



INTERNATIONAL CIVIL AVIATION ORGANIZATION

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SPECIAL COMMITTEE ON FUTURE AIR NAVIGATION SYSTEMS (FANS)

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Agenda Item 2: Further development of the global CNS system concept

POSSIBLE USE OF SSR MODE S RADAR FOR NAVIGATION PURPOSES

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1. INTRODUCTION

The use of data derived from navigational systems, for surveillance purposes (ADS), could be a good solution for increasing the capacity in areas where the installation of ground based radars is not feasible, such as oceanic areas. It could also be a good solution in continental areas where the installation of a surveillance radar cannot be justified on a cost versus benefits basis, due to the low air traffic density, and where the air traffic control system capacity could be sufficiently increased in this manner, so as to meet the demand.

As we also plan to use navigational systems for surveillance, we should consider as well the possibility of using surveillance systems for navigation, or at least as a back-up of the navigation system. The fact is that surveillance radars are already used indirectly for navigational purposes in those cases where the air traffic controller directs an aircraft by means of radar vectoring.

In the near future, terminal areas and high density traffic areas, will have SSR Mode S radars, with data link capability, and which could be used as navigation aids.

2. PROPOSAL

It is proposed that the data link of the SSR Mode S radar be used to send the aircraft its position data, as determined by the radar. This proposal could result in a reduction in the cost of providing air traffic control services due to the fact that many navigation aids which are used within the area of radar coverage would not be necessary any longer.

Position data should be sent from the SSR Mode S radar site to the aircraft, after the aircraft has requested this data, and whenever it is detected by the radar.

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### 3. DISCUSSION

The period of time between the moment the SSR Mode S radar station determines the position of an aircraft, and the moment when the position data is received by the aircraft through the data link, is a very important factor which determines the feasibility of this proposal.

If this period of time is very short, it should not be necessary to extrapolate to determine the actual position of the aircraft. Also, it should not be necessary to use an Electronically Scanned Antenna (ESA) as a means of transferring position data without waiting for the next revolution of the radar antenna.

Current surveillance radars use beams formed by an array which itself is mechanically rotated at a fixed rate. The time available to transfer data depends on this rotation rate.

An Electronically Scanned Antenna (ESA) is a static non-rotating array producing beams which can be pointed in any direction at will, and maintained there until a data transfer has been completed. Changes of direction can be made almost instantaneously-in micro-seconds-using modern fast-switching microwave devices. It is obvious that an antenna system such as this, permitting variable dwell-time on chosen targets, could be much more efficient.

### 4. OPERATING MODES

The aircraft position data, as determined by the SSR Mode S radar, and after properly processing it, could be used in three different modes of operation.

Display Mode.

Comparison-Alert Mode.

Navigation Mode.

In the display mode, position data derived from the radar is simply displayed in the cockpit visualization unit, in the manner considered most appropriate.

In the comparison-alert mode, position data derived from the radar is compared with the avionics data, triggering a corresponding alarm whenever there is a discrepancy between the two. This mode permits the detection of errors in either the aircraft's navigation systems, or in the mode S radar systems.

In the navigation mode the position data derived from the radar could be used to update the aircraft's INS or sufficiently processed to be able to simulate other navigation aids (such as VOR).

## 5. IMPLEMENTATION

The implementation of this proposed navigation system implies:

- i) The establishment of an adequate communications protocol, defining the format and meaning of the necessary messages.
- ii) The detailed specification of the necessary modifications to be performed on the SSR Mode S radars, with the object of enabling the radar digitizer to send position data to aircraft directly through the data link.

It would be conveniente to define if the position information should be provided in rho-theta format or x, y co-ordinates.

Also, the use of stationay Electroniacclly Scanned Antennas, in place of conventional antennas should be considered to improve radar detection and communication with the aircraft.

- iii) The enhancement of the airborne systems for the processing of this radar position data received by means of the data link, will include: the installation of a data channel in the INS for input of position data, and if it's considered worthwile, the implementation of new navigational systems based on the radar data.

## 6. CONCLUSIONS

The utilization of SSR Mode S radar for the dual purpose of detection and navigation would permit the elimination of a large portion of the navigation aids in the radar coverage area, and consequently reduce the expenses of the air traffic control system. In addition, navigation will be easier, and both pilots and air traffic controllers will be using the same reference for determining aircraft position.

## 7. ACTION REQUIRED

The FANS Committee is invited to discuss this WP, to accept its conclusions, and to agree to a course of action for the accomplishment of future studies on this matter.