UNIT–05

UNIT-01/LECTURE-01

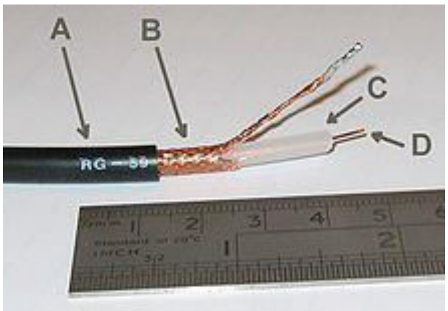
Transmission Media

Transmission Media

- A transmission medium is a material substance that can propagate energy waves. For example, the transmission medium for sounds is usually air, but solids and liquids may also act as transmission media for sound.
- The absence of a material medium in vacuum may also constitute a transmission medium for electromagnetic waves such as light and radio waves. While material substance is not required for electromagnetic waves to propagate, such waves are usually affected by the transmission media they pass through, for instance by absorption or by reflection or refraction at the interfaces between media.
- The term transmission medium also refers to a technical device that employs the material substance to transmit or guide waves. Thus, an optical fibre or a copper cable is a transmission medium. Not only this but also is able to guide the transmission of networks.

A transmission medium can be classified as a:

- Linear medium, if different waves at any particular point in the medium can be superposed;
- Bounded medium, if it is finite in extent, otherwise unbounded medium;
- Uniform medium or homogeneous medium, if its physical properties are unchanged at different points;
- Isotropic medium, if its physical properties are the same in different directions.



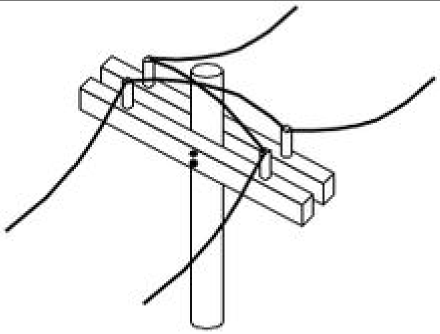
Coaxial cable

- Electromagnetic radiation can be transmitted through an optical medium, such as optical fiber, or through twisted pair wires, coaxial cable, or dielectric-slab waveguides. It may also pass through any physical material that is transparent to the specific wavelength, such as water, air, glass, or concrete. Sound is, by definition, the vibration of matter, so it requires a physical medium for transmission, as do other kinds of mechanical waves and heat energy. Historically, science incorporated various aether theories to explain the transmission medium. However, it is now known that electromagnetic waves do not require a physical transmission medium, and so can travel through the "vacuum" of free space. Regions of the insulative vacuum can become conductive for electrical conduction through the presence of free electrons, holes, or ions.

Transmission and reception of data is performed in four steps.

1. The data is coded as binary numbers at the sender end
2. A carrier signal is modulated as specified by the binary representation of the data
3. At the receiving end, the incoming signal is demodulated into the respective binary numbers
4. Decoding of the binary numbers is performed.

- Twisted pair cabling is a type of wiring in which two conductors of a single circuit are twisted together for the purposes of cancelling out electromagnetic interference (EMI) from external sources; for instance, electromagnetic radiation from unshielded twisted pair (UTP) cables, and crosstalk between neighbouring pairs. It was invented by Alexander Graham Bell.
- In balanced pair operation, the two wires carry equal and opposite signals and the destination detects the difference between the two. This is known as differential mode transmission. Noise sources introduce signals into the wires by coupling of electric or magnetic fields and tend to couple to both wires equally. The noise thus produces a common-mode signal which is cancelled at the receiver when the difference signal is taken.
- This method starts to fail when the noise source is close to the signal wires; the closer wire will couple with the noise more strongly and the common-mode rejection of the receiver will fail to eliminate it. This problem is especially apparent in telecommunication cables where pairs in the same cable lie next to each other for many miles. One pair can induce crosstalk in another and it is additive along the length of the cable. Twisting the pairs counters this effect as on each half twist the wire nearest to the noise-source is exchanged.
- Providing the interfering source remains uniform, or nearly so, over the distance of a single twist, the induced noise will remain common-mode. Differential signaling also reduces electromagnetic radiation from the cable, along with the associated attenuation allowing for greater distance between exchanges.
- The twist rate (also called pitch of the twist, usually defined in twists per meter) makes up part of the specification for a given type of cable. Where nearby pairs have equal twist rates, the same conductors of the different pairs may repeatedly lie next to each other, partially undoing the benefits of differential mode. For this reason it is commonly specified that, at least for cables containing small numbers of pairs, the twist rates must differ.[1]
- In contrast to ScTP (screened twisted pair), STP (shielded twisted pair), FTP (foiled twisted pair) and other shielded cabling variations, UTP (unshielded twisted pair) cable is not surrounded by any shielding. It is the primary wire type for telephone usage and is very common for computer networking, especially as patch cables or temporary network connections due to the high flexibility of the cables.

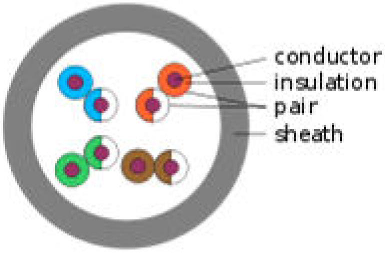


- The earliest telephones used telegraph lines, or open-wire single-wire earth return circuits. In the 1880s electric trams were installed in many cities, which induced noise into these circuits. Lawsuits being unavailing, the telephone companies converted to balanced circuits, which had the incidental benefit of reducing attenuation, hence increasing range.
- As electrical power distribution became more commonplace, this measure proved inadequate. Two wires, strung on either side of cross bars on utility poles, shared the route with electrical power lines. Within a few years, the growing use of electricity again brought an increase of interference, so engineers devised a method called wire transposition, to cancel out the interference.
- In wire transposition, the wires exchange position once every several poles. In this way, the two wires would receive similar EMI from power lines. This represented an early implementation of twisting, with a twist rate of about four twists per kilometre, or six per mile. Such open-wire balanced lines with periodic transpositions still survive today in some rural areas.
- Twisted pair cables were invented by Alexander Graham Bell in 1881. By 1900, the entire American telephone line network was either twisted pair or open wire with transposition to guard against interference. Today, most of the millions of kilometres of twisted pairs in the world are outdoor landlines, owned by telephone companies, used for voice service, and only handled or even seen by telephone workers.

