NIELIT GORAKHPUR

Course Name: O Level (2nd Sem) **Subject:** Introduction to ICT Resources
Topic: Computer Network – Guided Media **Date:** 02-06-2020

Computer Network

Guided Media

Guided media refers to the method of transmission of data over which signal can travel in a network. Examples of guided media include the following:

- Twisted pair wire
- Coaxial cabling
- Fiber optic cabling

1. Twisted pair wire

A twisted pair of wires consists of two insulated copper wires, typically about 1 mm thick. The wires are twisted together in a helical shape. The purpose of twisting the wires is to reduce electrical interference from similar pairs that are close by.

Twisted pair wires are commonly used in local telephone communication and for digital data transmission over short distances up to 1 km. When many twisted pairs run in parallel for a substantial distance, such as all the wires coming from a multistory apartment to the telephone exchange, they are bundled together and placed in a protective sheath. The pairs in these bundles would interfere with one another if they are not twisted.

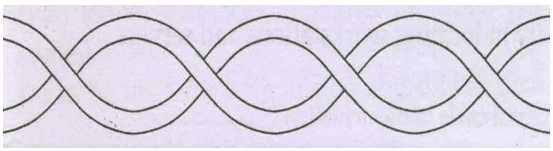


Figure: A twisted-pair of wires

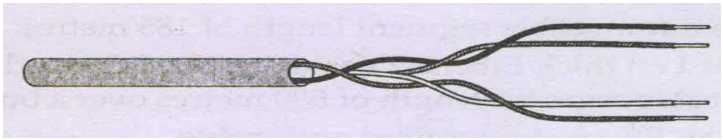


Figure: Unshielded twisted pair (UTP) cable

Wire pairs are normally used to connect terminals to the main computer up to short distances from the main computer. Data transmission speeds up to 9600 bits per second can be achieved if the distance is not more than 100 meters.

Advantages

(a) Being the oldest method of data transmission, trained manpower to repair and service this media of communications is easily available.
(b) In a telephone system, signals can travel several kilometers without amplification when twisted pair wires are used.
(c) This media can be used for both analog and digital data transmission. The bandwidth depends on the thickness of the wire and the distance traveled, but several megabits per second can be achieved for a few kilometers in many cases.
(d) It is the least expensive media of transmission for short distances.
(e) If a portion of a twisted pair cable is damaged, the entire network is not shut down as it may be the case with coaxial cable.

Disadvantages

(a) Easily picks up noise signals which results in higher error rates when the line length exceeds 100 meters.
(b) Being thin in size, it is likely to break easily.
(c) It can support 19,200 bps up to 50 feet on RS-232 port. On a l0BaseT, which supports 10 Mbps, twisted pair wires can be used up to 100 meters.

Unshielded twisted pair, commonly referred to as UTP, is more common of the two configurations. Shielded wire is used in an electrically noisy environment to limit the effects of noise absorption. Twisted pair wiring is commonly used for LAN media. The twisted pair version of Ethernet is designated as 10BASE-T, in which 10 refers to the Ethernet rate of 10 Mbps.

Twisted pair cabling comes in several varieties. In computer networks, two of these are important. Category 3 twisted pair cable consists of two insulated wires gently twisted together. Four such pairs are typically grouped together in a plastic sheath for protection and to keep the eight wires together. Another more advanced category, 5 twisted pairs, are similar to category 3 pairs but with more twist per centimeter and Teflon insulation, which results in less crosstalk and better quality signal over longer distances, making them more suitable for high-speed computer communications.

