Repeaters and Hubs

>> Repeaters: Physical layer device that amplifies the transmission signal between two cable segments.

>> Hub: a multiport repeater; no intelligence.

>> Works in half-duplex mode.

>> Active hubs: Each port is a repeater that amplifies the signal for each connection (CMSA/CD).

>> Passive hubs: Do not amplify the signal at all.

>> Hubs usually create a star topology with the Ethernet devices.

>> Creates a single collision domain.

>> Forwards a jam signal to all ports if it detects a collision.

>> Most hubs have RJ45 ports; some have BNC or Attachment Unit Interface (AUI) connectors too.

>> Some hubs have an uplink port (MDI-X: Medium Dependent Interface – corss over) for hub-to-hub straigh-through connection.

>> For 10BaseT network, up to five segments and four repeaters are allowed between any two hosts.

>> Performance degrades as the number of hubs/devices increases.

>> Fast Ethernet hubs and Gigabit Ethernet hubs exist, but failed to appear due to the entry of Switches.

Repeater

Hub

NETGEAR
Ethernet Hub
EN 104TP

Bay Networks

NETGEAR HUB EN104TP   Link   Rx

Pwr   Normal / Uplink

Col

1   2   3   4

Switch (switching hub, bridging hub, officially **MAC bridge)**

>>   Multiport bridge, first created by a company called Kalpana

>>   Visually similar to hub.

>>   Mainly in twisted pair connections; but available in Fibre Channel and Asynchronous Transfer Mode.

>>   Layer 2 device. Ie, works in data link layer and physical layer.

>>   Forwards frames based on MAC addresses.

>>   Switched point-to-point connections between communicating devices; hence multiple collision domains, full use of band width and full duplex connections.

>>   Switches that can work at network layer are called layer-3 switches.

>>   When the system is up, a switch acts like a hub. When the devices begin to transfer packets, the switch understands the Mac address of the devices connected to each port and makes a MAC address table. This process is called Learning.

>>   The switches work in *promiscuous mode.*

Switch...

There are four forwarding methods used in switches:

1. Store and forward: the switch buffers and verifies each frame before forwarding it; a frame is received in its entirety before it is forwarded.

2. Cut through: the switch starts forwarding after the frame's destination address is received. There is no error checking with this method. When the outgoing port is busy at the time, the switch falls back to store-and-forward operation.

3. Fragment free: a method that attempts to retain the benefits of both store and forward and cut through. Fragment free checks the first 64 bytes of the frame, where addressing information is stored. According to Ethernet specifications, collisions should be detected during the first 64 bytes of the frame, so frames that are in error because of a collision will not be forwarded.

4. Adaptive switching: a method of automatically selecting between the other three modes.

Switch...

Types based on configuration

Unmanaged switches – No configuration interface or options. They are plug and play. They are typically the least expensive switches, and therefore often used in a small office/home office (SOHO) environment.

Managed switches – Have one or more methods to modify the operation of the switch. Common management methods include: a command-line interface (CLI) accessed via serial console, telnet or Secure Shell, an embedded Simple Network Management Protocol (SNMP) agent allowing management from a remote console or management station, or a web interface for management from a web browser. These switches can be *Smart (or intelligent)* switches with a limited set of management features, or *Enterprise managed (or fully managed)* switches with a full set of management features.

Cisco SG110D 110 Series 5-Port Unmanaged Network Switch

Cisco SG300-10 10-Port Gigabit Managed Switch

Router

>> Layer 3 device

>> Works at Network layer, data link layer and physical layer.

>> Connects two or more different networks.

>> Connects a LAN to another, a LAN to a WAN or a WAN to another.

>> Reads the IP address in the packet and with the help of routing tables, forwards the packet to the destination.

>> May have different types of physical layer connections such as copper cables, fiber optic, or wireless transmission, and can support different network layer standards.

>> Used in small home-networks to large ISP interconnections.

