SO, WHO'S **REALLY** OUT THERE?

Getting audio traffic warnings is a real comfort and low cost systems could soon be a reality for light aircraft

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Electronic Conspicuity – it's a heck of a clumsy phrase and difficult enough to say out loud without tripping over your tongue, but it's an important concept to aid 'see-and-avoid'. In essence, it simply means being detectable via a radio signal – the questions are – how, and at what cost?

To examine the possibility of increasing safety for GA via some electronic means, a CAA working group, consisting of representatives from aircraft, microlight, glider, hang-glider, paraglider and balloon associations, together with NATS and the MoD, was set up between mid-2013 and Autumn 2014 with Martin Robinson (AOPA) as the nominated chair.

It looked at the general requirements in relation to the needs of each of the various groups and then at different ways of implementing such an electronic capability. Its conclusion was that Automatic Dependent Surveillance – Broadcast (ADS-B) was the most promising. The risks of GA airborne collisions were presented to the group by the LAA, who looked at statistics from the last 37 years.

In summary, it found that the main threat to powered aircraft was powered aircraft, the main threat to gliders was gliders and the risk was 10 times greater at the airfield or glider launch site than in the cruise.

The problem was that ADS-B implementation would be expensive in the GA world. The equipment is strongly regulated for all the usual aviation safety reasons and certification costs, especially for the aviation GPS component, are high.

Then there was the 'known traffic environment' question. In controlled airspace, air navigation service providers require a complete 'known traffic environment' for safe traffic management and aircraft are usually required to operate a transponder.

In Class G airspace, this isn't required although using a transponder where fitted is strongly recommended. However, a transponder is not mandatory, nor is it possible for some airspace users to carry one for physical reasons and/or because they have no electrical power. Problems arise

While they don't replace see-and-avoid, traffic alert systems do provide the comfort of early warnings of potential conflicts with similarly equipped aircraft; glider pilots have been installing a system called FLARM for some time

when Class G airspace users without a transponder inadvertently stray into controlled airspace. If they are detected by primary radar, this can cause major disruption, leading to go-arounds which can cost several thousands pounds for a civil airliner, let alone the ATC burden of managing the following arrival sequence and the knock-on effect on airline scheduling. If not detected, there is the risk of an airprox and its consequences.

Minimising such infringements and managing them when they occur is a continuing problem for NATS. Earlier NATS' initiatives such as the Airspace Aware can help reduce the likelihood of some airspace users entering controlled airspace but, once the infringement has occurred, the situation is different.

