International Journal of Engineering, Science and Mathematics
Vol. 7 Issue 4, April 2018,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Advancement of Bandwidth Optimization and Wavelength Division Multiplexing Of Plastic Optical Fiber in LANs: A Study

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Abstract - Optical multiplexing is the art of combining multiple optical signals into one to make full use of the immense bandwidth potential of an optical channel. It can perform additional roles like providing redundancy, supporting advanced topologies, reducing hardware and cost, etc. The idea is to divide the huge bandwidth of optical fiber into individual channels of lower bandwidth, so that multiple access with lower-speed electronics is achieved. This chapter focuses on one of the most common and important optical multiplexing techniques, wavelength division multiplexing (WDM). The chapter begins with a quick historical account of the origin of optical communication and its exponential growth following the invention of erbium-doped fiber amplifier (EDFA) leading to the widespread adoption of WDM. Alternate multiplexing schemes are also briefly discussed, including time-division multiplexing (TDM), space-division multiplexing (SDM), etc. A typical WDM link and its components are then discussed with special focus on WDM Mux/demultiplexer (DeMux). Further, certain challenges in this field are addressed along with some potential solutions. The paper highlights some features and Advancement of Bandwidth Optimization and Wavelength Division Multiplexing Of Plastic Optical Fiber in LANs.

KEYWORD: Bandwidth, Optimization, Wavelength Division Multiplexing,Plastic Optical Fiber

I. INTRODUCTION

Wavelength division multiplexing has become commonplace in cable television infrastructure, as it allows the distribution of switched channels to small groups of customers. It achieves so by allowing multiple separate signals to be transmitted over common fibers and common optical amplifiers.

Unfortunately, optical signals on separate wavelengths communicate as they pass through the fiber, and these interactions, often combined with distinct optical components in the circuit, produce different crosstalk rates. These mechanisms can seriously affect recovered RF signal quality, depending on the parameters of a given link. As our study shows, the quality of discrete components in general, and particularly the wavelength demultiplexer, is usually the limiting factor in achieving reasonable low rates of crosstalk interference.

Wavelength-division multiplexing (WDM) allows multiple communication links to use a common transmission fiber by simultaneously transmitting multiple wavelengths. This work describes WDM technology, including options specified by standards like ITU-T Recommendations G.652 to G.657, such as coarse and dense WDM. Discuss wavelength spectrum allocation for L-, C-, S-, E-, and O-bands. This also defines similar technologies, such as time-division multiplexing and erbium-doped fiber amplifiers.

In this research, various topics were introduced. This paper was divided into various sections. Optical Fiber. Detailed introduction to these topics was presented.

. II. OBJECTIVES

- To consider the use of a wavelength division multiplexing (WDM) technology is promising for realizing further advances in high-speed communications.

III.VISION

The vision of the present research is to explain the bandwidth optimization and wavelength division of plastic optical fiber. The researcher will identify High Performance of Plastic Optical Fibers Technique in Advanced Local Area Optical Communication Networks. We can conclude that within conventional Raman amplification in plastic fiber media link, the higher optical signal power, average repeater spacing, soliton bit rate and product per channel that is suitable for maximum transmission distance in Local area optical communication networks.

IV. MISSION

The mission of this study is describes investigation of transmission in LAN with the use of Plastic optical fiber (POF) for WDM type transmission. Step index plastic optical fibre (SI-POF) and SI-POF couplers were used. The paper includes a comparison between transmission bandwidth of different wavelengths and possibilities of using the proposed WDM in LAN network.

V. BANDWIDTH IN COMMUNICATIONS AND WAVELENGTH DIVISION MULTIPLEXING

Bandwidth in communications resembles wardrobe space in your home-you can never have enough. What's more, Internet activity is influencing the interest for communication capacity to become speedier than the closet of a youngster with a no-restriction charge card. Bandwidth-hoarding megabytes of energized designs are supplanting reduced email messages. Data, video and voice signals swarm transmission frameworks that had adequate space only a couple of years back. The communications business needs space to move around. That is precisely what another age of fiber-optic technology is conveying to networks, for example, the relevantly named Project Oxygen. The technology that makes this new bandwidth conceivable is called wavelength division multiplexing, or WDM, and it speaks to the second significant fiber-optic upset in telecommunications.

The principal came amid the 1980s when phone organizations bound the United States and different nations with fibers to make a worldwide spine of information pipelines that could convey incomprehensibly a larger number of data than the copper wires and microwave joins they supplanted. WDM makes this preferred standpoint a mammoth stride advance increasing the potential capacity of every fiber by filling it with not only one but rather numerous wavelengths of light, each fit for conveying a separate signal.

