Astronaut Michael L. Gernhardt, STS-104 mission specialist, is shown during an extravehicular activity (EVA) with the International Space Station. This space walk was the first to use the new Quest air-lock, which includes an antenna designed and built at Georgia Tech.

IMAGE COURTESY OF NASA

Picking Up the Right Signals

A unique antenna developed at Georgia Tech ensures critical crew communication on the International Space Station.

A unique antenna designed and built at the Georgia Institute of Technology for NASA and The Boeing Company is now part of a vital crew communication system on the International Space Station.

Shaped like a bathroom towel bar, the 2-foot-long Orlan Antenna is located in the cramped cylindrical air lock that space-walking astronauts use to exit and enter the Space Station for construction, maintenance and other activities. Its unique design allows the Space Station crew to communicate with users of the Russian-built Orlan spacesuits during critical times when they are preparing to enter space through the air lock.

Because of its placement in the air lock, the dual-band antenna was designed to serve as a hand- or foothold for astronauts clambering into space — and to survive large temperature changes and bashing by equipment the astronauts carry. But the most difficult design challenge came from the antenna's environment: It must work reliably inside the conductive air lock structure despite electromagnetic energy patterns that change constantly with the movement of astronauts. Most antennas are designed to work on the exterior of an aircraft or spacecraft.

"This was a very challenging design because we were essentially working with an antenna inside a metal can," explains Barry Mitchell, senior research engineer with the Sensors and Electromagnetic Applications Laboratory at the Georgia Tech Research Institute (GTRI). "The conductive walls of the air lock reflect signals back to the antenna, and bounce them around inside the cavity. The astronauts in the chamber also perturb the antenna patterns and make them difficult to predict."

Further complicating the challenge were the frequencies used by the Russian spacesuits — 120 and 250 Megahertz. The 120-Megahertz frequency was barely short enough to resonate inside the air lock's 63-inch diameter, necessitating an antenna so large that it could serve double duty as a handhold.

Working with Boeing engineers based in Huntsville, Ala., GTRI researchers considered three types of antennas before settling on the half-loop design that resembles a towel bar. Boeing had hoped to use a patch-type device similar to the antenna used for the U.S.-designed spacesuits that also use the chamber. But testing showed a patch antenna for the Russian frequencies would have been too large for the chamber to accommodate, says Victor K. Tripp, who led development of the antenna during the 1990s as a GTRI principal research engineer.

"There just weren't many parameters that we could adjust," he adds.

To develop and test their designs, the Georgia Tech research team built a 1:6 scale model of the air lock, complete with 1-foot-tall scale model astronauts covered with a conductive metal coating to simulate their spacesuits. Electromagnetic energy measurements taken inside the scale model complemented two different computer techniques in determining and evaluating the options for antenna configuration, size and placement.

"How the astronaut or astronauts are oriented in the air lock affects how well the antenna works, and the antenna had to work no matter what the positions of the astronauts," Tripp explains. "The modeling suggested that signals were generally better when there were two astronauts in the chamber, rather than with just one."

After study at GTRI's Atlanta facilities, the prototype antenna — 2 feet long and raised 4 inches off the metal wall — was tested in a full-scale mockup of the air lock at the Johnson Space Center in Houston. Measurements made there closely approximated predictions from the GTRI modeling and scale-model tests.

Dependable operation of the air lock antennas is essential. While astronauts wait within the lock sealed in their spacesuits, the antennas must carry verbal communication between astronauts and crew, and also transmit vital signs and other data necessary to monitor the physical condition of each astronaut and spacesuit. For instance, cooling equipment in the spacesuits must be monitored at all times to make sure the astronauts do not become too hot.

The Orlan Antenna operates with the Russian-designed spacesuits used on the Space Station. In these suits, a conductive metal film that is part of the insulation system serves double duty as the antenna, with the upper and lower halves of the suit insulated from each other. The larger U.S.-designed spacesuits use a different communication system with higher frequencies and a discrete antenna.

As part of the STS-104 mission, Shuttle Atlantis delivered the Boeing-built air lock to the International Space Station in July 2001. Until the installation of the structure — now known as Quest — U.S.-designed spacesuits could only be used when a shuttle was docked with the Space Station and astronauts could use its air lock.

Manufacture of the nickel-plated aluminum antennas provided GTRI with an education on high-reliability, space-qualified hardware. Each design and production step required extensive documentation and testing in compliance with ISO 9000 quality requirements.

"The level of work, the quality required and the level of documentation and testing were unprecedented, much more than is required for military specifications," Mitchell says. "We got a new appreciation for space-qualified hardware."

