A FIBER OPTIC PRIVATE NETWORK FOR THE DALLAS MORNING NEWS

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ABSTRACT

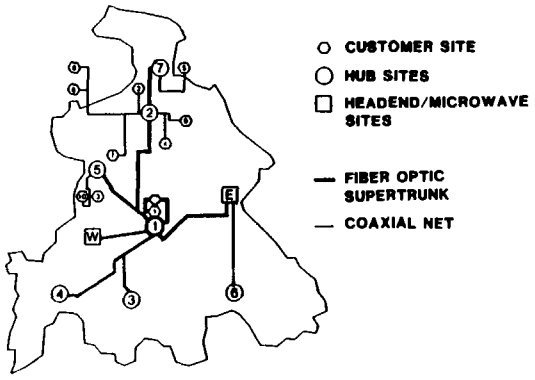
Classically, data communications for public and private institutions have been accommodated on a coaxial institutional network (shadow trunk) using RF data modems at the customer premise.

Warner Amex Cable Communications Inc. has installed an 80-km fiber optic backbone network in the City of Dallas to accommodate high quality, high capacity traffic including video and large private data users. The first major user of this network is the Dallas Morning News, for which a private link was established.

In the Dallas Morning News application, we are transmitting information from two laser-fax machines for platemaking between the plant in downtown Dallas and Plano--a distance of 36 km without repeaters at an optical transmission rate of 44.7 Mb/s. This paper will describe the system, its construction, and performance.

THE DALLAS NETWORK

The Dallas Morning News installation is a private system operating over a newly installed fiber backbone network which forms a part of the Warner Amex cable franchise in Dallas, Texas. Warner Amex won the cable franchise in 1981 and constructed the network using an arrangement of hubs (shown as circles in Figure 1) from which cable TV would be distributed to subscribers in Dallas. Cable TV programming is distributed to these hubs from the headend using AML microwave. As a requirement of the franchise, a shadow institutional network was constructed using coax, which is to serve public and private institutions with data and video communications services. This coaxial network roughly shadows all CATV trunk and, as such, provides a tree-type data network which emanates from the hubs. The hubs can, therefore, be used as cross-connect points or pseudo-central offices. Although coax provides an excellent means for interconnecting multiple low capacity data users, it is not well suited for longer distance trunking of high capacity users. Also, coax is not a preferred approach for hub interconnect for data or video over the distances imposed by the Dallas geography. The amplifier cascades reduce reliability and performance below that desired for either service. A suitable hub interconnect was required in order to establish a full data network and as a potential back-up for the video microwave feeds. Although the microwave has been performing exceptionally well for the subscriber video, and, therefore, requires no alternate back-up, the microwave has a limited return (two-way) capability. For data, another approach was needed.



Interconnect Concept
Figure 1

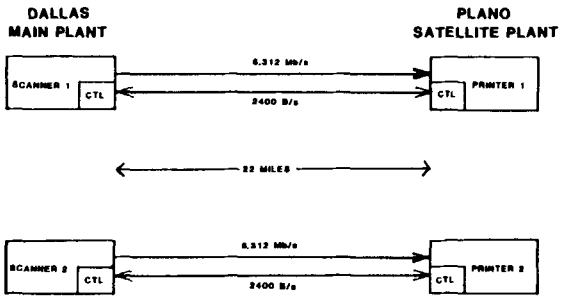
Fiber optics is an exceptionally high capacity, low loss, and noiseless medium which has proven abilities for long distance transmission without repeaters (amplifiers). In 1983, Warner Amex established a program to evaluate fiber optics as a potential means for interhub supertrunks for video as well as data. The results of our video evaluations were reported at the 1983 and 1984 NCTA Conventions [1, 2]. Although it is still under evaluation for full-scale deployment, we were very successful in demonstrating that single mode fiber was indeed capable of competing with FM on coax for video supertrunks while providing performance of 8 to 12 channels per fiber with 60 dB weighted SNR. We were also quite aware of the widespread use of fiber for data and voice traffic, and its ability to provide high capacity trunks over distances well in excess of our hub spacings without any repeaters at all. Our cost studies [3] showed fiber to be the most cost effective means for data transport in the metropolitan area when circuit capacities exceeded three to four DS-1s (1.544 Mb/s circuits). Further implementation of the fiber as drops from

the hubs would depend on user need and capacity. Small users, for instance, could access the coaxial network when fiber is not justified. If these users require interconnect with locations served by other hubs, then fiber would be used as the high volume interconnect. We further developed a means for fiber trunking of the signals directly from the coax without changing the format. Thus was created a hybrid fiber/coaxial network, shown conceptually in Figure 1, which takes optimum advantage of the capabilities of both technologies.

With this knowledge, fiber optics became the obvious choice for interhub trunking. A decision was made to implement these trunks as the higher volume business customers required service to certain areas or as customers began to cluster in a hub service area. Warner Amex was now in a position to serve the Dallas community with state-of-the-art fiber optic services.

