Multilateration pioneer takes stock

Ivan Uhlir of ANS CR reviews progress on multilateration in the Czech Republic, and looks ahead to future developments

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Multilateration (MLAT) employs multiple ground stations placed at strategic locations (either around an airport, in the local terminal area or dispersed across a wider geographical area). These ground stations receive position data from aircraft equipped with Mode A, Mode C, or Mode S transponders, plus Automatic Dependent Surveillance – Broadcast (ADS-B) and military IFF.

Aircraft position is determined based on the time difference of arrival of the replies. MLAT has a higher update rate than secondary surveillance radar (SSR), which takes 4–12 seconds to receive replies from transponder-equipped aircraft.

MLAT is flexible enough for multiple concepts of use. It can be deployed passively when used with SSR for surface movement surveillance, and is often integrated with an advanced surface movement guidance and control system (A-SMGCS). The technology can be used for approach control around airports in hilly terrain, which cannot be covered by radar. MLAT is also able to support the transition to ADS-B, possibly as an interim solution if equipage issues cause delays, or as a back-up system if satellites fail.

Another common use is in active wide area multilateration (WAM), in which a network sensor tracks a broad area to interrogate transponders in the absence of an SSR. In 2014, Austria put into operation a nationwide WAM system supplied by Saab, and India began operating a network of 21 ground stations supplied by Comsoft covering the subcontinent, including part of the Bay of Bengal and the Indian Sea. Comsoft also supplied the WAM system that went into operation across Denmark early in 2014, and ERA completed installation of WAM at Fujairah International Airport in the United Arab Emirates in July 2014 to provide ATC separation services in terminal and en route airspace.

Multiple surface MLAT and WAM projects are in progress throughout the world, but the story began in the Czech Republic. Air Navigation Services of the Czech Republic (ANS CR) was the first air navigation service provider (ANSP) to implement a WAM system, commissioned in Ostrava in 2002 and used operationally from 2003. Ostrava was followed by surface MLAT at Prague as an element of A-SMGCS (commissioned in 2004). ERA was the equipment supplier in all cases.

"We started with a local WAM system near Ostrava, with a maximum coverage of 40 n miles," recalled Ivan Uhlir, surveillance expert in the ANS CR Development and Planning Division. "Today we are using it as a complementary system with radar, because it compensates for disadvantages with SSR."

The Ostrava installation comprised five receiver and two interrogator stations for runway approach monitoring, plus remote control and monitoring systems. The WAM system was certified using the ICAO Annex 10 and Eurocontrol standard for SSR, because at that time there was no specific standard for MLAT technology. Flight tests proved coverage out to 80 n miles, with surveillance down to the airport surface at Ostrava – but the accuracy and stability of the system allowed the Czech Civil Aviation Authority to reduce traffic separation in the terminal area from 5 n miles to 3 n miles.

At Prague, terminal airspace was already provided by two SSRs, but ANS CR wanted continuous operation of two surveillance systems. This led to a demand for three surveillance sources to be constantly available, in case one of them suffered a system outage or required maintenance.

Initially, WAM at Prague included 10 receiver stations, interrogators, and test transponders, with surveillance data fully integrated with Eurocontrol's ARTAS tracker.

The WAM system has high accuracy and probability of detection, allowing monitoring in future of approaches on parallel runways at Prague (this project is underway). It also provides precise low-altitude detection of all aircraft in the terminal area out to 120 n miles.

WAM monitors all traffic in and out of Prague in passive mode when SSR is in operation – this enables ANS CR to check radar performance. If an imminent failure is detected or an actual radar outage occurs, the system is able to transition into active interrogation of air traffic.

Uhlir noted that maintainability is a major advantage for MLAT compared with radar, as maintenance requirements for the former are 90% software-based, whereas radars are 60–70% hardware-based. "The MLAT hardware is configured to be highly reliable, which means that 99% of problems are software-related," he added. "These issues can be rectified off-site" by ERA.

"Maintaining security is a bit more problematic than with radar, because MLAT sensors are often installed in public places e.g. on mobile phone masts. But it's cheaper to protect this system because we have a high level of redundancy. Failure on one receiver doesn't cause the system as a whole to fail."

Uhlir admitted the pitfalls of being the pioneer of MLAT for air traffic management. "It's sometimes not the best idea to be a pioneer. We were the first to deploy MLAT without standardisation. Later on, with the creation of standards, we realised we did not match all the requirements."

Another disadvantage of the ANS CR approach

Civil multilateration deployments in the Czech Republic

Prague Václav Havel Airport	WAM (10 sensors), surface MLAT (20 sensors), SQUID (152 vehicle transponders)
Ostrava Leoš Janáček Airport	WAM (7 sensors), surface MLAT (4 sensors), SQUID (73 vehicle transponders)
Brno-Tuřany Airport	WAM (7 sensors)

Source: ERA, December 2014

was that it assigned MLAT in phases between 2002 and 2009, with Prague and Brno following the initial deployment at Ostrava. "This meant we had three levels of technology, reflecting the legacy of technological development at ERA."

