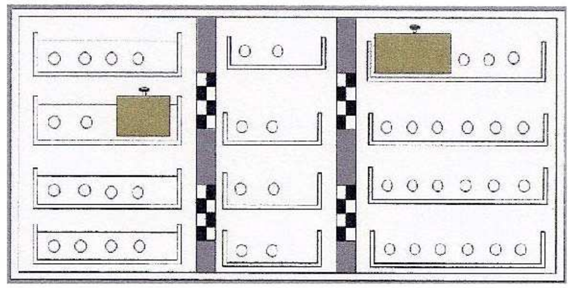
Real Time Wireless Network for Avionics Applications

Epsilon Lambda Electronics Corp.
396 Fenton Lane, Suite 601
West Chicago, IL 60185-2687

Contact: Mr. Robert Knox
Phone: (630) 293-7118 x 202
Email: bobk@epsilonlambda.com
Website: www.epsilonlambda.com



Two Wireless Standard Modules mounted in a Cable-less Avionics Equipment Bay

Command: NAVAIR
Topic: N05-142

CABLE-LESS AVIONICS; Real Time Wireless Network for Avionics Applications (WNAA)

PROBLEM STATEMENT

All air and space platforms, both military and commercial, carry avionics systems. Many of tomorrow's platforms will need to increase their infrastructure to accommodate emerging Network Centric Warfare capabilities. Aircraft weight minimization is a priority to increase mission capabilities. The cables and harnesses that are part of the avionics and communication systems take up space and add weight to an aircraft. A "cable-less avionics", or WNAA avionics radio system, answers the need for less weight for the avionics and communication systems.

The Epsilon Lambda Electronics solution is a robust, real time, high security, wide-band wireless network based on mesh network management protocol. The use of WNAA, operating in the 60 GHz frequency band, is attractive and advantageous because it offers the following benefits:

- wide bandwidth, affordable COTS semiconductor devices are now emerging
- several GHz of available spectrum allows huge data capacity within the band
- radiation leakage from an aircraft experiences high absorption in the atmosphere thereby enhancing operational security
- enhanced operational systems reliability through redundancy

Life cycle total cost reduction is also a key potential benefit of WNAA technology because of reduced time and cost to implement second and third generation retrofit avionics systems to legacy aircraft.

WHO CAN BENEFIT?

The WNAA technology can be applied to any electronics system having two or more modules. These enhanced electronics systems could be employed on any ground, air or space platform. Air platforms include military and commercial transport aircraft. Military platforms include fighter aircraft, bombers, transport and helicopters. Space platforms include satellites and vehicles such at the Orion Crew Module or the Altair Lunar Lander in the NASA Constellation Program. This technology targets fixed wing aircraft. Outside of the DoD, commercial aircraft can use WNAA to connect among avionics system modules and also to connect to crew members and passengers for work management and entertainment. Prime contractors that could benefit from this technology include Boeing, Lockheed Martin, Northrop Grumman, Harris, L-3 Systems, Rockwell Collins, BAE and General Dynamics.

BASELINE TECHNOLOGY

Currently radio and avionic systems for voice and data communication within aircraft are connected through use of cables, connectors and wire harnesses. A wireless local area network system that instead utilizes node hardware and network operating code is innovative and will be revolutionary. The Department of Defense is interested in implementing a real-time wireless architecture that will be backward compatible with existing wired networks such as Fiber-Channel, MIL-STD-1553 cable versions and Ethernet.[1]

The concept of cable-less avionics has already been implemented in a limited way by NASA aboard the Space Shuttle and International Space Station. The objective was to simplify the addition of sensors that are intended to monitor platform health. NASA has employed wireless links, operating at low microwave frequencies, to monitor the data output from various sensors added to these platforms on a retrofit basis. Known as Integrated Vehicle Health Management (IVHM) technology, the motivation for this emerging wireless method was to accomplish the retrofit of sensors to legacy platforms will less time and cost. This wireless IVHM sensor technology demonstrates the benefits of using wireless, but is inadequate to supply the high data capacity requirements of most avionics systems.

TECHNOLOGY DESCRIPTION

The Epsilon Lambda Electronics solution is the use of a wireless local area network (WLAN) to connect fixed avionics modules located in equipment bays and the mobile equipment required by crew members. More specifically, the Epsilon Lambda solution, which is the subject of a

[1] Solicitation N05-142

U.S. Patent Application, uses millimeter wave radio frequency carriers in the FCC designated spectrum known as V-band (nominally 57-64 GHz). Commercialized WLAN technology is typically implemented within frequency bands in the low microwave region (one to six GHz).

