Backbone Fiber Optic Cable Installation

by Richard J. McConville

How the United Telephone Company of Florida engineered and constructed a project over 200 miles in length.

Richard J. McConville, a member of Florida Ch. 26, is a Senior Engineer with the United Telephone Company of Florida. He was responsible for the design and engineering of the Talking Bridge, Cape Coral, Florida — 1974.

Mr. McConville is Chairman of the Florida Utility Coordination Committee 1985/1986.

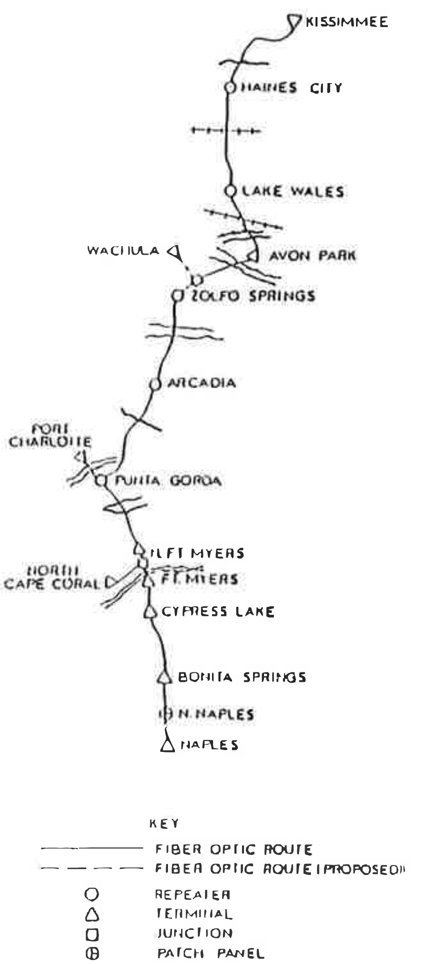
United Telephone Company of Florida's Long Range Plan for interconnecting facilities between Kissimmee in the North Division and Fort Myers in the South Division provided the opportunity to implement an ambitious fiber optic program.

This undertaking was different from any other in the company in that it involved 3 specific estimates and 27 major work orders. The cable construction crossed all four districts in the South Division and part of General Telephone Company's serving area, totalling a distance of 200 miles.

The fiber route was designed to provide the capacity to meet the private line, special service and intertoll requirements. With the addition of incremental fibers, several area reinforcement projects were accomplished very economically. A single mode fiber optic transmission system operating at 1300 nameters and electronics supplying 136 mb/s was selected to allow the Fort Myers area to share in the digital network service offering. This system is soon to be expanded to 565 mb/s.

The engineering and construction approach was based on maximizing utilization of available resources to develop a framework for comparison between existing construction methods and fiber construction methods.

Placing guidelines, established at a joint Engineering and Construction meeting, September 1984, were followed in the design and installation of the fiber cable. Upon approval of the project, the route was selected and engineering began on the fiber optic cable. Preparation of the specific estimate was the first step.



An in-depth route survey was conducted to uncover special or unusual situations that might influence the engineering and construction of the fiber cable. Points of access to the right-of-way were defined. The majority of the cable was to be placed in the road right-of-way by plowing and/or trenching. Traffic control requirements were studied and soil conditions evaluated to determine construction methods that would be suitable. Conflicts and obstructions that would have a direct influence on the selection of splice locations were identified; this exercise permitted utilizing maximum size cable reels. As a further precaution, a ripping pass (prerip) in the same direction as the cable being installed was made mandatory to locate and remove obstructions prior to plowing the cable.

It was decided to bury the cable at a depth of 42 inches in the running line and 48 inches under ditches and at road crossings. Iron pipe was placed at all state road crossings, due to the wet and sandy soil. To meet future demand for fiber, innerduct was placed in the four-inch pipes crossing under railroads, streets, streams and on bridges.

Consideration was given to placing the direct buried fiber cable in a two-inch polyethyline duct; but, after assessing the installation costs, the two-inch duct was ruled out and six-inch marker tape was chosen as an alternative. Railroad right-of-way was considered but due to its lack of proximity to the cable route and the availability of the road right-of-way, it was not pursued.