However, because the ANS CR system is mainly software-based, it is feasible to upgrade installations to a common standard. "This is the subject of a new contract we are working on in the first quarter of 2015," Uhlir explained to *IHS Jane's*. "Our plan is to install identical software and interface in each location. We will still end up operating two different HW [hardware] technologies instead of three, but it's not a problem."

Later ANSPs to deploy surface MLAT and WAM, such as Naviair of Denmark, operate a complete countrywide system with uniform hardware and software. "Denmark and Austria looked at our experience for a long time and were able to learn from ANS CR," Uhlir noted. "I believe that MLAT is a very useful source of surveillance data for total coverage in small countries [ANS CR is responsible for 78,000 km^2 of airspace]. A good solution for small countries is to have a very accurate, redundant [MLAT] system for TMAs [terminal manoeuvring areas], and automatically use it for countrywide coverage."

As developers such as Sensis (now part of Saab), Thales, Indra, and Comsoft followed ERA by implementing MLAT projects, optimists predicted the technology would replace SSR functions. Uhlir himself participated with EUROCAE to standardise MLAT as a substitute for SSR, but he acknowledged that radar remains a crucial element of air traffic control. "I still believe that multilateration will fully replace secondary radar in future, but today it's not feasible. A mix of technologies – radar, ADS-B, and multilateration – has advantages." This strategy has been followed in a number of countries – in Denmark, for instance, one radar in Copenhagen complements nationwide MLAT coverage.

"There is no requirement for ANSPs to use MLAT – Eurocontrol only specified a level of service quality to be met by SSR, ADS-B or MLAT," Uhlir noted. "Eurocontrol is pushing us to a maximum level of safety. European regulations are oriented towards interoperability, reflecting the priorities of Single Sky. There are identical requirements for parameters such as accuracy and probability of detection, in very detailed specifications."

In late 2014, Uhlir presented a vision to ANS CR for future airspace surveillance. As some of the radars currently in use reach the end of their service life, they will be replaced by MLAT. The aim is to have a minimum flight level (usually 300 m above terrain level) to be detected by MLAT in major TMAs around Czech airports.

"Today we have three SSR sites in the Czech Republic. In future we expect to have two plus MLAT supported by additional receivers to improve system availability. I expect that we will not replace the SSR at Prague, and further in the future, by 2027 we will have MLAT plus a single radar with 200 n miles coverage of the whole country."

FAB effect

As Functional Airspace Blocks (FABs) are developed, the cross-border surveillance capabilities of MLAT ought to make it more attractive to ANSPs – yet Uhlir described this as "a big problem".

ANS CR is part of FAB Central Europe, alongside Austro Control, BHANSA (Bosnia-Herzegovina), Croatia Control, HungaroControl, LPS SR (Slovakia), and Slovenia Control. "A unifying MLAT deployed across all FAB CE members would be an excellent solution – to have one system for all of FAB CE airspace – but it's impossible," he admitted. This is partly because different MLAT systems are in use. ANS CR operates ERA technology, while Austro Control uses MLAT from Saab, and other countries have no MLAT in place.

"A way forward would be to connect receivers in Austria with our central processing unit [in the Integrated ATC Centre in Jenec]," said Uhlir. "This would provide a unified interface, but we can't do it because each company guards its interfaces carefully. Eurocontrol and EUROCAE WG70 planned to specify MLAT interfaces in ASTERIX, but companies have no interest."

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ANS CR employs multilateration at Prague Václav Havel Airport.

MSPSR prospects

Uhlir wants to exploit the potential of multistatic primary surveillance radar (MSPSR). The technology could attract small airports and airfields – chiefly those with a large proportion of non-transponder general aviation traffic – which cannot install primary radar because it is too expensive.

As a non-cooperative solution that does not rely on a dedicated transmitter to locate aircraft, MSPSR uses existing digital broadcast signals. The solution is based on advanced MLAT, where the location of aircraft is derived from the time of arrival of the broadcast signal reflected from the aircraft and measured at multiple receiver locations on the ground. A network of stations can transmit and receive omni-directional and continuous waveforms using active or passive transmitters. Infrastructure deployment costs would be minimised by using existing transmitters such as radio or TV broadcast masts.

ANS CR some years ago participated with Thales on tests of MSPSR using digital TV transmission. "We had very good accuracy but the problem was that we had no detection above FL50–FL60," Uhlir said. ERA put together a passive demonstrator for European ANSPs in late 2013, and is currently building an active prototype that it expects to complete by the first half of 2015. The company also makes a military product called Silent Guard based on coherent location. This is an entirely passive radar that relies on existing infrastructure as opposed to active transmission technology. ERA is designing the civil version with independent transmitters to ensure signal availability.

Regulators must move before the benefits of MSPSR can be realised. "I've suggested that Eurocontrol open a EUROCAE Working Group, which would develop a minimum operational performance specification," said Uhlir. "Industry is running ahead of the regulators – the technology is there but there are no rules." ■