

ELEVENTH AIR NAVIGATION CONFERENCE

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

:

THE UAT'S ROLE IN THE UNITED STATES FAA ADS-B LINK DECISION

(Presented by the United States)

SUMMARY

This paper provides an overview of the United States Federal Aviation Administration (FAA)'s ADS-B link decision with additional information on universal access transceiver (UAT) to recognize its suitability as a leading candidate to support long-term automatic dependent surveillance — broadcast (ADS-B) requirements.

1. OBJECTIVE

1.1 The “Future Aeronautical Mobile Communications Scenarios” paper developed by Member states of the International Civil Aviation Organization (ICAO) and presented at this 11th Air Navigation Conference provides an inventory of automatic dependent surveillance — broadcast (ADS-B) solutions and potential scenarios that satisfy requirements for future surveillance functions. This document has the objective of providing guidance towards a harmonized global architecture. The United States (United States) Federal Aviation Administration (FAA) supports the surveillance concepts described in this document and is proceeding forward with an architecture which is in agreement with this document. The Eurocontrol and the FAA have worked very closely in the area of future surveillance planning in an effort to achieve international agreement on a direction which will help ensure international interoperability. This has resulted in the identification of 1 090 MHz Mode S extended squitter (1 090 ES) as a common ADS-B link to support near term applications with the selection of a second future link if necessary.

2. **LINK DECISION**

2.1 The FAA announced its ADS-B link architecture decision which utilizes a combination of a 1 090 ES ADS-B link for air carrier and private/commercial operators of high performance airframes and a universal access transceiver (UAT) ADS-B link for the typical general aviation user. This decision commits the FAA to moving forward with the operational use of ADS-B enabled capabilities within the United States. It is anticipated that this decision will allow avionics manufacturers to move forward expeditiously with their plans to produce commercial ADS-B avionics and will allow airspace users to make investment decisions on ADS-B equipage. ADS-B is seen as a cornerstone enabler for free flight because it provides common situational awareness for more shared air and ground responsibility. ADS-B is expected to improve safety and to increase efficiency and capacity.

2.2 The United States ADS-B link decision is based in part on results from a technical performance assessment of three candidate link technologies including 1 090 ES, UAT and the very high frequency data link (VDL) Mode 4. The assessment was performed by the Joint FAA/Eurocontrol Technical Link Assessment Team (TLAT) and follow-on work of the FAA and Eurocontrol. Comparisons of the links on a non-technical basis (e.g. cost, spectrum, transition issues) were also taken into consideration in the decision. ICAO's AMCP recently completed a similar link comparison at the request of the Air Navigation Commission (ANC). This study was initiated in response to modifications to the ADS-B system configurations and designs, which occurred after the TLAT report was issued. The results from this study have been used by the ANC to assess the need for UAT Standards and Recommended Practices (SARPs).

3. **1090 ES/UAT INTEROPERABILITY**

3.1 The link decision is designed to satisfy short-range (<40 NMI) air-to-air applications and longer range (up to 200 NMI) air-to-ground air traffic control (ATC) surveillance applications in the NAS. Aircraft that fly in high altitude airspace would equip with 1 090 ES. General aviation aircraft that are not capable of high altitude operations would equip with UAT. Interoperability between the links will be provided within coverage of the ground ADS-B infrastructure using the multilink gateway service provided via the TIS-B uplink (ground-to-air). TIS-B is also used to provide "ADS-B reports" on aircraft that are not transmitting ADS-B information. The 1 090 ES is selected for the airspace that is principally used by the domestic and international commercial aircraft. The FAA and Eurocontrol have coordinated on the selection of 1 090 ES as the interoperable link for the United States and the core of Europe. The UAT is selected to provide ADS-B and associated services for the general aviation users because of its lower cost and greater uplink capacity, especially for FIS-B services. If long range air-to-air applications are validated for use in the long-term that cannot be satisfied by 1 090 ES alone, UAT would be a leading candidate to support these requirements. The United States supports progressing UAT ICAO SARPs so that UAT can be considered an international candidate for ADS-B.

4. SYSTEM ADVANTAGES

4.1 Performance

4.1.1 As part of the TLAT assessment and the ICAO comparative analysis, the three candidate ADS-B data links were assessed and compared against a number of criteria. The criteria which discriminated among the links were in the areas of link performance, spectrum, and operational use. Each of the three candidate ADS-B data links was seen to have advantages. For example, the 1 090 ES is the only link candidate to have a globally allocated operational radio frequency. VDL Mode 4 was evaluated as having particularly good results for airport surface operations. For single-link implementations of ADS-B, UAT exhibits the longest air-to-air range (125 NM vs. 70 NM for VDL Mode 4 and 40-50 NM for 1 090 MHz extended squitter) to support air-to-air applications in future high-density airspaces such as core Europe.

