CNS/ATM for Naval Aviation

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Purpose

This newsletter provides information to the Naval aviation community concerning requirements, issues, and developments in Communications, Navigation and Surveillance / Air Traffic Management (CNS/ATM).

SURVEILLANCE

Automatic Dependant Surveillance

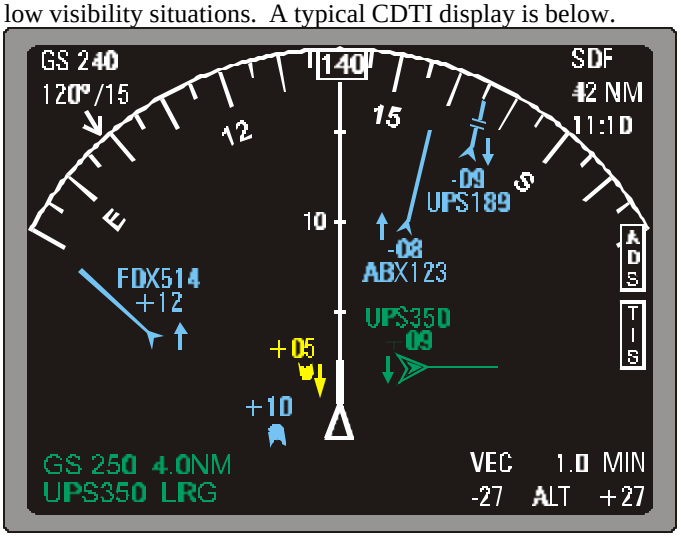
To pilots, the most substantial impact on their CONOPS will be the implementation of Automatic Dependent Surveillance (ADS), particularly ADS-Broadcast (ADS-B). ADS-B is not a new concept – it has been used in nature for hundreds of thousands of years. Its application in the civil aviation arena has the potential to provide pilots with an increase in situational awareness of the position and intent of other aircraft operating in their vicinity.

To understand ADS-B, consider the coleoptera lampyridae, commonly known as the firefly or lightning bug. This flying beetle chemically illuminates its abdomen, periodically broadcasting (squittering) its current position and, per entomologists, other information such as gender as well. Other fireflies use the squittered position to track each other (the insect equivalent of situational awareness (SA)). Besides the obvious continuation of the species aspect, the firefly uses the squittered position of other fireflies for separation purposes. In the generic ADS-B concept, aircraft, about once a second, will squitter their unique ID, GPS-derived position, altitude, velocity vector, and other information to any aircraft or ground station equipped with ADS-B receive capability within line-of-sight for separation purposes. In civil aircraft, the once a second squitter will start upon power up without any action of the pilot (hence, the "automatic" of ADS).

Until recently, pilots without an air search radar relied primarily on visual sightings and voice-relayed ground-based radar/Secondary Surveillance Radar (SSR) information to maintain a safe separation from other aircraft. Recently, passenger and some military aircraft have installed the Traffic Alert and Collision Avoidance System (TCAS) II system, which, like one version of ADS-B, uses Mode S as their data link. Aircraft using TCAS II must interrogate other aircraft in their vicinity and receive a reply. Aircraft TCAS Mode S responses provide ID, altitude information, and maneuver information. Range to other aircraft is computed from the time delay between interrogation and response, and approximate azimuth information is determined using directional antennas.

With ADS-B using Mode S, estimates for range are on the order of 60-100 miles, a substantial improvement over the expected 14-40 mile range for TCAS. An ADS-B equipped aircraft would be able to display all aircraft squittering ADS-B information within line-of-sight. Unlike TCAS II, an ADS-B aircraft would not have to individually interrogate other aircraft, but would automatically receive the once per second ADS-B broadcasts from other aircraft in their vicinity. Additionally, the civil CONOPS envisions equipping airport ground vehicles for improved ramp/taxiway SA.

The most important advantage of ADS-B is enhanced safety. A Cockpit Display of Traffic Information (CDTI) of ADS-B data gives a pilot the real time positional relationships and intent for all ADS-B equipped traffic. A study has shown that a typical pilot can locate air traffic eight times faster if he knows where to look. This is especially advantageous during low visibility situations. A typical CDTI display is below.



Ground tracks, closure rates, altitudes, climb/descent, and traffic alerts can be displayed in a variety of ways as well as waypoints, and weather and navigation annuciations. Ground based traffic information service broadcasts (of non ADS-B equipped aircraft), if available, can be displayed separately or fused for increased SA.

