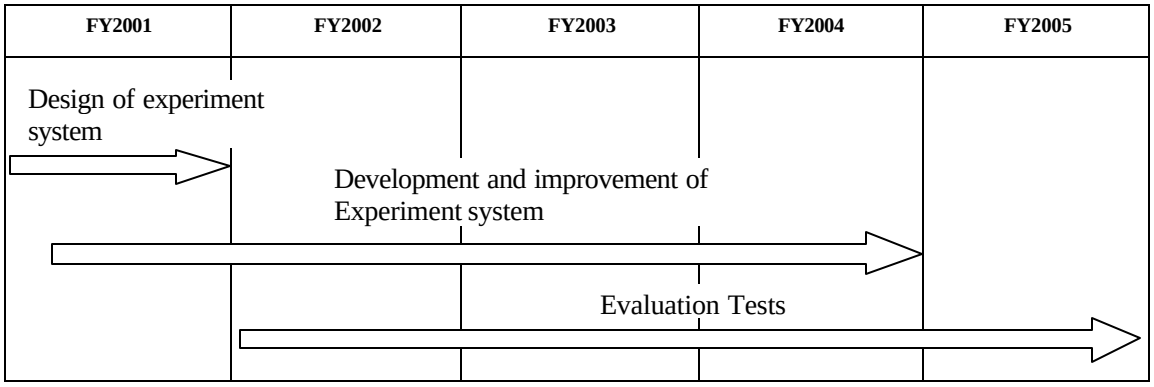

Figure 4 Evaluation Plan at ENRI

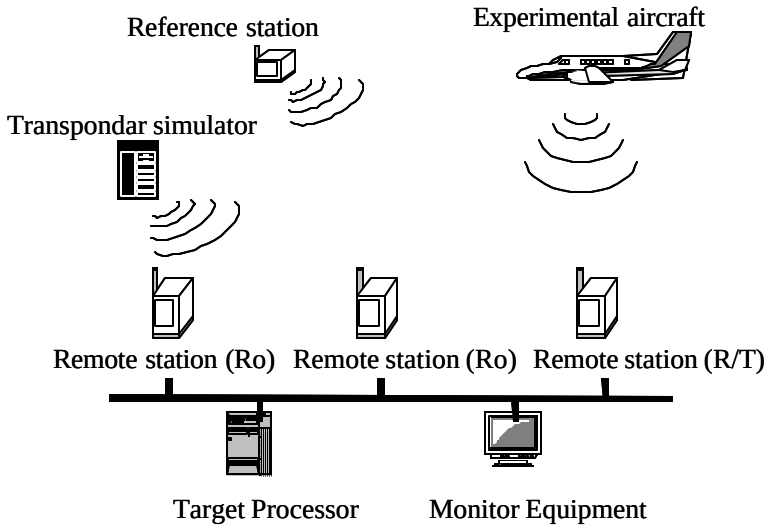

Figure 5 Configuration of the Experimental System

4. Consideration of ADS-B technical link

4.1 Three candidates of technical link for ADS-B

There are three candidates of technical link for ADS-B. Those are SSR Mode S Extended Squitter, UAT and VDL Mode 4. Following is summary of these technical link characteristics.

(Reference: Technical Link Assessment Report written by TLAT, March 2001)

1) SSR Mode-S ES (Extended Squitter)
   Frequency: 1090MHz
   Bit Rate: 1Mbit/sec
   Transmission Rate for PV: Position at 2Hz, Velocity at 2Hz
   Multiple Access Technique: Random messages
   RF Channels: One channel
2) UAT (Universal Access Transceiver)
   Frequency: 978MHz (in the U.S.)
   Bit Rate: 1.041667Mbit/sec
   Transmission Rate for PVT: PVT every 1 second
   Multiple Access Technique: Slots to separate ground/air. Aircraft use random messages
   RF Channels: One Channel
3) VDL (VHF Digital Link) Mode 4
   Frequency: 118-138MHz
   Bit Rate: 19.2kbits/sec/channel
   Transmission Rate for PVT: 1,2, 5, or 10 seconds (can be carried between 1-60, event-driven or by command)
   Multiple Access Technique: Self-organizing TDMA (75 shots/second per channel)
   RF Channels: 2 (25kHz) Global Signalling Channels, plus up to 2 Regional and 3 Local Channels in high Density Airspace)

4.2 Consideration to the appropriate ADS-B technical link

As everybody knows, aircraft equipped different ADS-B link cannot see each other directly. If we adopt Multilink Gateway system, it will become to enable. But it will force system integrator, such as JCAB, to spend much investment to build comprehensive ADS-B surveillance system. Therefore we should consider most appropriate ADS-B link carefully. Also we, Asia Pacific counties, should choose same ADS-B link to assure interoperability for international commercial aircraft. Now coordination in Asia Pacific region is needed!

SSR Mode-S ES is the only ICAO standardized ADS-B link technology for which global radio frequency spectrum authorization currently exists. Also ICAO mandated to carriage ACAS for large airplane. It is written in Annex 6, Chapter 6.18 that "From 1 January 2003, all turbine-engined aeroplanes of a maximum certificated take-off mass in excess of 15,000 kg or authorized to carry more than 30 passengers shall be equipped with an airborne collision avoidance system (ACAS II)". ACAS equipment consists of ACAS processing unit, Mode-S transponder and so on. Therefore this means that ICAO also mandated to carry Mode-S transponder for large airplane. And it is relatively easy to install Extended Squitter function into Mode-S transponder.

Based on these reasons, **we believe that SSR Mode-S ES is most appropriate ADS-B technical link for international commercial aircraft.**

On the other hand, GA aircraft are not required to carriage ACAS, and basically those aircraft don't have enough avionics to improve situation awareness like WX radar, ACAS, EGPWS and so on. Therefore ADS-B technical link which has enough capability to improve situation awareness using two way data link between aircraft and ground, especially up-link capability which can enable FIS-B, is appropriate for GA aircraft. Based on these considerations, UAT and VDL mode 4 are appropriate ADS-B technical links for GA aircraft. And making a selection from two links will be done based on regional environments.

However we have heavy frequency congestion problem of VHF band in Japan. It means we

won't be able to assign any VHF frequency for VDL Mode 4. And also UAT has great advantages including Bit Rate, Transmission Rate for PVT and so on, compared with VDL Mode 4. Therefore we consider from technical perspective that UAT is the appropriate ADS-B technical link for GA aircraft in Japan.
