Internet offers new ATM vision

Efforts are under way on both sides of the Atlantic to investigate the use of Internet Protocol for data communications in air traffic control

The broad outlines of United States and European air traffic management (ATM) systems for the decade after next are emerging under the Federal Aviation Administration’s (FAA’s) NGATS programme, also known as NextGen, and Eurocontrol’s Single European Sky ATM Research (SESAR).

Both call for an Internet-based revolution in communications and efforts are under way in the two continents to prove the necessary concepts and technologies.


While the two programmes are intended to feed respectively into the new US and European regional ATM systems that should be operational from about 2020–25, those bodies of airspace are separated by the heavily used North Atlantic airways. It would therefore come as little surprise if the coming years saw the two concepts growing ever closer.

Even now, a presentation by Airborne Networking Project Manager Ralph Yost shows how a stream of airliners crossing the Atlantic could act as nodes on a broadband Internet Protocol (IP)-based network carrying ATM and a wide variety of other information. For its part, Europe believes that the work could ultimately find global application. “Our project proposes concepts, methods and infrastructures that could potentially be used worldwide,” says Markus Werner of NewSky member company TriaGnoSys.

Whatever their ultimate application, both programmes see aircraft-to-aircraft links as fundamental. “NextGen requires connectivity between aircraft as well as to aircraft,” says Yost, who oversaw an impressive demonstration of such a capability in mid-2006.

Airborne Networking sees all the participating aircraft acting as air-to-air relays, each operating in a peer-to-peer relationship with other aircraft and supporting the network whether or not it is consuming bandwidth for its own purposes. Yost’s team showed this concept in action, flight-trialling prototype hardware from two different contractors – AeroSat of New Hampshire and PMEI of Bethesda, Maryland – in three test aircraft from the William J Hughes Technical Center.

The equipment remains in use for continuing concept development work.

Instant availability

“The aim was to show that NGATS technologies and capabilities are available now,” says Yost. “Each of the two airborne systems has its own way of supplying network connectivity to aircraft, but they are compatible because they both employ standard TCP/IP protocols.”

The AeroSat aircraft fits include a single high-gain directional antenna for long-range connectivity and two omnidirectional units for use over ranges of about 100 n miles. This combination supports two TCP/IP data communications options: 90 Mbit/s — that is, 45 Mbit/s in each direction in the Ka- and Ku-bands — for aircraft nominated to support the network backbone; and a 1-2 Mbit/s L-band link to allow secondary aircraft to access the backbone. In the demonstration, the high-bandwidth link was established with the groundstation and fed a local-area network (LAN) on the aircraft.

The PMEI system, supporting a narrowband 19 kbit/s link, combines a standard aircraft omnidirectional VHF antenna with a small multichannel data radio offering an additional voice channel that can be used simultaneously. Internal GPS can be used to provide own-ship position data, which can then be shared with other network users to enhance situational awareness. Again, the system connects with a standard LAN on the aircraft.

This 2006 demonstration employed the FAA’s Bombardier Global 5000 and the since-retired B-727 flying lab, both based at Atlantic City; and a Bombardier Challenger 604 from the FAA Aero-nautical Center in Oklahoma City. Each aircraft carried both sets of airborne equipment.

During the demonstration, the aircraft used the PMEI equipment to communicate with the ground and with one another in the air. The AeroSat fits supported links between the Global 5000 and the ground, as well as between the Global 5000 and the B-727. During the first of two full-scale in-flight demonstrations in July 2006, Yost emailed recipients around the world from the Global 5000, flying at 20,000 ft (6,096 m) over the Atlantic off New Jersey.

Other applications included the transmission of a revised four-dimensional-trajectory flight-plan from the ground to the aircraft — “the pilot acknowledged receipt, reviewed and accepted it and started flying it right away,” says Yost — as well as delivery of weather information to the flight deck, passenger Internet/VPN access and aircraft-to-aircraft security communications by air marshals.

