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Optical Fibre Communication: A review

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Abstract- *Recently, optical fiber communication technology have made great progress, where has been constantly exploring new technologies has greatly enhanced communications capabilities in the traditional sense, this makes the optical fiber communication technology in a broader context has been applied. Deployment of optical communication systems is costly and reconfiguration is in some cases impossible or uneconomical, therefore the experiments and simulation of systems has become necessity to predict and optimize system performance. This paper deals with communication using optical fibres. The transmission using high bandwidth can handle vast amounts of information, which can be further improved by reduction in fibre losses, increase in data rates and distances, development of optical sources and detectors compatible with fibres. The recent development in the area of fibre optic communication as well as the advances in different fibre types and their properties, optical sources, detectors, system limitations and applications are also discussed in the paper*

Keyword: *Bandwidth; Optical Communication technology, Data rate.*

I. Introduction: Fiber optics communication is a technology that is use to transmit signals like data, video or voice which is modulated with pulse of light that serves as an electromagnetic carrier wave send down a glass tube over a long distance with very little attenuation or loss. This modulated pulse of light propagates through the glass tube using the principle of total internal reflection (TIR). A fiber optics communication link also known as a fiber channel is a system which provides a point-to-point data connection between two points. It comprises of data transmitter consisting of a laser diode or Light Emitting Diode (LED) which convert electric signal to light, a transmission fiber in which the modulated light propagate, and a receiver which consist of a photo detector that converts light to electric signal. The use of fiber optics was generally not available until 1970 when Corning Glass Works was able to produce a fiber with a loss of 20dB/km. Today's optical fiber attenuation ranges from 0.5dB/km to 1000dB/km depending on the optical fiber used. The applications of optical fiber communications have increased, at a rapid rate, since the first commercial installation of a fiber-optic system in 1977. Telephone companies began early on, replacing their old copper wire systems with optical fiber lines. Today's telephone companies use optical fiber throughout their system s the backbone architecture and as the long-distance connection between city phone systems. Cable television companies have also begun integrating fiber optics into their cable systems. The trunk lines that connect central offices have generally been replaced with optical fiber.

II. Importance of Optical Fiber: A flexible conduit that is used to illuminate microscopic objects, fiber optics can also transmit information similarly to the way a copper wire can transmit electricity. However, copper transmits only a few million electrical pulses per second, compared to an optical fiber that carries up to a 20 billion light pulses per second. This means telephone, cable and computer companies can handle huge amounts of data transfers at once, much more than conventional wires can carry. Fiber optic cable was developed because of the incredible increase in the quantity of data over the past 20 years. Without fiber optic cable, the modern Internet and World Wide Web would not be possible.

III. ADVANTAGES OF OPTICAL FIBER COMMUNICATION:

1. **Extremely high bandwidth** – No other cable-based data transmission medium offers the bandwidth that fiber does.

2. Easy to accommodate increasing bandwidth – Using many of the recent generations of fiber optic cabling, new equipment can be added to the inert fiber cable that can provide vastly expanded capacity over the originally laid fiber. DWDM, or Dense Wavelength Division Multiplexing, lends fiber optic cabling the ability to turn various wavelengths of light travelling down the fiber on and off at will. These two characteristics of fiber cable enable dynamic network bandwidth provisioning to provide for data traffic spikes and lulls.

3. Resistance to electromagnetic interference – Fiber has a very low rate of bit error, as a result of fiber being so resistant to electromagnetic

interference. Fiber-optic transmission is virtually noise free.

4. Early detection of cable damage and secure transmissions – Fiber provides an extremely secure transmission medium, as there is no way to detect the data being transmitted by "listening in" to the electromagnetic energy "leaking" through the cable, as is possible with traditional, electron-based transmissions. By constantly monitoring an optical network and by carefully measuring the time it takes light to reflect down the fiber, splices in the cable can be easily detected.