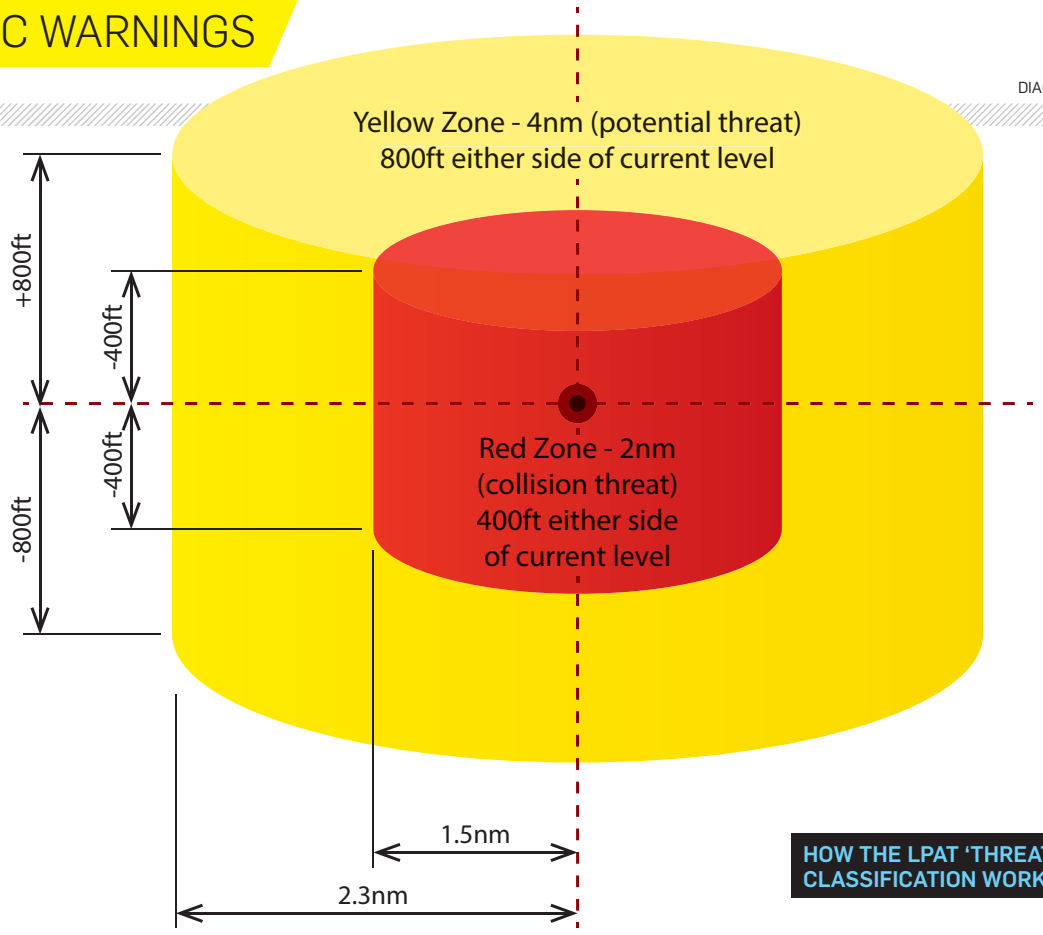
Three years ago, NATS came up with the idea for a device to help this situation for all GA – not only those who might be expected to carry a transponder. Most importantly, it recognised that there was an opportunity to offer real and significant benefits to GA pilots as well by using the 'ADS-B-in' function to indicate the presence and position of nearby aircraft and so assist 'see and avoid'.

This is the Low Power ADS-B Transceiver (LPAT). The basic notion is to transmit and receive ADS-B signals and to display received signals on a small traffic display with audio warnings. But how is this different from the existing and expensive ADS-B and GPS units already available to commercial aircraft? The main differences are:

Most importantly, it recognised there was an opportunity to offer real and significant benefits to GA pilots

- **Transponder vs Transceiver:** Transponders respond to interrogations from secondary radars and have to meet stringent requirements on reception, transmission and timing of 1030/1090MHz radio signals. A transceiver is a simpler device that transmits and receives autonomously.
- **Portability:** LPAT is designed as 'carry on' equipment rather than being panel-mounted, reducing both certification requirements and installation costs.
- **Low power:** Benefits of reducing the transmission power are:
  - Enabling the device to be battery powered – the lower the power, the longer the battery will last.
  - Reducing the possibility of radio interference to other airspace users by reducing the range at which the signal will be detected. A balance has to be struck here so the reception range is still enough to enable timely detection by others and of others.
  - Enabling the device to be used safely close to the human body. This is valuable for hang-glider and paraglider pilots who may have little or no structure to which the device can be fixed and who, instead, can carry it on their person.
- **GPS unit:** Using a non-certified and, therefore, less expensive GPS unit that does not have to meet all the stringent requirements to support ATC separation.
- **Type of usage:** The LPAT is explicitly not used for ATC separation but to indicate the presence and position of another aircraft as an aid to visual acquisition for see-and-avoid. For ATC infringement management, it positively distinguishes a real aircraft from background clutter, which greatly reduces the probability of a CAS infringement being undetected compared to primary radar alone. ➔

DIAGRAM: PETER LIDDIARD



HOW THE LPAT 'THREAT' CLASSIFICATION WORKS

- **Cost:** Simplification of the device and using a less expensive GPS unit reduces the cost.

NATS has developed the LPAT through a contract with Funke Avionics (FAV) and prototype units are being used for flight trials that have just started with GA pilots from both within NATS and AOPA members.

ELECTRONIC VISIBILITY VIA ADS-B – PROJECT EVA

Project EVA is a large-scale demonstration project, co-funded by the Single European Sky ATM Research programme (SESAR) in Brussels, which runs until early autumn 2016. The focus is to fly prototype ADS-B equipment in a GA VFR environment to see how well it performs and what pilots think of it, as well as to look into all the issues surrounding bringing such equipment to market as an affordable device for GA pilots.

