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Largest private U.S. building project cabled with air-blown fiber

The Getty Center, a world-class arts and cultural complex, opts for an air-blown optical-fiber system.

Patrick Gorrell, AIDCO Inc.

With an overall construction cost of approximately $1 billion, the sprawling Getty Center campus is both enormous in its scope and magnificent in its setting and architecture. Situated on a rugged hilltop overlooking Los Angeles, CA, and the Pacific Ocean, the 110-acre site provides a picturesque setting for a world-class cultural complex whose multiple buildings will comfortably house more than 800 full-time employees and visiting scholars. In addition, the center, with its multi-pavilion museum and art galleries, will host more than 1.5 million visitors and art enthusiasts per year.

Scheduled to open to the public in December 1997, the Getty Center has already taken the prize as the largest single-phase construction project under way in the United States. However, with more than 3 million feet of air-blown optical fiber (ABF) already installed, the project may also lay claim to another important title—as one of the nation's largest and most innovative examples of a project using fiber-to-the-desk (FTTD) technology. In fact, the ABF system installed may prove to be the most versatile, cost-effective, and future-proof cabling system ever installed on a major campus.

The full-time occupants of the Getty Center are the employees of the J. Paul Getty Trust, a private operating foundation dedicated to the visual arts and the humanities. The Getty Center offers people opportunities to more fully understand, experience, value, and preserve the world's artistic and cultural heritage through a museum, five institutes, and a grant program.

With such a massive investment being made in the facility, the primary challenge in designing and installing the telecommunications system was to match the permanence of the facility with a cabling plant that would be equally long-lived. Also, the Getty Center's elaborate and costly architectural features would not readily lend themselves to system changes.

In a telecommunications industry that is rapidly changing, future-proofing the installation appeared to be a difficult goal. However, the selection of FTTD using Sumitomo Electric Lightwave's FutureFlex ABF cabling system and a design incorporating a centralized network architecture (CNA) has proven to be a workable solution.

Photo by 3M Telecom Systems Div.

The Getty Center is a world-class cultural complex situated on a hilltop overlooking Los Angeles, CA. It is scheduled to open to the public in December.

CNA delivers benefits

The ABF system at the Getty Center is compliant with the recently approved architectural and distance specifications of the telecommunications systems bulletin TSB-72 of the Telecommunications Industry Association (TIA—Arlington, VA), a specification intended to pave the way for fiber-based CNA designs. The CNA design model takes advantage of the longer transmission distance possible over optical fiber to eliminate the floor-by-floor electronics required in telecommunications closets served by copper-wire installations. Most or all network electronic equipment can then be housed in a single computer room—hence, the name of the scheme, "centralized network architecture."

The Getty Center's cabling system is a good example of the many benefits that can accompany a CNA design. For example, the system capitalizes on the increased distance capabilities of optical fiber to eliminate all of the traditional telecommunications closets (TCs). As a result, the active network electronics customarily installed in these closets has been relocated into a single, centralized, and much improved computer room. In addition, a small amount of backboard space is allocated in the electrical rooms to support the crossconnection of backbone and horizontal optical-fiber cables.

This scheme has proved to be a cost-saving bonanza. For instance, the total cost savings in floor space saved and related construction costs avoided were more than $5 million, more than enough to pay for the entire telecommunications cabling system. Additional savings were delivered through the centralization or "pooling" of the network electronics into one central location, where electronic equipment could be used more cost-effectively.

Photo by 3M Telecom Systems Div.

During an air-blown optical-fiber installation at the Getty Center in Los Angeles, technician Vasken Bezjian of AIDCO Inc. (Chino, CA) inserts a splice-holding connector card into the FibrMax 2700 fiber management system from 3M Telecom Systems Div.

centers. The 3M FibrMax 2700 high-density crossconnect system not only provided a significant reduction in the amount of rack space required to support fiber termination, but it also came equipped with a relatively large and practical cable-management system that included most of the required vertical and horizontal patch-cord routing capabilities. With a total capacity of 360 fiber strands (or duplex connections to 180 network devices) in each cabinet, a single cabinet installed in the top of each rack in the computer room couldprovide enough capacity to support three XYLAN switchesinstalled below. The 56 connections supported by each switch—166 connections per rack, total—balanced well with the capacity of the cabinets above, ensuring that all racks were used efficiently.