Unlike TCAS, when traffic conflicts arise, ADS-B does not provide resolution advisories. Each system is designed around a specific philosophy. TCAS guides the pilot out of conflicts while ADS-B relies upon the pilot's skills not to fly into conflicts. Undoubtedly, future ADS-B developments will include traffic warnings and recommended evasive maneuvers. At least one company, Honeywell, is developing a combined TCAS/ADS-B system.

ADS-B impacts military CONOPS in several ways. Its use will be essential to reach the zone of engagement. But with each aircraft squittering unique clear IDs or pseudo IDs, an enemy can determine the force composition. The squitter can be shut off prior to reaching the zone of engagement with obvious safety implications, however allowing the pilot to continue to receive civil aircraft squitters thus aiding in IFF (improved SA). The platform could switch to encrypted squitters allowing a rapid ID of friendlys and reducing fratricide, but sacrificing low probability of detection safeguards. There are also the risks of spoofing and aliases. The point is that there is no single military-use-of-ADS-B CONOPS that all platforms can apply.

Besides ADS-B, there is ADS-A (ADS-Addressable). ADS-A will be used by ground stations to provide Air Traffic Management (ATM) facilities with very accurate position information by interrogating suitably equipped platforms for information. A suitably equipped platform is one where Mode S can support DAP (Downlink of Aircraft Parameters). The intent of ADS-A is for a ground station to download specific information from registers on board the aircraft. Note that there is a difference in how Mode S is employed in TCAS vice ADS-A. TCAS does not have DAP (which requires an extended squitter).

In the US and in Europe, most of the testing on ADS-B has focused on the Mode S Data Link with DAP, modified to squitter ID, GPS-position, course and speed and other data (such as magnetic heading) once per second. Experimental work, primarily in Europe, is also being expended on a VHF-band data link for ADS-B, VDL Mode 4. VDL-4 has the advantage of extending ranges to other aircraft out to a nominal 200 miles. A third link being considered for ADS-B is Universal Access Transceiver (UAT) at 966 MHz which Mitre/CAASD and UPS Aviation Technologies (formerly, IIMorrow) are developing. The FAA is expected to choose an ADS data link technology for implementation by 2002.

EUROCONTROL has mandated that all aircraft be equipped with Mode S with DAP starting in 2003. In the US, ADS-B is expected to be required for air to ground sometime after 2005, and will likely be available somewhat earlier for air to air as aircraft equip and begin transmitting on ADS-B. By 2010, the FAA expects to have completed the deployment of ADS ground stations.

Mode S with DAP will be included as a capability in the Common IFF Transponder. This joint PMA-209/PMA-213 product will replace shipboard IFF and aircraft APX-100 IFF transponders solving maintainability and reliability issues, and implementing civil requirements in military equipment. The current schedule calls for the first production Common IFF Transponders to be available in the first quarter of FY 01.

CNS/ATM NEWS

CAA ADS-B Demonstration 10 July 1999

Based here at NAS Pax, a Navy P-3C, modified by NAWCAD, participated in Ohio Valley tests on 10 July, 1999 that demonstrated three ADS-B technologies. Sponsored by the Cargo Airlines Association (CAA) and the FAA, this demonstration investigated three competing ADS-B data link technologies: Mode S, UAT and VDL Mode 4.

Test results are still being analyzed, but ADS-B showed promise. NAWCAD is reviewing the military situational awareness utility of ADS-B, the limitations on candidate ADS-B data links, and human factors associated with implementation of ADS-B displays in the cockpit.

Our thanks to those who helped to make the Navy participation in this demonstration a reality.

8.33kHz Channel Spacing Implementation Nears

Starting **7 October 1999**, **8.33 kHz VHF channel spacing** (in lieu of 25 kHz spacing) **is required** at altitudes over FL245 **in Europe** by EUROCONTROL (see Volume I, issue 1 for the list of requiring nations). UHF is available as a workaround in most of Europe. However aircraft using UHF may experience delays and will not be able to monitor some civil VHF communications in Europe, a safety concern when flying at flight levels above FL245. In France, the requirement will be lowered to FL195 in two years. A UHF workaround will not be available in Austria east of 12 degrees East, although 8.33 kHz will be required in this area only above FL340. Certain areas of Switzerland do not have UHF coverage.

8.33 kHz versions of the AN/ARC-210 radio are now being delivered by PMA-209 and commercial off-the-shelf (COTS) 8.33 kHz radios also are available