

## **ELEVENTH AIR NAVIGATION CONFERENCE**

**Montreal, 22 September to 3 October 2003**

**Agenda Item 7 Aeronautical air-ground and air-to-air  
: communications**

### **STATUS OF ADS-B ACTIVITY IN JAPAN**

(Presented by Japan)

#### **SUMMARY**

This paper introduces ADS-B related activities in Japan and also gives a consideration to the appropriate technical link for ADS-B. It seems that SSR Mode-S ES (extended squitter) is the most appropriate ADS-B technical link for international commercial aircraft and also UAT and VDL Mode 4 are appropriate ADS-B technical links for general aviation aircraft.

## **1. INTRODUCTION**

1.1 Automatic dependent surveillance — broadcast (ADS-B) Planning and Implementation Working Group (ADS-B WG in Japan) was organized in July 2000. ADS-B WG is composed of 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, air traffic services (ATS) automation system vendors, ATC related consultants. The main objective of ADS-B WG is to formulate implementation plan of ADS-B in Japan from both operational and technical perspective taking into account of technological development in the world.

1.2 The current work of ADS-G WG is to clarify the benefit derived from ADS-B based on ATS environment in Japan. Examples of ATS environment in Japan are as follows. a) Most of the en-routes airspace (high altitude) over Japanese archipelago is covered with ARSR/SSRs and the high traffic density airspace is covered with two or three radar sites. b) Some of the en-route airspace (low altitude) where general aviation aircraft is flying are not covered by radars because of the high mountains. The mountainous landform generates a lot of radar blind areas, especially at low altitude in Japan. The enhancement of situational awareness of general aviation aircraft flying in the radar blind areas is highly desired. c) Current ASDE (airport surface detection equipment) has some undetected radar areas due to complicated

configuration of terminal buildings. The enhancement of radar coverage in high traffic density areas (e.g. near gates) at the airport is highly desired.

## **2. ACTIVITIES OF ADS-B WG**

2.1 In FY2001, ADS-B WG began to develop a roadmap for implementation of ADS-B, and also to develop the concept of OCS (operational case study) and the template of OED (operational environment definition). Following investigation and analysis for each OCS, it will clarify:

- a) application of ADS-B and its benefits;
- b) required infrastructure including equipments on vehicles and cockpit display for traffic information (CDTI) for each ADS-B technical link;
- c) required operations and procedures including responsibility of controllers and pilots in low visibility;
- d) requirements of airborne equipments; and
- e) alternative method including multilateration technique.

2.2 Based on each OCS, it will develop OEDs including following items.

- a) description of the purpose of introduction of ADS-B based on operational cases;
- b) improvement of operations and procedures;
- c) definition of environment for operational improvement;
- d) definition of services and applications conforming to the operational environment; and
- e) description of the details of these services and applications in operational cases; and
- f) definition of implementation requirements and equipments.

## **3. ENRI'S ACTIVITIES FOR ADS-B (SSR MODE S EXTENDED SQUITTER)**

3.1 ENRI started an ADS-B development project from FY2001. ENRI conducts development and evaluation of a 1 090 MHz extended squitter ADS-B experimental system in this project. The experimental system has a multilateration surveillance capability for complementing ADS-B. ENRI plans to evaluate functions and performance of ADS-B and multilateration in airport surface and terminal areas.

3.2 ENRI carried out a design of the experimental system and developed a remote station, a target processor, a monitor equipment and a transponder simulator in FY2001. ENRI also evaluated

performance of the remote station using the transponder simulator and functions of ADS-B using their experimental aircraft in FY2002. ENRI is now preparing to install the multilateration system at Sendai Airport. After installation, ENRI is going to conduct evaluation tests for multilateration and ADS-B 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. ENRI also plans to improve receiving and processing techniques of the remote stations in order to overcome interference problems.

#### **4. COMPARISON OF CANDIDATES OF TECHNICAL LINK FOR ADS-B**

4.1 There are three candidates of technical link for ADS-B. Those are SSR Mode S ES (extended squitter), universal access transceiver (UAT) and VHF digital link (VDL) Mode 4. Technical characteristics of these links are described below. (Reference: Technical Link Assessment Report written by TLAT, March 2001)

##### **1) SSR Mode S ES (extended squitter)**

|                           |                                    |
|---------------------------|------------------------------------|
| Frequency:                | 1 090 Mhz                          |
| Bit rate:                 | 1 Mbit/sec                         |
| Transmission rate for PV: | Position at 2 Hz, Velocity at 2 Hz |
| Multiple access:          | Random messages                    |
| RF channels:              | 1 channel                          |

##### **2) UAT (universal access transceiver)**

|                           |                                                               |
|---------------------------|---------------------------------------------------------------|
| Frequency:                | 978 Mhz (in the United States)                                |
| Bit rate:                 | 1.041667 Mbit/sec                                             |
| Transmission rate of PVT: | PVT at 1 Hz                                                   |
| Multiple access:          | Slots to separate ground/air,<br>aircraft use random messages |
| RF channel:               | 1 channel                                                     |

##### **3) VDL (VHF digital link) Mode 4**

|                           |                                                                                                            |
|---------------------------|------------------------------------------------------------------------------------------------------------|
| Frequency:                | 118-138 Mhz                                                                                                |
| Bit rate:                 | 19.2 Kbit/sec/channel                                                                                      |
| Transmission rate of PVT: | 1, 2, 5 or 10 s (can be carried between 1-60, event driven or by command)                                  |
| Multiple access:          | Self-organizing TDMA (75 shots/second/channel)                                                             |
| RF channel:               | 2 (25 Khz) global signalling channels, plus up to 2 regional and 3 local channels in high density airspace |

## 5. **CONSIDERATION OF APPROPRIATE TECHNICAL LINK FOR ADS-B**

5.1 The aircraft equipped with different ADS-B link cannot communicate with each other, thus does not improve the situation awareness. In order to integrate different ADS-B link, the multilink gateway system has to be introduced. However, it will make ATS providers to invest much money to build comprehensive ADS-B surveillance system. Therefore, the most appropriate ADS-B link has to be chosen carefully. By choosing the most appropriate ADS-B link, the interoperability for international commercial aircraft has to be assured.

5.2 SSR Mode-S ES is the only ICAO standardized ADS-B link technology for which the global authorization of radio frequency spectrum currently exists. Most of the nations has already made it mandatory to carry airborne collision avoidance system (ACAS) specified in ICAO Standards and Recommended Practices (SARPs). It is written in Chapter 6.18 of Annex 6 — *Operation of Aircraft* “From 1st January 2003, all turbine-engine 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. This means it is mandatory to carry Mode-S transponder for large airplane. Therefore, it is relatively easy to install extended squitter function into current Mode-S transponder. It seems that SSR Mode-S ES is the most appropriate ADS-B technical link for international commercial aircraft.

5.3 On the other hand, GA aircraft are not required to carry ACAS, and basically those aircraft don't have enough avionics to improve situation awareness like WX radar, ACAS, enhanced ground proximity warning system (EGPWS). Therefore, ADS-B technical link that has enough capability to improve situation awareness using two-way data link between aircraft and ground, especially up-link capability which can enable Flight information service-broadcast (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. The selection from two links will be done based on regional environments.

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