Accomplishments since 2006 include flight tests of VoIP (Voice over Internet Protocol). “In partnership with PMEI and Cisco, we demonstrat-ed VoIP over the VHF system — it was quite a challenge with such minimal bandwidth,” says Yost.
He emphasises that, while any operational system based on such an architecture lies years in the future, its broad outlines can be described already. Aircraft flying at 35,000 ft would be within radio reach of a ground-station at a range of 225 n miles. Maximum aircraft-to-aircraft range, limited by the curvature of the Earth, could be more than 450 n miles. To maintain acceptable link margins and minimise the effect of multipath signal reflections, typical operational ranges could be 150 n miles air to ground and 300 n miles air to air. Four equally spaced aircraft would therefore be needed to supply 45 Mbit/s IP data communications to an aircraft in oceanic airspace at a range exceeding 1,000 n miles from the groundstation.

Between now and 2012, Yost and his team will continue to establish the feasibility of Airborne Networking as a means of providing aircraft TCP/IP connectivity within NextGen. "One of the central requirements of NextGen is network connectivity for aircraft and that has to be developed one way or another," Yost says. "I think we’ve made a good start in that direction."

Heading down the same road is NewSky, funded EUR2.1 million (USD3.1 million) by the European Commission and designed to feed into SESAR. Led by the German Aerospace Centre’s Institute of Communications and Navigation, the NewSky team includes: German ATM provider DFS; Thales Aleana Space of France; UK technology company QinetiQ; and communications specialist TriGnoSys. Eurocontrol contributes technical project oversight and a number of the team members also belong to the SESAR Joint Undertaking.

Development focus

"We’re aware of Airborne Networking," says Werner. "While they have done a lot of flight-trial work to date, we are focused more on the development of new mobility, quality-of-service and security solutions and their demonstration in a laboratory testbed." Flight trials may follow, though they are not currently included in the scope of NewSky.

In another difference from Airborne Networking, which has concentrated so far on terrestrial radio technologies, NewSky is addressing the use of satellite-based Internet links. Prime applications are expected to include fully integrated communications between pilots and controllers — particularly in remote areas such as polar regions and in heavily congested airspace like that of Western Europe — plus greatly enhanced links for airline administration and operations, passenger communications and in-flight entertainment.

“Our job is to develop nothing less than a global aeronautical communications network,” explains Werner. “Several current European research activities are looking at various datalink technologies for improved aeronautical communications — ground-based, satellite-based, aircraft to aircraft. But so far no attempt has been made to integrate them all into a network-centric whole — that’s where NewSky comes in.”

One of NewSky’s central tasks is to consider the eventual transition from today’s Open Systems Interconnection (OSI) based Aeronautical Telecommunication Network (ATN), which was conceived as a global standard but which has been held back by the failure of the OSI protocols to win wide acceptance.

TriGnoSys is making various contributions to NewSky: cost-benefit analyses; algorithms to govern the routing of data traffic on satellite networks; and strategies for seamless handovers between ground and satellite networks. But its most visible contribution will be the laboratory setup that is due to be used to validate the new concept by the end of May 2009.

“The laboratory trials will address a variety of applications, from familiar ones like VoIP to more advanced ones like real-time multicasting of weather information,” says Werner. “We will use Inmarsat’s new 432 kbit/s SwiftBroadband as the satellite link and possibly a prototype of ICAO’s [International Civil Aviation Organisation’s] proposed L-band-based Broadband Aeronautical Multi-carrier Communications system for the terrestrial side. The conceptual aircraft equipment — modem, router and user interface — will be installed in the lab and will operate over the two systems; none of the links will be simulated.”

NewSky is scheduled to deliver its concept and outline architecture for a future ATM network in mid-2008, followed by a detailed design before the end of the year. Formal development of the testbed will begin in March 2008, although preliminary work has been under way for some months. Results from the lab are due to be delivered by mid-2009, with a final network concept and architecture to follow three months later.

An all-encompassing air-to-ground data network to support not only ATM but also airline operational, administrative and passenger functions has long been a holy grail for the aviation community. The ATN as originally conceived was to have been the solution, but it has been stunted by the failure of OSI to enter the telecoms mainstream. IP, by contrast, is now embedded as a de facto global standard and there is a good chance that it will underpin ATM on both sides of the Atlantic from 2020–25.

Brendan Gallagher

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During a July 2006 trial of the Airborne Networking concept, information was delivered to an electronic flight bag installed on an FAA Bombardier Challenger 604.