THE REQUIREMENT

The Dallas Morning News (DMN) entered the picture in 1983 as a user of state-of-the-art printing and telecommunication mediums. DMN was searching for a highly reliable means of transmitting laser-fax information between their printing plant in the Dallas central business district (CBD) and their satellite plant in Plano, 22 miles away (see Figure 2).



The Dallas Morning News
Press-Fax Requirement
Figure 2

Because of the location of the new Plano north Dallas printing facility, communications capable of transmitting pages of text and graphics between the composing room in the downtown headquarters location and the north site was necessary. The alternative to a communications link was to physically transport page negatives by automobile to the north printing plant.

A decision was reached by the Dallas Morning News to buy digital laser facsimile equipment (state-of-the-art) to read page paste-ups and write page negatives from which offset plates could be made. This decision was based on a number of reasons. One was that normal copy flow from the newsroom precluded physical transport of page negatives to the north site. Another was to enhance the quality and speed of the operations of the Dallas Morning News.

The alternatives for a digital transmission link were to buy services from the existing local exchange carrier, buy and install and own a microwave system, or provide for a private terrestrial communications system (coaxial based or fiber optics based).

A very real concern in using a microwave system was the frequency slots available (congestion), the environmental impact of a 24-mile microwave link, and the dynamic real estate development in the Dallas area--a fear that new and interfering buildings would be built in the line of site and thus interrupt the communications capability of the locations. This led them to believe that microwave was not the best option.

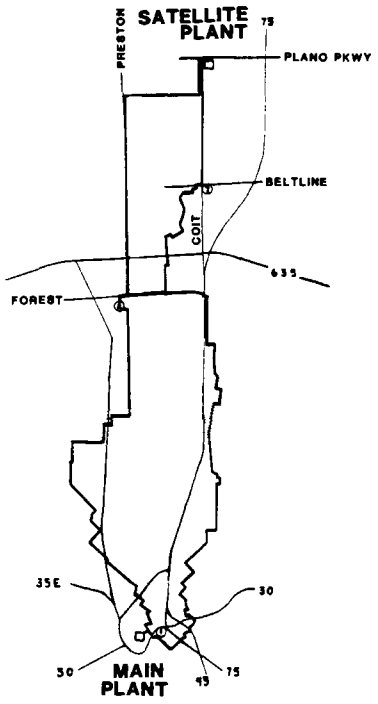
The minimum bit rate needed for the systems was DS-2 or 6.312 Mb/s (T-2). The local exchange carrier was initially able to provide this service only by multiplexing T-1 circuits (1.544 Mb/s, DS-1), and thus a private terrestrial link was the most viable approach.

SYSTEMS IMPLEMENTATION

The interest expressed by the DMN for a communications link to Plano from the CBD prompted Warner Amex to consider building the fiber trunk between Hubs 1, 2, and 7, and to extend the trunk into Plano to serve the DMN satellite plant. The requirement for a high degree of availability (99.98%), however, underscored the need for some path diversity in the event that the cable was damaged. This is a concern of all commercial customers since it may take from 4 to 12 hours to restore a cable, depending on circumstances. Our AML microwave system was evaluated as a means of providing the diverse path. Although it was capable of handling the capacity requested by the DMN, the cost of interfacing a hybrid fiber/microwave link, the cost of microwave transmitters (one per channel at $15,000 each), and the limited per-channel capacity (6.3 Mb/s) eliminated this as a consideration. A coaxial trunk was also considered. Since this could be implemented by reconfiguring and activating the coaxial institutional network already in place, it would be inexpensive. Again, however, the cost and complexity of interfacing the frequency channelized carrier based coaxial system to the fiber system, which employs TDM transmission, was a negative factor. An additional negative factor was the length of the amplifier cascade from the Dallas CBD to Plano. A diverse fiber route, on the other hand, was not only fully compatible with the primary, but could be implemented with no added electronics. Since it could be overlashed on the existing coaxial cable plant, construction was

inexpensive. Fiber became the obvious choice for the back-up link with all factors, including future expansion, being considered.

The route is illustrated in Figure 3. The direct line distance between facilities is approximately 22 miles. The cable route distance is 25 miles for the primary and 27 miles for the redundant path. The cable enters Hubs 1 and 2 and passes Hub 7, forming a double loop for redundant interconnect of Warner Amex hubs. These hubs can, therefore, be used for repeaters, routing nodes, maintenance points, or hybrid (coax/fiber) network interface points. Since the DMN requested a private network, interface at the hubs was not necessary. In fact, repeaterless operation was obtained for the full distance between the Plano plant and the CBD plant. The four fibers dedicated to the DMN were spliced through for the interconnect, and all electronics resides within the DMN facilities. Although all maintenance points are within the DMN, auto-dial fault alarms automatically alert Warner Amex maintenance dispatch over phone lines in the event of a major or minor alarm condition.