5.When high frequency signal are propagated through convention coaxial cable ,it loss half of its power only after a few hundred meters where as the optical fiber loss the sauce amount of power in 15km or more. Thus repeater will be required at very long distance.

6. The Transmission rate is possible on optical fiber is 10GB/sec while in coaxial cable is 1GB/sec.

7. Because of very small size and light in weight and large flexibility, it produces a number of advantages over copper wires at the installation time.

8. As the fiber optic has no electrical conductivity, therefore grounding and protection are not necessary.

9. Insensitivity to electromagnetic interference, such as when a telephone wire losses some of its signal to another.

10. Fiber do not lose any light, therefore the transmission is also secure and cannot be disturbed.

11. Lack of electrical signals in the fiber, so it cannot shock or other hazards. This makes fibers suitable for work in explosive atmospheres.

12. Easy to install and Compatibility with digital technology.

13. Lightness and small size of the cable, capable of carrying a large number of signals.

IV. DISADVANTAGES OF FIBER OPTICS:

1. Installation costs are still high – Despite the fact that fiber installation costs are dropping by as much as 60% a year, installing fiber optic cabling is still relatively costly. As installation costs decrease, fiber is expanding beyond its original realm and major application in the carrier backbone and is moving into the local loop, and through technologies such as F Fiber to the Home, Premises and PONs (Passive Optical networks) enabling subscriber and end user broadband access.

2. Special test equipment is often required – The test equipment typically and traditionally used for conventional electron-based networking is of no use in a fiber optic network. Equipment such as an OTDR (Optical Time Domain Reflect meter) is required, and expensive, specialized optical test equipment such as optical probes is needed at most fiber endpoints and connection nexuses in order to properly provide testing of optical fiber.

3. Susceptibility to physical damage – Fiber is a small and compact cable, and it is highly susceptible to becoming cut or damaged during installation or construction activities. Because railroads often provide rights-of-way for fiber optic installation, railroad car derailments pose a significant cable damage threat, and these events can disrupt service to large groups of people, as fiber optic cables can provide tremendous data transmission capabilities. Because of this, when fiber optic cabling is chosen as the transmission medium, it is necessary to address restoration, backup and survivability.

4. Wildlife damage to fiber optic cables – Many birds, for example, find the Kevlar reinforcing material of fiber cable jackets particularly appealing as nesting material, so they peck at the fiber cable jackets to utilize bits of that material. Beavers and other rodents use exposed fiber cable to sharpen their teeth and insects such as ants desire the plastic shielding in their diet, so they can often be found nibbling at the fiber optic cabling. Sharks have also been known to damage fiber optic cabling by chomping on it when laid underwater, especially at the repeating points. There is a plant called the Christmas tree plant that treats fiber optic cable as a tree root and wraps itself around the cable so tightly that the light impulses travelling down the fiber are choked off.

5. Price - Even though the raw material for making optical fibers, sand, is abundant and cheap, optical fibers are still more expensive per metre than copper. Although, one fiber can carry many more signals than a single copper cable and the large transmission distances mean that fewer expensive repeaters are required.

6. Fragility - Optical fibers are more fragile than electrical wires.

7. Affected by chemicals - The glass can be affected by various chemicals including hydrogen gas (a problem in underwater cables.)

8. Opaqueness - Despite extensive military use it is known that most fiber become opaque when exposed to radiation.

9. Requires special skills - Optical fiber cannot be joined together as a easily as copper cable and requires additional training of personnel and expensive precision splicing and measurement equipment.

10. The joining of fiber optics cables need greater care because if the Joining is not correct; a lot of attenuation will produce in high Wave length.

11. As the fiber optics have no electrical conductivity, therefore additional Copper cable is not used with optical fiber to provide power supply to the repeaters.

12. The installation cost is very high as compare to the other types of T/N lines.

V. APPLICATIONS OF FIBER OPTICS

As the popularity of optical fibers continue to grow, so does their applications and practical uses. Fiber optic cables became more and more popular in a variety of industries and applications.