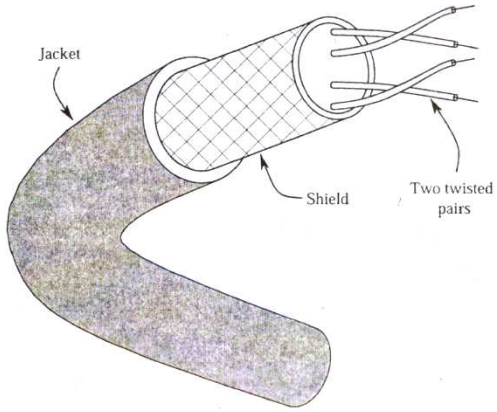
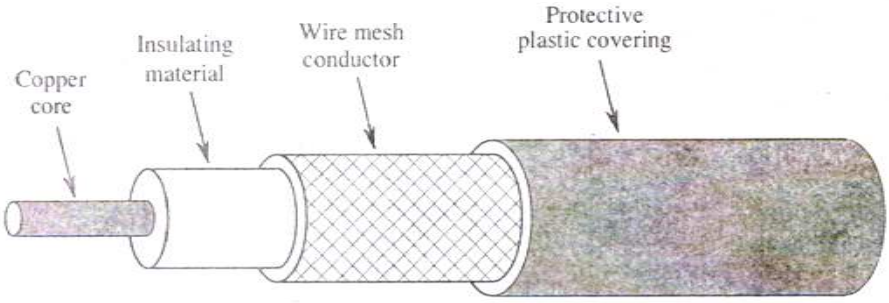


Figure: Shielded two-pair cable

2. Coaxial Cabling

Coaxial cable consists of a stiff copper wire as the core, surrounded by an insulating material. The insulator is encased by a cylindrical conductor, often as a closely woven braided mesh. The outer conductor is covered in a protective plastic sheath. The signal is transmitted by the inner copper wire and it is electrically shielded by the outer metal sleeve.



Different terms of coaxial cable implementation

Terms	Implementation
10Base2	An implementation of the 802.3 Ethernet standards on thin Ethernet (RG-58) coaxial cable. It has a data transfer rate of 10 megabits per second and a maximum cable segment length of 185 meters.
10Base5	An implementation of the 802.3 Ethernet standards on thick Ethernet coaxial cable. It has a data transfer rate of 10 megabits per second and a maximum cable segment length of 500 meters over a bus topology.
10BaseF	Emerging 802.3 standards that define the use of an Ethernet over fiber optic cable.
10BaseT	An implementation of the 802.3 Ethernet standards over Unshielded Twisted Pair (UTP) wiring. It is similar to the wiring used with modern telephone systems using RJ-45 connectors. The standard is based on a star topology, with each node connected to a central wiring centre and a maximum cable- segment length of 100 meters.
Thick Ethernet	Connecting coaxial cable used on an Ethernet network. The cable is 1 centimeter (0.4 inch) thick and can be used to connect network nodes up to a distance of approximately 1006 meters.
Thin Ethernet	Connecting coaxial cable used on an Ethernet network. The cable is 5 millimeters (0.2 inch) thick and can be used to connect network nodes up to a distance of approximately 165 meters. Normally used for office installations.

Two kinds of coaxial cable are widely used:

1) 50-ohm cable is commonly used for digital transmission.
2) 75-ohm cable is commonly used for analog transmission in cable TV transmission.

IEEE uses the 10Base5 designation for thick Ethernet coaxial cable and 10Base2 for thin Ethernet coaxial cable. Coaxial cables can support data rates of up to several tens of Mbps at distances up to several thousand feet. Certain types of signaling enable high data rates over distances of several miles.

Baseband networks are the ones where the entire bandwidth of the cable is utilized for a single channel. Broadband is basically a frequency division multiplexed situation, where the coaxial cables bandwidth is separated into sub-channels of either equal or varying frequency ranges that can be treated as separate communication media.

Coaxial cable is difficult to connect to network devices and generally requires more planning than twisted pair system. Many coaxial systems require the connectors on the main cable to be attached directly to the adapter on PCs. This reduces flexibility in locating workstations and servers.

