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Review on Fiber Optic Communication

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Abstract: *Fiber-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. The light forms an electromagnetic carrier wave that is modulated to carry information. Fiber is preferred over electrical cabling when high bandwidth, long distance, or immunity to electromagnetic interference are required. This type of communication can transmit voice, video, and telemetry through local area networks, computer networks, or across long distances..*

Keywords: Fiber-optic

I. INTRODUCTION

Fiber-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. The light forms an electromagnetic carrier wave that is modulated to carry information.

Fiber is preferred over electrical cabling when high bandwidth, long distance, or immunity to electromagnetic interference are required. This type of communication can transmit voice, video, and telemetry through local area networks, computer networks, or across long distances.

Optical fiber is used by many telecommunications companies to transmit telephone signals, Internet communication, and cable television signals. Researchers at Bell Labs have reached internet speeds of over 100 peta bit ×kilometer per second using fiber-optic communication.

The process of communicating using fiber-optics involves the following basic steps:

1. creating the optical signal involving the use of a transmitter, usually from an electrical signal.
2. relaying the signal along the fiber, ensuring that the signal does not become too distorted or weak.
3. receiving the optical signal.
4. converting it into an electrical signal.

Evolution of fiber Optic system

First generation

• The first generation of light wave systems uses GaAssemiconductor laser and operating region was near 0.8 μm. Other specifications of this generation are as under:

• i) Bit rate : 45 Mb/s

• ii) Repeater spacing : 10 km

Second generation

i) Bit rate: 100 Mb/s to 1.7 Gb/s
ii) Repeater spacing: 50 km
iii) Operation wavelength: 1.3 μm
iv) Semiconductor: In GaAsP

Third generation

i) Bit rate : 10 Gb/s
ii) Repeater spacing: 100 km
iii) Operating wavelength: 1.55 μm

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Fourth generation

• Fourth generation uses WDM technique.

i) Bit rate: 10 Tb/s

ii) Repeater spacing: > 10,000 km

Iii) Operating wavelength: 1.45 to 1.62 µm

Fifth generation

• Fifth generation uses Roman amplification technique and optical solitiors.

i) Bit rate: 40 - 160 Gb/s

ii) Repeater spacing: 24000 km - 35000 km

iii) Operating wavelength: 1.53 to 1.57 µm

Element of an Optical Fiber Transmission link

Basic block diagram of optical fiber communication system consists of following important blocks.

1. Transmitter
2. Information channel
3. Receiver.

• The light beam pulses are then fed into a fiber – optic cable where they are transmitted over long distances.

• At the receiving end, a light sensitive device knownas a photocell or light detector is used to detect thelight pulses.

• This photocell or photo detector converts the lightpulses into an electrical signal.

• The electrical pulses are amplified and reshaped backinto digital form.

Fiber Optic Cable consists of four parts.

• Core
• Cladding
• Buffer
• Jacket

Core The core of a fiber cable is a cylinder of plastic that runs all along the fiber cable's length, and offers protection by cladding. The diameter of the core depends on the application used. Due to internal reflection, the light travelling within the core reflects from the core, the cladding boundary. The core cross section needs to be a circular one for most of the applications.

Cladding

Cladding is an outer optical material that protects the core. The main function of the cladding is that it reflects the light back into the core. When light enters through the core (dense material) into the cladding(less dense material), it changes its angle, and then reflects back to the core.

Buffer

• The main function of thebuffer is to protect the fiber from damage and thousands of optical fibersarranged in hundreds of optical cables. These bundles are protected by the cable's outer covering that is called jacket.

JACKET

Fiber optic cable's jackets are available in different colors that can easily make us recognize the exact color of the cable we are dealing with. The color yellow clearly signifies a single mode cable, and orange color indicates multimode.

Fiber optic Cable

Advantages of Fiber Optic Transmission

Optical fibers have largely replaced copper wire communications in core networks in the developed world, because of its advantages over electrical transmission. Here are the main advantages of fiber optic transmission.