4.1.2 UAT is a broadcast data link system specifically designed for ADS-B with no constraints from legacy-based systems. The performance of UAT was found to be superior to the other two links especially in future high-density airspace. The extended air-to-air ranges (with sufficiently frequent receipt of ADS-B messages) offered by UAT were achieved even though UAT was the only link configured to accommodate all intent information required and desired by the RTCA ADS-B minimum aviation system performance standards (MASPS) (RTCA Document 242-A), thus accommodating a heavier ADS-B data loading than either of the other two data links in the ICAO comparative analysis. Even though UAT performance was evaluated assuming high levels of interference from both DME and JTIDS/Link 16 sources, UAT still achieved greater compliance with RTCA MASPS air-air requirements for range of state vector and intent reception than the other data links.

4.1.3 It has been suggested that a combination of data links, consisting of 1 090 ES and VDL Mode 4, would achieve performance comparable to that of UAT in future high-density airspaces. Aside from the increased cost considerations, designing a single system combining two data links is a complex, difficult task. Despite the efforts of a number of experts, as of the date of this paper, there has been no combined 1 090 ES/VDL Mode 4 system proposed which has been confirmed as being both implementable on air transport aircraft and able to achieve the level of performance of UAT. Also, UAT may serve in a role of complementing 1 090 ES in a cost effective manner with the possible sharing of airborne resources (e.g. antennas).

4.2 Spectrum

4.2.1 As mentioned above, 1 090 ES is the only ADS-B data link with spectrum approval for global operation. UAT is currently obtaining operational approval in the United States to operate in the L-band at 978 MHz. UAT operates outside of the highly congested VHF band, which is favorable from a spectrum availability and interference mitigation perspective. A European planning activity is proposing four channels for VDL Mode 4 use-for the performance analysis in the high-density air traffic scenario presented in the ICAO comparative analysis, four channels were required for air-to-air ADS-B state vector transmissions alone (i.e., intent information was not included).

4.3 Operational use and maturity of technology

4.3.1 Of the three links, only UAT is being used operationally for airborne applications. UAT has a certification baseline for airborne equipment consisting of both a minimum operational performance standard (MOPS) and a technical standard order (TSO C-154, issued by the FAA). The ICAO ANC is considering approval for the initiation of UAT SARPs development as part of the Aeronautical Communications Panel's (ACP) future work plan. A major part of the activity of the UAT MOPS working group was in selecting the operating frequency to minimize impact to distance measurement equipment (DME) worldwide and to insure UAT was as robust as possible to its expected interference environment. Toward this end, much of the effort of the working group focused on the following actions:

- a) extensive testing (of Capstone UAT hardware) to accurately characterize transmitter and receiver performance for incorporating into network-level simulations;
- b) network-level simulations of UAT/ADS-B in a demanding future traffic environment to assess performance using metrics established in the ADS-B MASPS (RTCA DO-242A) and criteria provided by Eurocontrol;
- c) development of extreme interference scenarios from outside sources of interference (DME and L16) for inclusion in the network-level models.

4.3.2 The 1 090 MHz ES has a MOPS and approved ICAO SARPs. VDL Mode 4 has an interim MOPS and approved ICAO SARPs and has accomplished numerous trials and flights in various projects in Europe and having a local implementation of surface movement applications at Arlanda airport in Stockholm.

5. CAPSTONE PROGRAMME

5.1 Currently, there are over 180 UAT equipped aircraft, mostly air taxi operators with single and twin-engine aircraft as part of the United States FAA's Capstone programme. Additionally, ten ground stations have been installed in Western Alaska. In January of 2001, the FAA approved the use of UAT/ADS-B to support "radar-like services" for equipped aircraft in areas of Western Alaska without radar coverage. This represents the first operational use of ADS-B to support air traffic services in the world. The Capstone programme is currently planning to upgrade the installed avionics and ground stations to the recently completed standards documented in the UAT MOPS. Additionally, the programme plans to award new contracts for another 200 avionics suites to equip aircraft (fixed wing and helicopter) in Southeast Alaska and for 30 new ground stations.

6. CONCLUSION

6.1 The FAA has announced a link decision which utilizes a combination of 1 090 ES and UAT. The FAA and Eurocontrol have agreed on 1 090 ES as a coordinated initial ADS-B link to support near term capabilities and to provide international interoperability. The UAT will be used to support general aviation and provides performance advantages over the other link candidates, which makes it a leading candidate as the long-term ADS-B link for high performance air carriers.

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