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RESEARCH ARTICLE

Ways to Improve the Throughput in Fiber Optic Communication - An Overview

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ABSTRACT: fiber optic communications systems are widely employed for applications ranging from major telecommunications backbone infrastructure to Ethernet systems, broadband distribution, and general data networking. Since light wave is used for transmission all the advantages of light wave are available with this communications. In this paper all the possible ways are considered which are improving the data speed starting from transmitter to the receiver via fiber cable. Conclusions are made on the basis of different study of each possible way to improve throughput.

KEYWORDS: Fiber optic, refractive index, Dispersion loss, chromatic loss, Laser, Attenuation

1. INTRODUCTION

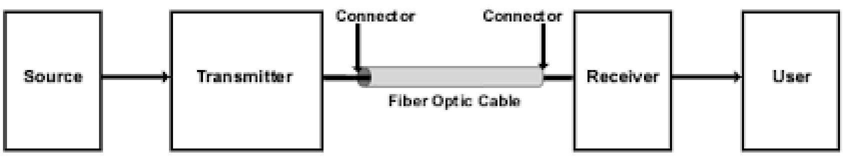

Fig. 1 Block Diagram of Optical fiber communication.

Any fibre optic data transmission system will comprise a Transmitter (Light source), fiber Optic Cable and Receiver (Detector)

In the system the transmitter of light source generates a light stream modulated to enable it to carry the data. Conventionally a pulse of light indicates a "1" and the absence of light indicates "0". This light is transmitted down a very thin fibre of glass or other suitable material to be presented at the receiver or detector. The detector converts the pulses of light into equivalent electrical pulses. In this way the data can be transmitted as light over great distances

Different techniques and components are used by system network providers that provide extremely high data rates over long distances. Nevertheless the basic principles are the same whatever the system. All the possible way are discussed in the subsequent topic . [1]

2. FIBER OPTIC TRANSMITTER

The most commonly used devices are light emitting diodes, LEDs, and semiconductor laser diodes.

The simplest transmitter device is the LED The first drawback is that they offer a very low level of efficiency. Only about 1% of the input power enters the optical fibre. LEDs produce incoherent light that covers a relatively wide spectrum because of this any chromatic dispersion in the fibre will limit the bandwidth of the system.

In view of their performance, LEDs are used mainly in local-area-network applications where the data rates are typically in the range 10-100 Mb/s and transmission distances are a few kilometres.

Where higher data rate required then lasers are used. They offer some significant advantages, light output is directional and this enables a much higher level of efficiency in the transfer of the light into the fibre optic cable.. A further advantage is that lasers have a very narrow spectral bandwidth as a result of the fact that they produce coherent light. This narrow spectral width enables the lasers to transmit data at much higher rates because modal dispersion is less apparent. Another advantage is that semiconductor lasers can be modulated directly at high frequencies because of short recombination time for the carriers within the semiconductor material.

For very high data rates or very long distance links run the laser at a constant output level (continuous wave). The light is then modulated using an external device which will laser chirp and reduces the chromatic dispersion in the fibre optic cable.

Use VCSELs The vertical cavity surface-emitting laser is the newest laser structure. [2][3]

3. REPEATERS AND AMPLIFIERS

Use an optical amplifier. These amplifiers directly amplify the optical signal without the need to convert the signal back into an electrical format. The amplifiers consist of a length of fibre optic cable that is doped with a rare earth mineral named Erbium. The treated fibre cable is then illuminated or pumped with light of a shorter wavelength from another laser and this serves to amplify the signal that is being carried. [1]

4. RECEIVERS

Light travelling along a fibre optic cable needs to be converted into an electrical signal so that it can be processed and the data that is carried can be extracted. The component that is at the heart of the receiver is a photo-detector. This is normally a semiconductor device and may be a p-n junction, a p-i-n photo-diode or an avalanche photo-diode.

5. FIBER OPTIC CABLE

FIBER

The optical fiber guides the light launched into the fiber core. The cladding is a layer of material that surrounds the core. Optical cable made up of Glass, Silica and other minerals has following limitation during transferring of light wave data through it.

Some of the factors related to fiber that affecting the speed and solution for that discussed in subsequent topics.[1]

5.1 **DISPERSION**

Dispersion or spreading of optical pulses as they travel along the fiber. Dispersion limits the bandwidth of the fiber because the spreading optical pulse limits the rate that pulses can follow one another on the fiber and still be distinguishable at the receiver.

There are two types of Dispersions

- Intermodal
- Chromatic

Intermodal Dispersion can be eliminated by Single-mode fiber.

In a single –mode Optical fiber the Zero-dispersion wavelength is used.

