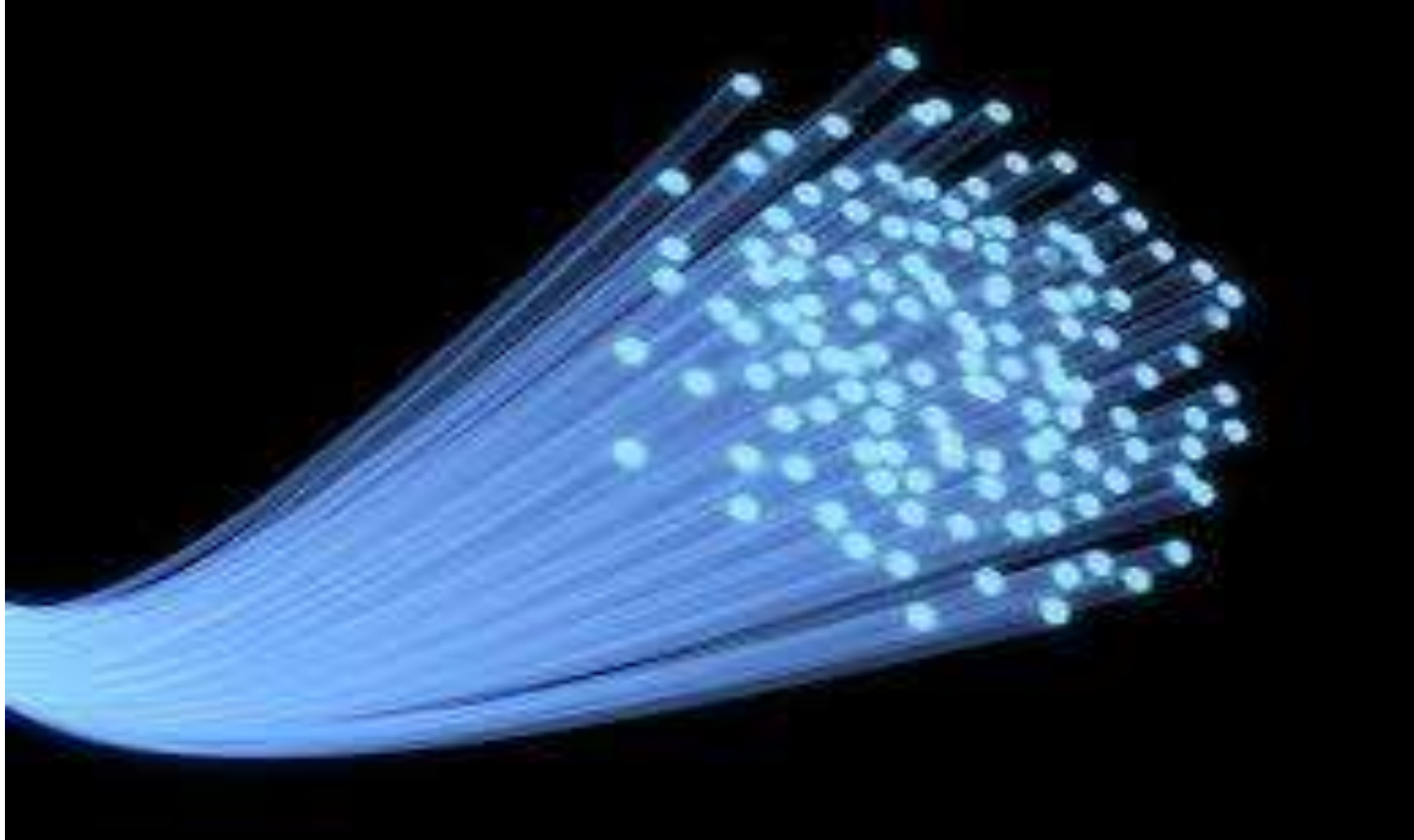


OPTICAL FIBER COMMUNICATION SYSTEM



- Optical fiber communication system is a way for transmitting information from one place to another.
- The information may be in the form of voice, data, message, etc.
- In Fiber optics, information is coded in a beam of light and send down a glass or plastic pipes. These pipes are called as optical fibers.

What is optical fiber?

