Improved surveillance is possible by combining data from different systems

Integration of SSR and ADS data will permit an increase in traffic capacity and aviation safety in high density continental airspace.

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THE IDEA of integrating secondary surveillance radar (SSR) and automatic dependent surveillance (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 (Phase II) Committee at its second meeting, held in Montreal in 1991. The idea was backed up by some other countries, and the Committee agreed to include SSR and ADS data integration in the list of tasks which need to be undertaken to support the implementation of the future air navigation system (FANS) concept, today known as the ICAO communications, navigation and surveillance and air traffic management (CNS/ATM) systems concept.

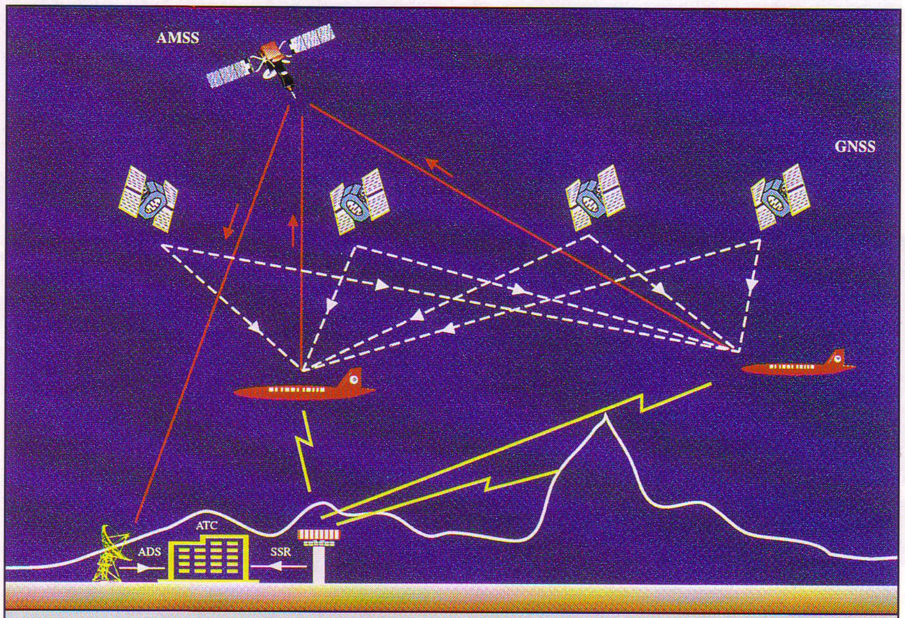
One of the advantages of the future air traffic services (ATS) system is its potential to decrease aircraft separation in order to allow an increase in the density of traffic. With aircraft operating more frequently at close proximity, there is a need to improve the availability of accurate positional 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 a number of improvements, providing better surveillance in a cost-effective manner. Data integration permits the air traffic control (ATC) system to automatically acquire 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 are applied. The coding of altitude data in eight-foot increments and the availability of the vertical rate, as provided by ADS, will improve the ability of ATC to monitor and to make highly accurate predictions of aircraft trajectories in the vertical plane, thus enhancing the short term conflict alert (STCA) function by significantly reducing the number of false alarms. When satellite data link is used to support the ADS function, it permits the ground system to acquire surveillance data from low altitude and other blind areas where radar — due to its line-of-sight propagation limitations — is blind; aircraft positional losses become more critical in high density traffic areas where very reduced separation will be applied.