Wavelength division multiplexing has developed "advantageously, as more established fiber cables were getting filled," says Richard Mack, VP at KMI Corp, a Newport, R.I.-based market examiner firm having some expertise in fiber optics. Exploiting WDM, long-distance transporters, for example, AT&T and MCI have possessed the capacity to abstain from laying costly new cables; rather, they draw extra wavelengths through existing fibers. The WDM upheaval has touched base with unexpected quickness.

To allow space for development, telephone organizations had laid cables containing 24 to 36 fibers, numerous held for possible later use as "dull fibers." Each fiber conveyed several megabits for every second at a solitary wavelength. From that point forward, bearers have raised data rates to 2.5 Gbit/s and lit the greater part of the dim fibers.

Wavelength Division Multiplexing Technology

Wavelength division multiplexing (WDM) technology is an optical communication technology utilizing frequency division multiplexing of optical space to accomplish concurrent transmission on a solitary fiber channel optical signal. Wave-division multiplexing standard has extensive system capacity, high usage of fiber optic long distance transmission line transmission hardware, capacity development and redesign helpful, and is the best answer for giving ultra-high-speed, high-capacity optical fiber communication. Dr.Gao Kun, the 1966 British Chinese dielectric waveguide hypothesis initially proposed optical fiber can be utilized for optical communication of logical verification. 1970 Corning Glass Company first assembling an optical fiber on the planets in the first place was the loss of 20 dB for each kilometer, enhanced soon decreased to 4dB. WDM technology is the first to utilize the origin of the optical fiber in the United States.

WDM technology inside a wavelength window of the fiber, yet additionally can be utilized as a part of the distinctive windows. 90's because of the time division multiplexing (TDM) technology, the fast development of its technology is straightforward, useful, prevail in the field of optical communications, WDM development isn't quickly, WDM technology until 1995 preceding entering the abundant development time frame.

VI. PLASTIC OPTICAL FIBER

Plastic optical fiber (POF) is an optical fiber which is made out of plastic. Customarily PMMA (acrylic) is the center material, and fluorinated polymers are the cladding material. Since the late 1990s be that as it may, substantially higher-execution POF in view of per fluorinated polymers (primarily poly perfluorobutenylvinylether) has started to show up in the commercial center. In extensive distance across fibers, 96% of the cross segment is the center that allows the transmission of light.

Like conventional glass fiber, POF transmits light (or data) through the center of the fiber. The center size of POF is now and again 100 times bigger than glass fiber. POF has been known as the "purchaser" optical fiber in light of the fact that the fiber and related optical connections, connectors, and establishment are on the whole cheap. The conventional PMMA fibers are ordinarily utilized for low-speed, short-distance (up to 100 meters) applications in advanced home machines, home networks, modern networks (PROFIBUS, PROFINET), and auto networks (MOST).

The per fluorinated polymer fibers are generally utilized for considerably higher-speed applications, for example, data focus wiring and building LAN wiring. In connection to the future demand of high-speed home networking, there has been an expanding enthusiasm for POF as a conceivable choice for cutting edge Gigabit/s interfaces inside the house.

For telecommunications, the more hard to-utilize glass optical fiber is more typical. Despite the fact that the real cost of glass fibers are lower than plastic fiber, their introduced cost is significantly higher because of the exceptional dealing with and establishment strategies required.

A fibre optic cable can be divided into three different parts. These parts are the core, cladding, and buffer. This structure has been shown in Figure 1.

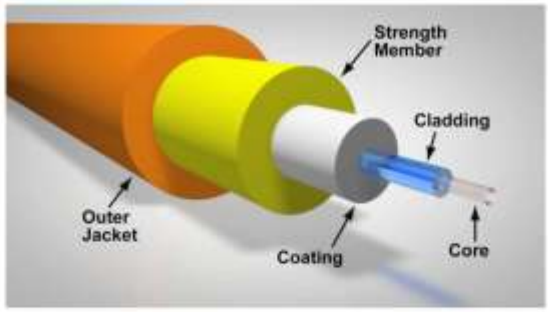

Figure1: Structure of Optical Fibre Cable

The middle portion of the cable is called the core and this core consists of silica material. It is the section of the fiber which transmits light. The next layer is cladding, after the heart. The 4 cladding serves as a wave guide for the waves of light to pass through the cable. It consists of the pure silica. The cladding has a very important role in wave propagation. If this component is not present the waves will shoot out of the core. Finally, the cladding will translate back into the heart. There's a buffer layer on after that.

This buffer layer normally protects against ultraviolet light to the heart and cladding. It also provides steady cable. As for buffer, this is at the center of these three layers. It consists of acrylic polymer;

The concept of light transmission in optical fibre is based on the principle of internal total reflection. Depending on the angle of incidence the light is reflected or refracted. The angle at which light strikes the interface between a denser optic material and a thinner optic material. The core has a higher refractive index as compare to cladding. It allows the beam that strikes that surface to be reflected at less than the critical angle. This is expressed in Figure2.

