WORKING PAPER

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SPECIAL COMMITTEE FOR THE MONITORING AND CO-ORDINATION OF DEVELOPMENT AND TRANSITION PLANNING FOR THE FUTURE AIR NAVIGATION SYSTEM (FANS PHASE II)

FOURTH MEETING

Montreal, 15 September to 1 October 1993

Agenda Item 4: **Research and development programmes, trials and demonstrations in communications, navigation and surveillance (CNS) and air traffic management (ATM)**

Agenda Item 5: **Air traffic management (ATM)**

ADS/SSR DATA INTEGRATION STUDY

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INFORMATION PAPER
(Presented in English and Spanish only)

SUMMARY

This paper presents details of the study on ADS/SSR data integration that AENA promptly will carry out in close cooperation with a consulting firm being contracted specifically for this purpose. The principal objective of the study is to develop an adaptable tracking algorithm which will process both SSR and ADS data. The study will also look at related operational requirements.

1. INTRODUCTION

The idea of integrating SSR and ADS data with the purpose of enhancing the surveillance function, increasing the level of surveillance availability, and monitoring the integrity of the navigation system, was presented by Spain to the FANS Committee

at its FANS II/2 Meeting held in Montreal from the 29th of April to the 17th of May 1991. The idea was backed up by some other countries, and the Committee agreed to include it in the list of tasks which need to be undertaken to support the implementation of the FANS concept, current ICAO CNS/ATM systems concept.

2. ADS/SSR INTEGRATION ADVANTAGES

2.1 ENHANCEMENT OF THE SURVEILLANCE FUNCTION

One of the features of the future ATS system is that through continuous application of a separation closer to the minima it will permit the potential density of traffic in the airspace to increase.

With aircraft operating more frequently at close proximity, there is a need to increase the availability of accurate positional data, and therefore, to enhance tracking algorithms in order to take advantage of all the surveillance sources available and process new parameters related to the attitude of aircraft.

Integrating SSR data with ADS data offers the following suitable improvements for better surveillance in a cost-effective manner:

- permits the ATC system to acquire automatically certain airborne data such as heading, speed, etc., which will improve the ground tracking of aircraft, thus ensuring that the required level of safety is maintained when lower separation minima will be applied;

- the coding of altitude data in 8 ft increments, and the availability of the vertical rate, as provided by ADS, will improve the ability of ATC to monitor and to make high quality predictions of aircraft trajectories in the vertical plane, thus enhancing the Short Term Conflict Alert (STCA) function to significantly reduce the number of false alarms;

- when satellite data link is used to support the ADS function, it would permit the ground system to acquire surveillance data from low altitude and other blind areas, where the radar, due to its line-of-sight propagation limitations, is blind; aircraft positional losses will become more critical in high density traffic areas, where very reduced separations will be applied;

- permits the ground tracking algorithm to use ADS data instead of radar data when SSR replies overlap and garbling occurs. Synchronous garbling is a serious system shortcoming which also may require action by the controller and pilot to establish correct aircraft identification;

- permits the renewal rate of surveillance data, currently conditioned by the radar antenna turn, to be selectively adapted on each aircraft according to instantaneous ATC needs, by simply modifying its ADS polling rate; This rate could be automatically controlled by the tracking algorithm itself (increasing the rate when the aircraft turns, or when radar losses start occurring and, therefore, the figure of merit of radar data decreases, etc.) and by the STCA function (when an alarm process initiates, etc);

- permits to minimize the number of SSRs needed to provide mono-radar coverage by filling in the small gaps in coverage with ADS;

- permits the ground tracking algorithm to use ADS positional data when aircraft are temporarily confronted with SSR transponder problems or screening of their on-board SSR antennas during manoeuvres;

- permits the ground system to automatically acquire aircraft call signs, thus overcoming current problems connected with SSR code-call sign correlation, and with radar identification and transfer procedures; and

- the availability of the next two way points, provided by ADS, will permit the ground system to detect incorrect waypoint data insertion before a dangerous situation arises. As the separation minima is reduced, the impact of these mistakes would become more critical, since the resulting deviations could constitute a collision risk in a shorter period of time than would be the case with larger separations minima.

