LIGHTWAVE APPLICATIONS IN COMMUNICATIONS - AN OVERVIEW

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ABSTRACT

Lightwave applications now range from Kbps to Gbps systems. They include both local data services and longhaul transmission in terrestrial and submarine applications. LAN and subscriber loop applications start to build up enough volume to allow lightwave products to be manufactured at low cost.

Introduction

In the early nineteen seventies, Corning Glass Works demonstrated the first optical fiber with low enough transmission losses to threaten other high capacity transmission media, such as the then popular circular, millimeter waveguides. Ever since, lightwave has made steady, sometimes dramatic, in roads, competing successfully with microwave relay and coaxial transmission cable in the long haul business as well as the data transmission in Local Area Networks (LANs) and subscriber loops. Applications in these areas will be discussed.

Long-Haul Transmission

Initial Lightwave Systems used multimode technology and were installed in metropolitan areas with dense microwave networks and congested cable ducts. They operated at 45 Mbps, 90 Mbps, and 135 Mbps. As the cost of single mode and multimode fiber became comparable and laser technology, including reliability,dramatically improved, there was an almost complete shift to single mode systems in the United States. The fact that development on a transatlantic, single mode laser cable (TAT-8) was started in the same decade, was an indication of the trust that was placed in the technology. Initial introduction of Wavelength Division Multiplexing (WDM) to increase the capacity of multimode terrestrial systems was clearly defeated by higher bit rate, lower cost multimode, and later, single mode systems.

This trend to higher bit rates has continued, and there are now 1.7 Gbps systems commercially available while, as presented later in this session, researchers have demonstrated systems with bit rates in the tenths of Gigabits (Figure 1).

Meanwhile, research in coherent systems is going on with the goal of approaching ultimate receiver sensitivities and futher increase repeater spacings. These systems (Figure 2), both hetero and homodyne, are very similar to our microwave radio systems. Even nonreciprocal devices, such as Faraday isolators, start to play the role all too familiar to the microwave community. While there have been coherent heterodyne systems deployed in Europe (see corresponding paper in this session), the widespread commercial use of coherent systems will depend most on the availability of highly stable semiconductor lasers.

Subscriber Loop

The U.S. Telephone Companies (ROBCS) have decided very early to install, almost exclusively, single mode fibers. By doing this, they definitely planned for future expansion, banking on the need for broadband services in the office and even the home. This decision coupled with the potentially very high volume of LW products has already exerted an intense pressure on the lightwave equipment suppliers to make their products cost-competitive with copper. To make effective use of the fiber bandwidth, the RBOCS will almost certainly have to offer some kind of a video service.

Local Area Networks (LANs)

Distance limitations, Electro Magnetic Interference (EMI), and ground loop problems in copper networks made multimode

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a fiber a very attractive medium for data distribution, even at very low bit rates. One example is the introduction of lightwave modems at 19.2 Kbps (RS232C) which are bidirectional using time compression techniques, and LEDs which function both as transmitters and receivers (Figure 3). This scheme cuts the fiber cable, connector and electronics costs in half and extends the distance from 50 feet on twisted pair to several kilometers on fiber. The potential market for such devices, if incorporated in PCs or other workstations, is very large (Figure 4). At bit rates of about 10 Mbps, lightwave communication equipment for automated factories is keeping pace with this expanding market. Since factories produce a lot of EMI because of DC switching, etc., fiber is a natural. A factory LAN called MAP (Manufacturing Automation Protocol) is presently being standardized by the IEEE standards committee 802.4, and fiber is becoming an integral part of the standard (Figure 5).

Finally, there is a 100 Mbps token passing ring network, the Fiber Distributed Data Interface (FDDI), parts of which are already on American National Standard. This network may be the major back end system in the near future.

Conclusion

It has been shown that lightwave communication products cover the whole range, from low bit rate (Kbps), short distance to very high bit rate (Gpbs), long distance, communication systems. These systems do not yet strain the bandwidth of the fiber. The creation of communication services that utilize this fiber capacity which are attractive to the consumer are a challenge to both the marketers and engineers.