S.NO	RGPV QUESTIONS	Year	Marks
Q.1	Explain transmission media.	Dec2012	7
Q.2	Explain the different types of guided media with examples.	Dec 2013	7

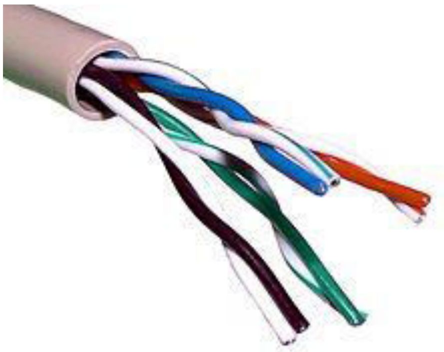
UNIT-05/LECTURE-02

Unshielded twisted pair (UTP) (RGPV Dec 2012)



Unshielded twisted pair

- For urban outdoor telephone cables containing hundreds or thousands of pairs, the cable is divided into smaller but identical bundles. Each bundle consists of twisted pairs that have different twist rates. The bundles are in turn twisted together to make up the cable. Pairs having the same twist rate within the cable can still experience some degree of crosstalk. Wire pairs are selected carefully to minimize crosstalk within a large cable.



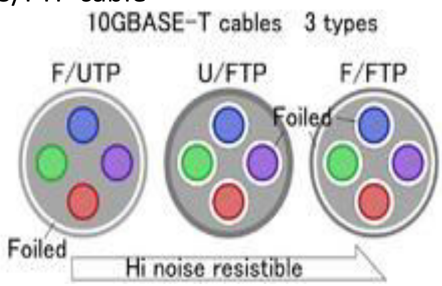
Unshielded twisted pair cable with different twist rates

- UTP cable is also the most common cable used in computer networking. Modern Ethernet, the most common data networking standard, can use UTP cables. Twisted pair cabling is often used in data networks for short and medium length connections because of its relatively lower costs compared to optical fiber and coaxial cable.
- UTP is also finding increasing use in video applications, primarily in security cameras. Many cameras include a UTP output with screw terminals; UTP cable bandwidth has improved to match the baseband of television signals. As UTP is a balanced transmission line, a balun is needed to connect to unbalanced equipment, for example any using BNC connectors and designed for coaxial cable.

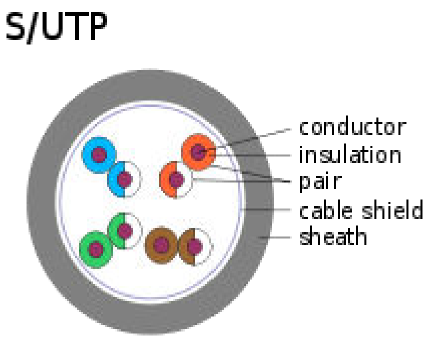
Cable Shielding

F/UTP cable

S/FTP cable



U/FTP, F/UTP and F/FTP are used in Cat.6a cables



S/UTP cable

- Twisted pair cables are often shielded in an attempt to prevent electromagnetic interference. Shielding provides an electric conductive barrier to attenuate electromagnetic waves external to the shield and provides conduction path by which induced currents can be circulated and returned to the source, via ground reference connection.

- This shielding can be applied to individual pairs or quads, or to the collection of pairs. Individual pairs are foiled, while overall cable may use braided screen, foil, or braiding with foil.

- When shielding is applied to the collection of pairs, this is usually referred to as screening, however different vendors and authors use different terminology, employing "screening" and "shielding" interchangeably; for example, STP (shielded twisted pair) or ScTP (screened twisted pair) has been used to denote U/FTP, S/UTP, F/UTP, SF/UTP and S/FTP construction).
- Because the shielding is made of metal, it may also serve as a ground. Usually a shielded or a screened twisted pair cable has a special grounding wire added called a drain wire which is electrically connected to the shield or screen. The drain wire simplifies connection to ground at the connectors.

Common shielded cable types used by Cat. 6a, Cat.7 and Cat.8 cables include:

Shielded twisted pair (U/FTP)

- Also pair in metal foil. Individual shielding with foil for each twisted pair or quad. This type of shielding protects cable from external EMI from entering or exiting the cable and also protects neighboring pairs from crosstalk.
- **Screened twisted pair (F/UTP, S/UTP and SF/UTP)**
- Also foiled twisted pair for F/UTP. Overall foil, braided shield or braiding with foil across all of the pairs within the 100 Ohm twisted pair cable. This type of shielding protects EMI from entering or exiting the cable.
- **Screened shielded twisted pair (F/FTP and S/FTP)**
- Also fully shielded twisted pair, shielded screened twisted pair, screened foiled twisted pair, shielded foiled twisted pair. Individual shielding using foil between the twisted pair sets, and also an outer metal and/or foil shielding within the 100 Ohm twisted pair cable. This type of shielding protects EMI from entering or exiting the cable and also protects neighboring pairs from crosstalk.

Examples of common industry abbreviations

Industry acronyms	ISO/IEC 11801 name	Cable screening	Pair shielding
UTP	U/UTP	none	none
STP, ScTP, PiMF	U/FTP	none	foil
FTP, STP, ScTP	F/UTP	foil	none
STP, ScTP	S/UTP	braiding	none
S-FTP, SFTP, STP	SF/UTP	braiding, foil	none
FFTP	F/FTP	foil	foil
SSTP, SFTP, STP PiMF	S/FTP	braiding	foil

- The code before the slash designates the shielding for the cable itself, while the code after the slash determines the shielding for the individual pairs:

  TP = twisted pair
  TQ = twisted pair, individual shielding in quads
  U = unshielded
  F = foil shielding
  S = braided shielding (outer layer only)

S.NO	RGPV QUESTIONS	Year	Marks
Q.1	How signal travel in twisted pair cable and in coaxial cable	Dec.2013	6

UNIT-05/LECTURE-03

Most common twisted-pair cables:

Name	Typical construction	Bandwidth	Applications	Notes
Level 1		0.4 MHz	Telephone and modem lines	Not described in EIA/TIA recommendations. Unsuitable for modern systems.[7]
Level 2		4 MHz	Older terminal systems, e.g. IBM 3270	Not described in EIA/TIA recommendations. Unsuitable for modern systems.[7]
Cat 3	UTP[8]	16 MHz[8]	10BASE-T and 100BASE-T4 Ethernet[8]	Described in EIA/TIA-568. Unsuitable for speeds above 16 Mbit/s. Now mainly for telephone cables[8]
Cat 4	UTP[8]	20 MHz[8]	16 Mbit/s[8] Token Ring	Not commonly used[8]
Cat 5	UTP[8]	100 MHz[8]	100BASE-TX & 1000BASE-T Ethernet[8]	Common in most current LANs[8]
Cat 5e	UTP[8]	100 MHz[8]	100BASE-TX & 1000BASE-T Ethernet[8]	Enhanced Cat5. Same construction as Cat5, but with better testing standards.
Cat 6	UTP[8]	250 MHz[8]	10GBASE-T Ethernet	Most commonly installed cable in Finland according to the 2002 standard. SFS-EN 50173-1
Cat 6a	U/FTP, F/UTP	500 MHz	10GBASE-T Ethernet	Adds outer shielding. ISO/IEC 11801:2002 Amendment 2.
Cat 7	F/FTP, S/FTP	600 MHz	Telephone, CCTV, 1000BASE-TX in the same cable. 10GBASE-T Ethernet.	Fully shielded cable. ISO/IEC 11801 2nd Ed.
Cat 7a	F/FTP, S/FTP	1000 MHz	Telephone, CATV, 1000BASE-TX in the same cable. 10GBASE-T Ethernet.	Uses all four pairs. ISO/IEC 11801 2nd Ed. Am. 2.
Cat 8.1	F/UTP	1600-2000 MHz	Telephone, CATV, 1000BASE-TX in the same cable. 40GBASE-T Ethernet.	In development.
Cat 8.2	F/FTP, S/FTP	1600-2000 MHz	Telephone, CATV, 1000BASE-TX in the same cable. 40GBASE-T Ethernet.	In development.

