IEEE Aerospace Conference 2011 Abstract
Session 11.11 Smart Sensing and Wireless Technologies for IVHM

Wireless Sensor Networks for Developmental and Flight Instrumentation

Richard Alena, Fernando Figueroa, Jeffrey Becker, Mark Foster, Ray Wang, Suman Gamudevelli, George Studor

Wireless sensor networks (WSN) based on the IEEE 802.15.4 Personal Area Network and ZigBee Pro 2007 standards are finding increasing use in home automation and smart energy markets providing a framework for interoperable software. The Wireless Connections in Space Project, funded by the NASA Engineering and Safety Center, is developing technology, metrics and requirements for next-generation spacecraft avionics incorporating wireless data transport. The team from Stennis Space Center and Mobitrum Corporation, working under a NASA SBIR grant, has developed techniques for embedding plug-and-play software into ZigBee WSN prototypes implementing the IEEE 1451 Transducer Electronic Datasheet (TEDS) standard. The TEDS provides meta-information regarding sensors such as serial number, calibration curve and operational status. Incorporation of TEDS into wireless sensors leads directly to building application level software that can recognize sensors at run-time, dynamically instantiating sensors as they are added or removed. The Ames Research Center team has been experimenting with this technology building demonstration prototypes for on-board health monitoring. Innovations in technology, software and process can lead to dramatic improvements for managing sensor systems applied to Developmental and Flight Instrumentation (DFI) aboard aerospace vehicles.

A brief overview of the plug-and-play ZigBee WSN technology is presented along with specific targets for application within the aerospace DFI market. The software architecture for the sensor nodes incorporating the TEDS information is described along with the functions of the Network Capable Gateway processor which bridges 802.15.4 PAN to the TCP/IP network. Client application software connects to the Gateway and is used to display TEDS information and real-time sensor data values updated every few seconds, incorporating error detection and logging to help measure performance and reliability in relevant target environments. Test results from our prototype WSN running the Mobitrum software system are summarized and the implications to the scalability and reliability for DFI applications are discussed.

Our demonstration system, incorporating sensors for life support system and structural health monitoring is described along with test results obtained by running the demonstration prototype in relevant environments such as the Wireless Habitat Testbed at Johnson Space Center in Houston. An operations concept for improved sensor process flow from design to flight test is outlined specific to the areas of Environmental Control and Life Support System performance characterization and structural health monitoring of human-rated spacecraft. This operations concept will be used to highlight the areas where WSN technology, particularly plug-and-play software based on IEEE 1451, can improve the current process, resulting in significant reductions in the technical effort, overall cost and schedule for providing DFI capability for future spacecraft.