In the areas plagued with rodent problems between Zolfo Springs and Avon Park, gopher protected cable was specified. The gopher protection, along with 42-inch depth, offered maximum protection to the fiber cable.

To further reduce chances of damage, it was decided to place the splice below ground in Quazite composite splice boxes. This substructure was selected due to its light weight and load bearing capability. The splice box was buried 24 inches below ground surface. Electronic markers were placed over the splice box for future location.

The demand for fiber optic cable was greater than the available supply throughout the undertaking; therefore, it was necessary to work closely with the manufacturer to ensure cable delivery dates were met.

In addition to ensuring cable delivery dates, permits from the Department of Transportation for the use of road right-of-way had to be acquired. The cable was routed through environmentally sensitive areas, requiring authorization from the U.S. Army Corps of Engineers, Florida Department of Natural Resources and Florida Department of Environmental Regulation. Permitting was also required by county and local municipalities. Agreements with the railroad had to be renegotiated because two railroad crossings were required and were not included in the current agreement.

A company inspector was present during all construction work performed by the contractor. When the cable arrived from the manufacturer, it was tested with an optical time domain reflectometer. It was tested again after being placed. If the cable was under unusual stress while being placed, the cable was tested before additional cable was placed from the reel. This safeguard was taken to reduce construction delays. As a result of intensive precautions, cable damage was almost nonexistent throughout the undertaking; only one six fiber cable was cut by a trencher. No other damage was incurred.

In the underground systems, the innerduct was pulled into the four-inch conduit from individual 4,000 feet reels mounted on a specially designed flatbed truck.

If there was more than adequate four-inch duct in the duct system to meet the extended service requirements, innerducts were not placed. When the top duct was available, it was used to add additional protection. All the slack was pulled toward the splice manhole. A butt splice was completed on the lightguide cable by AT&T personnel who used the bonded method while working in a splicing van. The splice was placed in a combination lightguide closure. Before splicing the cable, the ends were linked together and coiled into a 26-inch diameter coil. This method was used to allow the cable to enter and exit the manhole as one run. When the butt splice was completed, the cable re-entered the manhole and coiled easily due to the set the cable had taken while coiled. The coils were tied behind the other cables in the manhole.

The overall undertaking was divided into three sections because of facility reinforcement requirements. Section one, from Fort Myers to Punta Gorda, a distance of 25 miles, was engineered and constructed first. Punta Gorda to Port

Fort Myers, showing the fiberglass duct housing the fiber optic cable.

Charlotte and North Fort Myers to North Cape Coral were included in this section.

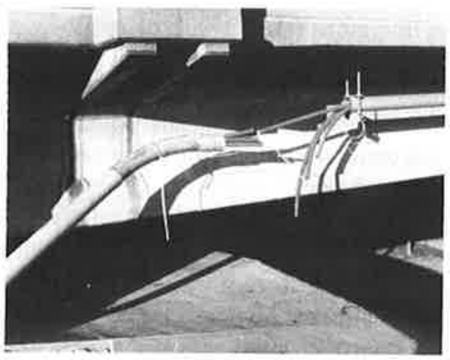
The Avon Park to Kissimmee run, 64 miles, was engineered and constructed second and the Punta Gorda to Avon Park run, 63 miles, was engineered and constructed as the third section. Before engineering was completed on this section, a fourth section was added — the Cypress Lake to Naples run, 27 miles. Construction of the Punta Gorda to Avon Park and Cypress Lake to Naples was completed concurrently.

It was not long before major obstacles surfaced that could have a major impact on the project. The first section of the fiber optic cable from Fort Myers to Port Charlotte was to follow the existing toll route. Reinforcing an existing facility route appeared as a routine job, but this was not the case. The cable was to cross the Caloosahatchee River on the existing Edison drawbridge; however, this bridge is scheduled for replacement within five years. Another river crossing had to be selected.

Consideration was given to an underwater crossing but immediate access to the cable would not be available in the event of failure. Approximately 2,000 feet west of the Edison bridge, the Caloosahatchee bridge spans the river, a distance of 5,300 feet. This was the most likely choice but the underground system from the central office to the Caloosahatchee bridge consisted of small congested manholes and three-inch wood and plastic ducts. All of the ducts were filled or considered unusable. It was estimated that it would cost $50,000 to rebuild the system. Due to the time allotted for completion of the fiber project and the funds available, rebuilding the system was not a viable solution.