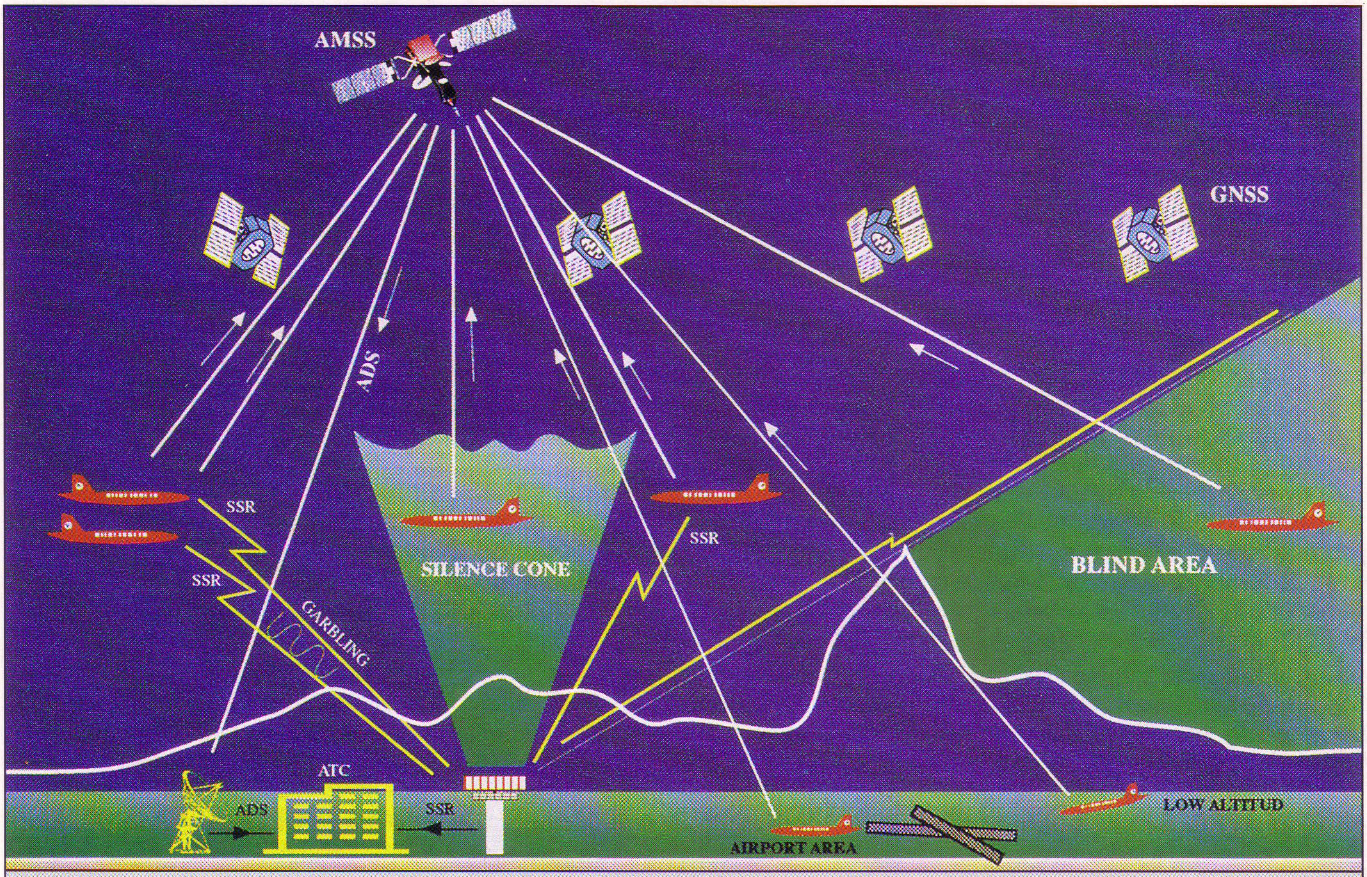
Data integration also permits the ground tracking algorithm to use ADS data instead of radar data when SSR replies overlap and garbling occurs. Synchronous garbling is a serious system shortcoming which also may require action by the controller and pilot to establish correct aircraft identification. In addition, data integration 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 reporting 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 by the STCA function (when an alarm process initiates, etc.).

The number of SSRs needed to provide mono-radar coverage can be minimized by filling in the small gaps in coverage with ADS. Data integration also permits the ground-tracking algorithm to use ADS positional data when aircraft are temporarily confronted with SSR transponder problems or shielding of their on-board SSR antennas during manoeuvres.

Data integration permits the ground system to automatically acquire aircraft call signs, thus overcoming current problems connected with SSR code-call sign correlation and radar identification and transfer procedures. In addition, the availability of the next two waypoints, provided by ADS, will permit the ground system to detect incorrect waypoint data insertion before a dangerous situation arises. As the separation mini-



Integration of SSR and ADS systems would improve aircraft surveillance in a cost-effective manner.



Limitations in SSR capability can be overcome by combining radar data with data obtained by space-based technology.

mum is reduced, the impact of these mistakes become more critical since the resulting deviations could constitute a collision risk in a shorter period of time than would be the case with higher separation minima.

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

In order to provide the required level of surveillance availability, adequate redundancy must be ensured through utilization of the greatest possible diversity of system types. Using both SSR and ADS data provides this diversity. Also, the degree of redundancy and duplication in the provision of the surveillance function should be kept to a minimum 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.

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 separation needs 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 the positional data provided by the ATC radar surveillance system could enable the ground system to detect navigational errors. This capability would permit the timely intervention of mistakes by both the air traffic controller and the pilot to prevent such errors from reaching the point where they constitute a collision risk.

One of the advantages of monitoring the navigation system by this means is the wide range of error detection capability; both errors due to the malfunction of the GNSS space segment and errors resulting from the malfunction of the airborne equipment are detectable. In addition, 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 potential conflicting aircraft or the terrain, or according to the phase of flight, by simply modifying its ADS reporting rate. Some aircraft might not need to be monitored as often as others.

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

Conclusion

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

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