dimension of patches produces the required frequencies.

To achieve excellent polarization isolation and control of antenna sidelobes for the MSPA, the orientation of each stacked-patch element within the array is optimized to reduce the cross-polarization. A specialized feed-distribution network was designed to achieve the required excitation amplitude and phase for each stacked-patch element.

The patches are thin copper/Kapton layers bonded to Astro-Quartz layers. As illustrated in the figure, three copper/Kapton/Astro-Quartz layers are built to function as the upper patch, lower patch, and ground plane. The lower radar patches sit on a honeycomb dielectric structure above the conducting ground plane. The honeycomb is filled mostly with air and, therefore, introduces only a small loss at L-band frequencies. On the top of the radar patches sits another honeycomb dielectric structure to support the radiometer patches. All of the layers and the honeycombs are drilled to allow attachment to the feed wires to the lower patch (radar). The lower patch is fed through the ground plane, while the upper patch acts as a parasitic patch to introduce the 1.413 GHz.

A seven-element stacked patch array with elements forming a hexagonal pattern is the most suitable for space applications; however, a 16-element array with a 4×4 rectangular configuration is better for airborne and ground applications.

This work was done by Yahya Rahmat-Samii, Keerti Kona, and Majid Manteghi of the University of California at Los Angeles (UCLA); and Steven Dinardo, Don Hunter, Eni Njoku, William Wilson, and Simon Yueh of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-44470

Biomedical Wireless Ambulatory Crew Monitor

John H. Glenn Research Center, Cleveland, Ohio

A compact, ambulatory biometric data acquisition system has been developed for space and commercial terrestrial use. BioWATCH (Biomedical Wireless and Ambulatory Telemetry for Crew Health) acquires signals from biomedical sensors using acquisition modules attached to a common data and power bus. Several slots allow the user to configure the unit by inserting sensor-specific modules. The data are then sent real-time from the unit over any commercially implemented wireless network including 802.11b/g, WCDMA, 3G.

This system has a distributed computing hierarchy and has a common data controller on each sensor module. This allows for the modularity of the device along with the tailored ability to control the cards using a relatively small master processor. The distributed nature of this system affords the modularity, size, and power consumption that betters the current state of the art in medical ambulatory data acquisition.

A new company was created to market this technology.

This work was done by Alan Chmiel and Brad Humphreys of ZIN Technologies for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18357-1.

Wireless Avionics Packet To Support Fault Tolerance for Flight Applications

A simple network interface supports fault detection and autonomous fault recovery.

NASA's Jet Propulsion Laboratory, Pasadena, California

In this protocol and packet format, data traffic is monitored by all network interfaces to determine the health of transmitter and subsystems. When failures are detected, the network interface applies its recovery policies to provide continued service despite the presence of faults. The protocol, packet format, and interface are independent of the data link technology used. The current demonstration system supports both commercial off-the-shelf wireless connections and wired Ethernet connections. Other technologies such as 1553 or serial data links can be used for the network backbone.

The Wireless Avionics packet is divided into three parts: a header, a data payload, and a checksum. The header has the following components: magic number, version, quality of service, time to live, sending transceiver, function code, payload length, source Application Data Interface (ADI) address, destination ADI address, sending node address, target node address, and a sequence number.

The magic number is used to identify WAV packets, and allows the packet format to be updated in the future. The quality of service field allows routing decisions to be made based on this value and can be used to route critical management data over a dedicated channel. The time to live value is used to discard misrouted packets while the source transceiver is updated at each hop. This information is used to monitor the health of each transceiver in the network.

To identify the packet type, the function code is used. Besides having a regular data packet, the system supports diagnostic packets for fault detection and isolation. The payload length specifies the number of data bytes in the payload, and this supports variable-length packets in the network. The source ADI is the address of the originating interface. This can be used by the destination application to identify the originating source of the packet where the address consists of a subnet, subsystem class within the subnet, a subsystem unit, and the local ADI number. The destination ADI is used to route the packet to its ultimate destination. At each hop, the sending interface uses the destination address to determine the next node for the data.

The sending node is the node address of the interface that is broadcasting the packet. This field is used to determine the health of the subsystem that is sending the packet. In the case of a packet that traverses several intermediate nodes, it may be the node address of the intermediate node. The target node is the node address of the next hop for the packet. It may be an intermediate node, or the final destination for the packet.

The sequence number is used to identify duplicate packets. Because each interface has multiple transceivers, the same packet will appear at both receivers. The sequence number allows the interface to correlate the reception and forward a single, unique packet for additional processing. The subnet field allows data traffic to be partitioned into segregated local networks to support large networks while keeping each subnet at a manageable size. This also keeps the routing table small enough so routing can be done by a simple table lookup in an FPGA device.

The subsystem class identifies members of a set of redundant subsystems, and, in a hot standby configuration, all members of the subsystem class will receive the data packets. Only the active subsystem will generate data traffic. Specific units in a class of redundant units can be identified and, if the hot standby configuration is not used, packets will be directed to a specific subsystem unit.

This work was done by Gary L. Block, William D. Whitaker, James W. Dillon, James P. Lux, and Mohammad Ahmad of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-46327

Aerobot Autonomy Architecture

Potential applications include scientific exploration, military surveillance, and radio relay.

NASA's Jet Propulsion Laboratory, Pasadena, California

An architecture for autonomous operation of an aerobot (i.e., a robotic blimp) to be used in scientific exploration of planets and moons in the Solar system with an atmosphere (such as Titan and Venus) is undergoing development. This architecture is also applicable to autonomous airships that could be flown in the terrestrial atmosphere for scientific exploration, military reconnaissance and surveillance, and as radio-communication relay stations in disaster areas. The architecture was conceived to satisfy requirements to perform the following functions:

- Vehicle safing, that is, ensuring the integrity of the aerobot during its entire mission, including during extended communication blackouts.
- Accurate and robust autonomous flight control during operation in diverse modes, including launch, deployment of scientific instruments, long traverses, hovering or station-keeping, and maneuvers for touch-and-go surface sampling.
- Mapping and self-localization in the absence of a global positioning system.
- Advanced recognition of hazards and targets in conjunction with tracking of, and visual servoing toward, targets, all to enable the aerobot to detect and avoid atmospheric and topographic hazards and to identify, home in on, and hover over predefined terrain features or other targets of scientific interest.

Testing of a Prototype Aerobot is an essential part of the continuing effort to develop an architecture for autonomous operation of aerial vehicles in the atmosphere of Earth as well as of remote planets. These photos show the JPL aerobot during autonomous flight tests conducted at the El Mirage dry lake in the Mojave Desert. The top image shows vehicle liftoff, and the bottom image shows the aerobot in autonomous flight mode.

The architecture is an integrated combination of systems for accurate and robust vehicle and flight trajectory control; estimation of the state of the aerobot; perception-based detection and avoidance of hazards; monitoring of the integrity and functionality ("health") of the aerobot; reflexive safing actions; multi-modal localization and mapping; autonomous planning and execution of scientific observations; and long-range planning and monitoring of the mission of the aerobot. The prototype JPL aerobot (see figure) has been tested extensively in various areas in the California Mojave desert.

This work was done by Alberto Elfes, Jeffery L. Hall, Eric A. Kulczycki, Jonathan M. Cameron, Arin C. Morfopoulos, Daniel S. Clouse, James F. Montgomery, Adnan I. Ansar, and Richard J. Machuzak of JPL for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-45837