Advantages of Coaxial Cable

(a) It has better shielding against electromagnetic interference than twisted pair cable. Thus, it can span longer distances at higher data bits per second (bps).
(b) It can be used for both analog and digital data transmissions. For analog data transmission, 75-ohm broadband coaxial cable is used and for digital data transmission, 50-ohm baseband cable is used.
(c) Coaxial cable has a higher bandwidth and excellent safeguard against electrical noise (noise immunity). RG-58 cable (10Base2) is a thin coaxial cable (50-ohm) in widespread use for LAN connections. RG-11 (10Base5) cable is a coaxial cable that is thicker and sturdier, and can withstand more rugged surroundings. It can be used with much longer segment lengths. RG-59, a 75-ohm coaxial cable, and RG-62 (93-ohm) cable are used in ARCnet LAN or IBM 3270 applications.
(d) It is inexpensive as compared to twisted pair wires and UTP cables but easy to handle.
(e) Coaxial cable has a bandwidth in the range of 300-400 MHz. It is capable of carrying over 50 standard 6 MHz colour TV channels or thousands of channels of voice-grade and/or low- speed data over a single cable. CD-quality audio (1.4 Mbps), or a digital bit stream at 3 Mbps, can be mixed on coaxial cable for transmitting video signals. Broadband cable is inferior to baseband cable for sending digital data but has the advantage that a huge amount of broadband cable is already available in the Cable TV systems.

Note: ***Cable TV systems may begin operating as Metropolitan Area Networks and offer telephone and Internet services at low cost.***

3. Optical Fiber

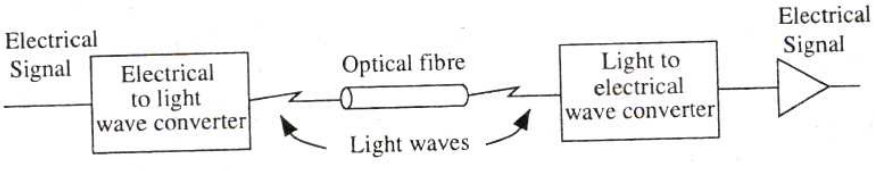
Optic fiber is the newest form of bounded media. This media is superior in data handling and security characteristics. The cable transmits light signals rather than electrical signals. It is by far more efficient than other network transmission media. Each fiber has an inner core of glass or plastic that conducts light. There are two types of light sources for which fiber cables are available. These sources of light are:

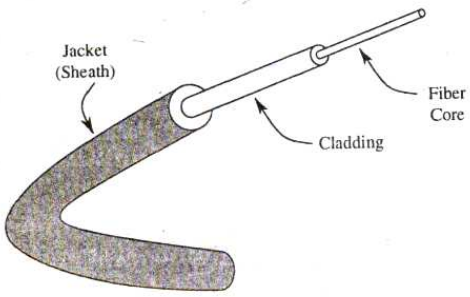
- Light Emitting Diodes (LEDs)
- Light Amplification by Stimulated Emission Radiation (Lasers)

The system basically consists of fiber optic cables made of tiny threads of glass or plastics. In a single-mode fiber, the core is 8 to 10 microns (about the size of hair). In multimode fibers, the core is of about 50 microns in diameter. Towards its source side is a converter that converts

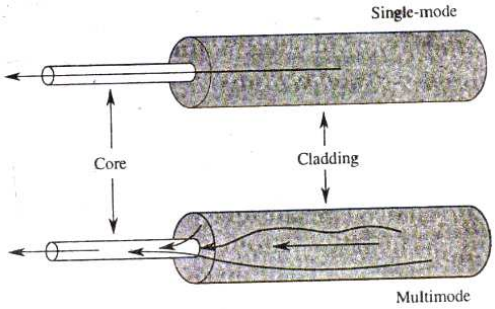
electrical signals into light waves. These light waves are transmitted over the fiber. Another converter placed near the sink converts the light waves back to electrical signals by photoelectric diodes. These electrical signals are amplified and sent to the receiver. Each fiber has an inner core of glass or plastic that conducts light. The inner core is surrounded by cladding. Cladding is a layer of glass that reflects the light back into the core. Each fiber is surrounded by a plastic sheath.

The principle of operation of the fiber optic system





Fiber optic cables with cladding and jacket (sheaths)



Single-mode and multimode optical fibers

Types of Fiber Optic Cables

Optical fibers may be multimode or single mode type. Single mode fibers allow a single light path and are typically used with laser signaling. They allow greater bandwidth than multimode but are more expensive. Multimode fibers use multiple light paths. The physical characteristics of the multimode fiber make all parts of the signal (those from the various paths) arrive at the same time, appearing to the receiver as though they were one pulse.