FTTD a simple design

The fiber-optic cabling system installed at the Getty Center depends on an overall system design that would be appropriate for any fiber-based CNA installation. The design makes use of four basic elements:

- Duplex fiber patch cords are cut in half and connected from the rack-mounted switching units (hubs) to a high-density crossconnect cabinet (splice center) located in the top of each equipment rack.
- Within the crossconnect cabinet, the cut patch cords are mechanically spliced to high-count fiber backbone cables routed to strategic electrical closets located throughout the campus.
- Within the electrical closets, the backbone cables are again spliced to horizontal distribution cables serving the workstations. At the workstation, horizontal cables are terminated in wall plates or higher-density, flush-mounted multimedia boxes serving large clusters of workstations.
- Duplex patch cords are connected from the wallplate to fiber-ready network interface cards within each computer terminal, printer, or other network-connected device.

Despite the seeming simplicity of a fiber-based centralized network architecture, though, system designers and installers may find that when it comes to planning and installing these systems, "the devil is in the details." In the case of the Getty Center, many aspects of the design required rigorous planning and strict attention to detail in order to prevent a full-fledged disaster.

FTTD projects using a CNA design centralize all of the electronics. Consequently, a large number of patch cords and related interconnections have to be installed and managed in a single, concentrated facility. This makes selecting the cable-management and centralized fiber-termination equipment crucial.

In the case of the Getty Center, traditional fiber-termination cabinets were replaced by newer and more efficient fiber-splice

Customized cable management

Cable management leading directly to and from the switches was enhanced by slotted Panduit duct sections, which were installed between each of the switches and separated them vertically within each rack. Foamed plastic cylinders installed over the slots in the duct gripped the fiber patch cords and provided bend-radius protection for cords as they entered the duct. This customized cable-management plan allowed cable installers to dress patch cords in an aesthetic and orderly manner that permitted removal of independent boards in the switch without interfering with other rows of patch cords.

Cable management was also eased by a new type of mini patch cord that replaced traditional duplex zip cords. Although more fragile than traditional zip cords, the mini cords are about one-third their size and are very useful in maximizing the capabilities of any cable-management system. While judged too fragile to be used in workstation applications, when used in the more controlled and managed environment of the computer room, their fragility proved to be an excellent trade-off against the space savings in the cable-management system.

Another important design consideration was how to determine what type of cabling medium to use and how many fiber strands were required. Just as this question has plagued those designing fiber backbones in the past, it continues to haunt designers of FTTD projects today.

Projecting future needs and planning fiber-optic cable runs is less of a problem with an ABF system, however. With air-blown fiber, additional cable strands or other media may be installed in minutes, with no disruption to the surrounding environment. Installed cables may also be removed, relocated, and reused at any time, over and over again. The only challenge in the Getty Center installation was to ensure that enough additional fiber-holding tubes were provided initially to support the projected long-term growth of the organization.

Anatomy of an ABF system

Building an ABF cabling system similar to the one installed at the Getty Center is accomplished in three simple steps: installing the tube, interconnecting the tube-cable segments, and blowing in the fiber media.

The first step calls for installing a unique product called tube cable, which is a small, tubular-shaped, plastic housing that serves as the routing vehicle for the air-blown fiber-optic cable. A replacement for plastic innerduct, tube cable comes in an assortment of configurations that may include one to nineteen individual tubular cells wrapped with a common external plastic jacket. This jacket gives a tube cable the general appearance and installation characteristics of most other types of cables—for example, bend radius, compression, and pulling strength.

Photo by Sulka & Co.

The first two rows of racks in the centralized computer room of the Getty Center are worked on by AIDCO project foreman Gary Juarez (right) and technician Vasken Bezjian (left).