>> Working of routers rely on routable protocols and routing protocols

>> Routable protocols: To identify the systems and binding. Eg:TCP/IP

>> Routing Protocol: To communicate with other routers and to know the routes.
   Eg: DV, LS

Home router

Cisco router

Virtual Private Network (VPN)

>> A secure private network across a probably unsecure public network.

>> Users can send receive data through VPN as if they are using a private network.

>> VPN is created by establishing a virtual *point-to-point* connection through the use of dedicated connections, virtual tunneling protocols, or traffic encryption.

>> VPNs can be either remote-access (connecting a computer to a network) or site-to-site (connecting two networks).

>> Remote-access: An employee accessing his company's network from home.

>> Site-to-site: Two branches of a company at different places shares a network.

>> Ensures confidentiality, integrity and authrntication through tunneling protocols and encryption techniques.

>> Secure VPN protocols can be IPSec, Transport Layer Security (SSL/TLS), etc

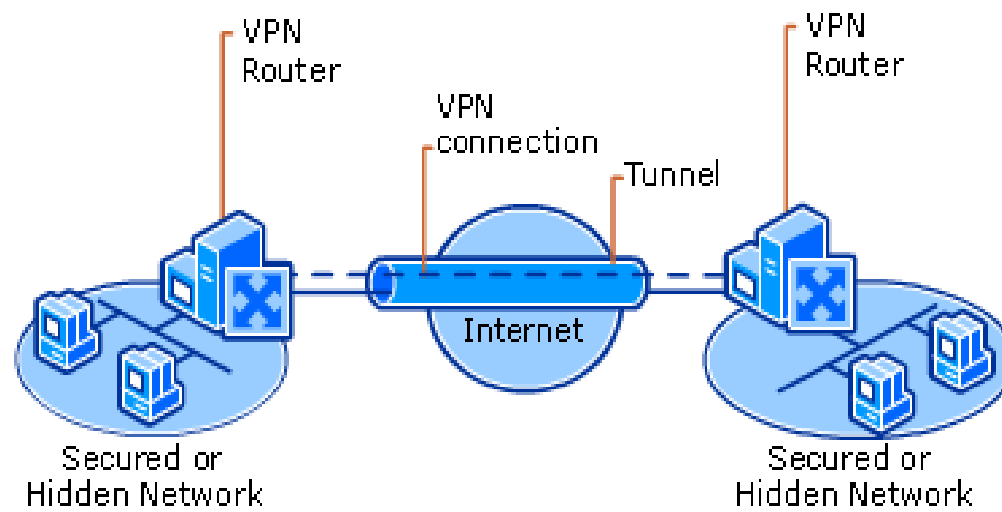**Virtual Private Network (VPN)...**

>> A VPN network may contain the following types of devices;

