Automatic Dependent Surveillance Broadcast (ADS-B)

Surveillance development for Air Traffic Management

As air traffic is predicted to increase steadily over the coming years, there is a clear need to ensure that standards of safety and efficiency are maintained, or even enhanced. This is recognized by the Single European Sky programme in Europe (SESAR) and the NextGen programme in the U.S.A. (read FAST article - Demonstrating the green trajectory), the two major bodies driving the Air Traffic Management (ATM) development over the coming years.

Automatic Dependent Surveillance Broadcast (ADS-B) is all about communications between aircraft, and also between aircraft and ground. Both are vital in ensuring safe flights and efficiency in terms of fuel use, time and emissions. ADS-B is an integral part of the planned efficiency drive towards 2020.

Taking advantage of the latest technology, ADS-B is designed to be retrofit on aircraft flying today. Here, we will look at aspects associated with the retrofit and take a look at the developments that are planned for the future.

Christine VIGIER
Design Management Avionics
Airbus Upgrade Services

ADS-B summary

In its final form, ADS-B is designed to ease Air Traffic Control (ATC) as the number of approaches grows, enhancing safety and increasing airport capacity.
In the air, the information provided by ADS-B enhances the pilots' traffic awareness, allowing more optimal flight levels leading to fuel savings.
ADS-B is considered in two parts as described:

- ADS-B OUT provides a means of automated aircraft parameter transmission between the aircraft and the ATC.

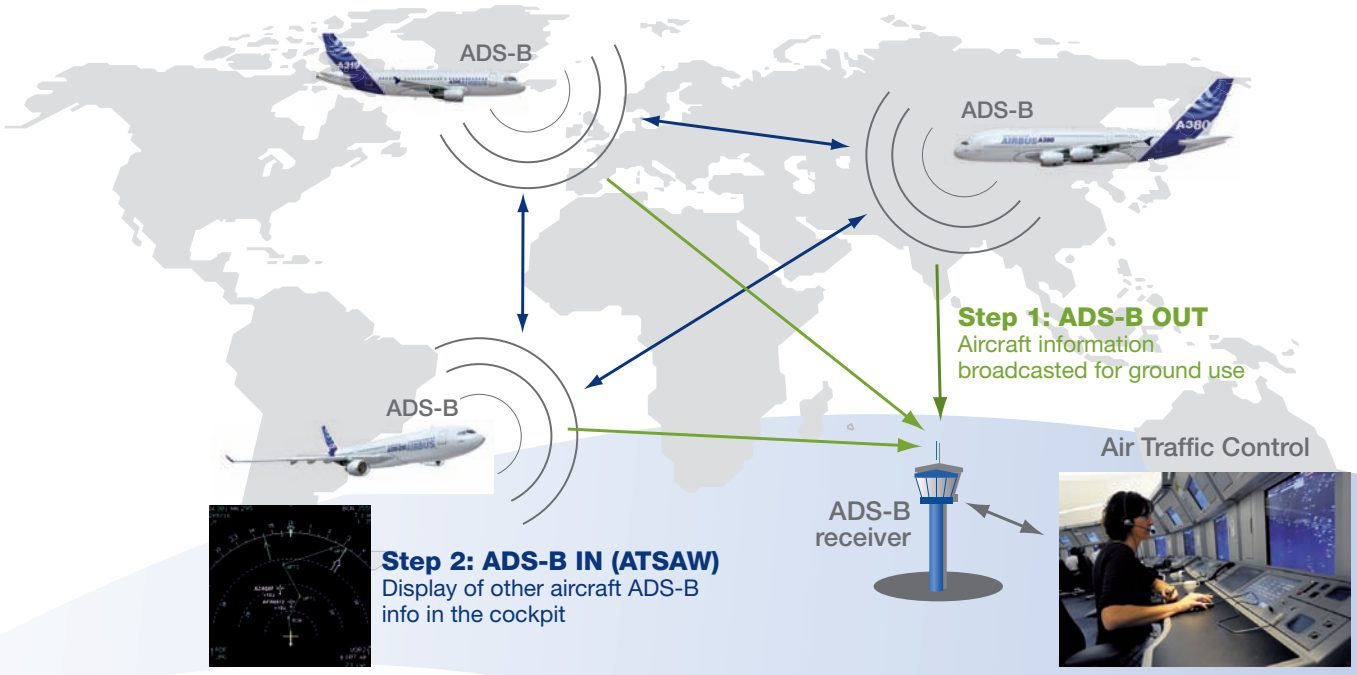
- ADS-B IN provides automated aircraft parameter transmission between aircraft themselves.