2.2 INCREASE THE LEVEL OF SURVEILLANCE AVAILABILITY

Reductions in the separation minima, and the continuous application of certain types of tactical control, require the surveillance function to have a high availability because radar system outages will become much more critical.

In order to provide the required level of surveillance availability, adequate redundancy should be ensured through the highest possible diversity of systems, since diversity in system types minimizes the risks. Using both SSR and ADS provides this diversity.

Also, the degree of redundancy and duplication in the provision of the surveillance function should be kept to a minimun consistent with operational efficiency and safety. Satellite ADS permits the degree of surveillance redundancy to be adapted for each aircraft according to instantaneous ATC needs, thus providing redundancy in a very cost-effective manner.

2.3 NAVIGATION INTEGRITY MONITORING

Several means of monitoring the integrity of the Global Navigation Satellite System (GNSS) are under investigation in many places.

To provide a warning to the pilot within 10 seconds when an error in the GNSS occurs might not be sufficient in high density traffic areas where reduced separations need to be applied and deviations resulting from a navigation error could constitute a collision risk in a very short period of time.

Cross-checking ADS positional data of each aircraft (derived from its navigation system) with its positional data determined by the ATC radar surveillance system could enable the ground system to detect navigational errors so as to permit the timely intervention of both, the air traffic controller and the pilot, to prevent these errors from growing to such proportions as to constitute a collision risk.

One of the advantages of this means is that not only errors due to the malfunction of the GNSS space segment can be detected, but also due to the malfunction of the airborne equipment. Also errors due to the malfunction of any other navigation system (VOR, DME, INS, etc.) being used by the aircraft could be detected.

Another advantage is that the monitoring (cross-checking) interval for each aircraft can be selectively adapted according to its instantaneous relative position with respect to other possible conflicting aircraft or the terrain, or according to the phase of flight, by just modifying its ADS polling rate. Some aircraft might not need to be monitored as frequently as others.

Under certain circumstances, and in areas where the integrity of the SSR surveillance system can not be monitored by conventional means, like in oceanic areas close to the coast, cross-checking SSR data with ADS data can also provide integrity monitoring of the SSR system.

2.4 CONCLUSION

SSR data when combined with ADS data can enhance the surveillance function to a level of performance similar to that of the Mode S SSR, providing in addition coverage in low altitudes and other blind areas when satellite data link is used for ADS transmission. It also provides a flexible diversified redundancy which permits to reach the adequate level of availability in a very cost-effective manner, and a way to timely monitor the integrity of the navigation systems being used by aircraft.

3. ADS/SSR DATA INTEGRATION STUDY

Spanish Airports and Air Navigation (AENA) as a continuation to the initial work (WP/36) presented to the FANS (PHASE II) second meeting, will now carry out a detailed study on ADS/SSR integration, in close cooperation with a consulting firm being contracted specifically for this purpose.

The study is divided into eight tasks, each of which is outlined bellow.

Task 1: SSR limitations analisys. Limitations related to integrity, availability, accuracy, etc. will be identified.

Task 2: Current tracking algorithms analisys. Current mono and multiradar trackers used to overcome some of the limitations of SSR will be analised.

Task 3: ADS contributions analisys. ADS contribution to overcome the limitations of both SSR and trackers will be analised.

Task 4: Development of an adaptable ADS tracking algorithm. An intelligent algorithm which will control itself in real time the ADS contracts based on its own data needs and operational requirements will be developed.

Task 5: Development of an adaptable ADS/SSR tracker. An intelligent ADS/SSR algorithm which will control itself in real time the ADS contracts based on SSR data availability and accuracy, and operational requirements will be developed.

Task 6: Demonstration, evaluation and validation of the algorithms. By means of the appropriate hardware and software the algorithms will be demonstrated, evaluated and validated.

Task 7: Preliminary definition of characteristics for an ADS/SSR integrated ATC system

Task 8: ADS contributions at national level. ADS and ADS/SSR integration advantages at national level (Spanish FIR) will be identified.

The study is scheduled to start by September 1993 and last for six months, being the outcome of the study provided in both Spanish and English.

It is expected tha the algorithms resulting from the study will be implemented in an ADS/SSR ATC Working Position to be used by AENA in the EUROCONTROL SATCOM/ADS Mediterranean Trials.

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