As an alternative to rebuilding the system, a work order was prepared to push a rigid one-inch smooth wall plastic pipe to clear blockages. This method was successful and the duct was cleared from the central office to the bridge approach. The $50,000 rebuild was deferred.

In order to attach a duct to the bridge, a permit was filed with the Department of Transportation, which initially denied the request. The DOT was concerned about disrupting the high volume vehicular traffic using the bridge. After extensive negotiations, the permit was approved with the condition that the work required be completed at a time and in a manner not in conflict with traffic flow.



Four 1-1/4 inch corrugated PVC innerducts were placed in the fiberglass duct on the Caloosahatchee bridge. The fiberoptic cable has been installed in one of the innerducts.

When the Caloosahatchee bridge was built, malleable concrete inserts were installed by the bridge contractor for the telephone company. These inserts, used for installing supporting rods, support 1,430 pounds and are eighteen feet apart. The threaded rods used for suspending the hanger system were screwed into the inserts supporting a five-inch fiberglass duct. Four 1-1/4 inch corrugated PVC innerducts were placed in the fiberglass duct, using a 5,400 foot length of strand as the winch line. To pull the fiber cable into the innerduct, a small diameter marine rope was used as a winch line with a capstan winch. A swivel and shackle were used to connect the Kellum grip to the winch. Polywater lubricant was applied to the innerduct to reduce friction.

During the pulling-in operation, the cable pulling tension was measured with a dynamometer. On the first attempt, the pulling tension exceeded the maximum pulling tension of 600 pounds and had to be abandoned. Investigation of the problem revealed that a jet line had snagged in the innerduct. It was removed and the cable was pulled in on the second attempt. The pulling load did not exceed 250 pounds.

The fiber optic cable reel was placed on the south side of the bridge and the cable pulled through the innerduct to the north side of the bridge. The remainder of the cable was removed from the reel, laid out in a figure eight pattern to prevent kinking and pulled from the other end into the conduit to the Central

Office. This method was also used to pull long reels of cable in the underground system.

Crossing a second river in this section from Punta Gorda to Port Charlotte, a distance of 6,375 feet, presented different challenges. Unlike the Caloosahatchee bridge, the Barron Collier bridge over the Peace River did not have inserts installed and the bridge had to be drilled. Two adhesive anchors were installed every twenty feet into the bridge and the rods were driven into the anchor. The adhesive capsule creates its own base material which bonds with the bridge concrete. Standard hanger assemblies were connected to the rod. The hangers support a four-inch fiberglass conduit. Three one-inch flex innerducts were pulled into the fiberglass duct. The cable was pulled across the bridge in one pull.

North of the Caloosahatchee bridge, 5,000 feet of 4-inch PVC duct was placed by the trenching method to connect to the manhole system for the North Fort Myers central office. It was at this location that an area reinforcement project was added to the undertaking. The 18-fiber cable connects to a 22-fiber cable to the North Fort Myers central office and a 4-fiber cable connects to the North Cape Coral office.

In North Fort Myers, duct was removed from the underground system by a contractor building a sewer line and not replaced. After the duct was replaced and the innerduct installed, placing of the fiber cable in the underground went smoothly.

It is the policy of the Department of Transportation to require utilities to place their facilities back at the field edge of the right-of-way. When the engineers laid out the buried route between North Fort Myers and Punta Gorda, the fiber was placed alongside the existing cable on the back of the right-of-way. The contractor trenched the cable using a Vermeer Trencher. It was not long before rock was encountered at 30 inches. With concurrence from the DOT, the running line was moved two feet toward the road. The trencher avoided the rock and the 42-inch depth was maintained. On the north end of the job, heavy rock was encountered and neither a backhoe or trencher could penetrate it. The contractor obtained a Vermeer rock cutter T600 with a rock chain to remove the rock.

There were five creek crossings and a major road crossing in this section. A four-inch pipe was pushed under one of the creeks and three one-inch ducts were plowed into the other creek. Three crossings were completed on overpasses.