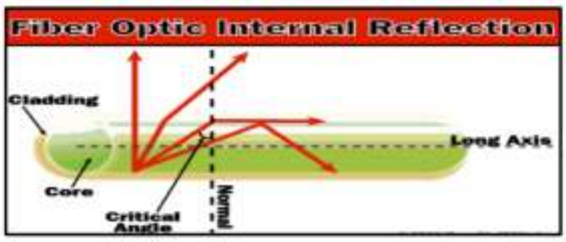

Figure2: Principle of Optical Fibre

VII. RECENT ADVANCEMENT IN WAVELENGTH-DIVISION-MULTIPLEXING PLASTIC OPTICAL FIBER TECHNOLOGIES IN LANs

Optical networks are high-capacity communication networks using optical data transmission technologies. Since light has higher frequencies and shorter wavelengths, more information bits can be transmitted in optical networks. Optical networks operate at terabits per second. The optical fiber communication system provides higher speed and capacity.

Growing research priorities are centered on high-speed telecommunications and data communications networks with rising demand for connectivity even from home, owing to the tremendous achievements of modern multimedia technologies (high-definition (HD), three-dimensional visual information (3D) or remote "face-to - face communication") that forecast data transmission speed requirements.

Polymer Optical Fiber (POF) technology has emerged as a useful medium for short-range scenarios such as Local Area Networks (LANs), in-home and office networks, automotive and avionic multimedia buses, or data center connections, among others. Nonetheless, its potential communication ability requires greater utilization to meet consumer criteria for higher-data levels.

Strong increase in bandwidth demand is a growing challenge for service operators to deliver their high-quality service to the device of end users. Currently, commercially available egalitarian service plans range from 50-100Mbps, while premium packages usually range from 100-150Mbps. And note that the bandwidth in the local loop is expected to rise with an average of 20-50 percent annually. Current developments concentrate on gigabit-order data transfer, while at the same time incorporating the idea of FTTx (Fiber to the Home / Node / Building / Curb) installations into the customer's premises in the near future. There is a global consensus that the optical fiber solution offers adequate bandwidth to satisfy consumer demand at the necessary short-range transmission distances (typically up to 200 m). In this optical fiber network deployment scenario, POF offers several advantages over short distances over conventional optical silica multimode fiber. Such fiber type can provide an effective solution as its great advantage is the potential lower cost associated with easy installation, splicing and connection.

This is because POF has higher dimensions, greater numerical aperture (NA) and larger critical curvature radius compared to glass optical fibers[1]. It's more flexible and ductile, making handling simpler. Consequently, POF termination can be realized not only faster, but also cheaper than with silica optical fiber multimode. To summarize, POFs have multiple applications in low or competitive sensor systems, compared to well-established traditional technologies[2].

To date, the most used type of POF is the step index POF (SI-POF), but many variants were produced and tested showing different performance between them[3]. SI-POF is made of polymethyl-methacrylate (PMMA), (also known as standard POF) with 980 μm core diameter, 10 μm cladding thickness and 0.5 NA. SI-POF, however, suffers from high modal dispersion, which reduces the available bandwidth to usually 50 MHz/100 m[4]. It is only used in the visible spectrum range (VIS) where it can have appropriate attenuation (e.g., at 650 nm, 100 dB / km).

It is due to the large attenuation due to strong carbon-hydrogen (C-H) vibration (C-H) absorption loss. Nonetheless, increases in POF fiber bandwidth can be accomplished by rating the refractive index, adding so-called Graded-Index POFs (GIPOFs). Although it was demonstrated that first developed PMMA-GIPOFs obtain very high transmission bandwidth compared to SI counterparts[5], the use of PMMA is not yet attractive due to its heavy absorption in near-infrared (near-IR) regions into infrared (IR) regions.

As a result, PMMA-based GIPOFs can only be used in the visible spectrum at a few wavelengths. Today, sadly, almost all gigabit optical sources work in near-infrared (typically 850 nm or 1300 nm), where PMMA and related polymers are largely opaque. Loss reduction was accomplished using amorphous perfluorinated polymers for core material. This new form of POF is called perfluorinated GIPOF (PF GIPOF), and has a fairly low loss wavelength range from 650 nm to 1300 nm (even potentially in the third transmission window)[6]. PF-GIPOF systems can also use available off-the-shelf light sources for silica fiber-based systems. PF-based GIPOF had a 1310 nm attenuation of about 30dB / km. Attenuation around 20dB / km was achieved only three years after achieving lower and lower attenuation values. PF-based GIPOFs theoretical limit is ~0.5 dB / km at 1250-1390 nm.