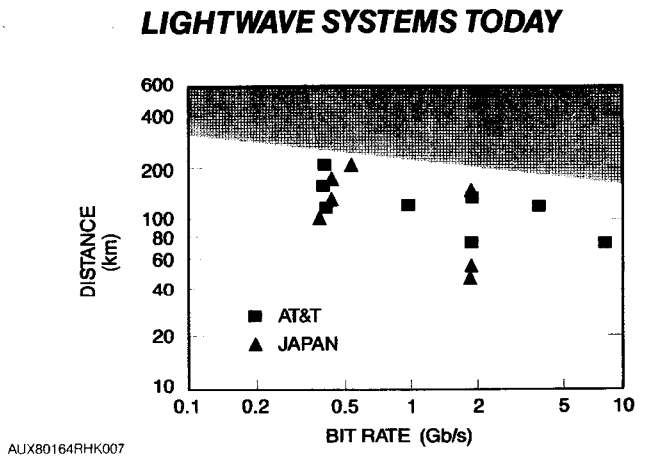
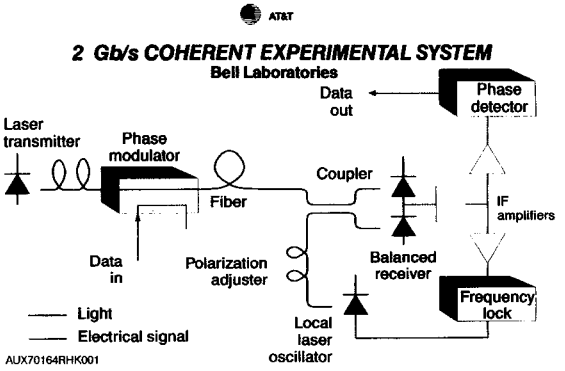


FIGURE 1



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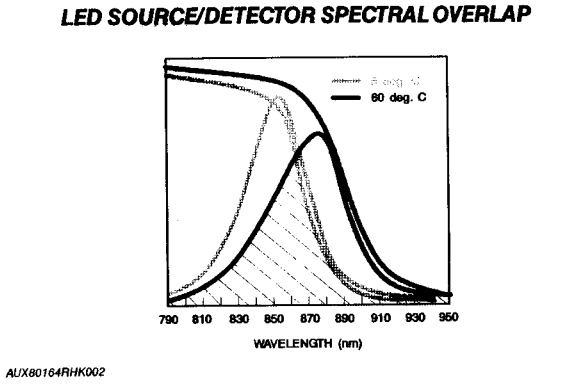

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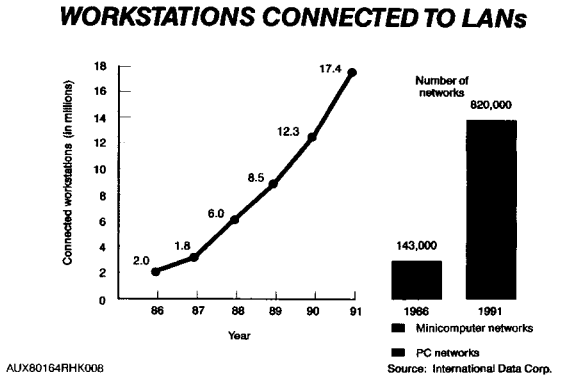

FIGURE 4

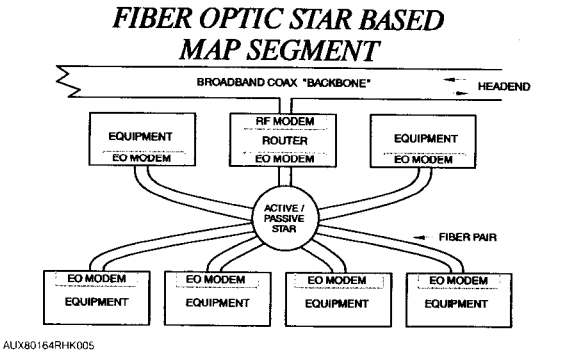

FIGURE 5