- An Optical fiber is a thin, flexible, transparent fiber made by glass or plastic to a diameter comparable with a human hair.
- Optical fibers are used most often as a means to transmit light between the two ends of the fiber.
- A fiber-optic cable can have as few as two strands or as many as several hundred.
- Each strand can carry something like 25,000 telephone calls, so an entire fiber-optic cable can easily carry several million calls.



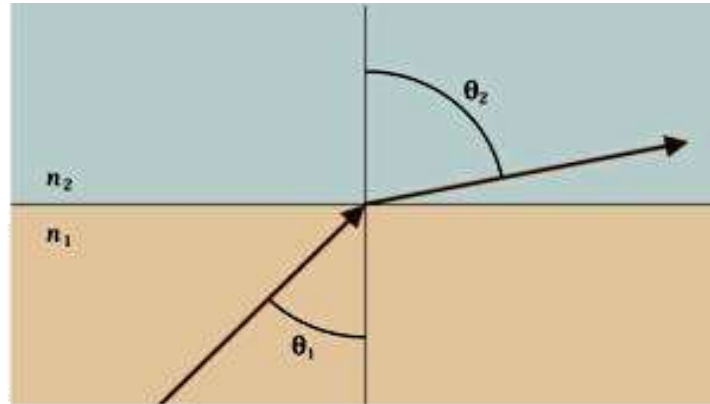
A section of 144-strand fiber-optic cable.

In 1870, John Tyndall, using a jet of water that flowed from one container to another and a beam of light, demonstrated that light used internal reflection to follow a specific path. As water poured out through the spout of the first container, Tyndall directed a beam of sunlight at the path of the water. The light followed a zigzag path inside the curved path of the water. This idea known as total internal reflection. This idea is the basic of optical fibers.

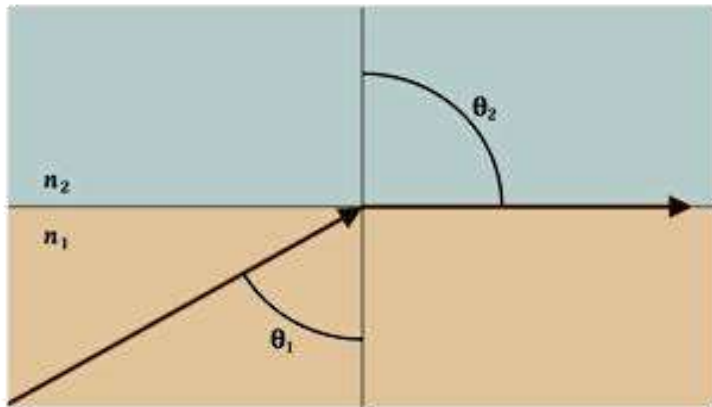
JOHN TYNDALLEXPERIMENT IN 1870.



