

ELEVENTH AIR NAVIGATION CONFERENCE

Montreal, 22 September to 3 October 2003

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

COMPARATIVE ANALYSIS OF ADS-B DATA LINKS

(Presented by the Secretariat)

SUMMARY

This working paper summarizes the results of a comparative analysis of potential ADS-B links developed by the eighth meeting of the Aeronautical Mobile Communications Panel (AMCP/8).

Action by the conference is in paragraph 3.

1. INTRODUCTION

1.1 As defined in ICAO Annex 10, automatic dependent surveillance-broadcast (ADS-B) is a surveillance technique in which aircraft automatically provide, via a broadcast mode data link, data derived from on-board navigation and position-fixing systems, including aircraft identification, four-dimensional position, and additional data as appropriate.

1.2 Progress in the development of an ADS-B concept of use is presented in AN-Conf/11-WP/6. As pointed out in that paper, one of the constraints to be taken into account as a part of the activities leading to the implementation of ADS-B is the availability of standardized technology. The present working paper addresses some of the associated issues.

1.3 At the request of the Air Navigation Commission (ANC), the eighth meeting of the Aeronautical Mobile Communications Panel (AMCP/8) (Montreal, 4-13 February 2003) considered a comparative analysis of potential ADS-B data links. One of the goals of the analysis was to provide material on the performance of data links, for use by States when implementing ADS-B. Following its review of the report of AMCP/8, the ANC requested the Secretariat to make available to AN-Conf/11 the material developed by AMCP/8 (AN-Conf/11-IP/12 refers).

2. DISCUSSION

2.1 Basis for the AMCP comparative analysis

2.1.1 The comparative analysis finalized by AMCP/8 was based on the most recent system definitions available to the panel and on updated simulations and analyses of each of the following three ADS-B data links:

- a) secondary surveillance radar (SSR) Mode S extended squitter (ES);
- b) VHF digital link (VDL) Mode 4; and
- c) universal access transceiver (UAT).

2.1.2 In the course of the analysis, the data links were assessed and compared against a number of criteria. The criteria used included those considered in the assessments of data links for surveillance applications carried out by AMCP in preparation to AMCP/5, criteria derived from RTCA minimum aviation system performance standards (MASPS) for ADS-B, and additional criteria supplied by Eurocontrol to the joint FAA/Eurocontrol Technical Link Assessment Team (TLAT).

2.1.3 In order to evaluate system performance in several different air traffic situations, two air traffic scenarios (a high-density one and a low-density one) were used as representative of future environments.

2.2 Limitations of the AMCP analysis

2.2.1 AMCP/8 recognized that the comparative analysis had certain limitations. For example, the emerging operational requirements used to provide a common basis for the analysis, although providing a reasonable summary of current industry requirements, were not ICAO Standards. However, there was general agreement that limitations were unavoidable in practice, due to the schedule and resource constraints naturally associated with this type of activity.

2.3 Summary of the results of the analysis

General

2.3.1 Due to the large number (>80) of criteria and parameters considered in the course of the analysis, the results do not readily lend themselves to the development of a concise summary. In particular, each of the three data links could be seen to have relative advantages over the others with regard to some criteria.

2.3.2 The results of the analysis are briefly reviewed below with regard to one set of significant criteria extracted from among all the criteria considered in the analysis. For a complete assessment of the results of the analysis, reference should be made the full set of results (AN-Conf/11-IP/12 refers).

Performance

2.3.3 The air-to-air ADS-B performance of UAT was overall superior to the other two links in both high density and low density scenarios.

2.3.4 Air-ground ADS-B performance was simulated for the UAT, with the finding that all known update rate criteria were met out to at last 150 NM using a single antenna (in the absence of a collocated tactical air navigation (TACAN) emitter). Air-ground performance for VDL Mode 4 and SSR Mode S ES was not simulated but system experts were of the view that all known requirements could be met with appropriate sectorized antennas.

2.3.5 AMCP/8 noted that VDL/4 offer advantages for airport surface performance due to the favourable propagation characteristics of the VHF band.

Spectrum

2.3.6 As mentioned above, the SSR Mode S ES is the only ADS-B data link with spectrum approval for global operation. Radio regulatory approval for the UAT to operate at 978 MHz in the United States is currently being finalized. Four channels for VDL Mode 4 use are being proposed in the framework of European planning activities.

Maturity of technology

2.3.7 ICAO Standards and Recommended Practices (SARPs) for SSR Mode S ES and VDL Mode 4 are currently included in Annex 10 and are being updated to reflect evolution of the technologies. SARPs development for the UAT has started within the Aeronautical Communications Panel (ACP) (formerly the AMCP).

2.3.8 The UAT is being used operationally for airborne applications in the FAA Alaska Region. A certification baseline for UAT airborne equipment, consisting of both minimum operational performance standard (MOPS) and a Technical Standard Order (issued by the FAA) has been developed. MOPS for the SSR Mode S ES have been developed, and a Technical Standard Order is under development by the FAA.

2.3.9 For VDL Mode 4, interim MOPS and a European Norm (EN) for ground stations have been developed. VDL Mode 4 trials and flights have taken place in the framework of various projects in Europe. A local implementation of surface movement applications at Arlanda airport in Stockholm is under way.

2.3.10 An operational trial of ADS-B using SSR Mode S ES has been initiated in Australia. The initiative involves the installation of a ground station (near Bundaberg in Queensland), the equipage of a number of aircraft with appropriate avionics and the integration of received ADS-B reports in the air traffic management operational display system. So far, five aircraft have been properly equipped and the

performance achieved (in terms of coverage and reliability of aircraft identity/manoeuvre information) has been excellent and exceeding original expectations.

2.4 Role of comparative analyses in ICAO standardization

2.4.1 As highlighted in AN-Conf/11-WP/13, decisions to implement new aeronautical communication technologies need to be based on adequate information on the characteristics and relative advantages of the available standardized technologies. Comparative analyses such as the one discussed in this paper can provide useful information in this respect and should be conducted by ICAO when considering the standardization of new technologies. The results of such analyses should also be disseminated to States as appropriate to assist States undertaking implementation decisions.

3. ACTION BY THE CONFERENCE

3.1 The conference is invited to note the summary of the results of the comparative analysis contained in this paper and to agree to the following recommendation:

Recommendation 7/zz — Comparative analyses of communication technologies

That ICAO:

- a) when considering the standardization of new communication technologies, make use, to the maximum extent possible, of comparative analyses as a tool to assess the potential technical, operational and economic benefits and applicability of such technologies; and
- b) disseminate the results of such analyses as appropriate to assist States in their implementation decisions.

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