In the section between Avon Park and Kissimmee, there were four separate work orders in progress at the same time. Coordination of material with labor and equipment was essential. The General Telephone Company and North Division areas were new to our engineers and they put a great deal of effort into researching the records and coordinating their plans with utilities and municipalities. Locating utilities and other obstructions during design was essential as maximum cable lengths were used to keep splices to a minimum. Care had to be exercised when placing the cable near citrus grove areas — construction crews had to keep clear of the groves.

Contracting crews are working to complete the crossing of Charlies Creek in Wauchula, Florida.

Private right-of-way was required on the west side of Haines City. The existing right-of-way was congested with water and sewer lines and the space available would make the fiber vulnerable to water main breaks. Placing the fiber in a private easement reduced the risk.

A joint venture was arranged with GTE Sprint (now US Sprint) as a condition for issuing a permit by Polk county, due to the limited right-of-way. Two 1-1/2 inch corrugated ducts were plowed in with a Ditch Witch 6510 equipped with a vibratory plow one-inch off the pavement — extreme caution was required. No problems were encountered by either crew when the fiber cable was placed. Due to the distance between Avon Park and Kissimmee, two remote repeater structures were placed to house the regenerators, one in Lake Wales and the other on the east side of Haines City.

Maneuvering the ridges and side slopes along the right-of-way on US 27 was the job assigned to the Case 475 equipped with a vibratory plow. A ripping pass was accomplished before the cable was plowed, enabling the cable to be placed with relative ease from Lake Wales to Dundee.

Meeting the in-service date on this section was essential as a major toll reroute was involved. With advance planning and coordination, the goal was accomplished.

Construction of the third section between Punta Gorda and Avon Park, which consisted of 7 work orders, was no sooner in progress when the long-delayed summer rains began; side swales filled with water and the ground became difficult to maneuver. Most of the right-of-way in this area was narrow and low and, with the rains, became a swamp. The forward motion of the machines was causing extensive damage to the right-of-way. To overcome this problem, cable laying machines that could work in wet areas were needed. A plow train and crew consisting of two Kimutsu, A D-85 and D-65, were moved from another part of the project to tackle the job. The D-85 was equipped with hydrostatic drive and a hydraulic static plow with offset feature. The crews, working as a team, placed the cable and a Case 450 with swamp tracks was used to restore the right-of-way.

There was extensive construction along the route which the contractors had to contend. Plowing the cable in a narrow right-of-way with a road resurfacing and widening job in progress was accomplished without any major problems. In one area that had just been reseeded, the contractor had to place the cable alongside a newly installed six-inch water main.

Overcoming the adverse conditions encountered in this section was accomplished through the coordination and cooperation efforts of the contractors working together to complete the projects on time. When one piece of machinery was not equipped to do the job, another unit was brought in. If sufficient manpower was not available, additional manpower was provided. Despite all the obstacles encountered in this section, the fiber cable was placed and the in-service date met.

The majority of the cable between Naples and Fort Myers, which consists of four work orders, was placed in the underground system. The cable was hand pulled with manual assistance at intermediate manholes. Pulling tension did not exceed 200 pounds.

In Bonita Springs beyond the duct system, a four-inch duct was available to place the fiber cable. A rigid one-inch smooth plastic pipe was pushed into the four-inch duct to clear any blockage that existed. The fiber cable was pulled into the one-inch pipe. Rock was also encountered in this section and a Case 580 backhoe equipped with a three thousand pound hammer was used to remove the rock. Once the rock was removed, the final leg of cable was placed.

As the fiber optic cable extends over exchange division and company boundaries, extra precaution was taken in the design, engineering and construction of the cable to reduce maintenance costs, minimize service interruption and dramatically extend the service life of the cable.

The backbone fiber optic cable project has provided an opportunity to develop through hands-on experience the technique required for establishing a fiber optic program.

By utilizing available resources and having the ability to handle a fast-paced project, this undertaking was completed on schedule and within the budgeted constraints. The success of this undertaking was the result of conscientious attention to the details of planning, engineering and construction by the team assembled, backed by efficient organization support. IRWA