Customer (C) devices: A device that is within a customer's network and not directly connected to the service provider's network. C devices are not aware of the VPN.
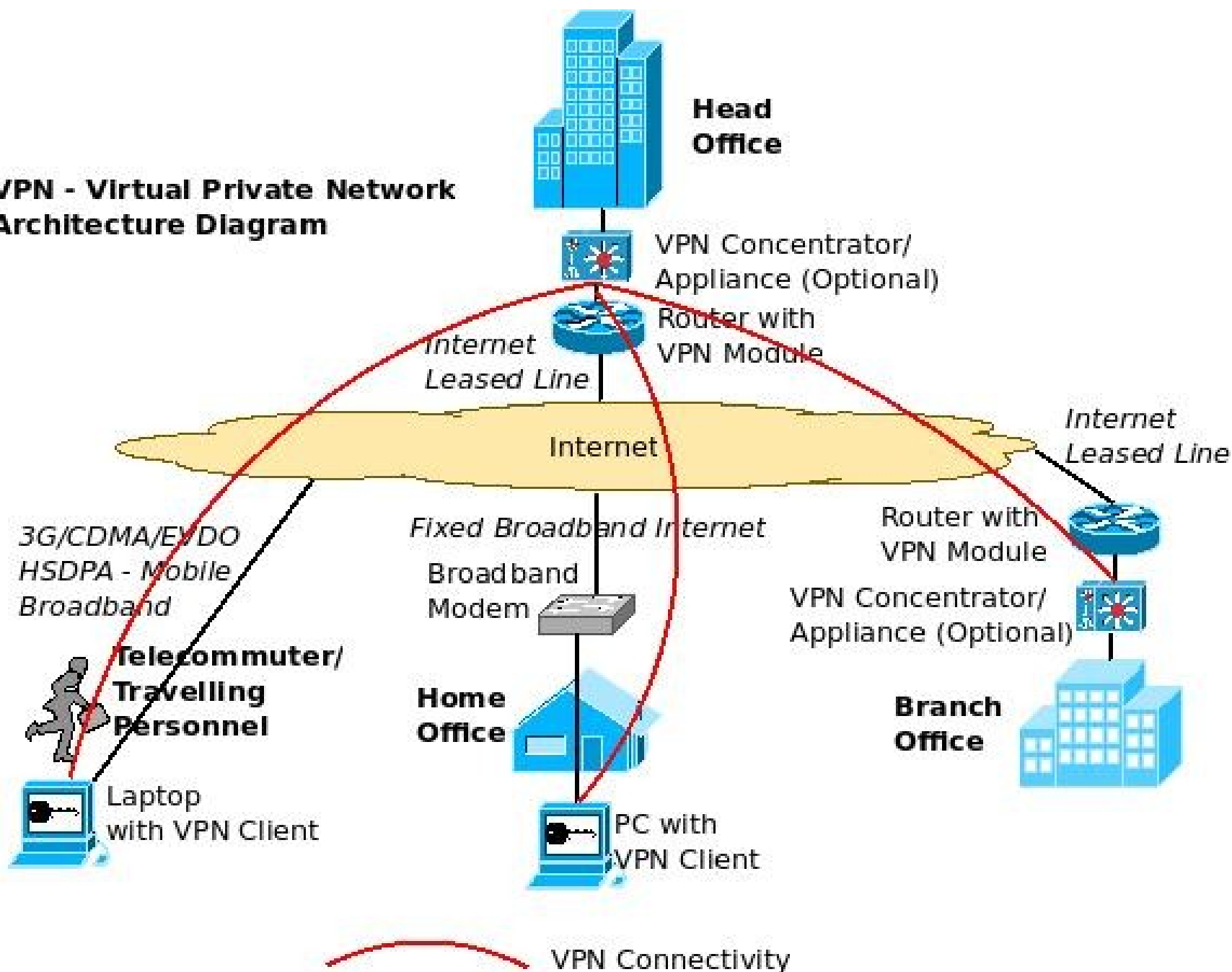
Customer Edge device (CE):   A device at the edge of the customer's network which provides access to the VPN.

Provider edge device (PE):   A PE is a device, or set of devices, at the edge of the provider network which connects to customer networks through CE devices and presents the provider's view of the customer site. PEs are aware of the VPNs that connect through them, and maintain VPN state.

Provider device (P):   A P device operates inside the provider's core network and does not directly interface to any customer endpoint.

Head Office

VPN - Virtual Private Network Architecture Diagram

VPN Concentrator/ Appliance (Optional)

Router with VPN Module

Internet Leased Line

Internet Leased Line

Internet

3G/CDMA/EVDO HSDPA - Mobile Broadband

Fixed Broadband Internet

Router with VPN Module

VPN Concentrator/ Appliance (Optional)

Broadband Modem

Telecommuter/ Travelling Personnel

Home Office

Branch Office

Laptop with VPN Client

PC with VPN Client

VPN Connectivity

MoDem (Modulator – Demodulator)

>> Converts between a stream of digital bits and an analog signal.

>> To send and receive data over a telephone line or a cable or satellite connection.

>> Dial-Up Modems: Use dial up telephone lines. Can be external or internal to the PC.

>> DSL Modems: Popular broadband modems. Mostly seen integrated into broadband routers. Input can be the phone line coming through a splitter and output can be connected to the system by an RJ45 jack.

