Digital Avionics

By the Digital Avionics Technical Committee

Digital Avionics activities played an important role in the advancements made in civil aviation, military systems, and space applications.

Civil Aviation

A significant development this year was the introduction of Internet connectivity on aircraft, providing e-mail and web services for passengers and improving entertainment systems and crew information services. Boeing debuted their Internet Connexion system on a Lufthansa 747 flight in January. The initial system uses two conformal Ku-band phased-array antennas, but future plans include a next-generation antenna with a single aperture design. Data rates are 20 Mbps for uploads and 1 Mbps for downloads. The distribution network conforms to 802.11B and will be integrated with in-flight entertainment systems. Aircrews will be a prime user, including support for the Electronic Flight Bag. Boeing is installing the system on four commercial carriers as well as US Navy and US Air Force aircraft.

Boeing also worked with Intel to demonstrate a broadband wireless capability on a leased KLM 737. The demonstration flight used separate transmit and receive antennas connecting through a Telstar 6 satellite to provide 5 Mbps uploads and 128 Kbps downloads.

Airbus, Tenzing Communications, and Rockwell teamed to develop an in-flight broadband communications and data management service. Using a phased approach, the service initially offers a 9.6 Kbps proxy service for e-mail and short text messages. The second phase will include 64 Kbps high-speed communications using the Inmarsat Swift64 system. The higher rate will provide the capability for sophisticated cockpit, cabin and maintenance communications. Early demonstrations used Ku-band satellite links for uploads and the Swift64 system for downloads.

NASA-Glenn in partnership with the FAA, NASA-Langley, and industry led the development of a new communications, navigation, and surveillance (CNS) system that delivers aviation information services in an internet-like manner to aircraft and ground facilities as interconnected nodes on a high-speed digital communications network. The resultant Internet Protocol-based Airborne Internet will allow intelligent redistribution from centralized to distributed nodes, enabling the Small Aircraft Transportation System (SATS) to achieve higher volume operations and reduce the pilot workload to a single-pilot workload, the key factors to increasing the nation s mobility. To date, CNS systems have been proprietary, separate, centralized air-ground networks, but the SATS Airborne Internet will provide a means to reduce avionics equipage cost while bringing all users into a common integrated system. This integrated approach supports multiple aviation applications through the use of common open systems protocols that allow real-time, positively acknowledged access to critical services via a high-speed digital communications network. The Airborne Internet incorporates major commercial off-the-shelf technologies from the telecommunications industry into a revolutionary aviation environment for CNS and Internet services.

A multi-organizational team, led by NASA-Glenn, successfully developed and demonstrated a revolutionary technology, called the Mobile Router, that autonomously connects and configures networks as an aircraft traverses from one operating theater to another. Advanced communications technology, mobile network technology, mobile encryption technology, and user application technology were verified during the demonstration. The Mobile Router provides secure, autonomous communications to and from aircraft enabling advanced, automated, data-intensive air traffic management concepts, increasing National Air Space (NAS) capacity, and potentially reducing the overall cost of air travel operations. All of the technologies demonstrated are commercially available and fully interoperable with existing terrestrial network devices.

Rannoch Corporation deployed a new surveillance technology, called AirScene, at several airports, improving aircraft safety and airport management of operations. Two years of extensive flight-testing and a favorable comparison with the terminal radar at Calgary proved AirScene s multilateration technology as a candidate to provide radar-quality service for air traffic control applications. AirScene s reliability was also demonstrated with continuous operation in extreme weather conditions over the two-year period. Nav Canada s installation of the AirScene system at Springbank Airport will provide a fully certified operational solution using multilateration technology as the sole means of surveillance. An AirScene surveillance system will provide enhanced aviation security and aircraft operations monitoring at Tallahassee Regional Airport by monitoring aircraft movements and identification data through tracking of aircraft transponder signals and fusing the data with other relevant aircraft information in real time. The Dare County Regional Airport in North Carolina will manage aircraft operations using the AirScene technology to track and display all types of aircraft in flight and to broadcast traffic information services. Aircraft with newer avionics will receive real-time Cockpit Display of Traffic Information. An AirScene system will be deployed at Raleigh-Durham International Airport to provide comprehensive aircraft noise and airport operations management. The system will include the latest state-of-the-art noise and operations monitoring software integrated with a network of compact acoustic sensors and AirScene s patented flight tracking system.