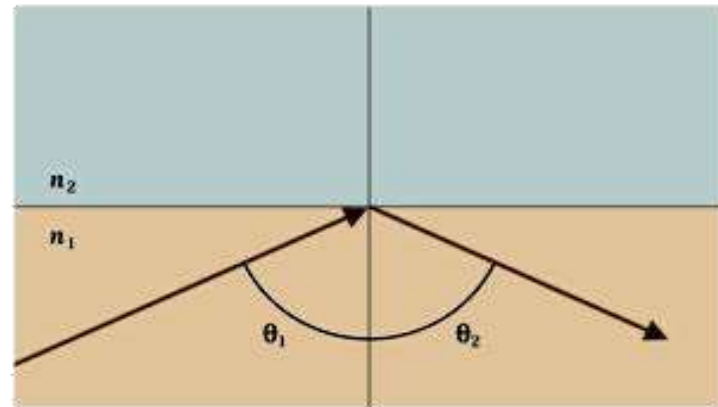
TOTAL INTERNAL REFLECTION



(a) Angle of incidence less than critical angle



(b) Angle of incidence equal to critical angle



(c) Angle of incidence greater than critical angle

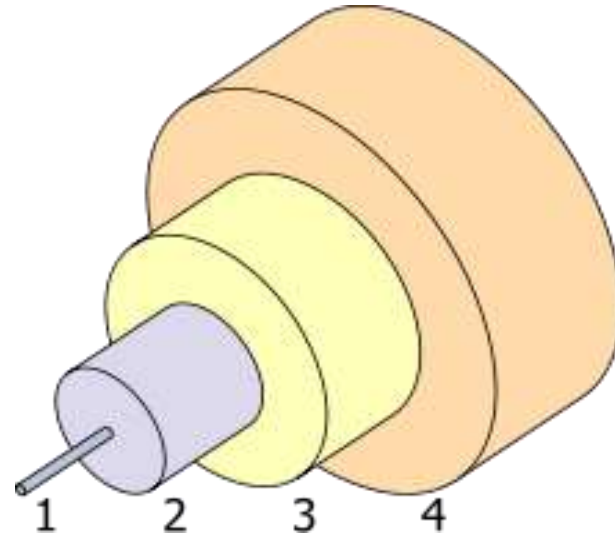
STRUCTURE OF OPTICAL FIBRE

1. Core: 8 μm diameter

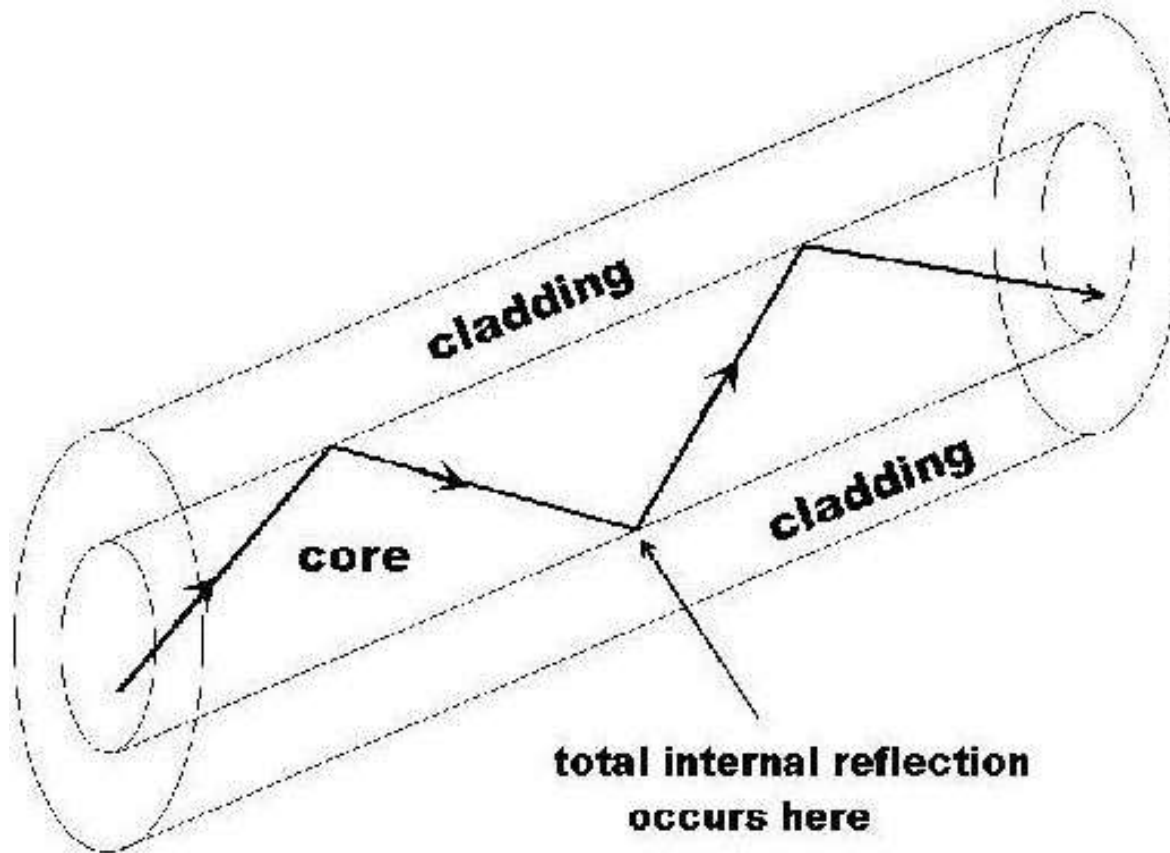
2. Cladding: 125 μm diameter

3. Buffer: 250 μm diameter

4. Jacket: 400 μm diameter



How Light Travels in Fiber



- Image from ece.umd.edu/~davis

Types of fiber-optic cables

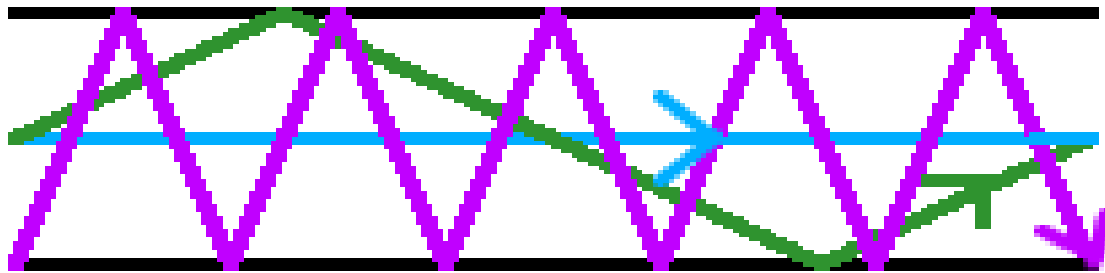
single-mode

- simplest type of optical fiber
- very thin core about 5-10 microns (millionths of a meter) in diameter.
- all signals travel straight down the middle without bouncing off the edges.
- Used in Cable TV and telephone signals
- can send information over 100 km .

Multi-mode.

- Each optical fiber in a multi-mode cable is about 10 times bigger than one in a single-mode cable.
- light beams can travel through the core in multiple different modes.
- are used to link computer networks together.
- can send information only over relatively short distances