Solid Core Cable Vs Stranded Cable

- A solid core cable uses one solid wire per conductor and in a four pair cable there would be a total of eight solid wires. Stranded conductor uses multiple wires wrapped around each other in each conductor and in a four pair with seven strands per conductor cable, there would be a total of 56 wires (2 per pair x 4 pairs x 7 strands).
- Solid core cable is supposed to be used for permanently installed runs. It is less flexible than stranded cable and is more prone to failure if repeatedly flexed. Stranded cable is used for fly leads at patch panel and for connections from wall-ports to end devices, as it resists cracking of the conductors.

- Connectors need to be designed differently for solid core than for stranded. Use of a connector with the wrong cable type is likely to lead to unreliable cabling. Plugs designed for solid and stranded core are readily available, and some vendors even offer plugs designed for use with both types. The punch-down blocks on patch-panel and wall port jacks are designed for use with solid core cable.

Advantages

- It is a thin, flexible cable that is easy to string between walls.
- More lines can be run through the same wiring ducts.
- Electrical noise going into or coming from the cable can be prevented.
- Cross-talk is minimized.

Disadvantages

- Twisted pair's susceptibility to electromagnetic interference greatly depends on the pair twisting schemes (usually patented by the manufacturers) staying intact during the installation. As a result, twisted pair cables usually have stringent requirements for maximum pulling tension as well as minimum bend radius. This relative fragility of twisted pair cables makes the installation practices an important part of ensuring the cable's performance.

- In video applications that send information across multiple parallel signal wires, twisted pair cabling can introduce signaling delays known as skew which cause subtle color defects and ghosting due to the image components not aligning correctly when recombined in the display device. The skew occurs because twisted pairs within the same cable often use a different number of twists per meter in order to prevent crosstalk between pairs with identical numbers of twists. The skew can be compensated by varying the length of pairs in the termination box, in order to introduce delay lines that take up the slack between shorter and longer pairs, though the precise lengths required are difficult to calculate and vary depending on the overall cable length.

Minor twisted pair variants

Loaded Twisted Pair

- A twisted pair that has intentionally added inductance, formerly common practice on telecommunication lines. The added inductors are known as load coils and reduce attenuation for voiceband frequencies but increase it on higher frequencies. Load coils cause distortion in voiceband on very long lines.[10] In this context a line without load coils is referred to as an unloaded line.

Bonded Twisted Pair

- A twisted pair variant in which the pairs are individually bonded to increase robustness of the cable. Pioneered by Belden, it means the electrical specifications of the cable are maintained despite rough handling.

Twisted Ribbon Cable

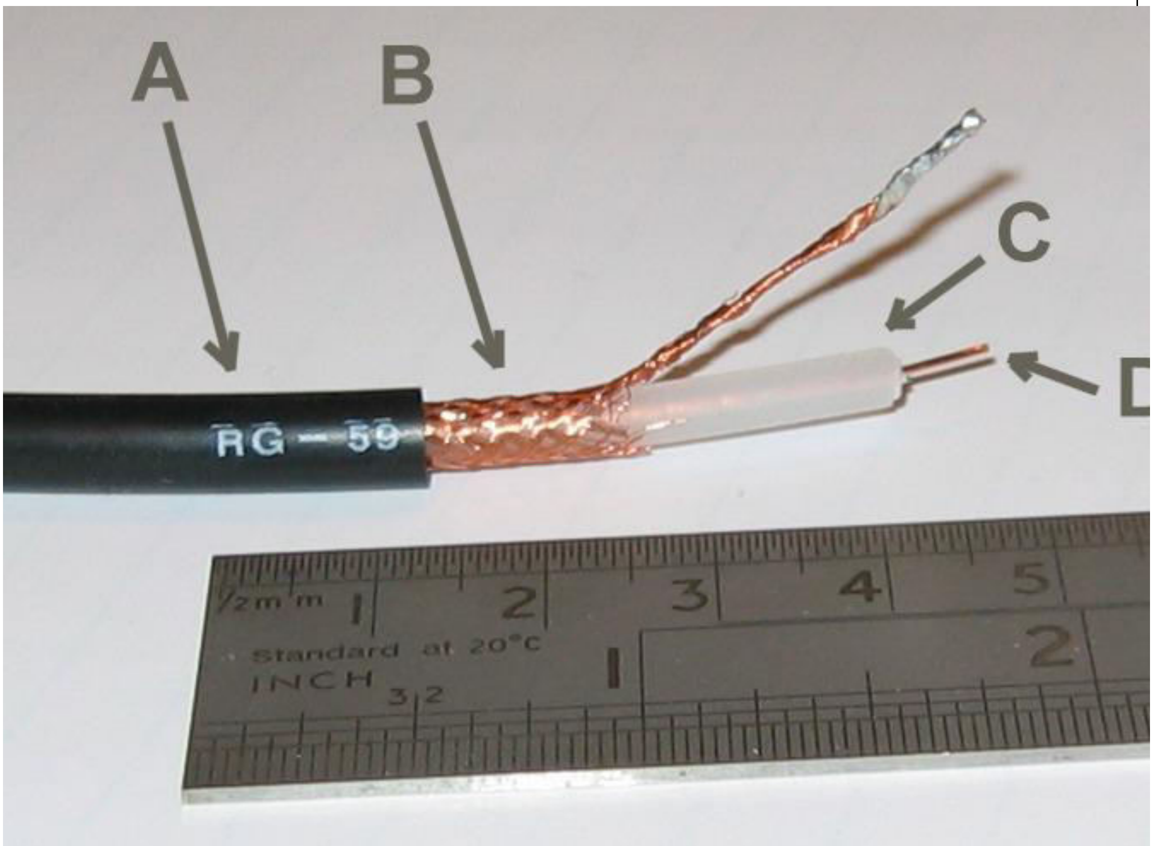
- A variant of standard ribbon cable in which adjacent pairs of conductors are bonded and twisted together. The twisted pairs are then lightly bonded to each other in a ribbon format. Periodically along the ribbon there are short sections with no twisting to enable connectors and PCB headers to be terminated using the usual ribbon cable IDC techniques.

