A Review on Enhancement of Optical Communication Based on Laser Source Input

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Abstract—An optical transmitter or a light source is required so that data can be transmitted through a fiber optic cable. In fiber optic communication the fiber optic transmitter is a major element and the selection of proper or required fiber optic transmitter completely depends on the application that is going to use it. Fiber optic transmitter has many characteristics. For fulfilling the particular requirements the fiber optic transmitter specifications are examined for a specific application. Therefore this paper will discuss the work done of various researchers.

Keywords—*Fiber optic transmitter, Time Division Multiplexing (TDM), Space Division Multiplexing (SDM), Wavelength Division Multiplexed (WDM), Optical Networks.*

I. INTRODUCTION

The Wavelength Division Multiplexed (WDM) transmission systems are used as a primary choice for future telecommunication applications due to the rapid increase in bandwidth demand with the rise of the Internet. In the WDM approach bit rate is kept the same and extra wavelengths are added, which carries the data at the same bit rate. As compared to Time Division Multiplexing (TDM) and Space Division Multiplexing (SDM) approaches the WDM approach seems to be the most practical in current telecommunication technology. In SDM approach additional fibers are required and each fiber needs a different set of optical amplifiers. Because of such requirements, the SDM approach proved to be more expensive when data is transmitted over long distance. Whereas, in case of a TDM approach, for increasing the speed of individual channel it requires very high- frequency optical modules. As WDM transmission systems use the lower bit rates per channel, therefore, the distance limit caused by polarization mode dispersion and chromatic dispersion is greater as compared to TDM transmission systems.

For this particular paper, the WDM system is chosen because they are more cost-effective and modular, as compared to TDM when it comes to design complicated networks. The tradeoffs are discussed in detail in [1]. Electro-optical switching or electronic switching is deployed in most of today's fiber-optic networks. It is necessary to keep the signal photonic during its complete optical path so that very high speed is obtained through optical systems. Optical routing and switching of the signal are provided at all the nodes and these nodes are connected through the optical links to form an optical network, all of this is done without electronic regeneration. With the help of non-zero dispersion compensating fibers, optical cross-connects, Raman amplifiers, Erbium- Doped Fiber Amplifiers (EDFA's), and other optical devices the WDM network will soon be a reality in the nearby future. Such systems provide powerful advantages to the telecommunication industry. The transparent protocol formats and bit-rates are provided by all-optical WDM networks and also at intermediate nodes, the need for costly electronic 3R regeneration is eliminated. Soon the metropolitan area networks will be using these networks too in access networks and these networks may become the essential national backbone for any network system. An optical WDM transmission system with 4 channels is shown in figure 1.

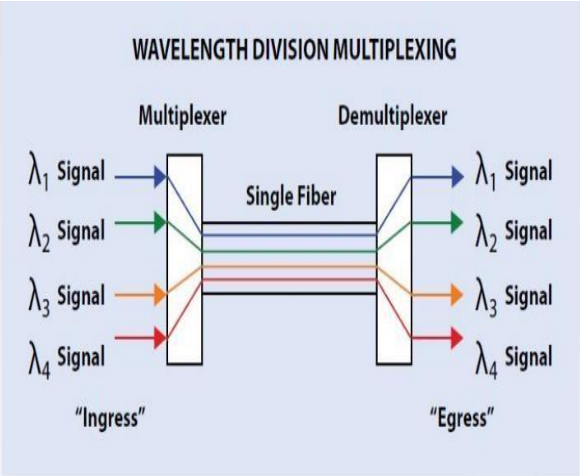

Figure 1: Optical WDM Transmission System

The power level is one of the main aspects of the fiber optic transmitter. For transmitting the light to another distant end, all along the fiber optic cable, the fiber optic transmitter is supposed to output the light at a high level so that it can reach there. The length of fiber optic cable may vary from a few meters to kilometers. And for distant transmissions or extended cables, the power of the transmitter is of great concern.