Single-mode fiber

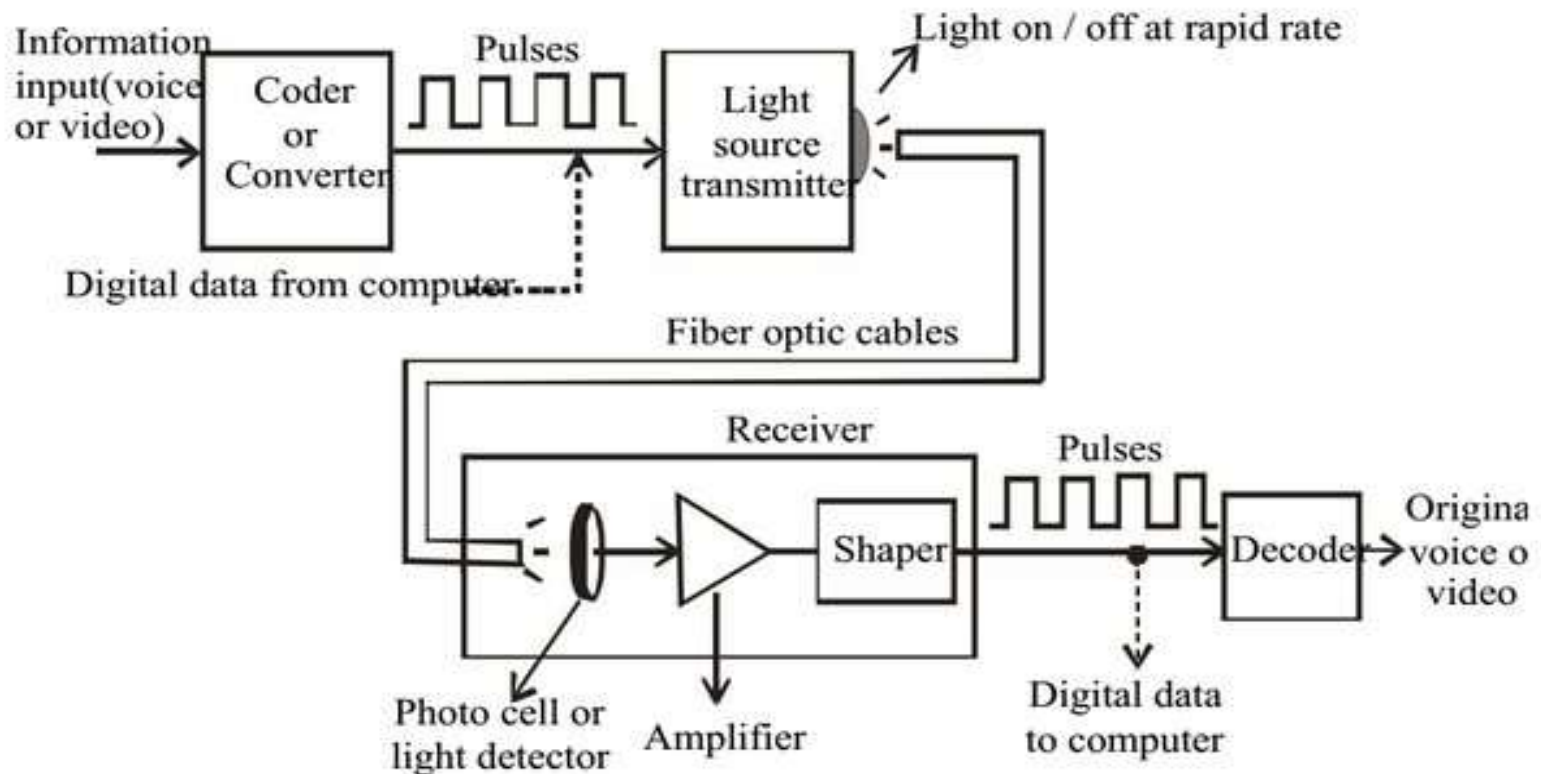


Multi-mode fiber

FIBRE OPTIC COMMUNICATION SYSTEM

A basic fiber optic communications system consists of three basic elements:

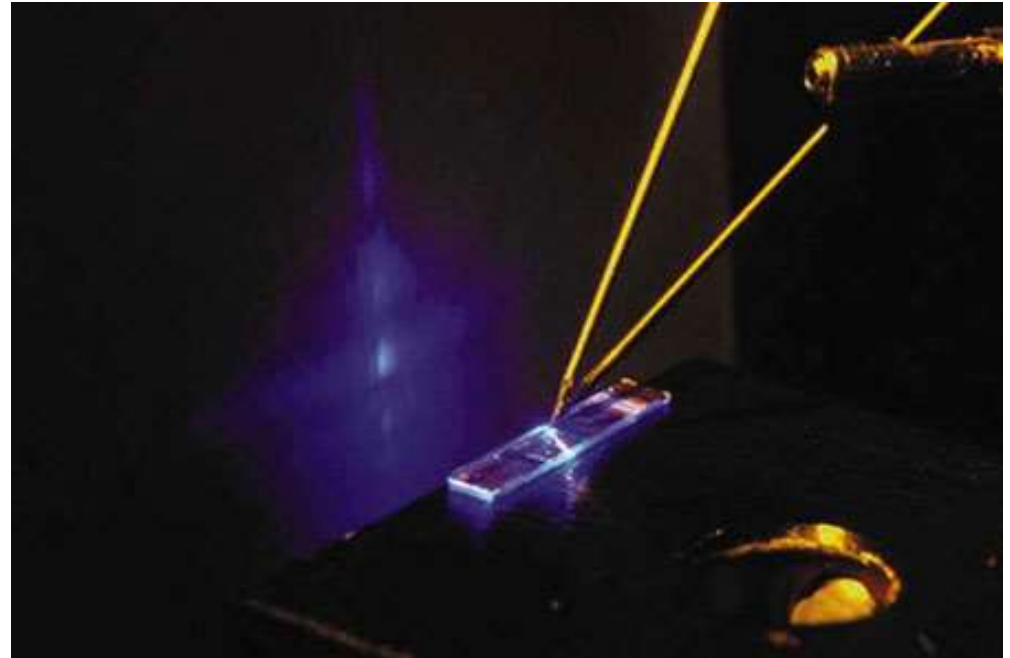
- Fiber medium
- Light source
- Light detector



Light Sources



LED (Light emitting diode)



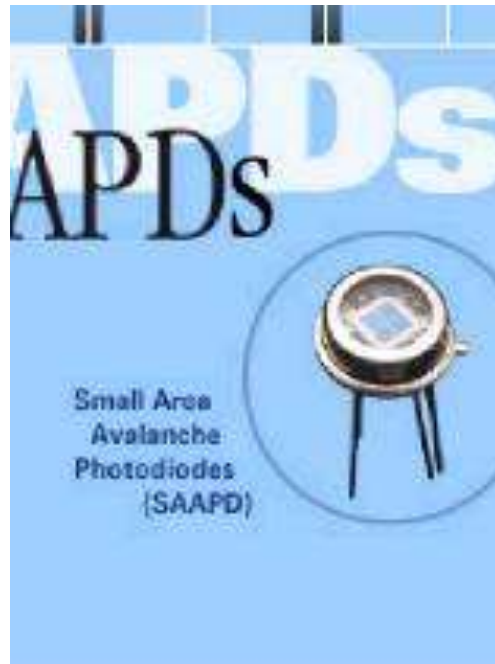
ILD (injection laser diode)