Boeing implemented a built-in Electronic Flight Bag (EFB) on the 777-300ER. The EFB replaces 77 lbs of manuals, has a video capability, and allows user-modified software. Pilots can use a touch screen to view documentation, weather and airport maps, and communications links. The system can also be linked to security cameras to help prevent unauthorized access to the cockpit. The built-in unit does not need to be stowed during takeoff and landing, a significant advantage over the previous laptop tool.

The FAA commissioned the Wide Area Augmentation System (WAAS) for instrument flight use. The WAAS enhances the accuracy and reliability of the global positioning system to transmit horizontal and vertical guidance capability. After avionics certification

Photos and Captions

Photo 1: TAMDAR sensor (TAMDAR Sensor.jpg)

Caption:

NASA-Glenn s WINCOMM project addresses communication issues associated with the timely and intuitive dissemination of weather data among users. An Optical Data Systems TAMDAR sensor, mounted on the NASA Glenn Twin Otter aircraft and flown on several flights, collected and transmitted data using multiple data links.

[Note: The photo is not high resolution, but it seems to stay clear and in-focus when resized.]

and flight procedures approval, the WAAS will give pilots the capability for precision instrument approaches at runways with minimal ground-based landing capability. Chelton Flight Systems and UPS Aviation Technologies received certification for WAAS avionics with horizontal navigation capabilities.

Military and Space

The U.S. Air Force is flight-testing hot-film sensors for active flow control in the diffusing engine inlets of unmanned combat air vehicles. The sensor arrays from Tao Systems monitor aerodynamic phenomena by electrically sensing the surface viscous airflow, providing excellent spatial resolution and millisecond response times. The evolution of the processing capability is one of the major advancements allowing the sensors to be used for active control systems. The on-board processor can provide the data real-time eliminating the need for post-test processing. Also, miniaturization of electronics has resulted in significant weight reductions for the air data system from 37 pounds in 1994 to only one pound today.

The U.S. Navy experienced problems when they upgraded the F-14B aircraft using a COTS heads-up-display (HUD) built by Flight Visions. Initial estimates were $50,000 per unit, a three-month development schedule, and 15 test flights. The COTS solution appeared to be a fast, cheap solution for a budget that could not afford to pay $150,000 per unit for the Kaiser Electronics HUD used in the F-14D. The COTS unit experienced failures due to several unexpected problems, including packaging design issues in the power supply that led to overheating. The development lasted 3 years, required 45 test flights, and had a final price per unit of $124,000. Although the final product was reliable and yielded cost savings, the project presented valuable lessons about the use of COTS products for the harsh environments of military and space applications.

The Air Force Research Laboratory demonstrated several advanced technologies on an XSS-10 microsatellite that completed rendezvous and imaging exercises with the second stage of its Delta II launch vehicle. The XSS-10 avionics included autonomous guidance navigation and control software and hardware, a miniaturized communication system, lithium polymer batteries, and an integrated camera and star sensor. After separation from the Delta stage, the XSS-10 drifted 700 feet away and then used the camera to fly back to within 330 feet of the Delta, took some images, and moved in to 115 feet of the Delta for some more images. The process was repeated twice. The goal of the mission was the development of technologies for microsatellites that can aid in military satellite inspection and maintenance.

Photo 2: Range Measurement Unit (RMUFlightbottom020303.tif)

Caption:

The functions of the Range Measurement Unit on the Mercury Laser Altimeter include laser firing, instrument timing, and 6-channel time-of-flight measurement with 15-deep, multi-stop channels and a resolution less than 0.5 ns.° [Power is less than 0.5 watt and mass is 120 grams. The digital logic is implemented in a single-event-upset hardened FPGA.]

[Note: If space allows, use the information in brackets. If space is limited, delete the info in brackets. FPGA is Field Programmable Gate Array; ns is nanosecond.