The 4-year project produced two flight units, two qualification units and a spare. GTRI also produced a single engineering model that was used for the preliminary design and testing.

Also contributing to the project were William Cooke, Greg Hampton, Cal Jameson, Jeff Kemp, Kerry Pullen and Al Vineyard, all of GTRI.

— John Toon

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> "This was a very challenging design because we were essentially working with an antenna inside a metal can."
>
> —Barry Mitchell

PHOTO BY STANLEY LEARY

A scale model of an astronaut wearing a Russian-designed spacesuit was used to study antenna patterns inside the crew air lock designed for the International Space Station. The model was coated with copper to simulate the conducting layer in the spacesuit.

PHOTO BY GARY MEEK

The Tech Tower – a symbol of the Georgia Institute of Technology.

"Innovation U."

The Georgia Institute of Technology has perhaps the most comprehensive program to support state and local economic development among all research universities in the United States, according to a Southern Growth Policies Board study of higher education economic development best practices.

Georgia Tech takes top ranking among U.S. research universities in economic development support.

The study, "Innovation U: New University Roles in a Knowledge Economy," profiles the economic development activities of 12 top universities chosen by development experts from among 164 institutions nationwide.

Georgia Tech relies on a broad range of economic development programs and external partnerships to achieve its goals of boosting Georgia's economy, the study reports.

"Georgia Tech is perhaps a unique example of external partnering," the study says. "Virtually every combination of industry relationship or economic development activity can be found at Georgia Tech, and in a very real sense the school is an operating partner with Georgia state government in the implementation and management of a variety of technology-focused initiatives. Perhaps more than any other research university in North America, economic development is an integral, critical component of the mission of the Georgia Institute of Technology, and this has been true from its very inception, along with its commitment to exemplary academics."

While formal economic development activities are housed in the Economic Development Institute (EDI) and its parent organization, the Office of Economic Development and Technology Ventures, Georgia Tech units ranging from individual academic colleges and schools to the Georgia Tech Research Institute, research contracting office and continuing education program support that mission, the study reports.

"The Georgia Tech culture, from president to academic units, is pervasively oriented toward outreach and engagement with the external world," the authors write in the study. "This means that the economic development mission is often realized through a variety of partnerships, which may or may not involve EDI in a formal administrative role."

The study credits Georgia Tech President Wayne Clough with championing the economic development mission and being personally involved in many of its key components. Clough serves on advisory groups for Yamacraw, the Georgia Research Alliance and the Metropolitan Atlanta Chamber of Commerce — where he is credited for pushing a key technology component of the chamber's strategy.

"Wayne Clough has been a frequent, vocal and visible advocate for Georgia Tech making an economic impact on Georgia and the world," the study says. "He also plays a direct, personal role in large technology-oriented initiatives that illustrate the unique position of Georgia Tech vis-à-vis the state."

The study began two years ago with a survey of 40 economic development practitioners, researchers and experts. The respondents were asked to rank 164 U.S. research universities and nominate the outstanding examples. The results identified a dozen universities that the experts considered the best in the nation at contributing to state and local economic development. Georgia Tech topped the list.

Economic development activities at those universities were then profiled in the study, done by Louis G. Tornatsky and Paul G. Waugaman, senior fellows with the Southern Technology Council, and Dennis O. Gray, a professor at North Carolina State University. (The Southern Technology Council is the technology policy arm of the Southern Growth Policies Board, based in Research Triangle Park, N.C.).

The high ranking in the study reflects Georgia Tech's concerted effort to fulfill its economic development mission, says Georgia Tech Provost Jean-Lou Chameau.

"Since its formation, economic development has been a vital part of Georgia Tech's mission," he says. "Georgia Tech actively pursues partnerships with industry, state government agencies and other organizations that help fulfill that mission. The Southern Growth Policies Board study shows that these collaborative efforts produce an impressive return for Georgia taxpayers."

Beyond President Clough and the Economic Development Institute, the study also profiles the Advanced Technology Development Center, Georgia Tech's nationally known technology business incubator, and the new VentureLab program designed to help faculty members commercialize technology they have developed. EDI, ATDC and VentureLab are part of the Office of Economic Development and Technology Ventures, headed by Associate Vice President Wayne Hodges.

"A key finding of this study is that Georgia Tech's economic development focus extends throughout the institution into numerous units that do not have a formal economic development mission," Hodges says.

Steven Danyluk, Brandon Steele and Jeff Hawthorne are developing sensors that can read the chemical makeup of a surface, creating a detailed image that reveals microscopic defects, corrosion and irregularities. They have formed a company, Intelligent Sensor Systems, Inc., to commercialize the Georgia Tech technology.