glossary

ADC: Air Data Computer
ADIRS: Air Data/Inertial Reference System
ATC: Air Traffic Control
ATSAW: Air Traffic Situational Awareness
DMC: Display Management Computer
EHS: Enhanced Surveillance
EIS: Electronic Instrument System
FCOM: Flight Crew Operating Manual
FM: Flight Manual
FMS: Flight Management System
FWC: Flight Warning Computer
GPS: Global Positioning System
HFDR: High Frequency Data Radio
IRS: Inertial Reference System
MCDU: Multi-purpose Control Display Unit
MMR: Multi-Mode Receiver
NRA: Non-Radar Airspace
OANC: On-board Airport Navigation Computer
OANS: On-board Airport Navigation System
OMS: On-board Maintenance System
SATCOM: Satellite Communication
SPI: Special Position Identification

First steps involved in ADS-B

Figure 1



STEP 1: ADS-B OUT

ADS-B OUT automatically transmits aircraft parameters from the aircraft to the ATC on ground. There is no need for the pilot's action and it conforms to EASA regulations on ADS-B OUT, for Non-Radar Airspace (NRA) operations. The capability must be declared in the FCOM and the FM shall be updated (see figure 2).

ADS-B OUT

Figure 2

	DO-260	DO-260B
Equipment required	• ATC transponder enhanced capable • MMR (with GPS capability) • Wiring provision EHS	• ADS-B OUT DO-260B • FWC
Availability date	Now	As per mandate (refer to figure 10)

Example on MCDU

Figure 3

In this example, the MCDU (Multi-purpose Control and Display Unit) shows the identity and the relative horizontal position of three aircraft. The pilot can see immediately that a flight level change to FL370 is not possible until 1412Z time, as computed by the TCAS (Traffic alert and Collision Avoidance System).

A different flight level can be requested as clearly indicated, taking into account the surrounding aircraft positions, trajectories and speeds.

STEP 2: ADS-B IN (ATSAW)

The Airbus approach to ADS-B IN is named the Air Traffic Situational Awareness (ATSAW) which enables the reception of ADS-B information from other aircraft in the vicinity. As for the ADS-B OUT, the capability must also be declared in the FCOM and the FM updated (figure 4).

ATSAW is splited in two steps:
- Step 2A: ATSAW operation in flight
- Step 2B: ATSAW operation on ground

STEP 2A: ATSAW OPERATION IN FLIGHT

a) ATSAW
- Improves cooperation with ATC (better understanding of ATC instructions),
- Improves the detection of opportunities for flight level changes in standard separation for reduced fuel savings and a reduction of CO_2 emissions,
- Improved efficiency on approach,
- Enhances identification and information on target aircraft,
- Increases runway capacity.

b) ATSAW with ITP (In Trail Procedures) today defined on the North Atlantic ocean (see figure 3):
- Enables more frequent altitude changes by temporarily reducing standard separation,
- Enables flying at the optimum flight level,
- Provides significant fuel savings.

STEP 2B: ATSAW ON THE GROUND

- Enhanced situational awareness during surface operations.

NEXT STEPS

STEP 3: SEQUENCING AND MERGING

The objective of the future step is to enable the flight crews to achieve and maintain automatically a given spacing with designated aircraft.
The two principle maneuvers are 'remain behind' and 'merge behind'.
The operational benefit will be the enhanced traffic regularity during the approach to airports with heavy traffic allowing increased airport capacity.

ADS-B IN (ATSAW)

Figure 4

	Step 2A	Step 2B
Equipment required	• ATC transponder EHS • MMR (with GPS capability) • EIS2 • Wiring provision • EHS traffic selector • FWC standard	As for Step 2A + OANC
Availability date	Early 2011	2013 TBC

How does ADS-B work?

ADS-B OUT

It uses ATC transponders to transmit aircraft information to the ground, using the Mode S 1090 MHz Extended Squitter with a refresh rate of 0.5 seconds.

Example on Navigation Display and MCDU

Figure 5

The Navigation Display (ND) shows the aircraft orientation and relative information from aircraft in the vicinity.

Figure 6

Additional information shown on the MCDU.

