Sumitomo Electric Lightwave Corp.
Fermilab - FutureFLEX Case Study
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Fermilab Accelerates Data Transmission Speeds On FutureFLEX® Air-Blown Fiber® Optic Network

Flexible, state-of-the-art cabling infrastructure supports fiber-to-the-desktop and increased bandwidth requirements for the nation 'S foremost high-energy physics laboratory.

Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois, was commissioned in 1967 by the U.S. Atomic Energy Commission to study the fundamental nature of matter and energy. Today, the world-renowned facility is operated by a consortium of 89 research universities and provides qualified researchers with the resources they need to carry out cutting-edge, high-energy physics investigations. Fermilab's scientific discoveries continue to revolutionize our knowledge of the universe, how it was formed and how it works.

In the mid-1990s, Fermilab sought to replace its aging, copper-based networks with a fiber optic network infrastructure. The legacy system - comprised of a varied assortment of communications protocols, such as RS-232, Thickwire, Thinwire, UTP-5 Ethernet, and some limited Fiber Distributed Data Interface (FDDI) - could not be upgraded sufficiently to handle rapidly increasing data transmission requirements and user demand for more sophisticated applications. A fiber-based system would provide platform independence, plus increased speed and capacity. In addition, fiber would offer superior signal integrity over longer distances, because it is unhampered by the length constraints of copper-based systems.

After comparing traditional fiber optic systems with air-blown fiber technology, Fermilab selected Sumitomo's FutureFLEX® Air-Blown Fiber" Optic Cabling System because it would provide the flexibility to accommodate future network upgrades and expansions both easily and cost-effectively. The phased renovation began in 1997 with installation of an air-blown fiber optic riser cabling system within Wilson Hall, a stately 16-story administrative office building, and has since been expanded to multiple sites and workgroups within Fermilab's 6,800-acre, prairie-like campus.

Designing for Today... and Tomorrow

According to Al Thomas, head of the Data Communications Department in Fermilab's Computing Division, considerable forethought and planning were given to designing a network infrastructure that would meet their bandwidth needs for 10 to 15 years to come.

"Operation of the Fermilab complex relies heavily on electronic communications," explains Thomas. "We needed a network that would allow massive amounts of data from our experiments to be transmitted to and from key areas, and also provide the speed and capacity to support increasing user demands for multimedia and other network-based video services to the desktop - including full motion video and data visualization." Additional goals set forth in Fermilab's conceptual design document included elimination of network length limitations, an inexpensive migration path to higher capacities and bandwidth, reduced network maintenance costs, and a longer system life cycle.

It soon became clear that the optimal solution was to build a flexible cabling infrastructure capable of supporting gigabit-per-second transmissions, independent of any specific protocol. Without such an infrastructure, upgrades and expansion of Fermilab's complex networks would be either impossible or prohibitively expensive to accomplish.

Air-Blown Fiber Fills the Bill

When Thomas and his team learned from Phase I installer Comret Midwest about the FutureFLEX® ABF System, they decided to implement air-blown fiber instead of a traditional fiber optic system. According to Keith Chadwick, Ph.D., the assistant head of Data Communications in Fermilab's Computing Division, "The use of FutureFLEX was a highly strategic decision. Our cost analysis revealed that ABF technology would not be significantly more expensive than traditional fiber. Moreover, with ABF there was no need for us to guess how much dark fiber would be required to handle future applications. Instead, we could simply install empty tube cables and blow in fiber as it was actually needed. This alone would provide a significant economic advantage."

Chadwick also notes that, while frequent network configuration changes are not a big issue at Fermilab, the need to easily add capacity to accommodate new and emerging applications is mission-critical. 'With the ABF backbone and ABF running to offices and labs, it becomes much easier to run Gigabit to the desktop over a pair of multimode fibers," Chadwick explains. "And, if future bandwidth needs dictate replacing existing multimode fiber with single mode, we can just blow out the old fiber and blow in new. This gives us the kind of long-term flexibility we were looking for."

