THE WORLD'S LARGEST PASSIVE OPTICAL LAN

Sandia's Optical LAN connects 265 buildings and saves $20 million over 5 years

By Sue Holmes, Sandia National Laboratories

PHOTOS: RANDY MONTOYA

Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration. With main facilities in Albuquerque, N.M., and Livermore, Calif., Sandia has major R&D responsibilities in national security, energy and environmental technologies, and economic competitiveness.

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It also has become a pioneer in large-scale passive optical networks, building the largest passive Optical Local Area Network in the world.

The network pulls together 265 buildings and 13,000 computer network ports and brings high-speed communication to some of the Labs' most remote technical areas for the first time. It will save an estimated $20 million over 5 years through energy and other savings and not having to buy replacement equipment. Sandia expects to reduce energy costs by 65% once the network is fully operational.

Fiber offers far more capacity, is more secure and reliable and is less expensive to maintain and operate than traditional LANs that use copper cables.

An Optical LAN gives people phone, data and video services using half-inch fiber optic cables made of 288 individual fibers instead of the conventional 4-inch copper cables. Copper cables typically fill up underground conduits and require steel overhead racks as well as distribution rooms filled with separate frames for voice and data cables.

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"The frames go away, and the walls are bare and the tray empties," said Sandia Senior Engineer Steve Gossage, who has spent his 36-year career at the organization in advanced information and network systems engineering.

The national laboratory has always pushed for speed beyond the fastest transmis-

LAN: Local Area Network
R&D: Research and Development

sion rate available, Gossage said. "When people were working in much slower data rates, kilobit-type rates at short distances, we were trying to get 10 times the distance and 10 times the speed," he said.

Adopting fiber optics

Sandia began looking at fiber optics early in the technology's development because of its promise of higher bandwidth over longer distances. The Labs started converting from copper in the 1980s, first installing then-emerging fiber optics in a single building and bumping that facility to megabit speeds. "Today we're way past that. We're at 10-gigabit-type rates and looking hard at 100," Gossage said.

After years of planning, Sandia completed a formal network plan in late 2008 and sought competitive bids the following year. Sandia selected Tellabs as the equipment vendor for the network, and Gossage and his colleagues simultaneously began to jump-start the deployment of the fiber infrastructure and set up a test lab to validate equipment configurations and the performance of network functions. The technology began moving to desktops in 2011, and by the end of 2012, Sandia had converted more than 90% of bulky copper cable to a fiber optic LAN.

Sandia, which will spend about $15 million on the project, needs superb computing capability for the problems it tackles.

"Whether it's a materials science problem or modeling an event, we need a lot of data and a lot of processing capability," Gossage said. "We need to be able to see it,we need to be able to view it, and we need to be able to put teams together. This is a large laboratory, deeply stocked with scientists, engineers and test labs. For the analyses we get, the problems are not small and they're not easy."

Sandia envisioned being able to use multiple wavelengths in a very high bandwidth single strand reaching the farthest tech areas. But decades ago, when Sandia began

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— Steve Gossage, Senior Engineer, Sandia National Laboratories putting in single-mode fiber to desks and adding underground fiber capabilities, the technology wasn't quite mature enough to take advantage of fiber optics' inherent multiple wavelengths and speeds.

So Sandia continued to install the fiber optic foundation and waited while the technology developed, progressing quickly when commercial optical networks began supporting voice, data and video to large collections of homes and offices.

"There weren't that many unknowns for us because we had been thinking about ways to do this on a large scale for quite a while," Gossage said. "We had already thought through what this might mean to us, what it might mean to our lifecycle costs and where the investments would be, and we were already pretty comfortable with fiber and the technologies that go with it."

Passive Optical LANs have greater range, reaching up to 30 kilometers, or 300 times farther than copper-based LANs.

Copper vs. fiber optics

Buildings with conventional copper LANs have separate networks for phones, computers, wireless, security and so on. Fiber optics puts everything in a single network cable, eliminating a large number of power-consuming switches and routers and making the network simpler to operate and cheaper to install. Because fiber optic systems are more compact and efficient, energy and maintenance costs go down.