S.NO	RGPV QUESTIONS	Year	Marks
Q.1	Explain the different types of guided media with examples.	Dec 2013	7

UNIT-05/LECTURE-04

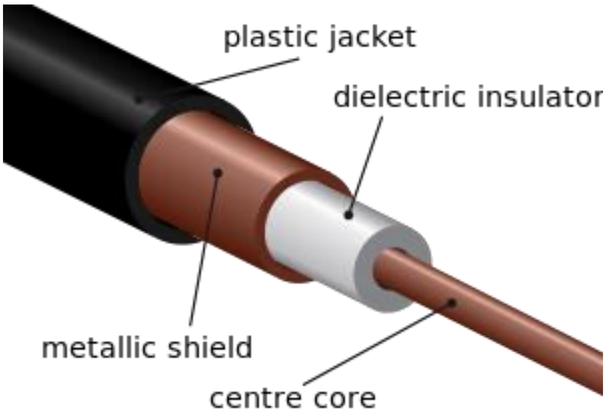
Coaxial Cable

- Coaxial cable, or coax is a type of cable that has an inner conductor surrounded by a tubular insulating layer, surrounded by a tubular conducting shield. Many coaxial cables also have an insulating outer sheath or jacket. The term coaxial comes from the inner conductor and the outer shield sharing a geometric axis. Coaxial cable was invented by English engineer and mathematician Oliver Heaviside, who patented the design in 1880. Coaxial cable differs from other shielded cable used for carrying lower-frequency signals, such as audio signals, in that the dimensions of the cable are controlled to give a precise, constant conductor spacing, which is needed for it to function efficiently as a radio frequency transmission line.

- 

- Coaxial cable conducts electrical signal using an inner conductor surrounded by an insulating layer and all enclosed by a shield, typically one to four layers of woven metallic braid and metallic tape. The cable is protected by an outer insulating jacket. Normally, the shield is kept at ground potential and a voltage is applied to the center conductor to carry electrical signals. The advantage of coaxial design is that electric and magnetic fields are confined to the dielectric with little leakage outside the shield. Conversely, electric and magnetic fields outside the cable are largely kept from causing interference to signals inside the cable. Larger diameter cables and cables with multiple shields have less leakage. This property makes coaxial cable a good choice for carrying weak signals that cannot tolerate interference from the environment or for higher electrical signals that must not be allowed to radiate or couple into adjacent structures or circuits.

- Common applications of coaxial cable include video and CATV distribution, RF and microwave transmission, and computer and instrumentation data connections.
- The characteristic impedance of the cable is determined by the dielectric constant of the inner insulator and the radii of the inner and outer conductors. A controlled cable characteristic impedance is important because the source and load impedance should be matched to ensure maximum power transfer and minimum standing wave ratio. Other important properties of coaxial cable include attenuation as a function of frequency, voltage handling capability, and shield quality.



Construction

- Coaxial cable design choices affect physical size, frequency performance, attenuation, power handling capabilities, flexibility, strength, and cost. The inner conductor might be solid or stranded; stranded is more flexible. To get better high-frequency performance, the inner conductor may be silver-plated. Copper-plated steel wire is often used as an inner conductor for cable used in the cable TV industry.
- The insulator surrounding the inner conductor may be solid plastic, a foam plastic, or air with spacers supporting the inner wire. The properties of dielectric control some electrical properties of the cable. A common choice is a solid polyethylene (PE) insulator, used in lower-loss cables. Solid Teflon (PTFE) is also used as an insulator. Some coaxial lines use air and have spacers to keep the inner conductor from touching the shield.
- Many conventional coaxial cables use braided copper wire forming the shield. This allows the cable to be flexible, but it also means there are gaps in the shield layer, and

the inner dimension of the shield varies slightly because the braid cannot be flat. Sometimes the braid is silver-plated. For better shield performance, some cables have a double-layer shield. The shield might be just two braids, but it is more common now to have a thin foil shield covered by a wire braid. Some cables may invest in more than two shield layers, such as "quad-shield", which uses four alternating layers of foil and braid. Other shield designs sacrifice flexibility for better performance; some shields are a solid metal tube. Those cables cannot be bent sharply, as the shield will kink, causing losses in the cable.

- For high-power radio-frequency transmission up to about 1 GHz, coaxial cable with a solid copper outer conductor is available in sizes of 0.25 inch upward. The outer conductor is rippled like a bellows to permit flexibility and the inner conductor is held in position by a plastic spiral to approximate an air dielectric.
- Coaxial cables require an internal structure of an insulating (dielectric) material to maintain the spacing between the center conductor and shield. The dielectric losses increase in this order: Ideal dielectric, vacuum, air, polytetrafluoroethylene (PTFE), polyethylene foam, and solid polyethylene. A low relative permittivity allows for higher-frequency usage. An inhomogeneous dielectric needs to be compensated by a non-circular conductor to avoid current hot-spots.
- While many cables have a solid dielectric, many others have a foam dielectric that contains as much air or other gas as possible to reduce the losses by allowing the use of a larger diameter center conductor. Foam coax will have about 15% less attenuation but some types of foam dielectric can absorb moisture—especially at its many surfaces — in humid environments, significantly increasing the loss. Supports shaped like stars or spokes are even better but more expensive and very susceptible to moisture infiltration. Still more expensive were the air-spaced coaxials used for some inter-city communications in the mid-20th century. The center conductor was suspended by polyethylene discs every few centimeters. In some low-loss coaxial cables such as the RG-62 type, the inner conductor is supported by a spiral strand of polyethylene, so that an air space exists between most of the conductor and the inside of the jacket. The lower dielectric constant of air allows for a greater inner diameter at the same impedance and a greater outer diameter at the same cutoff frequency, lowering ohmic losses. Inner conductors are sometimes silver-plated to smooth the surface and reduce losses due to skin effect. A rough surface prolongs the path for the current and concentrates the current at peaks and, thus, increases ohmic losses.
- The insulating jacket can be made from many materials. A common choice is PVC, but some applications may require fire-resistant materials. Outdoor applications may require the jacket resist ultraviolet light, oxidation and rodent damage. Flooded coaxial cables use a water blocking gel to protect the cable from water infiltration through minor cuts in the jacket. For internal chassis connections the insulating jacket may be omitted.

Applications

- Coaxial cable is used as a transmission line for radio frequency signals. Its applications include feedlines connecting radio transmitters and receivers with their antennas, computer network (Internet) connections, and distributing cable television signals.

