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.

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,

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.

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.

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.