Figure 7

The Pilot elects to see more information on AFR6512 by the menu selection.

Figure 8

The ND indicates the position and trajectory of other aircraft on taxiways

ADS-B IN

On aircraft, it is the TCAS computer that receives and treats the ADS-B information coming from ATC transponders of surrounding aircraft. The information is then displayed on the Navigation Display (ND) and the MCDU (see figures 5, 6 & 7). When ATSAW is activated and if the ADS-B information is available from aircraft in the vicinity, the following information is available for each pilot:

- Aircraft identification
- Absolute bearing/2D distance
- Heading/Tracking
- Wake vortex category
- Relative altitude/Absolute altitude
- Ground speed
- Vertical velocity

Aircraft architecture required for ADS-B OUT

ADS-B OUT NEEDS

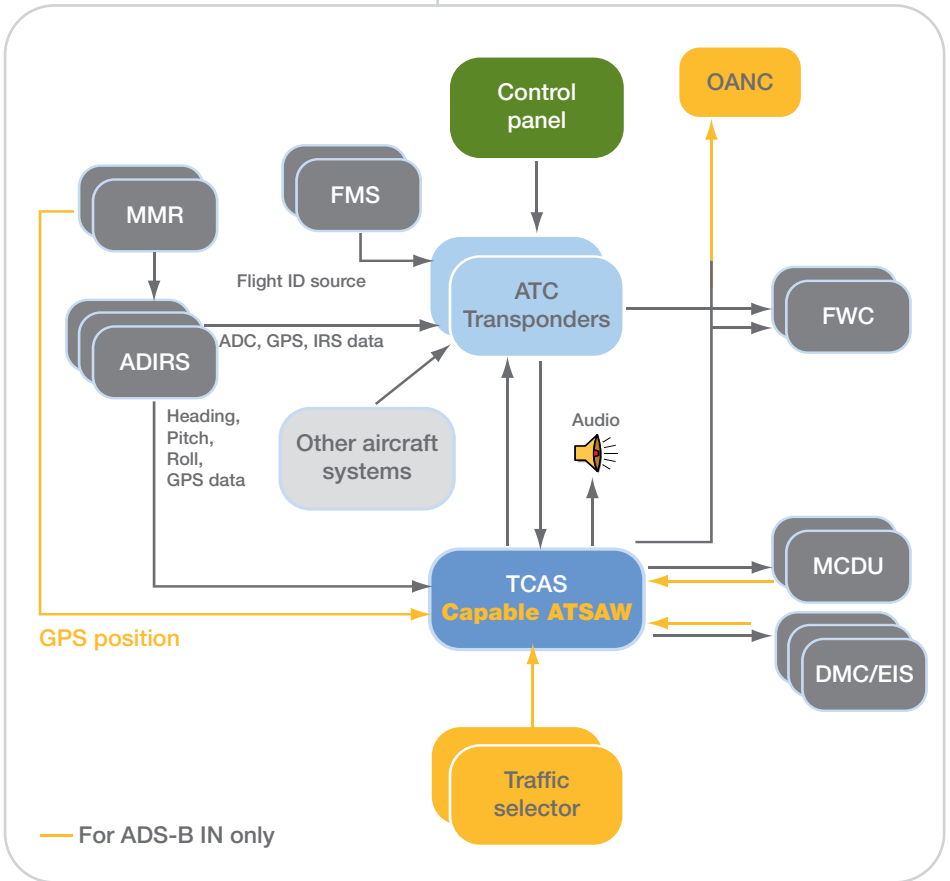
- ATC transponders at minimum DO-260 standard.
- Additional wiring associated with peripheral equipment,
- MMR in hybrid architecture with GPS capability.

CURRENT FLEET STATUS

Aircraft currently flying in Europe are generally well equipped for the transition to ADS-B OUT as the prerequisite ATC transponders Mode S (DO-260) are already required to meet the former enhanced surveillance mandate. Aircraft greater than five years of age and operating outside of Europe are more likely to need a new transponder in order to achieve ADS-B capability.