One advantage of coaxial over other types of radio transmission line is that in an ideal coaxial cable the electromagnetic field carrying the signal exists only in the space between the inner and outer conductors. This allows coaxial cable runs to be installed next to metal objects such as gutters without the power losses that occur in other types of transmission lines. Coaxial cable also provides protection of the signal from external electromagnetic interference

S.NO	RGPV QUESTIONS(IT)	Year	Marks
Q.1	Discuss the parameters of ultimate analysis of coal.	DEC2013 Dec 2011	4 4

S.NO	RGPV QUESTIONS(CS)	Year	Marks
Q.1	Briefly describe the broadband coaxial cable.	JUNE 2011	7

UNIT-05/LECTURE-05

Uses of coaxial cable

- Short coaxial cables are commonly used to connect home video equipment, in ham radio setups, and in measurement electronics. They used to be common for implementing computer networks, in particular Ethernet, but twisted pair cables have replaced them in most applications except in the growing consumer cable modem market for broadband Internet access.
- Micro coaxial cables are used in a range of consumer devices, military equipment, and also in ultra-sound scanning equipment.
- The most common impedances that are widely used are 50 or 52 ohms, and 75 ohms, although other impedances are available for specific applications. The 50 / 52 ohm cables are widely used for industrial and commercial two-way radio frequency applications (including radio, and telecommunications), although 75 ohms is commonly used for broadcast television and radio.
- Coax cable is often used to carry data or signals from an antenna to a receiver from a satellite dish to a satellite receiver, from a television antenna to a television receiver, from a radio mast to a radio receiver, etc. In many cases, the same single coax cable carries power in the opposite direction, to the antenna, to power the low-noise amplifier. In some cases a single coax cable carries (unidirectional) power and bidirectional data or signals.

Fiber Optical Cable (RGPV Dec2013)

- An optical fiber cable is a cable containing one or more optical fibers that are used to carry light. The optical fiber elements are typically individually coated with plastic layers and contained in a protective tube suitable for the environment where the cable will be deployed. Different types of cable are used for different applications, for example long distance telecommunication, or providing a high-speed data connection between different parts of a building.

- Optical fiber consists of a core and a cladding layer, selected for total internal reflection due to the difference in the refractive index between the two. In practical fibers, the cladding is usually coated with a layer of acrylate polymer or polyimide. This coating protects the fiber from damage but does not contribute to its optical waveguide properties. Individual coated fibers (or fibers formed into ribbons or bundles) then have a tough resin buffer layer and/or core tube(s) extruded around them to form the cable core. Several layers of protective sheathing, depending on the application, are added to form the cable. Rigid fiber assemblies sometimes put light-absorbing glass between the fibers, to prevent light that leaks out of one fiber from entering another. This reduces cross-talk between the fibers, or reduces flare in fiber bundle imaging applications.

All four connectors have white caps covering the ferrules.

- For indoor applications, the jacketed fiber is generally enclosed, with a bundle of flexible fibrous polymer strength members like aramid , in a lightweight plastic cover to form a simple cable. Each end of the cable may be terminated with a specialized optical fiber connector to allow it to be easily connected and disconnected from transmitting and receiving equipment.

- Fibre-optic cable in a Telstra pit

- An optical fiber breakout cable
- For use in more strenuous environments, a much more robust cable construction is required. In loose-tube construction the fiber is laid helically into semi-rigid tubes, allowing the cable to stretch without stretching the fiber itself. This protects the fiber from tension during laying and due to temperature changes. Loose-tube fiber may be "dry block" or gel-filled. Dry block offers less protection to the fibers than gel-filled, but costs considerably less. Instead of a loose tube, the fiber may be embedded in a heavy polymer jacket, commonly called "tight buffer" construction. Tight buffer cables

are offered for a variety of applications, but the two most common are "Breakout" and "Distribution". Breakout cables normally contain a ripcord, two non-conductive dielectric strengthening members an aramid yarn, and 3 mm buffer tubing with an additional layer of Kevlar surrounding each fiber. The ripcord is a parallel cord of strong yarn that is situated under the jacket of the cable for jacket removal. Distribution cables have an overall Kevlar wrapping, a ripcord, and a 900 micrometer buffer coating surrounding each fiber. These fiber units are commonly bundled with additional steel strength members, again with a helical twist to allow for stretching.

- A critical concern in outdoor cabling is to protect the fiber from contamination by water. This is accomplished by use of solid barriers such as copper tubes, and water-repellent jelly or water-absorbing powder surrounding the fiber.
- Finally, the cable may be armored to protect it from environmental hazards, such as construction work or gnawing animals. Undersea cables are more heavily armored in their near-shore portions to protect them from boat anchors, fishing gear, and even sharks, which may be attracted to the electrical power that is carried to power amplifiers or repeaters in the cable.
- Modern cables come in a wide variety of sheathings and armor, designed for applications such as direct burial in trenches, dual use as power lines, installation in conduit, lashing to aerial telephone poles, submarine installation, and insertion in paved streets.

Color Coding

Buffer/jacket color	Meaning
Orange	multi-mode optical fiber
Aqua	OM3 or OM4 10 gig laser-optimized 50/125 micrometer multi-mode optical fiber
Violet	OM4 multi-mode optical fiber (some vendors)[15]
Grey	outdated color code for multi-mode optical fiber
Yellow	single-mode optical fiber
Blue	Sometimes used to designate polarization-maintaining optical fiber

Connector Boot	Meaning	Comment
Blue	Physical Contact (PC), 0°	mostly used for single mode fibers; some manufacturers use this for polarization-maintaining optical fiber.
Green	Angle Polished (APC), 8°	
Black	Physical Contact (PC), 0°	
Grey, Beige	Physical Contact (PC), 0°	multimode fiber connectors
White	Physical Contact (PC), 0°	
Red		High optical power. Sometimes used to connect external pump lasers or Raman pumps.