>> Cable Modem: to access internet from cable line.

WiMAX (Worldwide Interoperability for Microwave Access)

>> Part of IEEE 802.16 standard (Wireless MAN)

>> For long range wireless networking for both fixed and mobile connections in 10 km.

>> Consists of a fixed base station installed by service providers and a fixed or mobile receiver in the client.
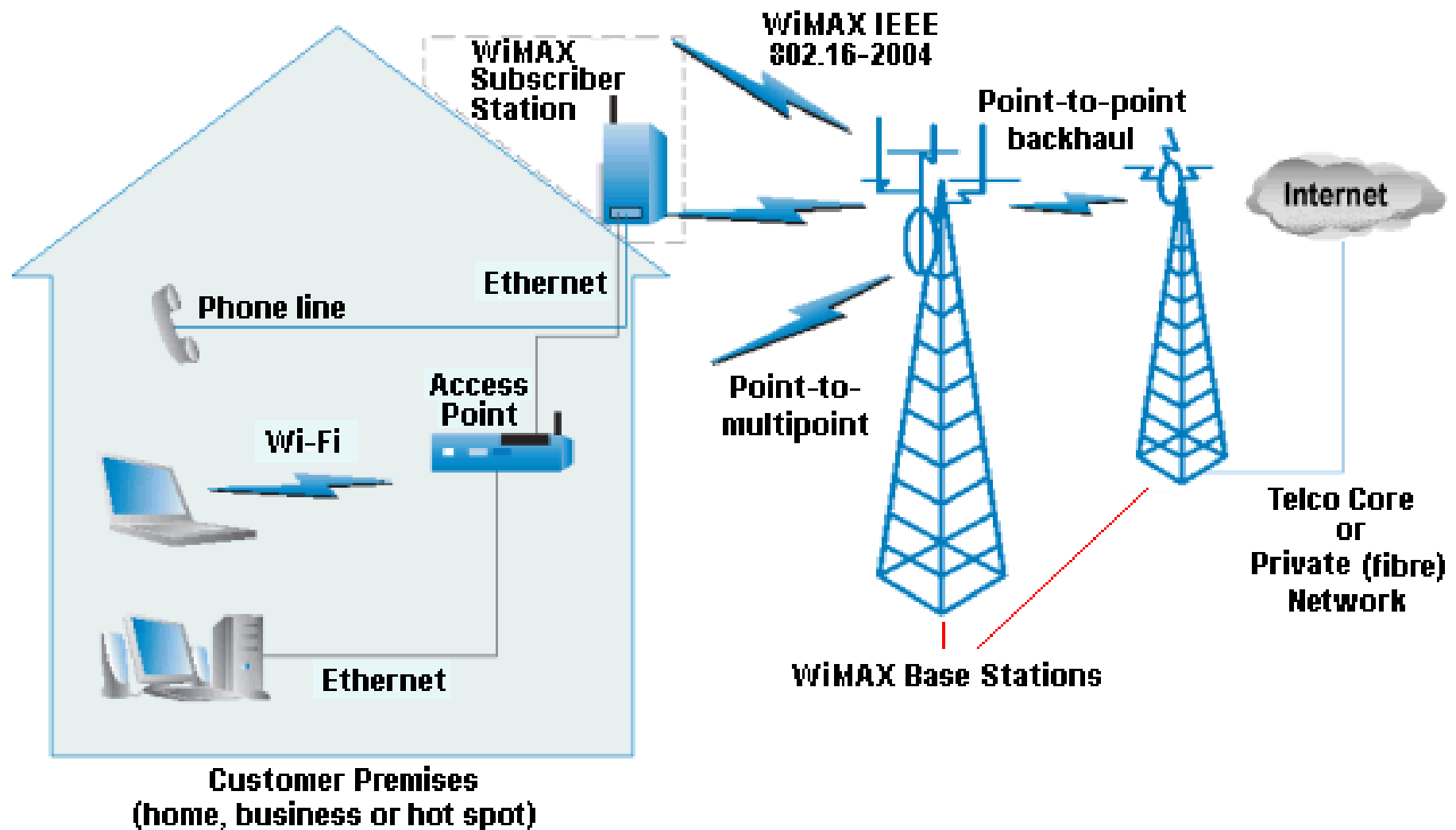
Network Communication Medium