Detectors

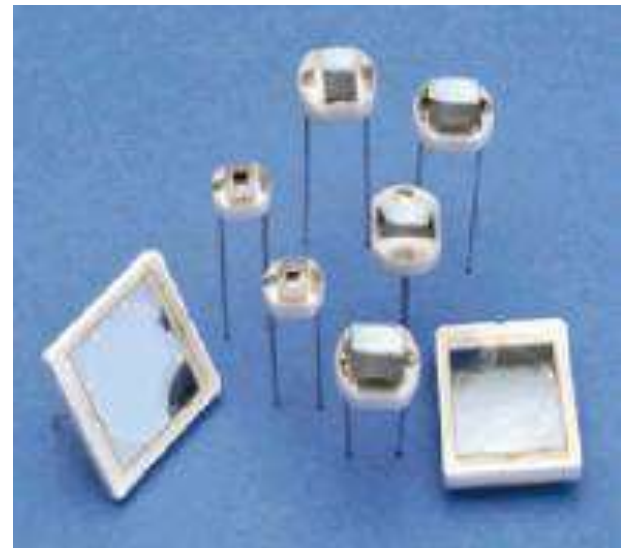
- Detector is the receiving end of a fiber optic link.

There are two kinds of Detectors

1. PIN (Positive Intrinsic Negative)
2. APD (Avalanche photo diodes)



APD



PIN

Losses in fiber optic communication system

- Material absorption
- Material Scattering
- Fiber coupling loss

Losses vary greatly depending upon the type of fiber

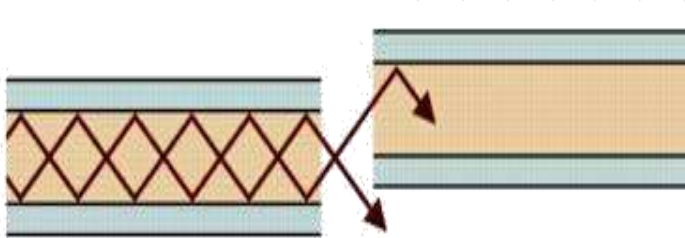
- Plastic fiber may have losses of several hundred dB per kilometer
- multimode glass fiber has a loss of about 2–4 dB per kilometer
- Single-mode fiber has a loss of 0.4 dB/km or less

Fiber coupling: Splices and Connectors

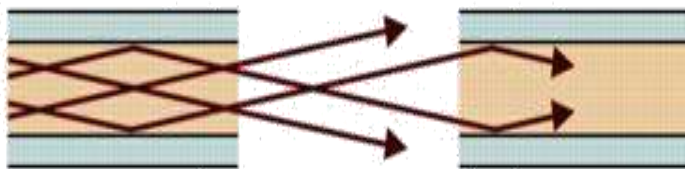
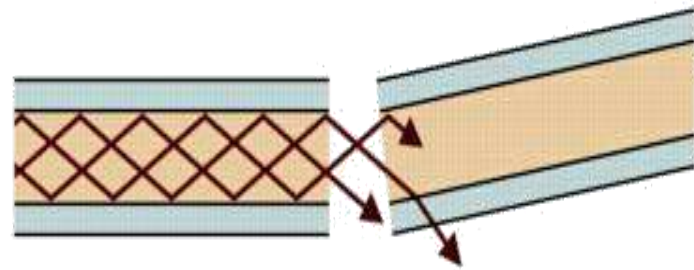
- Coupling the fiber to sources and detectors creates losses especially when it involves mismatches in the size of optical fibers.
- A *splice* is a permanent connection and a *connector* is removable.
- In fiber-optic systems, the losses from splices and connectors can be more than in the cable itself.

