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CONSTRUCTION OF A FIBER OPTIC COMMUNICATION NETWORK

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The objective of this research is to establish a fiber optic communication network and demonstrate the conversion of electrical energy to light (optical) energy. The authors have the further objective of teaching students the characteristics of a real fiber optic system. In the initial design, the authors decided to use commonly available and widely used hardware and software, to construct a fiber optic link step by step, to observe and troubleshoot each step and to catalogue problems and outcomes in order to share this research with students in the college's electronics and industrial engineering technology programs.

The components include a transmitter, a receiver, two converters, and transmission media. The system provides Full-duplex transmission: a data signal can be transmitted in both directions simultaneously. In order to transmit a real message, we decided to use two computers as a basis for a peer-to-peer computer network.

In a conventional communication system, a signal travels over a pair of copper wires toward a receiver. Electrical signals originate in a generator. These data signals are encoded/modulated, and then enter a transmitter. The transmitter transmits the signal over a transmission link. At the receiver side, the signals must be decoded/demodulated to extract the original digital data.

Our system differed from a conventional network because we selected optical fiber as the main transmission medium. The electrical data signal is converted to an optical signal at the transmitter, and then the optical signal is converted to an electrical data signal at the receiver.

Our research consisted of three elements: computers, fiber link, and converters.

We selected two Gateway 2000 computers to transmit and receive messages. Each computer had a central processor microchip (Intel 80486 microprocessor), which has a 66 MHz computer clock speed.

We decided to use Microsoft Windows NT 4.0 Workstation as an operating system, because of its versatility and wide use in industry.

Since Windows NT requires at least 12 MB of RAM, we first upgraded the hardware of both computers. This entailed removing the computer case from the system unit. The RAM Memory bank was located, and a SIMM Module of 8 MB was installed into a 30 pin socket in the memory bank. Each Gateway Computer had 8 MB of RAM originally. By doubling the RAM, the computer's RAM was enabled to run multi-applications simultaneously.

Since the computers had been used previously, and contained several files unrelated to this research, we decided to purge the hard drive. We had to format the hard drives and then we installed DOS version 6.22 and a CD ROM driver (4x CD-ROM Drivers for A-SB4000UK). Windows NT 4.0 Workstation was then installed into both computers from a CD ROM.

Next we configured the network. First we chose the protocols for the network. A protocol is a set of rules used to govern the data transmission in a network. Since we want the system to be able to work with different networks, we selected the following protocols:

- TCP/IP. This protocol provides communication across interconnected networks. We chose this one for communicating with non-Microsoft system such as UNIX. TCP/IP is required for Internet communications.

- NWL Link IPX/SPX. This is a standard network protocol for many sites. It supports Novell’s NetWare client-server applications. We choose this one because our school offers NetWare 4.11 courses so we can connect to the school’s server.

- NetBEUI. This is a protocol used for a small size local area network. We chose it so that we could communicate with other computers that use the same protocol, NetBEUI for Windows NT network.

Our next task was to establish a security system for the communication network. This required creating users, establishing passwords, and assigning rights to each of the Principal Investigators,(PI).

Our next task was to set up a messaging system. We created a Post Office with a Mail Box for each user. The computers were connected by a twisted pair of copper wires as a test communication link. We tested the software to insure that the computers were operating as a network and formed a communication channel.

After that, we built our file system structure. In order to make the management of the files easier, we created the following directories:

- Application directory (APPS). This directory is used to hold the application software, such as : Word, XL, Access.

- Shares directory (SHARED). This directory is used to hold information shared by users of the network.

- Users directory (USERS). This one contains all users' home directories.

After the system was configured, software for the preparation of data was installed. We installed Microsoft Office 7.0 for Windows 95, which allowed us to use the software programs WORD, EXCEL, ACCESS, and POWER POINT. We created files, and graphics in Word and used these files as data.

A network was then established using conventional copper wires (UTP Unshielded Twisted Pair) to connect the computers. The challenge was to generate and transmit data from the first computer to the second computer over a wire network. There were at first numerous problems configuring the computers and establishing the proper protocols. After we established communications over a copper wire network, we proceeded to construct the fiber optic link.

The biggest challenge of this research is to make an optical path for light to travel. The transmitter signal was converted from electrical energy to light. The light traveled over a fiber optic line to the receiver. The receiver converted the light signal to electrical energy.

To build the system we had to make connectors that were used to connect the components of the network. Two converters were used to convert energy. Each converter consisted of an RJ45 plug with UTP cable. This UTP cable is connected to the Ethernet Card in the computer. The opposite side of the converter has two ST adapters. Each ST adapter is connected to a fiber optic cable using ST connectors. One of the cables is for transmitting data and the another is for receiving data. Fiber Optic Cables do not allow Bi-directional Data Flow. The converters have an LED to indicate the traffic of the data on the fiber optic line.

Since none of us had experience making fiber optic connectors, we did each step several times to understand the procedure and to let our students participate in the assembly.

After successful deployment of the fiber optic network with 50 cm length fiber, we constructed two new fibers with lengths of 30 m each. The fibers were constructed. We interchanged the new fibers into the network, and the network is now up and running with the 30 m fiber. The network was tested again over the new length by transmitting files. The cataloging of each step, and in particular the successful transmission of data over increasingly longer spans of fiber optics, have demonstrated the feasibility of fiber optics to the authors and now provides useful classroom exercises for hundreds of students.

We have successfully demonstrated that a fiber optic network can be constructed, and that data prepared on either side of the network can be transmitted , received, and decoded.

This research included the selection and construction of both transmitter and receiver, system configurations, energy conversion, and the use of parts and tools of a fiber optic system. From this research, the students participated in the new exciting field of fiber optic communications.

<u>Principal Investigators</u>

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