Extremely High Bandwidth: No other cable-based data transmission medium offers the bandwidth that fiber does. The volume of data that fiber optic cables transmit per unit time is far great than copper cables.

Longer Distance: in fiber optic transmission, optical cables are capable of providing low power loss, which enables signals can be transmitted to a longer distance than copper cables. Resistance to Electromagnetic Interference: in practical cable deployment, it's inevitable to meet environments like power substations, heating, ventilating and other industrial sources of interference. However, fiber has a very low rate of bit error (10 EXP -13), as a result of fiber being so resistant to electromagnetic interference. Fiber optic transmission is virtually noise free.

Low Security Risk: the growth of the fiber optic communication market is mainly driven by increasing awareness about data security concerns and use of the alternative raw material. Data or signals are transmitted via light in fiber optic transmission. Therefore there is no way to detect the data being transmitted by "listening in" to the electromagnetic energy "leaking" through the cable, which ensures the absolute security of information.

Small Size: fiber optic cable has a very small diameter. For instance, the cable diameter of a single OM3 multimode fiber is about 2mm, which is smaller than that of coaxial copper cable. Small size saves more space in fiber optic transmission.

Light Weight: fiber optic cables are made of glass or plastic, and they are thinner than copper cables. These make them lighter and easy to install.

Easy to Accommodate Increasing Bandwidth: with the use of fiber optic cable, new equipment can be added to existing cable infrastructure. Because optical cable can provide vastly expanded capacity over the originally laid cable. And WDM (wavelength division multiplexing) technology, including CWDM and DWDM, enables fiber cables the ability to accommodate more bandwidth.

Disadvantages of Fiber Optic Transmission

Though fiber optic transmission brings lots of convenience, its disadvantages also cannot be ignored. Fragility: usually optical fiber cables are made of glass, which lends to they are more fragile than electrical wires. In addition, glass can be affected by various chemicals including hydrogen gas (a problem in underwater cables), making them need more cares when deployed under ground.

Difficult to Install: it's not easy to splice fiber optic cable. And if you bend them too much, they will break. And fiber cable is highly susceptible to becoming cut or damaged during installation or construction activities. All these make it difficult to install.

Attenuation & Dispersion: as transmission distance getting longer, light will be attenuated and dispersed, which requires extra optical components like EDFA to be added.

Cost Is Higher Than Copper Cable: despite the fact that fiber optic installation costs are dropping by as much as 60% a year, installing fiber optic cabling is still relatively higher than copper cables. Because copper cable installation does not need extra care like fibercables. However, optical fiber is
still moving into the local loop, and through technologies such as FTTx (fiber to the home, premises, etc.) and PONs (passive optical networks), enabling subscriber and end user broadband access.

Special Equipment Is Often Required: to ensure the quality offiber optic transmission, some special equipment is needed. For example, equipment such as OTDR (optical time-domain reflectometry) is required and expensive, specialized optical test equipment such as optical probes and power meter are needed at most fiber endpoints to properly provide testing of optical fiber.

Applications of Optical Fiber Communications

Fiber optic cables find many uses in a wide variety of industries and applications. Some uses of fiber optic cables include:

- Medical

Used as light guides, imaging tools and also as lasers for surgeries

- Defense/Government

Used as hydrophones for seismic waves and SONAR , as wiring in aircraft, submarines and other vehicles and also for field networking

- Data Storage

Used for data transmission

- Telecommunications

Fiber is laid and used for transmitting and receiving purposes

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• Networking

Used to connect users and servers in a variety of network settings and help increase the speed and accuracy of data transmission

• Industrial/Commercial

Used for imaging in hard to reach areas, as wiring where EMI is an issue, as sensory devices to make temperature, pressure and other measurements, and as wiring in automobiles and in industrial settings

• Broadcast/CATV

Broadcast/cable companies are using fiber optic cables for wiring CATV, HDTV, internet, video ondemand and other applications Fiber optic cables are used for lighting and imaging and as sensors to measure and monitor a vast array of variables. Fiber optic cables are also used in research and development and testing across all the above mentioned industries.

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