The light type is also a matter of concern. There are two categories of light: incoherent and coherent light. A single frequency is contained by the coherent light whereas, in incoherent light, there is a different kind of light packets that have a different frequency. But in some incoherent emitters only single color is emitted because their wavelength or frequency is set for that purpose only. Therefore, the light's wavelength or frequency is also a major factor. Mainly these fiber optic systems are operated at a given wavelength.

The data rate of overall transmission is affected by the transmission modulation rate. For example, the telecommunications systems transmit the data at GBPS whereas as some low rate systems transmit data only a few MBPS.

II. TYPES OF FIBER OPTICS TRANSMITTER

In today's time, two types of fiber optic transmitter are being utilized and semiconductor technology is used for both types. They are:

- Laser diodes
- Light emitting diodes (LEDs)

There are many benefits of using semiconductor optical transmitters as they are reliable, convenient, and small. Though, both these optic transmitters are applied in different applications because of the difference in their properties.

Laser Diode Transmitter: - Telecommunication networks where cost is not a matter of concern use these laser diode fiber optic transmitters. They are more expensive than other types. As the power of the LED transmitter is more but the output of laser diode emitter is higher than the LED. A laser diode transmitter can emit the light of 100 mW. The simulated emissions are used for generating the light. The type of light that is generated is of coherent type. Additionally, greater levels of coupling efficiency are enabled in fiber optic cable because in laser diode emitters output of light is more directional as compared to LED transmitters. Due to such property single mode fibers can also be used because through them greater distance transmissions can also be achieved. One more advantage of using this laser diode emitter is that as output is generated as a coherent light therefore, it uses the single frequency only and has less modal dispersion.

LED Transmitter: - These are reliable and cheap fiber optic transmitters. Spontaneous emission method is used to generate the light that results in the emission of incoherent light with a relatively wide spectrum. The range of typical LED light output is 30 - 60 nm that is used in optical communications. The transmission distance is limited because the output range of signal caused the chromatic dispersion in transmission.

The researchers have discovered that output emitted light is not directional in case of LED therefore; they are coupled with the multimode fiber. Additionally, as all the output light cannot be coupled into fiber optic cable, it results in low efficiency overall.

There are many advantages of LED fiber optic transmitters in case of availability, lifetime and cost. Because the manufacturing technology is quite straight and easy they are produced at a large level and results in low cost.

III. RELATED WORK

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Mohammed Al-rubaiai: Strong attenuation of nearly all electromagnetic signals in water is the reason why underwater surveillance, exploration, along with various other uses presently depend on sub-sea wires as well as provide the user with the data. As wireless communication for

underwater applications, the acoustic modems were used as default method but data is delivered at low rates only and that too at a high cost. The applications that require low-to-median communication range, low complexity, low power, and high data rate, they are provided with a LED-based optical communication device. A new LED-based communication system is developed that consists of a receiver that is based on a blue-enhanced photodiode, a transmitter with a super-bright blue LED.

John G. Weber: Fiber optics is lengthy cylindrical plastic or glass pieces that use total internal reflection for transmitting the light. LED or laser diode is used to inject the light at transmitting end and photodetector is used at the receiving end. As compared to electric wires, fiber optic cables transmit huge data over long distances. Many sources that cause electromagnetic noise and affects the electric wires like the light weight of wire, susceptible to electrical arcs, ground loops etc. does not affect the fibers. As compared to copper wires, fibers are proved to be more reliable in telecommunication systems.

Karthik Chandrasekar: To support the growing traffic demands, it is better to adopt the all-optical multicast or all optical WDM networks for the future backbones. In a network, many switching nodes are equipped with optical splitters that provide the support for multicast. This work contributes in representing that all optical multicast can be used practically for both 1: N splitters and 1:2 splitters via proper incorporation of optical hardware components and in-line EDFA's that are available off the shelf.