Tube-cable assemblies are manufactured using a variety of materials and construction techniques, and each type of assembly is specially designed to cope with the specific environment in which it is to be installed. Styles include a wide-ranging assortment of both inside- and outside-plant designs.

In the Getty Center, 19-cell tube cables were installed along the horizontal backbone routes linking the computer room to the outlying electrical closets. Single-cell tube cables were installed in the horizontal routes connecting the closets to the workstations.

An important benefit of tube cable is that it is extremely small. Each tube-cable cell is 8 millimeters, or approximately 1/4 inch, in diameter. In comparison, a tube-cable assembly containing 19 cells is approximately 2 inches in diameter, or roughly the same size as most individual innerducts. This space saving played a crucial part in the success of the Getty project by optimizing the possibilities in a very limited conduit-routing system.

The second step in installing an ABF system begins at the intersection of the tube-cable segments, where individual tube-cable

Fiber—the obvious solution

Dan Silver, 3M Telecom Systems Div.

To manage the planning and implementation of the Getty Center technology network in Los Angeles, CA, the organization brought in 26-year telecommunications industry veteran Dave Archer as senior telecommunications analyst. Working with a team of five specialists, Archer found a cost-effective solution that would meet all of Getty's requirements for flexibility, upgradability, and future growth.

The scope of the project was defined by several parameters. Gigabit bandwidth was required to service a network of more than 2400 nodes. Telecommunications closet (TC) space was at a premium, so the system architecture had to consume as little floor space as possible. And the process of making changes to the network had to be fast, easy, and cost-effective.

In the spirit of this leading-edge facility, Archer's team was challenged to find the best long-term technology solution. "We're building a facility here to serve people for longer than the 50-year life span of normal business buildings," Archer explains.

The Getty Center network had to be designed for computers, printers, and similar devices, as well as videoconferencing. Due to the museum's extraordinary security requirements, telephone and security systems were scheduled to have their own cabling plants and not be integrated into the computer network.

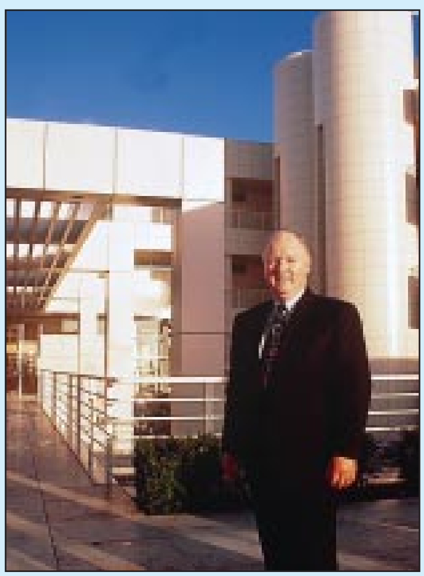

Photo by 3M Telecom Systems Div.

Senior telecommunications analyst Dave Archer decided to use a fiber-optic system at the Getty Center because it was cost-effective and would meet all of the institution's requirements for flexibility, upgradability, and future growth.

So Archer proposed that a fiber-based system be used to meet these needs. "When you need a combination of bandwidth with distance, fiber is the winner," says Archer. "While copper's bandwidth is being pushed, it cannot go as far as fiber."

In the long run, fiber proved to be the most effective solution. Use of a centralized network administration architecture allowed the elimination of all of the electronics between the desktop and computer room, enabling the center to save space. There was no need for switches in TCs, which would have consumed 100 square feet per closet. With 55 TCs on site, the savings totaled $5 million, enough to cover the cost of the entire cabling system.

Fiber also enabled Getty Center to meet its flexibility requirements. Air-blown optical-fiber (ABF) technology was selected for the cabling infrastructure. Because it can be installed in a fraction of the time it takes to pull conventional fiber cable, ABF enables installers to set up new users or make changes in minutes, working from the central equipment room and at the desktop. Had the installation called for copper or conventional fiber technology, it would have required at least one additional full-time technician, resulting in higher costs.