Architecture for ADS-B OUT and for ADS-B IN

Figure 9



ADS-B IN

STEP 2A

- TCAS capable
- Additional wiring
- Traffic selector in cockpit
- EIS2 capable

STEP 2B

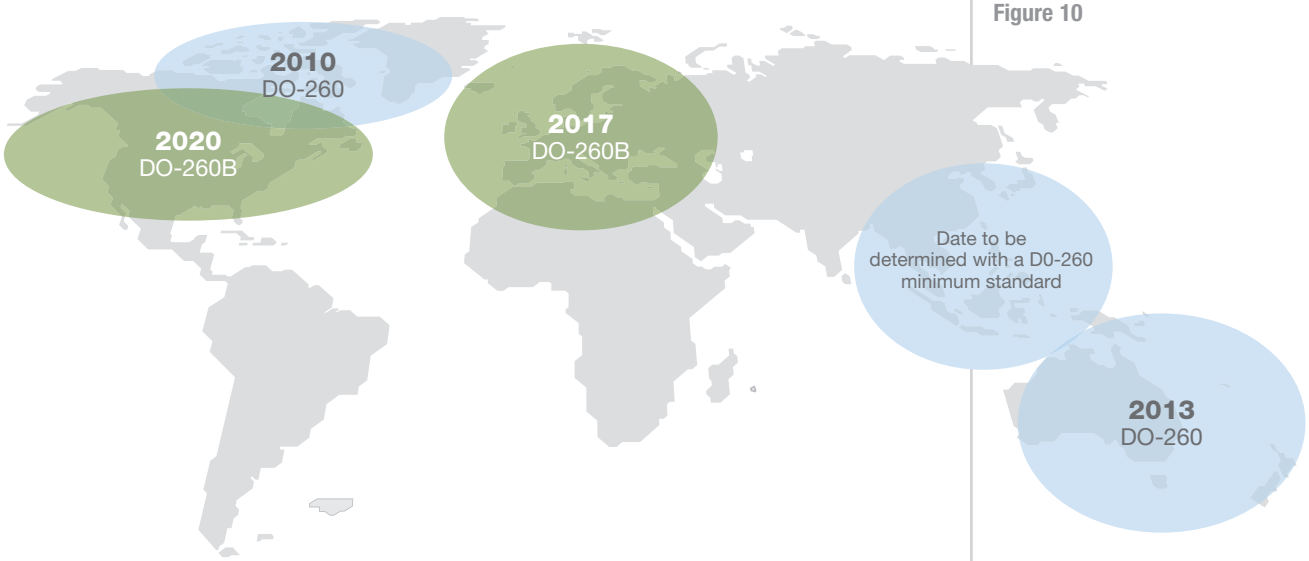
Step 2A + OANC
(On-board Airport Navigation Computer)

ADS-B IN TRIALS

To pioneer and test the new functions associated with ADS-B IN, trials are scheduled with the involvement of Eurocontrol and certain airlines which will have the ATSAW capability, some from production and others by retrofit. The European trials will commence in early 2011.

Mandates

Figure 10



ADS-B OUT MANDATES

Current operational requirements or mandates are already in service and others are anticipated. The figure 10 shows areas where a mandate already exists, such as the Hudson Bay, and also shows anticipated mandates in other regions. The upcoming mandates in Europe and North America require a new standard (DO-260B) which implies an upgrade to the FWC and connections between the MMR and the ATC transponder. This will enable additional benefits in terms of safety, flight efficiency and situational awareness, thanks to the GPS data enabling the transmission of more accurate information on aircraft positions and the improved latency in broadcasts.

CONTACT DETAILS

Christine VIGIER
Design Management Avionics
Airbus Upgrade Services
Tel: +33 (0)5 67 19 02 17
Fax: +33 (0)5 62 11 08 47
christine.vigier@airbus.com

Conclusion

Whilst the initial drivers from SESAR and NextGen are motivated by the need to maintain and where possible enhance safety standards, the commercial implications for operators are not forgotten. The benefits from the Automatic Dependent Surveillance Broadcast (ADS-B) are not only for Air Traffic Control (ATC), but also for the airlines, flight crew and passengers.
ADS-B OUT eases the flight crew and ATC workload, resulting in fuel and time savings thanks to more efficient approaches.

ADS-B IN presents additional opportunities for fuel and time savings, in particular by the utilization of 'In Trial Procedures' for long range flights in the oceanic airspace, maintaining safety.
ADS-B is in the early stages of a roadmap vision up until 2020 and has been adopted by SESAR and NextGen. Airbus Upgrade Services will continue to develop new solutions to ease flight operations, thus contributing to reduce the congestion in future Air Traffic Management.

AIRBUS