Yuchi Zhang: They reviewed various simulation methods used for performance testing of the diverged beam and Free-space Optical Communication (FSO) technology. In this particular work, they also reviewed the turbulence theory and its effect on the laser. The diverged beam and on-off keying (OOK) are assumed in the receiver, and in the transmitter, and for conversion of photon stream into electron stream avalanche photodiode (APD) is used in the simulation revision chapter. For simulating turbulence effect phase screens are used over the optical beam phase. Additionally, a data processing method is also presented and surveyed. Finally, a summary is provided for the divergence of the different beam along with performance.

A. Mansour: presented a survey on new challenges in wireless communication systems and discusses recent approaches to address some recently raised problems by the wireless community. At first a historical background is briefly introduced. Challenges based on modern and real life applications are then described.

Elechi Promise: investigated and analyzed the performance of the optical receiver at a wavelength of 1550nm, optic fiber of length 100km. Simulations was made and the Bit Error Rate analyzer values taken. Several values of Q-Factor and Bit Error Rate were tabulated and the corresponding graphs plotted. There was an improvement in the gain, quality factor, the quality of signal with a low noise value and the extended transmission or propagation time was reduced. The result of the design showed an improvement in the sensitivity of the receiver.

F. C. Garcia Gunning: discussed the potential for opening a new wavelength window at the 2 μm waveband for optical communications, showing current limitations of the system's performance. It focuses on novel results for key enabling technologies, including the analysis of laser injection locking at this waveband, an improved responsivity for bulk and strained InGaAs edge-couple detectors, and also an increased gain profile for thulium-doped fiber amplifiers.

Badiaa Ait Ahmed: presents a detailed study of N-channels Wavelength Division Multiplexing (WDM) Optical transmission system using Radio over Fiber (RoF) technology. The study was applied to optical long-haul networks to overcome the nonlinearity effects, chromatic dispersion, and signal loss. For this purpose, Fiber Bragg Grating (FBG) has been implemented in 4-channels, 8- channels, and 16 channels WDM transmission system network at 10 Gb/s to compensate the dispersion and the nonlinear distortion.

IV. MOTIVATION

As optical networks that use optical fiber provides the better bandwidth that is required for the present internet communication infrastructure and hence it is a most important factor. In the past few years, these optical fiber communication and transmission systems have grown exceptionally. Optical fiber cables are used to provide long-distance communication for over 80% of networks. The routing mechanism is influenced by QoS characteristics like loss rate, jitter, delay and bandwidth in optical networks. The optical system's response time is used to estimate the channel's transmission bandwidth or capacity. The time response consists of dispersion in fiber and signal in receiver and transmitter. The rise time of the several components limits the digital fiber optic communication system's data rate. As data rate is directly affected by optical bandwidth that is influenced by rising time, there is a need to design systems that help optical signal to pass through them to an improved time response is achieved. Effect of rising time could be better understood by having a good estimate of transmission quality.

V. ADVANTAGES OF OUR PROPOSED SOURCE

1) The cross talk chances are very less even if many fibers run together and therefore there is less signal loss as compared to Copper Cables.
2) Up to 40-100 Gbps bandwidth is supported.
3) Support bidirectional transmission, duplex communications from Receiver to Transmitter and vice versa.
4) For high bandwidth and speed, it can be easily upgradable.
5) There is no limitation on bandwidth or speed. Variable bandwidth and speed are supported by optical fiber cables that depend only on the quality of optics used at both ends.
6) Without regenerating the signal this optical fiber (Single Mode fiber cables) can transmit the signal to a longer distance up to 50 km.
7) Less affected by the fire.
8) Flexible and easy to install.
9) There is no Electromagnetic Interference as they carry light.
10) Cheaper than the conventional wires.

VI. CONCLUSION

In the case of short transmission distance, low data rates and cost-sensitive applications use the LEDs. The upper limit is represented by local area networks that have a maximum speed of 100 Mbps and transmission distance up to a kilometer. Whereas for data rates in Gbps and long distance telecommunications requires the fiber optic cables that use laser diode fiber optic transmitters which are more expensive than LEDs.

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