Workgroup-Based Network Architecture

Chadwick, who was intimately involved in every phase of the network design and implementation, described the network scope and architecture. "The network architecture in Wilson Hall and other sites is workgroup-based. For us, that was the most logical approach since our intent was to install several separate ABF networks, with multiple networks interconnected via a system of routers and switches. We now have a network for the Computing Division and experimental labs, as well as function-based networks for Facilities Engineering and the Receiving Department. Depending on end-user needs and applications, network speeds range from 10 Mbps on the low end to Gigabit speeds. This enables us to quickly move high-energy physics data from the experimental labs to the Computer Center where they are stored."

Today, Fermilab's network spans several buildings across the campus. In Wilson Hall, the main network links approximately 1,200 administrative offices. The Computer Center has another 150 offices and each of the experimental sites holds 150 to 200 offices. From the Computer Center to Wilson Hall, the team installed two 6-strand single mode fiber optic cables and one 6-strand multimode cable within a direct burial 19-cell tube cable. The 19-cell tube cables are also deployed to connect the Computer Center to the two major experimental laboratories. The less data-intensive networks use 7-cell tube cable.

Installation Complexity and Challenges

For Fermilab, the largest and most complex portion of the FutureFLEX installation was the main network, concentrated in Wilson Hall. In Phase I of the installation, performed by Comret Midwest, the ABF riser backbone was installed within a dumbwaiter shaft within the 16-story building. The work team had to remove the inoperative dumbwaiter mechanism and install the tube cable through the length of the shaft. A single conduit "home run" to Fiber Central, the main computer room, independently services each floor. The cabling installed in the shaft is riser-rated and consists of 96 multimode 62.5-micron fibers, with individual fibers color-coded along their entire length.

On each floor, horizontal fiber connections are made from the backbone to workgroup-based building support columns, with a pair of fiber cables allotted for each desk in the vicinity. In some cases, UTP jumpers are then run from the support columns to the desktop. For workstations requiring more sophisticated applications, fiber is run right to the desktop to provide plug-and-play convenience. Average runs from pillar to desktop are 50 to 500 feet.

On the office floors of Wilson Hall, there is one custom-fitted tube distribution unit (TDU) per floor. Standard FutureFLEX® TDUs are installed on the 16th floor and mezzanine. From the 15 1h to 16th floors and from the 2" floor down to the mezzanine and ground floors (areas not within the dumbwaiter shaft), workers had to core through the floor, run 4-inch aluminum conduit and create fire-stops between cored floors. Fire-stop material was also used in transition areas from riser to plenum cabling. Finally, on each floor, the fiber is terminated on wall units mounted to the building support columns. Each fiber termination unit supports 20 strands of glass fiber.

The FutureFLEX network in Wilson Hall terminates at Fiber Central, a specially designed room located not far from the backbone shaft on one of the office floors. Housing all active network electronics, Fiber Central is equipped with a raised floor, security door, dedicated climate control system, and its own power source to provide utmost network performance and reliability. When it was complete, the Wilson Hall installation alone required over 6,000 feet of 19-cell FutureFLEX tube cable. Single cell tube cable was used for horizontal runs, averaging 1,200 to 2,000 feet per floor, depending on the complexity of the route traveled.

Chadwick asserts that the biggest challenge was ensuring workers' safety as they installed the ABF tube cable infrastructure within the confines of the 3 1/2-ft by 4-fl shaft running from the l5 floor down to the 2nd floor. Fermilab solved the problem by custom-building special scaffolding and providing the installation crew with safety harnesses and fall protection training.

A Robust Installation and Sound Investment

Once Wilson Hall was fully networked, Fermilab entered Phase II of the project, extending the ABF infrastructure to encompass additional sites on campus, using the same workgroup-based philosophy. The FutureFLEX System currently supports a host of terminal servers, PCs, workstations, minicomputers and various workgroup LANs across the complex.

Five years into the project, Fermilab's massive communications system overhaul is rapidly nearing completion and now offers vast potential for growth. "We have been very satisfied with the results to date. FutureFLEX ABF technology is proving to be a sound investment and promises to deliver long-term life cycle performance and flexibility. Most importantly, there's a lot of extra capacity for future expansion -and that is just what we were looking for," concludes Chadwick.