Optical fibers are differentiated by core/cladding size and the mode of operation. The following are the common types of fiber optic cables:

(a) 8.3-micron core/12.5-micron cladding, single-mode,
(b) 62.5-micron core/125-micron cladding, multi-mode
(c) 50-micron core/125-micron cladding, multi-mode
(d) 100-micron core/140-micron cladding, multi-mode

Note: ***Micron is one millionth of a meter = 1/25,000 inch (approximately).***

Characteristics of Fiber-optic Cable

Fiber optic cable has the following characteristics:

1. **Cost:** It is more expensive than copper cable, but its costs are falling. Associated equipment costs can be much higher than for copper cable, making fiber optic networks much more expensive. Single mode fiber devices are more expensive and more difficult to install than multimode devices.
2. **Installation**: It is more difficult to install than copper cable. Every fiber connection and splice must be carefully made to avoid obstruction of light path. Also, the cables have a maximum bend radius, which makes cabling more difficult.
3. **Bandwidth capacity**: Because it uses light, which has higher frequency than electrical signals, fiber optic cabling provides data rates from 100 Mbps to 2 gigabits per second. The data rate depends on the fiber composition, mode and wavelength (frequency) of transmitter light. A common multimode installation can support 100 Mbps over several kilometers.

4. **Node capacity:** In the case of Ethernet network, fiber optic cables have a useful, upper limit of around 75 nodes on a single collision domain.
5. **Attenuation:** It has lower attenuation than copper wires, mainly because the light is'not radiated in the way electricity is radiated from copper cables. It has a different problem, namely, chromatic dispersion. Different wavelengths of light travel through glass differently, and the colours of a single pulse of light spread apart slightly as they travel down a cable. At a distance of several miles, one bit may shift into the next bit, causing data to be corrupted or lost. Single mode fiber optic cable conveys only one frequency of light down the cable, so it does not suffer from chromatic dispersion.
6. **Electromagnetic interference:** Fiber optic cable is not subjected to electrical interference. It does not even leak signals, so it is immune to eavesdropping. Because it does not require a ground, it is not affected by potential shifts in the electrical ground, nor does it produce sparks. This type of cable is ideal for high-voltage served areas or installations where eavesdropping can be a problem.
7. **Mode of transmission**: Fiber optic channels are half-duplex, which means that light signals can only move in one direction at a time. A full-duplex circuit can cause light wave interference without special electronics and hence it is generally not economically viable. Moreover, a bend radius that is too tight causes distortion and attenuation of the light signal due to changes in the electrical and physical characteristics of the inner core.
8. **Uses of optical fiber media:** Fiber optic media can support high bandwidth applications such as video conference, digital voice/image/graphics networking in LAN. It is the basis for several high bandwidth networking standards such as Fiber Distributed Data Interface (FDDI) and Synchronous Optical Network (SONET).

Comparison of fiber optics and copper wire

Advantages: Fiber optic cable has many advantages over copper wire as a transmission media.

- It can handle much higher bandwidth than copper. Due to the low attenuation, repeaters are needed only about every 30 km on fiber lines versus about every 5 km for copper.
- Fiber is not affected by power surges, electromagnetic interference or power failures. It is not even affected by corrosive chemicals in the air, making it ideal for factory environments where electrical interference is very high.
- Fiber cable is lighter than copper cable. One thousand twisted pair copper cables of 1 km long weigh 8000 kg. But fibers have more capacity and weigh only 100 kg, which greatly reduces the need for expensive mechanical support systems that must be maintained.
- Fibers do not leak light and are quite difficult to tap. This gives them excellent security against potential wire-tappers.

Disadvantages: Fibers have the following disadvantages over copper wires:

- Fiber is an unfamiliar technology that requires skills not easily available.
- Since optical transmission is inherently unidirectional, two-way communication requires either two fiber cables or two frequency bands on one fiber.
- Fiber interfaces cost more than electrical interfaces.

Exercise:

1: Write short notes on -

- **Twisted pair wire**
- **Coaxial cabling**
- **Fiber optic cabling**

2: Compare fiber optics and copper wire?