S.NO	RGPV QUESTION	YEAR	MARKS
Q.1	(a)Explain the principle of transmission in optical fibers. (b)Discuss the terrestrial propagation of electromagnetic waves.	Dec 2012	7 7

UNIT-05/LECTURE-06

Radio wave transmission

- In the radio signal. The electrons in our wire are moving, but not in one direction. These electrons are moving back and forth. Actually, the wave displayed in the activity is a representation of the back and forth movement of electrons. If the wave has a frequency of 200,000 Hz (cycles per second), the electrons in the wire are moving back and forth 200,000 times a second. When electrons move in a wire, an electromagnetic field is created around that wire. There's no magic behind this; it's just the way things work. Just as the electrons move in the wire, they move in the transmitter's antenna. And just as an electromagnetic field is created around the wire, a field is created around the antenna. But there is a difference between the wire and the antenna. The wire is shielded (surrounded by another wire) to keep the electromagnetic field in. The antenna, on the other hand, is designed to radiate the electromagnetic field. The electromagnetic field travels from the antenna in all directions and at the speed of light. It travels until it hits your radio's antenna as well as hundreds of other receiving antennas. And what happens at the receiving antenna? Just as a current in a wire produces an electromagnetic field, an electromagnetic field produces current in a wire (or antenna). This current is then amplified and processed by the radio.
- For the propagation and interception of radio waves, a transmitter and receiver are employed. A radio wave acts as a carrier of information-bearing signals; the information may be encoded directly on the wave by periodically interrupting its transmission (as in dot-and-dash telegraphy) or impressed on it by a process called modulation. The actual information in a modulated signal is contained in its sidebands, or frequencies added to the carrier wave, rather than in the carrier wave itself. The two most common types of modulation used in radio are amplitude modulation (AM) and frequency modulation (FM). Frequency modulation minimizes noise and provides greater fidelity than amplitude modulation, which is the older method of broadcasting. Both AM and FM are analog transmission systems, that is, they process sounds into continuously varying patterns of electrical signals which resemble sound waves. Digital radio uses a transmission system in which the signals propagate as discrete voltage pulses, that is, as patterns of numbers; before transmission, an analog audio signal is converted into a digital signal, which may be transmitted in the AM or FM frequency range. A digital radio broadcast offers compact-disc-quality reception and reproduction on the FM band and FM-quality reception and reproduction on the AM band.
- In its most common form, radio is used for the transmission of sounds (voice and music) and pictures (television). The sounds and images are converted into electrical signals by a microphone (sounds) or video camera (images), amplified, and used to modulate a carrier wave that has been generated by an oscillator circuit in a transmitter. The modulated carrier is also amplified, then applied to an antenna that converts the electrical signals to electromagnetic waves for radiation into space. Such waves radiate at the speed of light and are transmitted not only by line of sight but

also by deflection from the ionosphere.

- Receiving antennas intercept part of this radiation, change it back to the form of electrical signals, and feed it to a receiver. The most efficient and most common circuit for radio-frequency selection and amplification used in radio receivers is the superheterodyne. In that system, incoming signals are mixed with a signal from a local oscillator to produce intermediate frequencies (IF) that are equal to the arithmetical sum and difference of the incoming and local frequencies. One of those frequencies is applied to an amplifier. Because the IF amplifier operates at a single frequency, namely the intermediate frequency, it can be built for optimum selectivity and gain. The tuning control on a radio receiver adjusts the local oscillator frequency. If the incoming signals are above the threshold of sensitivity of the receiver and if the receiver is tuned to the frequency of the signal, it will amplify the signal and feed it to circuits that demodulate it, i.e., separate the signal wave itself from the carrier wave.
- There are certain differences between AM and FM receivers. In an AM transmission the carrier wave is constant in frequency and varies in amplitude (strength) according to the sounds present at the microphone; in FM the carrier is constant in amplitude and varies in frequency. Because the noise that affects radio signals is partly, but not completely, manifested in amplitude variations, wideband FM receivers are inherently less sensitive to noise. In an FM receiver, the limiter and discriminator stages are circuits that respond solely to changes in frequency. The other stages of the FM receiver are similar to those of the AM receiver but require more care in design and assembly to make full use of FM's advantages. FM is also used in television sound systems. In both radio and television receivers, once the basic signals have been separated from the carrier wave they are fed to a loudspeaker or a display device (usually a cathode-ray tube), where they are converted into sound and visual images, respectively.

Microwave transmission (RGPV DEC 2013)

- Microwave transmission refers to the technology of transmitting information or energy by the use of radio waves whose wavelengths are conveniently measured in small numbers of centimetre; these are called microwaves. This part of the radio spectrum ranges across frequencies of roughly 1.0 gigahertz (GHz) to 30 GHz. These correspond to wavelengths from 30 centimeters down to 1.0 cm.
- Microwaves are widely used for point-to-point communications because their small wavelength allows conveniently-sized antennas to direct them in narrow beams, which can be pointed directly at the receiving antenna. This allows nearby microwave equipment to use the same frequencies without interfering with each other, as lower frequency radio waves do. Another advantage is that the high frequency of microwaves gives the microwave band a very large information-carrying capacity; the microwave band has a bandwidth 30 times that of all the rest of the radio spectrum below it. A disadvantage is that microwaves are limited to line of sight propagation; they cannot pass around hills or mountains as lower frequency radio waves can.
- Microwave radio transmission is commonly used in point-to-point communication systems on the surface of the Earth, in satellite communications, and in deep space radio communications. Other parts of the microwave radio band are used for radars, radio navigation systems, sensor systems, and radio astronomy.

- The next higher part of the radio electromagnetic spectrum, where the frequencies are above 30 GHz and below 100 GHz, are called "millimeter waves" because their wavelengths are conveniently measured in millimeters, and their wavelengths range from 10 mm down to 3.0 mm. Radio waves in this band are usually strongly attenuated by the Earthly atmosphere and particles contained in it, especially during wet weather. Also, in wide band of frequencies around 60 GHz, the radio waves are strongly attenuated by molecular oxygen in the atmosphere. The electronic technologies needed in the millimeter wave band are also much more difficult to utilize than those of the microwave band.
- Wireless transmission of information

- One-way (e.g. television broadcasting) and two-way telecommunication using communications satellite
- Terrestrial microwave radio broadcasting relay links in telecommunications networks including e.g. backbone or backhaul carriers in cellular networks linking BTS-BSC and BSC-MSC.

A parabolic satellite antenna for Erdfunkstelle Raisting,

C band horn-reflector antennas on the roof of a telephone switching center

S.NO	RGPV QUESTION	YEAR	MARKS
Q.1	Write a note microwave transmission and infrared transmission	Dec 2013	7

UNIT-01/LECTURE-07

Infrared Transmission

- Infrared transmission refers to energy in the region of the electromagnetic radiation spectrum at wavelengths longer than those of visible light, but shorter than those of radio waves. Correspondingly, infrared frequencies are higher than those of microwaves, but lower than those of visible light.
- Scientists divide the infrared radiation (IR) spectrum into three regions. The wavelengths are specified in microns (symbolized µ, where 1 µ = 10^{-6} meter) or in nanometers (abbreviated nm, where 1 nm = 10^{-9} meter = 0.001 5). The *near IR band* contains energy in the range of wavelengths closest to the visible, from approximately 0.750 to 1.300 5 (750 to 1300 nm). The *intermediate IR band* (also called the *middle IR band*) consists of energy in the range 1.300 to 3.000 5 (1300 to 3000 nm). The *far IR band* extends from 2.000 to 14.000 5 (3000 nm to 1.4000 x 10^4 nm).
- Infrared is used in a variety of wirelesscommunications, monitoring, and control applications. Here are some examples:

- Home-entertainment remote-control boxes
- Wireless (local area networks)
- Links between notebook computers and desktop computers
- Cordless modem
- Intrusion detectors
- Motion detectors
- Fire sensors
- Night-vision systems
- Medical diagnostic equipment
- Missile guidance systems
- Geological monitoring devices

Transmitting IR data from one device to another is sometimes referred to as beaming.