"As we research and deploy new technologies, our main objectives are to enable the Labs' mission, decrease life-cycle costs and if possible reduce our footprint on the environment. With the deployment of passive optical networks we have been able to meet and exceed all of these objectives," said Sandia manager Jeremy Banks.

Where a conventional LAN serving 900 customers requires a space the size of 3 double ovens, an optical network serving 8,000 requires a microwave oven-sized space. Where a copper cable approach required Sandia to maintain and manage

600 separate switches in the field, Optical LAN allows the organization to operate a data center in one building with simple, standard ports to reach the offices. Because fiber optics reach beyond the 100-meter radius that once was the standard from a wiring closet to a desktop, remote areas such as the National Solar Thermal Test Facility have high-speed communications for the first time.

The only copper wire for most of Sandia today is a short connection from the wall to the desktop. Everything behind the wall is fiber.

Sandia is recycling copper as it is replaced, which keeps tons of valuable material out of a landfill.

Moving away from copper wasn't easy. It required new technology for the core communication system and made Sandia its own network provider, Gossage said. He credited a central team of about 10 people across Sandia who worked together throughout 2011, plus sub-teams totaling about 40 people. The teams included people from engineering design, information technology, network systems, computing, facilities, and security as well as people in the field pulling cable and connecting ports.

"Thank you is just not quite enough when you see people working that hard for that long to assist in change, because change is hard and worrisome and disquieting," Gossage said.

Still to come

Sandia is recycling copper as it is replaced, which keeps tons of valuable material out of a landfill. And the estimated $80,000 the organization will get for the copper will offset some of the fiber optic costs.

The Labs also must turn off hundreds of switches before potential energy savings can be fully realized. That will take some time because it depends on staffing and other factors, Gossage said.

More change could be coming. A small trial is under way for voice-over-fiber — putting data and voice in one system rather than the two systems Sandia uses today.

Fiber optical cable can provide sufficient bandwidth for 25 years or more.

Testing shows Sandia can protect voice running through a congested circuit — what Gossage calls "a Mother's Day test" — when everyone calls at the same time. The Gigabit Passive Optical Network standard that Sandia uses enables the organization to dedicate part of the bandwidth and give priority to selected traffic such as voice. That enables calls to go through even with heavy competition from data traffic.

Sandia also is working with a small number of researchers who need more bandwidth than they're getting. The Labs' needs are ahead of the market but the organization is pushing for next-generation increases in speed, Gossage said.

Communication speed improves every 5 to 8 years. With copper, each improvement required replacing large, heavy bundles of jacketed cable to re-engineer them to perform at the new speed, he said. Fiber optical cable can provide sufficient bandwidth for 25 years or more.

"We change the wavelength, we change the modulation rate, we don't get back in the ceiling, we don't get back in the customer's office," Gossage said. "So our return on investment, our capital investment, our operational investment, the impact on our customers — everything gets better." ■

The world's smallest: Tellabs Mini ONT

By Joan Engebretson

In the second quarter of 2013, Tellabs will begin shipping the Tellabs® 100 Series Mini Optical Network Terminal — the world's smallest ONT with Power-over-Ethernet.

ONTs connect users, serving as the interface between the Optical LAN and end-user equipment.

The Tellabs® 120W ONT installs in office walls in a standard size outlet. It provides two Gigabit Ethernet interfaces with Power-over-Ethernet to the user. The Tellabs® 120C ONT installs in standard cubicle raceways with the same interfaces and feature set as the Tellabs 120W ONT.

Purpose-built for enterprise networks, Tellabs new Mini ONTs:

- Reduce cabling requirements and exposure to damage or theft by eliminating ONTs on or under desks
- Minimize the space needed in the communication closet
- Reduce deployment costs by eliminating fiber jumpers and desk/wall mounts
- Require no power or battery backup at the desktop because they are remotely powered from the communication closet.

Compared with a conventional active Ethernet LAN, Tellabs Optical LAN can save up to 70% in total costs, lower power consumption by 80% and reduce space by 90%.

Tellabs 120C ONT (above) installs in standard cubicle raceways. **Tellabs 120W ONT** (below) installs in a standard size outlet.

ONT: Optical Network Terminal