Nevertheless, while these losses are slowly decreasing due to ongoing improvements in the manufacturing processes of this still young technology, the higher than silica attenuation prevents their usage in relatively long-linked applications, being mainly guided to cover in-building optical networks connecting lengths for in-building / home optical networks (with connecting lengths of less than 1 km) and so on. Additionally, PF-GIPOF can provide a bandwidth per product duration of ~400MHz x km at 850 nm and 1300 nm respectively, and can support 40Gbps to 200 m for any launch condition[7].

This is due to low material dispersion characteristics of PF-GIPOF (even lower than optical silica multimode fibers)[8]. Although POFs present a cost-effective solution for short-range optical deployments, their bandwidth characteristics still restrict reach distances and capacity to meet future transmission requirements for end-users.

Considering the vast industry experience and broad economies of scale, orthogonal frequency multiplexing (OFDM)[9], subcarrier multiplexing (SCM) and discrete multitone modulation (DMT) are considered promising technologies for low-cost, efficient and stable Gigabit transmission over hundreds of meters of POF. In particular, DMT modulation has been demonstrated to achieve near-optimum performance and allow highly spectral efficient transmission over silica multimode fibers (MMFs) and POFs.

Initially, SI–POF transmission was conducted with only one cable, usually at 650 nm, achieving data rates of 100 Mb/s over 275 m links; even multi-gigabit transmission over 50 m links was achieved. Commercial systems with data rates of 1 Gbit / s up to 50 m SI−POF with one channel were also recorded. In addition, theoretical simulations with data levels of 1.25 Gbit / s, 2.1 Gbit / s and 6.2 Gbit / s were demonstrated using a single channel with NRZ, CAP-64 and QAM512 modulations, up to 50 m of SI-POF. Using multiple channels over a single fiber, well-known as wavelength division multiplexing (WDM), is the next step to increasing the efficiency of an individual POF. In recent years, WDM techniques over POFs have proposed to extend the available bandwidth of POF-based systems.

Jončić et al.[10] first recorded a 10 Gbit / s transmission over 25 m of SI−POF using offline-processed NRZ modulation. Furthermore, the same authors achieved data rates up to 14.77 Gbit / s, with 4 channels using offline-processed discrete multitone modulation through up to 50 m of a SI−POF connection.

Similarly, many POF-based sensors introduce self-reference schemes by transmitting various wavelengths over one cable. Nonetheless, certain limitations need to be resolved in order to achieve the same capabilities as with WDM approaches based on silica. In the WDM technique, different wavelengths transmitted jointly over the fiber must be separated to retrieve all information.

Therefore, for a typical WDM optical communication link, at least two main elements are a multiplexer and a demultiplexer. The former is put before the single fiber to combine each wavelength into one waveguide. The latter is put behind the fiber to preserve some distinct wavelength. For silica-based infrared telecom systems, these two components have long been developed, bust must be completely new for POF-based WDM applications.

VIII. CONCLUSION

The research introduced the concept of optical multiplexing with particular focus on multiplexing the division of wavelengths. Other methods of multiplexing which highlight the operation and potential applications are also briefly described. Explain a WDM link by going into detail on the various components that make up the link. The chapter also contains a few challenges that degrade the relation output and possible methods to resolve those effects. With the WDM Mux / DeMux mentioned above, adding or dropping an unplanned channel can involve suspension of the traffic across the entire link. But with a reconfigurable optical add-drop multiplexer (ROADM), an operator can re-configure the multiplexing remotely so that data is not interrupted in other networks.

Multiplexers, combiners and variable optical attenuators are essential elements in POF networks when using the WDM approach, but are not yet widely available on the market due to the above-mentioned reasons resulting in their associated insertion losses. Nonetheless, reconfiguration may be an additional feature for certain networks, but most of them built in POF technology do not have this functionality.

This section will identify new POF devices with reconfigurable features for WDM applications addressing lightweight, scalable and low-consumption solutions and low insertion losses. They operate at wavelengths of interest for POF applications and their output will be compared to current state-of-the-art literature approaches. Others can leverage the properties of liquid crystal materials.

The main goal is to bridge the WDM POF-based network deployment bottleneck gap in the final delivery leg. Furthermore, a hybrid silica-POF WDM-PON network is analyzed that demonstrates the capabilities of novel Fiber Bragg Gratings (FBG) inscribed on micro-structured POF devices to be compatible with WDM topologies for both sensing and communication systems. In addition, the theoretical potential for future WDM-GIPOF deployment is discussed using the performance of this recent fiber type. The key findings are eventually addressed.

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