RJ 45 (RGPV Dec2013)

- A registered jack (RJ) is a standardize]physical network interface—both jack construction and wiring pattern—for connecting telecommunications or data equipment to a service provided by a local exchange carrier or long distance carrier. The standard designs for these connectors and their wiring are named RJ11, RJ14, RJ21,RJ35, RJ45, RJ48, etc. Many of these interface standards are commonly used in North America, though some interfaces are used world-wide. It is common to find a dash (hyphen) between the RJ and the number, but the actual standard has no dash or hyphen.
- The physical connectors that registered jacks use are mainly of the modular connector

and 50-pin miniature ribbon connector types. For example, RJ11 uses a six-position two-conductor (6P2C), RJ14 uses a six-position four-conductor (6P4C) modular plug and jack, while RJ21 uses a 25-pair (50-pin) miniature ribbon connector.

- The RJ45 physical connector is standardised as the IEC 60603-7 8P8C modular connector with different "categories" of performance, with all eight conductors present. A similar standard jack once used for modem/data connections, the RJ45S, used a "keyed" variety of the 8P8C body with an extra tab that prevents it mating with other connectors; the visual difference compared to the more common 8P8C is subtle, but it is a different connector. The original RJ45S [6][7] keyed 8P2C modular connector had pins 5 and 4 wired for tip and ring of a single telephone line and pins 7 and 8 shorting a programming resistor, but is obsolete today.
- Electronics catalogs commonly advertise 8P8C modular connectors as "RJ45". An installer can wire the jack to any pin-out or use it as part of a generic structured cabling system such as ISO/IEC 15018 or ISO/IEC 11801 using 8P8C patch panels for both phone and data. Virtually all electronic equipment which uses an 8P8C connector (or possibly any 8P connector at all) will document it as an "RJ45" connector.

Network interface card (RGPV Dec2013)

- A network interface card (NIC) is a circuit board or cardthat is installed in a computer so that it can be connected to a network. A network interface card provides the computer with a dedicated, full-time connection to a network. Personal computers and workstations on a local area network (LAN) typically contain a network interface card specifically designed for the LAN transmissiontechnology.

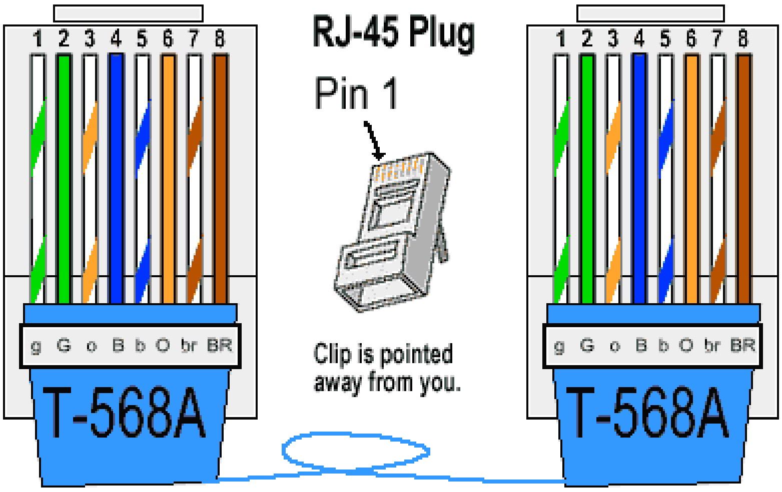
Straight Connection Cable Coding Standards

- The information listed here is to assist Network Administrators in the color coding of Ethernet cables. Please be aware that modifying Ethernet cables improperly may cause loss of network connectivity. Use this information at your own risk, and insure all connectors and cables are modified in accordance with standards. The Internet Centre and its affiliates cannot be held liable for the use of this information in whole or in part.

S.NO	RGPV QUESTION	YEAR	MARKS
Q.1	Write short note on RJ 45 and network interface card.	Dec2013	7
Q.2	(a)Explain the principle of transmission in optical fibers. (b)Discuss the terrestrial propagation of electromagnetic waves.	Dec 2012	7 7

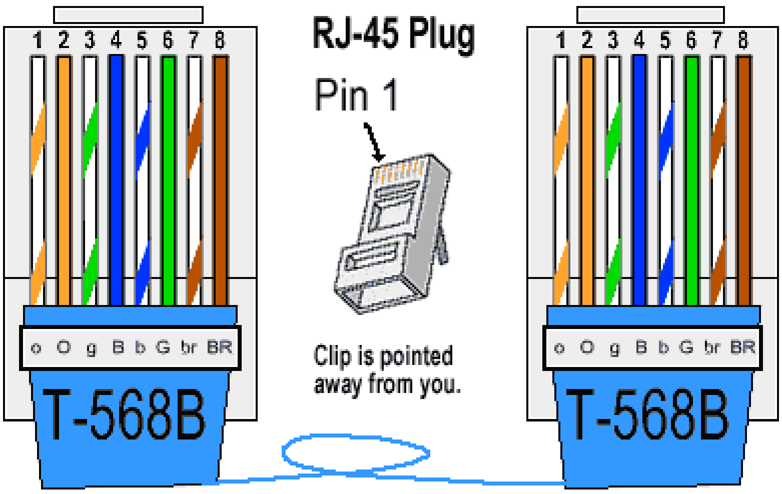
UNIT-05/LECTURE-08

T-568A Straight-Through Ethernet Cable :



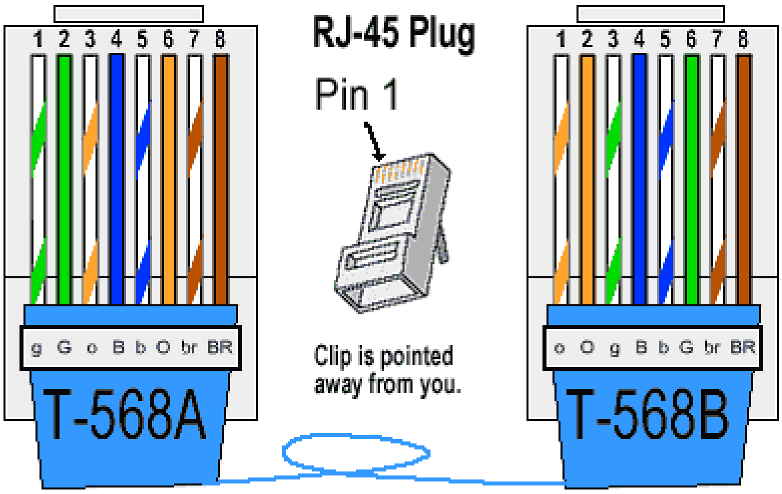
The TIA/EIA 568-A standard which was ratified in 1995, was replaced by the TIA/EIA 568-B standard in 2002 and has been updated since. Both standards define the T-568A and T-568B pin-outs for using Unshielded Twisted Pair cable and RJ-45 connectors for Ethernet connectivity. The standards and pin-out specification appear to be related and interchangeable, but are not the same and should not be used interchangeably.