Coupling losses

- Losses result from:
 - Axial or angular misalignment
 - Air gaps between the fibers
 - Rough surfaces at the ends of the fibers



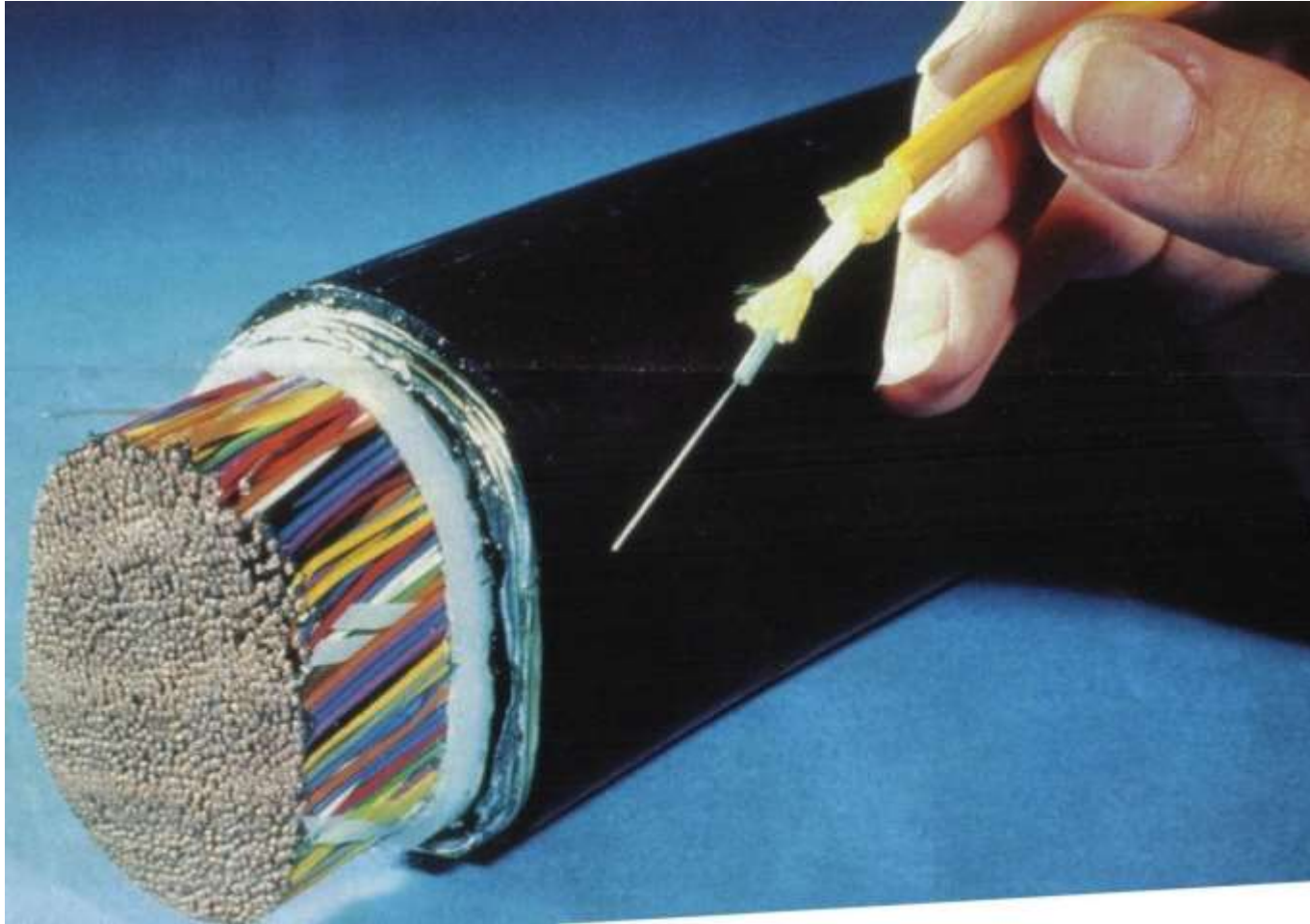
(a) Misalignment



(b) Air gap

(c) Rough ends

Optical fiber vs Copper



Advantages over conventional cables

- **Wide bandwidth**
- **Low loss**: In a coaxial cable losses increases with frequency. The higher the frequency of information signals the greater the loss, whereas in an optical fiber the attenuation is independent of frequency. They offer a loss of 0.2 dB/km.
- **Freedom from electromagnetic interference**: Optical fibers are not affected by interference originating from power cables and radio waves. They do not limit unwanted radiation and no cross talk between fibers exists.