Project EVA is led by NATS with AOPA (UK), FAV and Trig Avionics as partners. FAV have developed the LPAT prototype and Trig are developing a similar device that is panel mounted, based on their existing Mode S transponder.

AOPA is managing much of the flight activities using volunteer pilot members. Pilots will use both LPAT and the Trig device as well as taking advantage of the NATS' ADS-B Transponder Evaluation Trial.

This trial asks pilots to connect uncertified GPS receivers to their existing installed Mode S transponders to transmit ADS-B. The CAA has waived the minor modification fee for Annex II aircraft, for approval of the installation.

How LPAT looks in operation. It's designed to be 'carry on' equipment rather than being panel-mounted, reducing both certification requirements and installation costs. The Trig version interacts with another screen.

Any installation must be carried out by a licensed engineer or under the supervision of the LAA, according to the aircraft.

At a later stage, EVA flights will include multi-device trials when LPAT, the Trig device and ADS-B/transponder devices will all fly together to ensure interoperability and effectively assist 'see-and-avoid'. As LPAT has an optional input for FLARM signals, compatibility with FLARM will also be evaluated. The final EVA flight activity is ➔

the NATS' ATM Display Demonstration to demonstrate the integration of all the equipment's position information into an air traffic management display.

INTERNATIONAL ADS-B FOR GA

EVA doesn't stop in the UK. LPAT devices will be flown in Germany under the same sort of arrangements as in the UK, subject to approval from the German authorities. This is seen as a step towards full European approval of GA ADS-B equipage along the lines pioneered by NATS.

The FAA is also very active on ADS-B development. As well as worldwide 1090ES ADS-B, ADS-B equipment and services are also available on another frequency of 978MHz.

WHERE ARE WE GOING AND WHAT CAN WE EXPECT?

By mid-2016, both LPAT and the Trig TABS/TSAA device should have been flown extensively and their performance verified, evaluated and assessed for GA pilot usability. Use by NATS' air traffic management to display the ADS-B data should also have been demonstrated. Both LPAT and Trig devices should be available on the market for GA pilots to buy and use in the UK and steps towards use throughout Europe should have been taken.

The skies will be just a bit safer for all GA pilots who depend on 'see and avoid'.

WHY IS GPS SO EXPENSIVE?

GPS devices used for aviation have multiple self-checking and error reporting capabilities that are unnecessary for use in other applications. The position data that an aviation GPS delivers is accompanied by quality indicators that indicate the accuracy and integrity of every measurement. The surveillance integrity level of the unit is also indicated.

All this data is transmitted together with the position data so that receivers of the data know what degree of trust they can place in the data. When the data is used for aircraft separation, the quality requirements are very high and it is the development and rigorous testing of GPS units that can meet these criteria to support the ADS-B-out function that drives up the cost.

ADS-B

ADS-B was first conceived in the early 1990s as an add-on to Mode S transponders, initially called 'GPS squitter'. Today, the broadcast technique is more formally called 1090MHz Extended Squitter or '1090ES'.

The basic notion is that aircraft regularly and automatically broadcast their GPS position for use by anyone who can receive the signal, airborne or on the ground. This capability to transmit is known as 'ADS-B-out' and is the basis of Electronic Conspicuity.

ADS-B offers an alternative means of surveillance for ATC purposes, either instead of, or as a complement to, radar. Ground receiver stations are being implemented throughout Europe, usually together with Wide Area Multilateration (WAM) systems, which is another surveillance technique. NATS in the UK has an extensive ADS-B and WAM trial infrastructure covering a large part of southern England.

For the pilot, reception of information in the cockpit about the position of another aircraft makes it possible to know where the other aircraft is and prompt your lookout. This is known as 'ADS-B-in'. Importantly, if the other aircraft is in a position where you cannot see it, you're alerted to its presence.

ADS-B-in equipment is reasonably available, but it's no use at all unless other aircraft are transmitting 'ADS-B-out'.

As indicated by its original, and continuing, link with Mode S, the ADS-B-out signal is broadcast on 1090MHz, the worldwide surveillance frequency, also used by the Airborne Collision Avoidance System (ACAS) fitted to all commercial passenger-carrying aircraft above a certain weight and speed capability.