T-568B Straight-Through Ethernet Cable :



Both the T-568A and the T-568B standard Straight-Through cables are used most often as patch cords for your Ethernet connections. If you require a cable to connect two Ethernet devices directly together without a hub or when you connect two hubs together, you will need to use a Crossover cable instead.

RJ-45 Crossover Ethernet Cable :



A good way of remembering how to wire a Crossover Ethernet cable is to wire one end using the T-568A standard and the other end using the T-568B standard. Another way of remembering the color coding is to simply switch the Green set of wires in place with the Orange set of wires. Specifically, switch the solid Green (G) with the solid Orange, and switch the green/white with the orange/white.

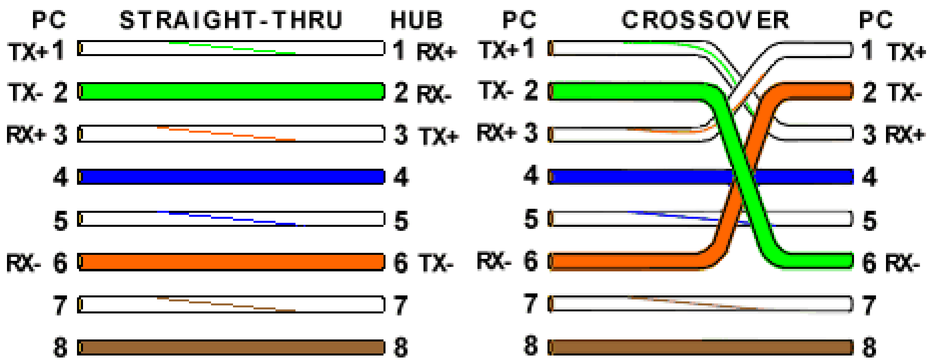
Ethernet Cable Instructions:

- Pull the cable off the reel to the desired length and cut. If you are pulling cables through holes, its easier to attach the RJ-45 plugs after the cable is pulled. The total length of wire segments between a PC and a hub or between two PC's cannot exceed 100 Meters (328 feet) for 100BASE-TX and 300 Meters for 10BASE-T.
- Start on one end and strip the cable jacket off (about 1") using a stripper or a knife. Be extra careful not to nick the wires, otherwise you will need to start over.
- Spread, untwist the pairs, and arrange the wires in the order of the desired cable end. Flatten the end between your thumb and forefinger. Trim the ends of the wires so they are even with one another, leaving only 1/2" in wire length. If it is longer than 1/2" it will be out-of-spec and susceptible to crosstalk. Flatten and insure there are no spaces between wires.
- Hold the RJ-45 plug with the clip facing down or away from you. Push the wires firmly into the plug. Inspect each wire is flat even at the front of the plug. Check the order of the wires. Double check again. Check that the jacket is fitted right against the stop of the plug. Carefully hold the wire and firmly crimp the RJ-45 with the crimper.
- Check the color orientation, check that the crimped connection is not about to come apart, and check to see if the wires are flat against the front of the plug. If even one of these are incorrect, you will have to start over. Test the Ethernet cable.

Ethernet Cable Tips:

- A straight-thru cable has identical ends.
- A crossover cable has different ends.
- A straight-thru is used as a patch cord in Ethernet connections.
- A crossover is used to connect two Ethernet devices without a hub or for connecting two hubs.
- A crossover has one end with the Orange set of wires switched with the Green set.
- Odd numbered pins are always striped, even numbered pins are always solid colored.
- Looking at the RJ-45 with the clip facing away from you, Brown is always on the right, and pin 1 is on the left.
- No more than 1/2" of the Ethernet cable should be untwisted otherwise it will be susceptible to crosstalk.
- Do not deform, do not bend, do not stretch, do not staple, do not run parallel with power cables, and do not run Ethernet cables near noise inducing components.

Basic Theory:



By looking at a T-568A UTP Ethernet straight-thru cable and an Ethernet crossover cable with a T-568B end, we see that the TX (transmitter) pins are connected to the corresponding RX (receiver) pins, plus to plus and minus to minus. You can also see that both the blue and brown wire pairs on pins 4, 5, 7, and 8 are not used in either standard. What you may not realize is that, these same pins 4, 5, 7, and 8 are not used or required in 100BASE-TX as well. So why bother using these wires, well for one thing its simply easier to make a connection with all the wires grouped together. Otherwise you'll be spending time trying to fit those tiny little wires into each of the corresponding holes in the RJ-45 connector.

UNIT-05/LECTURE-09

Ethernet Cable Tips:

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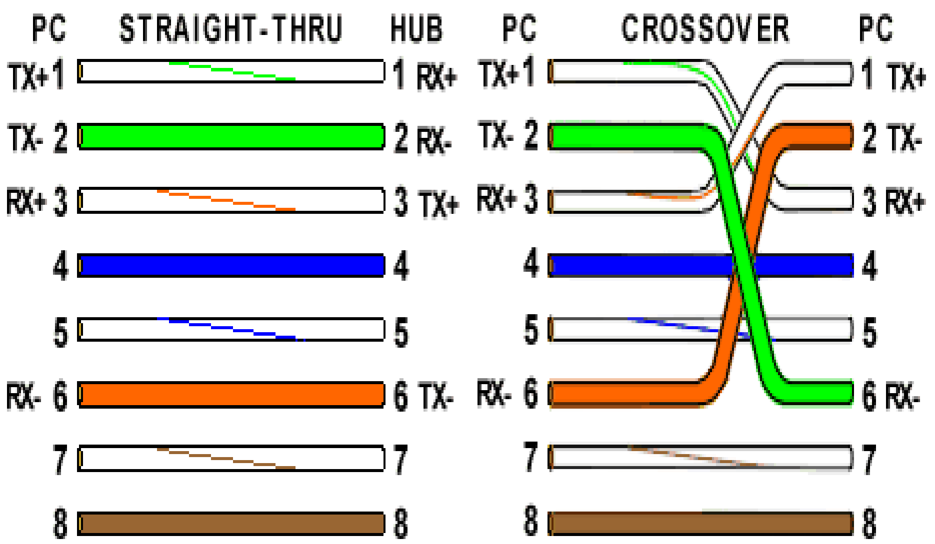

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Data Communication	Tanenbaum	2