PHOTO BY GARY MEEK

"This could not have happened without a strong economic development commitment that begins at the top with the president and provost."

Also described are the Georgia Tech Research Institute, numerous partnerships with industry, the Industry Contracting Office, Technology Licensing Office, Continuing Education efforts, Co-op Program, Career Services Office and the College of Engineering — whose strategic plan is cited for its support of entrepreneurship.

Other institutions profiled in the study include: North Carolina State University, Ohio State University, Pennsylvania State University, Purdue University, Texas A&M University, University of Wisconsin, Virginia Tech, University of California at San Diego, University of Utah, Carnegie Mellon University and Stanford University.

The study can be viewed and downloaded from the Southern Growth Policies Board Web site at www.southern.org/pubs/stc/innovationU/default.asp .

— John Toon

■ For the full version of this article, see **www.atdc.org/news/april222002.html**. For more information, you may contact Wayne Hodges, Office of Economic Development and Technology Ventures, Georgia Tech, Atlanta, GA 30332-0390. (Phone: 404-894-5217) (E-mail: wayne.hodges@edi.gatech.edu)

An Easier Connection

Long-distance collaboration between the Georgia Tech Research Institute (GTRI) and a California optical networking company has produced a unique piece of high-speed telecommunications equipment that will help BellSouth provide faster metropolitan and wide area Ethernet service to its customers.

The Model 9135G Gigabit Two-port Edge Access™ switch, manufactured by Canoga Perkins, facilitates high-speed Ethernet service for school systems and businesses that have multiple locations within a metropolitan area. The service is attractive because most school districts and companies already have expertise with Ethernet technology, which is widely used for local area networks inside buildings.

Completed in just four months, the project is part of a GTRI initiative to help companies speed new innovations to market.

"Ethernet has become not only the predominant standard for local area networks within a building or campus, but it is also becoming a standard for how telecom companies operate their infrastructure," explains Bob Smith, senior director of Data Transport and Connectivity for BellSouth. "We are starting to see standards and capabilities emerge that will allow Ethernet to play a broader role. The capability provided by this new equipment will allow us to offer the flexibility of service our customers want."

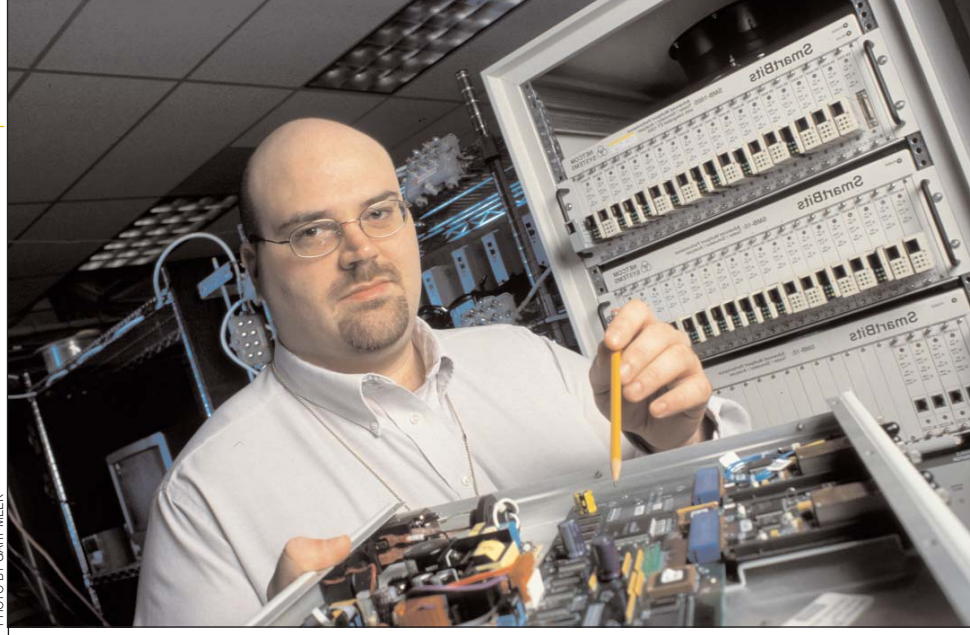

PHOTO BY GARY MEEK

GTRI engineer Joe Long and his colleagues worked closely with California company Canoga Perkins and BellSouth in the development of a unique piece of high-speed telecommunications equipment.

Canoga Perkins has been a long-term equipment supplier to BellSouth, which had been using Canoga Perkins Ethernet switches operating at 10 megabit- and 100 megabit-per-second speeds. When the Atlanta-based telecom company saw a need for a faster one-gigabit (1,000 megabit) switch, it asked Canoga to quickly produce the new equipment.