Another factor in the decision for fiber was the center's need to minimize downtime after its move. The staff had to be operational from day one, and the ABF installation made that possible.

Archer believes that examining the big picture was the key to making the right decision, leading him to identify fiber as the most forward-thinking alternative. He convinced Getty's management that the higher cost of fiber up front would be offset by not having to rewire the cabling plant later. "Our responsibility is to outfit the building with technology that will last as long as possible," he says. "Fiber optics is the medium of the future. If you can get to fiber now, it greatly reduces the trials and tribulations of conversions later on."

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cells are coupled, or patched, from one segment to another. A compact, easy-to-use, and inexpensive tube coupler unit is designed for this purpose, and may be used and reused to create any desired coupling arrangement. The coupling arrangement typically provides a continuous, non-stop route from any point in the tube-cable system to any other point.

A protective housing called a tube distribution unit (TDU) is also installed at the intersection of tube-cable segments. Best regarded as a tube-cable patching facility, a TDU provides a protective housing at the point where the tube-cable segments are coupled together, and also at the ends of segments. TDUs may take many forms, including wall-mounted boxes for indoor applications and watertight boxes or splice cases for use outdoors. TDUs may also be sized to create a custom fit in locations that require it.

The third and final stage of installing ABF starts once a tube-cable route is established. At this point the fiber-optic cable is installed using a patented cable-blowing method. Using a small, specialized apparatus called a blowing head and a compressed gas source such as nitrogen, a contractor can install fiber-optic cables in the longest campus cable runs using limited manpower and completing the job in just a few minutes. The process also eliminates the possibility of cable damage during installation, a common risk with conventional fiber.

ABF uses fiber bundle

The fiber-optic cabling used with the FutureFlex system is called fiber bundle. Of unusual appearance and with differing mechanical characteristics, fiber bundle is much more compact than conventional fiber-optic cable. Typical fiber-optic cable, for instance, is approximately $^1/_2$ to 1 inch in diameter; in contrast, fiber bundle is $^1/_{16}$ to $^1/_8$ inch in diameter.

This reduced size is primarily due to the fact that the materials added to improve cable strength in conventional fiber-optic cables are missing in fiber bundle. Conventional cables must survive a rigorous installation process, so most are rated for 600 to 800 pounds of total pulling exertion force. On the other hand, fiber bundle need contain few of these bulky strengthening materials because the method of blowing in the fiber eliminates all pulling exertion force.

Fiber bundle is, however, sheathed with a highly specialized jacketing material that has three key characteristics—it is very lightweight and easily propelled; it is made of materials that have a very low coefficient of friction with the materials used in tube cable (so it travels down tube cables easily and with minimal friction); and, it has a porous surface. The surface pores are caught in a current of air sent down the tube, so that they act like a sail on a sailboat. The specialized jacket both propels and supports the cable along its entire length during installation.

With most strengthening materials unneeded, the remaining jacketing materials in the fiber bundle are designed to provide protection from environmental hazards. For example, fiber bundle, when compared to conventional fiber-optic cable, provides superior protection from the negative effects of water, chemical, or other vapor intrusion. Installed within tube cables, the bundles are protected from freezing and other thermal effects, and from the hazard of shocks and vibrations.

Fiber bundle is available in a variety of configurations, including singlemode and multimode optical fiber, 62.5/125- and 50/125-micron sizes, and individual strand counts ranging from two to eighteen strands per bundle. Larger strand counts are not required, since the system is designed to support most applications point-to-point.

In addition to reducing cabling-installation cost, air-blown installation can eliminate the costly step of adding extra fiber conductors to the cable route, a common practice for future-proofing conventional fiber-optic cable runs. Using the same blowing process, ABF cables may be removed and replaced, reused after replacement, or rerouted to any new destination. All FutureFlex system components are designed to be reusable and are not ordinarily damaged during installation or use. Therefore, they are never rendered obsolete. The ease of installation, reduced cost, and reusable nature of ABF components combine to provide a realistic future-proofing capability that is an inherent feature of the system. ❑

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