ing network connectivity to aircraft, but they are compatible because they both employ standard TCP/IP (Internet) protocols."

The AeroSat aircraft fit includes a single high-gain directional antenna for long-range connectivity and two omnidirectional units for use over a typical range of about 100 n miles. This combination supports two TCP/IP data communications options: 90 Mbit/sec – that is, 45 Mbit/sec in each direction in the Ka and Ku-bands – for aircraft nominated to support the network "backbone" and a 1–2 Mbit/sec L-band link for secondary aircraft to access the backbone. In the demonstration the high-bandwidth link will be pointed at the ground station and will feed a local-area network on the aircraft.

Simultaneous use

The PMEI system combines a standard aircraft omnidirectional VHF antenna with a small multi-channel data radio offering an additional voice channel that can be used simultaneously. Internal GPS can optionally 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.

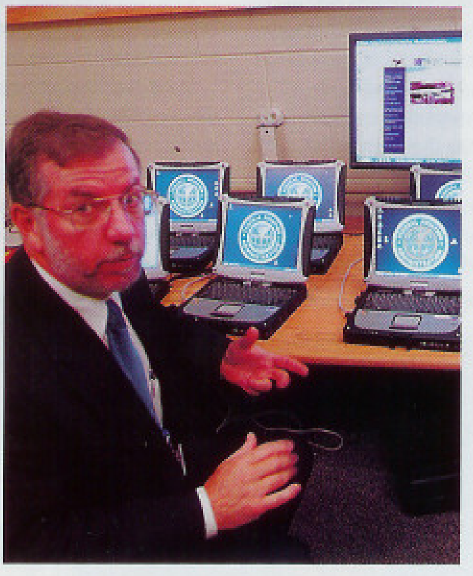
Although at 19 kbit/sec the PMEI solution is not as bandwidth-rich as the AeroSat system, it is slightly more mature in its development and has the added situational awareness capability inherent in its design. To make the most of its lower bandwidth, PMEI has devised a way of delivering updated weather information that is highly specific to each aircraft, so that the channel is not overloaded with irrelevant data. Both systems will work with onboard electronic flight bags.

In a potential operational system based on the AeroSat equipment, 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 communications to an aircraft at a range exceeding 1,000 n miles from the ground station. The actual ranges will be determined in future flight testing.

Radio receiver and repeater equipment on each participating AeroSat-equipped aircraft would allow it to receive high-speed data through either a ground station or a nearby aircraft and relay it to similarly equipped aircraft in flight. Such an aircraft-to-aircraft relay would in effect create a T-3 (45 Mbit/sec) IP data backbone.

This year's full-scale NGATS demonstration will employ three FAA aircraft: a new Bombardier Global 5000 and the veteran Boeing 727 flying lab, both based at Atlantic City, and a new Bombardier Challenger 604 from the FAA Aeronautical Centre in Oklahoma City. All three aircraft are fitted with PMEI hardware, and the two Atlantic City aircraft with AeroSat equipment.

All will use the PMEI equipment to communicate with the ground and with one another in the air. The AeroSat fits will support links between the Global 5000 and the ground, and between the Global 5000 and the 727. "We must first do the engineering work and prove that it works as we plan. Once we achieve that, then we can start to consider an audience," says Yost.



Programme manager Ralph Yost wants to demonstrate the technology is available today.

The FAA's Bombardier Challenger 604 in Oklahoma City will participate in full scale trials later this year.

One of the prime objectives is to reduce reliance on congested, labour-intensive voice communications. "We will use the system to send a proposed revised 4D-trajectory flight plan to the aircraft from the ground ATC system's master computer, which we call the Evaluator," says Yost. "The pilot will acknowledge receipt, review the plan, and then either modify it or accept it as proposed. He will then use the system to indicate acceptance and will begin flying the new plan right away." Yost says that Airborne Networking is currently no more than a proof of concept. "It is a newly proposed concept that has not yet been institutionalised within the FAA," he adds. "The two airborne systems are early product developments representing different approaches to network connectivity for aircraft."

Another strength of the approach is its freedom from the latency – reception lag – typical of geostationary satellite-based systems, according to Yost. "Satellite is great at high altitudes, en route on long flights over the ocean, when you can tolerate latency," he says. "But when you are in a terminal environment you have got to have direct air-to-air and air-to-ground communications."

Over the next few years the FAA will continue to look at technologies and products capable of meeting that need. At the same time it wants to build collaboration with other US agencies such as the Department of Defense. "The Airborne Networking team already has a close relationship with the Air Force and the FAA's Joint Planning and Development Office (JPDO), who are the primary architects of NGATS."

Leading the way towards the review and selection of suitable technologies is the Airborne Networking Consortium (AIC), which includes technology providers such as AeroSat and PMEI and, representing the air carriers, United Airlines. "AIC aims to create and publish open standards for products to work in the Airborne Networking architecture," comments Yost. "In the end, we see it growing in the same way as the original Internet grew, on the back of open standards and using commercially available technologies."

Future use

Yost believes that early Airborne Networking products could be available and in use in the next few years. "But a full system meeting our definition – a national or global Airborne Networking providing network connectivity for all classes of aircraft – is many years away." He also believes there are potential savings for air traffic service providers and aircraft operators. "Once we have created robust network connectivity for aircraft we will be able to start eliminating the legacy single-function ground and air systems still used in aviation today," he says.

Yost adds that applications for Airborne Networking should rapidly grow in number once it is in place. "Some early uses will include real-time aircraft systems monitoring, shared situational awareness on the flight deck, powerful connectivity for passengers, security functions for federal air marshals, and aircraft position reporting," he predicts.

As with the use of satellite to support air traffic safety services, the ultimate key will be the ability of Airborne Networking to offer the quality-of-service guarantees that would be demanded by ICAO and national administrations. "At this point in the programme we have not yet fully addressed that issue," Yost admits. "But we do acknowledge that we will have to prove that the system will be reliable, persistent, secure and available."

Brendan Gallagher ■

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