The 1090MHz frequency is very heavily utilised and cannot carry anything other than essential surveillance information.

FLARM

'Flight ALARM' – FLARM – was developed specifically for glider pilots and the particular problems of 'see-and-avoid' between gliders flying in the same region of thermal activity. It embodies the same ADS-B principles, namely transmission and reception of positions and cockpit indication of nearby traffic, on its own frequency. It has since been extended as 'Power FLARM' to receive 1090ES ADS-B as well.

TRIG AVIONICS TABS/TSAA ADS-B

Trig is developing an ADS-B capable Mode S transponder based on use of a lower certification and therefore less expensive GPS device. The device will conform to an FAA standard (TSO C-199) and is known as TABS – Traffic Awareness Beacon System. This provides the ADS-B-out component.

Trig is also developing the complementary ADS-B-in equipment that will receive and display the relative position of other ADS-B-out aircraft. This is following the TSAA – Traffic Situation Awareness with Alerts – standard developed by EUROCAE and RTCA.

The use of these two devices together provides a panel-mounted capability that is functionally almost identical to LPAT.

ADS-B IN THE U.S.

As well as ADS-B on 1090MHz, ADS-B is also available on a separate frequency of 978MHz. This is only in the U.S. and is known as the Universal Access Transceiver (UAT).

UAT is GA focused and dedicated to ADS-B. It has enough capacity to transmit other types of information, such as weather and terrain information, under the general heading of Flight Information Service Broadcast (FIS-B). This feature provides added value to UAT equipage for GA aircraft that do not fly above 18,000ft, as well as reducing congestion on the 1090MHz frequency.

ADS-B is a fundamental element of the FAA 'NextGen' or next generation ATC system. There is already a nationwide infrastructure of ADS-B surveillance stations, operating on both 1090MHz and 978MHz. Because of the dual frequency implementation, aircraft using 978MHz ADS-B cannot receive signals from aircraft using 1090ES ADS-B and vice-versa. This has meant that a network of stations that receive on one frequency and transmit on the other frequency has been constructed to enable 1090ES and UAT interoperability. This capability is known as ADS-R, or Automatic Dependent Surveillance Rebroadcast.

To further support interoperability between aircraft of all different types of equipage, a capability known as Traffic Information Service Broadcast (TIS-B) is also available. This is where the aircraft is detected by Secondary Surveillance Radar, the information on its position is translated into an ADS-B format and broadcast for reception by ADS-B-in-equipped aircraft.

ADS-B and ADS-R together with TIS-B provide complete information about aircraft known to the ATC system.

ABBREVIATIONS AND GLOSSARY

1090ES/1090MHz Extended Squitter (ADS-B transmission technique)
ACAS Airborne Collision Avoidance System
ADS-B Automatic Dependent Surveillance Broadcast
ADS-B-in ADS-B reception
ADS-B-out ADS-B transmission
ADS-R Automatic Dependent Surveillance Rebroadcast
AOPA Aircraft Owners and Pilots Association
ASI Airspace Safety Initiative
ATC Air Traffic Control
ATSOCAS Air Traffic Services Outside Controlled Air Space
CAA Civil Aviation Authority
ECWG Electronic Conspicuity Working Group
FAV Funke Avionics. Developers of the LPAT under contract to NATS
FIS-B Flight Information Service Broadcast
FLARM Flight Alarm. Traffic Awareness and Warning system originally designed only for glider use but now capable (Power FLARM) of receiving 1090ES ADS-B
GA General Aviation
GPS Global Positioning System
IAOPA International Council of Aircraft Owners and Pilots Associations
LAA Light Aviation Association
LPAT Low Power ADS-B Transceiver
MHz Megahertz
NATS National Air Traffic Services Power FLARM
SESAR Single European Sky ATM Research. Research programme for the future of ATM in Europe
SJU SESAR Joint Undertaking. Manages the SESAR Programme
TIS-B Traffic Information Service Broadcast
UAT Universal Access Transceiver (ADS-B transmission device/technique)
VFR Visual Flying Rules
WAM Wide Area Multilateration