The **zero-dispersion wavelength** is the wavelength or wavelengths at which material dispersion and waveguide dispersion cancel one another

For single mode the minimum-loss window at approximately 1550nm

Another way to alter the dispersion is changing the core size and the refractive indices of the material of core and cladding. As a straight forward solution tapered fibers and holey fibers or photonic crystal fibers (PCF) were produced. Essentially they replace the cladding by air. This improves the contrast of refractive indices by a factor of 10.

Doubly and quadruply clad single-mode fibers have two zero-dispersion points, and thus two zero-dispersion slopes.

In fiber optics, a quadruply clad fiber is a single-mode optical fiber that has four claddings. Each cladding has a refractive index lower than that of the core.

A quadruply clad fiber has the advantage of very low macrobending losses.

Double-clad fiber used for dispersion compensation, the inner cladding layer has lower refractive index than the outer layer. [4][1]

This type of double-clad fiber has the advantage of very low micro bending losses.

It also has two zero-dispersion points these fibers can be used for the compensation of chromatic dispersion in optical communications and other applications.

In single-mode fiber performance is primarily limited by chromatic dispersion (also called group velocity dispersion), which occurs because the index of the glass varies slightly depending on the wavelength of the light, and light from real optical transmitters necessarily has nonzero spectral width (due to modulation).

Chromatic dispersion, can be removed by a 'dispersion compensator'. This works by using a specially prepared length of fiber that has the opposite dispersion to that induced by the transmission fiber, and this sharpens the pulse so that it can be correctly decoded by the electronics.

Use of Circulator to Compensate for Dispersion

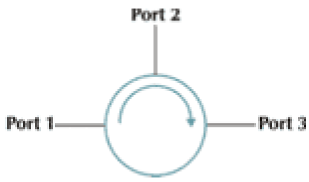

Fig. 2 Circulator

In this example light enters the circulator in port 1. Light that enters port 1 is output to port 2 only. Now the light travels through the DCM, reflects off of the reflector and re enters port 2. The light that enters port 2 is output on port 3 only. The net effect is that the light has now travelled through the DCM twice allowing us to use half as much fiber to get the same compensating effect.

5.2 ATTENUATION

Fiber attenuation, which necessitates the use of amplification systems, is caused by a combination of material absorption, Rayleigh_scattering, Mie scattering and connection losses. Although material absorption for pure silica is only around 0.03 dB/km (modern fiber has attenuation around 0.3 dB/km), impurities in the original optical fibers caused attenuation of about 1000 dB/km. Other forms of attenuation are caused by physical stresses to the fiber, microscopic fluctuations in density, and imperfect splicing techniques.

Transmission windows

Each effect that contributes to attenuation and dispersion depends on the optical wavelength. The wavelength bands (or windows) that exist where these effects are weakest are the most favorable for transmission. These windows have been standardized, and the currently defined bands are the following

Band	Description	Wavelength Range
O band	original	1260 to 1360 nm
E band	extended	1360 to 1460 nm
S band	short wavelengths	1460 to 1530 nm
C band	conventional ("erbium window")	1530 to 1565 nm
L band	long wavelengths	1565 to 1625 nm
U band	ultralong wavelengths	1625 to 1675 nm

Table 1. Band for fiber optics

Note that this table shows that current technology has managed to bridge the second and third windows that were originally disjoint.

Historically, there was a window used below the O band, called the first window, at 800-900 nm. The current lower windows (O and E) around 1300 nm have much lower losses. ; However, losses are high in this region so this window is used primarily for short-distance communications this region has zero dispersion. The middle windows (S and C) around 1500 nm are the most widely used. This region has the lowest attenuation losses and achieves the longest range. It does have some dispersion, so dispersion compensator devices are used to remove this.

6. CONNECTORS

As it is imperative that the optical fibre The fibre optic connector basically consists of a rigid cylindrical barrel surrounded by a sleeve. The main requirement si that the end of the fibre optic cable is held accurately in place so that the maximum light transfer occurs.

It is held securely and accurately in place, connectors will normally be designed so that the fibre is glued in place, and in addition to this strain relief is also provided

Fibre ends may also be polished. For single mode fibre, the ends may be polished with a slight convex curvature so that the centres of the cables from the two connectors achieve physical contact. This approach reduces the back reflections, although the level of loss may be slightly higher.

7. CONCLUSION

There are various factor that affect the data speed in fiber optic communication some of them are discussed in preceding topics. Conclusion of all the above are as follows.

i)Use LASER specifically VCSELs as a transmitter ii) Use the fibre optic cable that is doped with a rare earth mineral named Erbium iii) Use Doubly and quadruply clad single-mode fibers iv)Use dispersion compensator e.g. Circulator v) Use wavelength-division multiplexing to increase data capacity results of this are to reduced dispersion loss, proper amplification which in turn increased the data speed i.e throughput.

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