There are two carrier modulation methods that can be used. The first method is direct V-band carrier modulation using digital base-band signals. The second method, the one used in the first generation Epsilon Lambda WNAA design, is to modulate an intermediate microwave frequency (IF) signal with input data and then use block frequency up and down conversion to a V-band carrier frequency. By using an IF at 2.4GHz, the technology is able to utilize existing low cost COTS hardware and available network management code to operate the V-band network. Because hundreds of parallel channels can be frequency multiplexed in the wide spectrum of V-band, the data capacity of the network will also be hundreds of times greater than networks operating in the microwave frequencies.

Operating at 60 GHz, well above frequencies used aboard air and space platforms, the network is less susceptible to electromagnetic noise interference from on-board sources or from the external environment. Radiation propagation in V-band is strongly attenuated so that any radiation leakage from the platform will be less susceptible to detection and avionics systems will be less susceptible to jamming by unfriendly forces.

Table 1: Features, Advantages, and Benefits

Features	Advantages	Benefits
Eliminate data bus and power cables	Reduce weight	Improve platform performance and fuel economy
Eliminate data bus and power cables	Increase payload space	Add needed avionics functions
Use of V-band carrier frequencies	Broad bandwidth available	High speed data throughput
Use of V-band carrier frequencies	Small transceiver and antenna configuration	Reduced space requirement for nodes
Use of modular configuration	Better space utilization in equipment bays	Faster and less costly retrofit of avionics in legacy aircraft

CURRENT STATE OF DEVELOPMENT

A robust network design for operation in high multipath environment has been considered in the analysis and trade studies completed during Phase I and Phases II. Initial high multipath testing, already completed, will be followed by additional comprehensive testing within the equipment bays of a fighter aircraft to assure reliable operation of associated avionics modules. Various suppliers of microwave WLAN systems have sought, and obtained, security certificates for these products from DOD agencies. Similar certifications can be sought for WNAA equipment. Operation at 60 GHz, rather than low microwave frequencies, provides atmospheric absorption of about ten dB per kilometer which reduces the probability of detection at a distance by unfriendly forces.

Phase II research has its focus on development of node antenna/transceiver hardware in integrated circuit format to facilitate rapid transition to a DOD program of record. Pre-production node hardware is now in testing and will be used in network operational evaluation, first in the laboratory and then in a high multipath environment. The final step will be a demonstration of a network of two or more nodes when mounted within an avionics compartment of a fighter aircraft. A second design option, intended to improve network operating range and minimize effects of multipath fading, is development of custom network management code for operation of switched, directional antennas to implement directive beam diversity. All Phase II activity will be completed by September of 2009. Status of the technology maturity at that time will be TRL 6, operation of a system model in a relevant environment. Advancement of the technology to TRL 8/9 will take place during 2010 subject to funding advancement into Phase II.5 or a Phase III program. Partnership with Boeing and/or Northrop Grumman following Phase II is under consideration but not guaranteed at this time.

REFERENCES

Name	Organization	Phone	e-mail
TPOC	NAVAIR	301 342 9094	
TPOC	NAVAIR	301 342 0408	
John L. Olson	Boeing	314 234 1964	John.l.olson@boeing.com
James Mocarski David Snodgrass	Northrop Grumman	847 259 9600 (x6318)	James.mocarski@ngc.com David.snodgrass@ngc.com

Northrop Grumman has provided matching funds for Phase II under the SBIR Fast Track program. Boeing has recently placed a contract for a technology demonstration to take place aboard a tactical aircraft in December 2008.

ABOUT THE COMPANY

Epsilon Lambda Electronics Corporation was founded in 1974 to be the premier innovator of millimeter wave integrated systems and subsystems for radar and communications. The company has patented its unique Fiber Millimetrics circuit technology and has pioneered research on electronically steered phased array antennas for millimeter wavelengths. The company has been awarded 33 millimeter wave research prime contracts of which 15 were phase II awards. The company has commercialized several research technologies from its government awards into defense and automotive industry applications. For example, Epsilon Lambda supplied to Delphi Corporation the antenna/transceiver operating at 76 GHz for a commercialized automotive intelligent cruise control system. Several of the research awards were specifically in 60 GHz communications, the results of which have provided background for the WNAA technology development in the current NAVAIR Phase II contract.