- **Non conductivity**: Optical fibers are non-conductive and also doesn't attract lightning as copper cable can do . These are usable in explosive environment.
- **Small diameters and less weight**: Even multi fiber optical cables have a small diameter and are light weight, it can be applicable to long distance use. They are easier to handle.
- **Security**: It does not radiate signals and is impossible to tap without your knowledge, because the system will fail if it is tapped, due to the fact that it will leak light.
- **Safety**: Fiber is a dielectric and does not carry electricity. It presents no sparks or fire hazards. It does not cause explosions which occur due to faulty copper cable.

Disadvantage of fiber optic over copper wire cable

- Optical fiber is more expensive per meter than copper
- Optical fiber can not be join together as easily as copper cable. It requires training and expensive splicing and measurement equipment.
- Requires highly skilled installers.

AREAS OF APPLICATION

Due to its variety of advantages optical fiber communication system has a wide range of application in different fields.

- ❖ Telecommunications applications of fiber-optic cable are widespread, ranging from global networks to desktop computers. These involve the transmission of voice, data, and video over distances of less than a meter to hundreds of kilometers.
- ❖ Optical fibers are now the standard point to point cable link between telephone substations.
- ❖ Cable television companies also use fiber for delivery of digital video services.
- ❖ The high bandwidth provided by fiber makes it the perfect choice for transmitting broadband signals, such as high-definition television (HDTV) telecasts.

- ❖ Closed circuit television security systems(CCTV) use optical fiber because of its inherent security.
- ❖ Optical fibers can be used as sensors for the measurement mechanical force, pressure, electric field, electric current, magnetic field, temperature, nuclear radiations, density etc
- ❖ Fiber lamps are used for illumination in decorative applications, toys and artificial Christmas trees.



Optical fibers in military services



Fiber optics on the battlefield. This Enhanced Fiber-Optic Guided Missile (EFOG-M) has an infrared fiber-optic camera mounted in its nose so that the gunner firing it can see where it's going as it travels.

Fiber optics in medicine

- The properties of the fiber optic have allowed medical personnel to see places in the human body without cutting them open with greater ease and comfort for the patient.
- Endoscopes allow doctors to evaluate the interior surfaces of an organ by inserting a small tube into the body through a small cut. The procedures are relatively painless with the patient being sedated.
- One of the latest developments is called a **lab on a fiber**, and involves inserting hair-thin fiber-optic cables, with built-in sensors, into a patient's body in order to measure some critical aspect of how the patient's body is working, such as their temperature, blood pressure, cell pH, or the presence of medicines in their bloodstream.

Future trends

- Fiber optics communication is definitely the future of data communication.
- Some of the envisioned future trends in fiber optic communication are

A. All optical communication network:

Fiber optic communication is envisioned to be completely in the optical domain. Presently processing and switching of signals take place in the electrical domain. The optical to electrical conversion and vice versa adds a delay in the network and is a limitation to achieve very high data rates.

B. Multiterrabit optical networks: The need for increased bandwidth availability has led to the interest in developing multi terrabit optical networks. With the continuous reduction in the cost of fiber optic components ,the availability of much greater bandwidth in the future is possible.

C. Polymer optical fibers: Polymer optical fibers offer many benefits when compared to other data communication solutions such as copper cables, wireless communication systems and glass fiber. In comparison with glass optical fibers, polymer optical fibers provide easy and less expensive processing of optical signals and are more flexible.

D. Improvements in glass fiber design and

component miniaturization: Various impurities are added or removed from the glass fiber to change its light transmitting characteristics. The result is that the speed with which light passes along a glass fiber can be controlled, allowing for the production of customized glass fibers to meet the specific requirements to a given route. This trend is continued in the future, to produce more reliable, and effective glass fibers.

- The miniaturization of optical fiber communication components is another trend that is most likely to continue in the future.

conclusion

- The fiber optic communication industry is an ever evolving one ,the growth experienced by the industry has been enormous and there is still much work to be done to support the need for faster data rates, advanced switching techniques, and more intelligent network architectures that can automatically change in response to traffic patterns and at the same time be cost efficient.
- The trend is expected to continue in the future leading to a new generation in fiber optics communications.

Thank you