1. Communications / Data Storage

Since fiber optics are resistant to electronic noise, fiber optics has made significant advances in the field of communications. The use of light as its source of data transmission has improved the sound quality in voice communications. It is also being used for transmitting and receiving purposes.

2. Military

Optical systems offer more security than traditional metal-based systems. The magnetic interference allows the leak of information in the coaxial cables. Fiber optics is not sensitive to electrical interference; therefore fiber optics is suitable for military applications and communications, where signal quality and security of data transmission are important. The increased interest of the military in this technology caused the development of stronger fibers, specially designed cables and high quality components. It was also applied in more varied areas such as hydrophones for seismic and sonar, aircrafts, submarines and other underwater applications.

3. Medical

Fiber optics is used as light guides, imaging tools and as lasers for surgeries. Another popular use of fiber optic cable is in an endoscope, which is a diagnostic instrument that enables users to see through small holes in the body. Medical endoscopes are used for minimum invasive surgical procedures. Fiber optics is also used in bronchoscopes (for lungs) and laparoscopes. All versions of endoscopes look like a long thin tube, with a lens or camera at one end through which light is emitted from the bundle of optical fibers banded together inside the enclosure.

4. Mechanical or Industrial

Industrial endoscopes also called a bore scope or fiberscope, enables the user to observe areas that are difficult to reach or to see under normal circumstances, such as jet engine interiors, inspecting mechanical welds in pipes and engines, inspecting space shuttles and rockets and the inspection of sewer lines and pipes.

5. Networking

Fiber optics is used to connect servers and users in a variety of network settings. It increases the speed, quality and accuracy of data transmission. Computer and Internet technology has improved due to the enhanced transmission of digital signals through optical fibers.

6. Industrial/Commercial

Fiber optics is used for imaging in areas which are difficult to reach. It is also used in wiring where electromagnetic interference (EMI) is a problem. It gets used often as sensory devices to make temperature, pressure and other measurements as well as in the wiring of motorcars and in industrial settings.

7. Spectroscopy

Optical fiber bundles are used to transmit light from a spectrometer to a substance which cannot be placed inside the spectrometer itself, in order to analyse its composition. A spectrometer analyses substances by bouncing light off of and through them. By using optical fibers, a spectrometer can be used to study objects that are too large to fit inside, or gasses, or reactions which occur in pressure vessels.

8. Broadcast/CATV /Cable Television

Broadcast or cable companies use fiber optic cables for wiring CATV, HDTV, internet, video and other applications. Usage of fiber optic cables in the cable-television industry began in 1976 and quickly

spread because of the superiority of fiber optic cable over traditional coaxial cable. Fiber optic systems became less expensive and capable of transmitting clearer signals further away from the source signal. It also reduced signal losses and decreased the number of amplifiers required for each customer. Fiber optic cable allows cable providers to offer better service, because only one optical line is needed for every ± 500 households.

9. Lighting and Imaging

Fiber optic cables are used for lighting and imaging and as sensors to measure and monitor a vast range of variables. It is also used in research, development and testing in the medical, technological and industrial fields. Fiber optics are used as light guides in medical and other applications where bright light needs to shine on a target without a clear "line-of-sight path". In some buildings, optical fibers are used to route sunlight from the roof to other parts of the building. Optical fiber illumination is also used for decorative applications, including signs, art and artificial Christmas trees. Optical fiber is an essential part of the light-transmitting concrete building product, LiTraCon which is a translucent concrete building material.

VI. Conclusion: As conclusion, fiber optic technology is a revolutionary technological departure from the traditional copper wires twisted-pair cable or coaxial cable. As we move forward in the Information Technology age, the responsibility of moving extreme amounts of data must fall on the shoulders of this new technology. There is no doubt as to the vast opportunities that fiber optic technology can give and it should be continuously researched and expanded to cater for future demands.

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