With its business booming, however, the company couldn't meet the tight time constraints, so with BellSouth's approval, it turned to GTRI researchers, with whom it was already working on other projects.

BellSouth wanted the software interface for the new equipment to operate just like the slower switches so the upgrade would be transparent to customers. The equipment had to fit in the same space as older switches, yet be powerful enough to send a signal through up to 90 kilometers of fiber optic cable.

Engineers from GTRI, BellSouth and Canoga began working together on a fast-track strategy to meet the requirements in less than the standard six- to 12-month development time. GTRI took the lead in designing the hardware, while Canoga wrote the software and then brought it all together in a manufactured and tested product.

"We were able to create a solution in a very short period of time compared to what normal development cycles would have been," Smith notes. "It was truly a cooperative effort between Canoga, GTRI and BellSouth to make sure the switch provided the capabilities we needed, as well as the consistent look and feel."

That cooperative effort involved regular video and telephone conferences between GTRI engineers — Joseph Long, Matt Miller and Juan Santamaria — in Atlanta and the Canoga design team in Chatsworth, Calif. The groups posted designs on a shared Internet site, exchanged e-mail and held regular long-distance design meetings to make sure they were in synch.

> "We were able to create a solution in a very short period of time compared to what normal development cycles would have been. It was a truly cooperative effort..."
>
> —Bob Smith

IMAGE COURTESY OF CANOGA PERKINS

The Model 9135G Gigabit Two-port Edge Access™ switch, manufactured by Canoga Perkins, facilitates high-speed Ethernet service for school systems and businesses that have multiple locations within a metropolitan area.

"We were able to accomplish great things over distances with videoconferencing, even on very technical issues," says Long, a research engineer in GTRI's Information Technology and Telecommunications Laboratory. "It was an example of how by working very closely with a customer, we ended up with a product that was better than they could have done by themselves, or we could have done by ourselves."

BellSouth is now deploying the new optical switch at customer locations in its nine-state service region. Because school districts must connect multiple facilities, they are primary customers for the high-speed Ethernet service, though BellSouth also offers it to commercial customers.

"As an enabling technology, this is enhancing student abilities to get into the Internet and have more access to computer technology," explains Ted Zernhelt, a senior member of BellSouth's Science and Technology Group. "It gives schools the bandwidth they need to grow into the future and is a technology that school districts are comfortable with and understand."

Originally used for local area networks within facilities, Ethernet is being extended beyond the boundaries its designers originally intended. Though not a solution for all customers, BellSouth expects Ethernet to grow in speed and importance.

"As businesses distribute their resources across geographically dispersed areas, their ability to interconnect these locations in a seamless way becomes a real issue," Zernhelt explains. "Ethernet started to move into the metropolitan area network and eventually into the wide area network. BellSouth, as a public provider, is very interested in providing customers with the capabilities needed for seamless connectivity. This opens up new opportunities."

The two-port Canoga switch serves as a doorway between a network inside an individual school or corporate location and the BellSouth Ethernet system. Information packets intended for delivery outside the school or business location pass through the switch, while packets destined for local users stay inside. The smart circuitry inside the switch also handles compatibility issues, such as matching receiver sensitivity and transmitter power, easing the burden on local information technology managers.

Beyond making it easier to interconnect remote facilities, the Ethernet system also reduces equipment and network overhead.

"The data packets can remain Ethernet all the way from where they are sent to where they are received," Long explains. "They do not have to be encapsulated into another format or converted. When you have a very high bandwidth data stream, this can reduce overhead, making the operation cheaper and simpler."

"GTRI serves start-up companies and well-established companies that need talented engineers to help speed up projects to get new products to market."

— Ron Bohlander

The project for Canoga Perkins and BellSouth shows what Georgia Tech can do for its corporate customers, says Ron Bohlander, manager of GTRI's Commercial Product Realization Office.

"GTRI serves start-up companies and well-established companies that need talented engineers to help speed up projects to get new products to market," he says. "Working in collaboration with the Canoga Perkins engineering team, GTRI was able to help them complete this project and have units rolling off the production line in record time. This was extremely important to Canoga's customer, BellSouth, which had important customer commitments to keep."

Beyond speeding new technologies to market, GTRI can also help companies benefit from innovations developed in Georgia Tech laboratories.

"GTRI is actively engaged in research and development related to optical switching and is in touch with colleagues doing complementary research in the colleges of Georgia Tech," Bohlander adds. "We can offer a valuable mixture of technology insight and experience with manufacturing that helps a project move rapidly from concept to actual production."

— John Toon

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