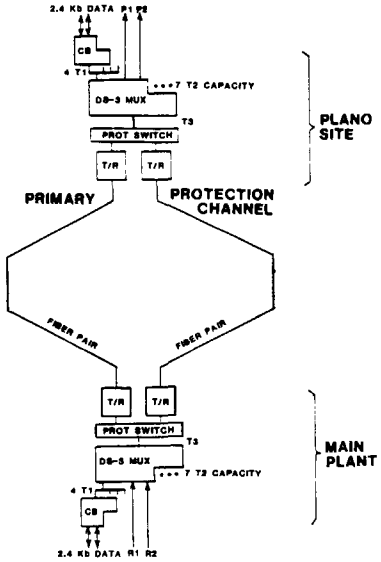
Routing
Figure 3

Approximately 90% of the plant was constructed aerial, with the remainder in underground conduit. Construction was accomplished with cable TV subcontractors using practices which are modifications of Warner Amex standard coaxial practices. Splicing was performed primarily by Warner Amex technicians after a period of on-the-job training by the cable supplier, Siecor. The project was constructed, installed, and activated on schedule. Construction, maintenance, and operation is managed by Warner Amex Dallas Commercial Services operations.

FIBER OPTIC SYSTEMS DESCRIPTION AND OPERATION

Figure 4 shows the schematic block diagram of the system. The main elements are:

a) Channel banks and data channel cards
b) Multiplexers
c) Fiber optic transmitters and receivers
d) Fiber pairs



System Block Diagram
Figure 4

The equipment used is the DML-45 single mode lightwave transmission terminals supplied by Rockwell International. The channel banks and data channel cards interface with the laser-fax control data lines and combine these digital lines (two 2.4 Kb/s channels) into a common data stream at a DS-1 rate (1.544 Mb/s). Channel cards are modular and can be mixed in each channel bank to accommodate various combinations of data rates. Standard RS232 interfaces are provided.

The DS-3 multiplexer contains data ports which can interface at a DS-1 rate (1.544 Mb/s) or a DS-2 rate (6.312 Mb/s). In this application, it is equipped with two DS-2 modules and one quad DS-1 module plus protection cards. The DS-3 multiplexer is expandable to accommodate seven DS-2 circuits or 28 DS-1 circuits. The multiplexer combines these circuits to form a single high speed DS-3 rate (44.7 Mb/s) line for transmission over the fiber optics.

The fiber optic transmitters receive the DS-3 rate signal, intensity modulate a laser, and

transmit this optical signal over the fiber to a mating receiver at the repeater or opposite terminal. The receiver contains a photodetector which converts the optical signal to a binary electrical signal.

The terminal electronics at each site is capable of working without repeaters over the full length of the single mode cable. The optical transmitters and receivers are duplicated in order to provide redundant electronics over the redundant path in the event of failure or damage to equipment or cable.

Protection switching, internal to the multiplexer, automatically switches from primary to the hot standby protection channel in the event of a failure or signal degradation beyond a certain threshold. Redundancy is provided within the multiplexers at the DS-3, DS-2, and DS-1 levels. The protection electronics monitors the bit error rate (BER) on the primary channel, and if it falls below a certain threshold (10^{-7} nominal), switches automatically to the back-up hot standby channel.

In each of two diversely routed cables, there are two fibers for DMN operation. In one cable, the two fibers provide the primary channel; in the other cable, the two fibers provide the back-up protection channel. In each pair, one fiber is for downstream data and the other is for return. The fiber used is single mode operating at 1300 nm wavelength.

RESULTS

The system was designed for a spliced fiber loss of 0.6 dB/km. Actual plant loss averaged 0.45 dB/km spliced, providing an end-to-end loss of only 17 dB for the primary path and 19 dB for the back-up. The equipment had an allowable optical power margin of 31.5 dB between terminals (connectors included). An excess power margin of 12.5 dB, therefore, remained. Key performance parameters for the system were a received bit error rate (BER) of 10^{-9} and an availability of 99.98% (1.75 hours/year downtime maximum). BER was monitored full time for a period of two months. During that time, no bit errors were recorded. Since activation in December 1984, availability has been 100%. All newspapers printed in the Plano satellite plant since January 7, 1985, have used the fiber link for press-fax.

CONCLUSION

Fiber optics provides an excellent, cost effective, highly reliable, ultra-high quality means for data transmission in the metropolitan area. For newspaper operations requiring satellite plant printing or printing operations separated from composing, fiber optics is a very practical transmission medium for linking the operations. Fiber offers the wide bandwidth necessary to operate laser-facsimile equipment without the degradation in performance often suffered with other narrowband or more noise-susceptable means of transmission such as microwave or telephone lines. Cable TV networks offer a convenient and low cost facility for constructing such links, and due to the usually abundant aerial right-of-way, offer a low cost opportunity to provide fully diverse routing--the ultimate in systems reliability. Fiber optics is a mature technology and uncomplicated to build and maintain. It may be considered without reservation for private network applications.

REFERENCES

[1] F. Ray McDevitt and Robert J. Hoss, "Repeaterless 16 km Fiber Optic CATV Supertrunk Using FDM/WDM," NCTA 83.

[2] Robert J. Hoss and F. Ray McDevitt, "Fiber Optic Video Supertrunking; FM vs. Digital Transmission," NCTA 84.

[3] F. Ray McDevitt and Robert J. Hoss, "Application of Fiber Optics to Networking in the CATV Industry," FOC 83.