>> Connects the devices in the physical layer

>> Bounded media: Physical connection using cables (Coax, TP, OFC)

>> Unbounded media: No physical connection. Wireless (Types of radio waves)

Coaxial Cable (Coax)

Wire mesh conductor

Center wire   (Copper)

Inner insulation (plastic)

Outer insulation
(PVC or teflon-type)
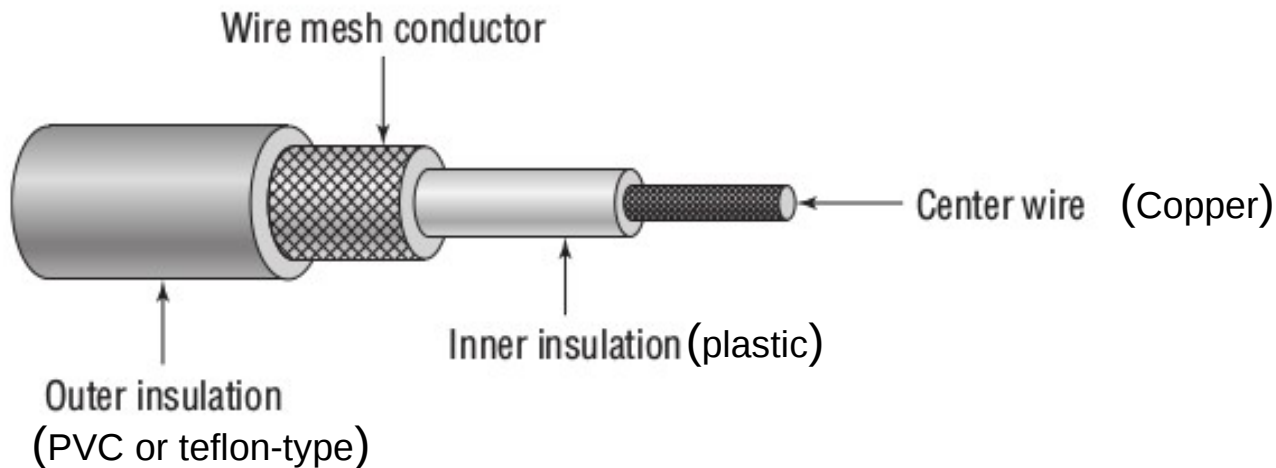
>> PCV produces toxic gases when burning, but teflon does not and hence costly.

>> Teflon-type covering that is frequently referred to as a **plenum-rated** coating.

>> Specified by Radio Guide (RG) system.

>> For networking RG-8 (thicknet) and RG-58A/U (thinnet) are used.

>> RG-59 is used for analog cable television.

>> *Thicknet* was thicker, costly, less flexible, had a maximum segment distance of 500m and was used primarily for network backbones.

>> *Thinnet* was thinner, less costly, flexible, had a maximum segment distance of 185m and was more often used in a conventional physical bus.
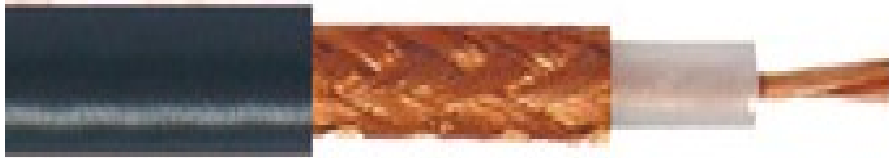
RG-58 A/U - stranded core - for Thinnet

RG-8 - solid core - for Thicknet

RG174
RG316

RG58AU

RG58U

Micro Loss 900

RG8X

RG8

Teflon®

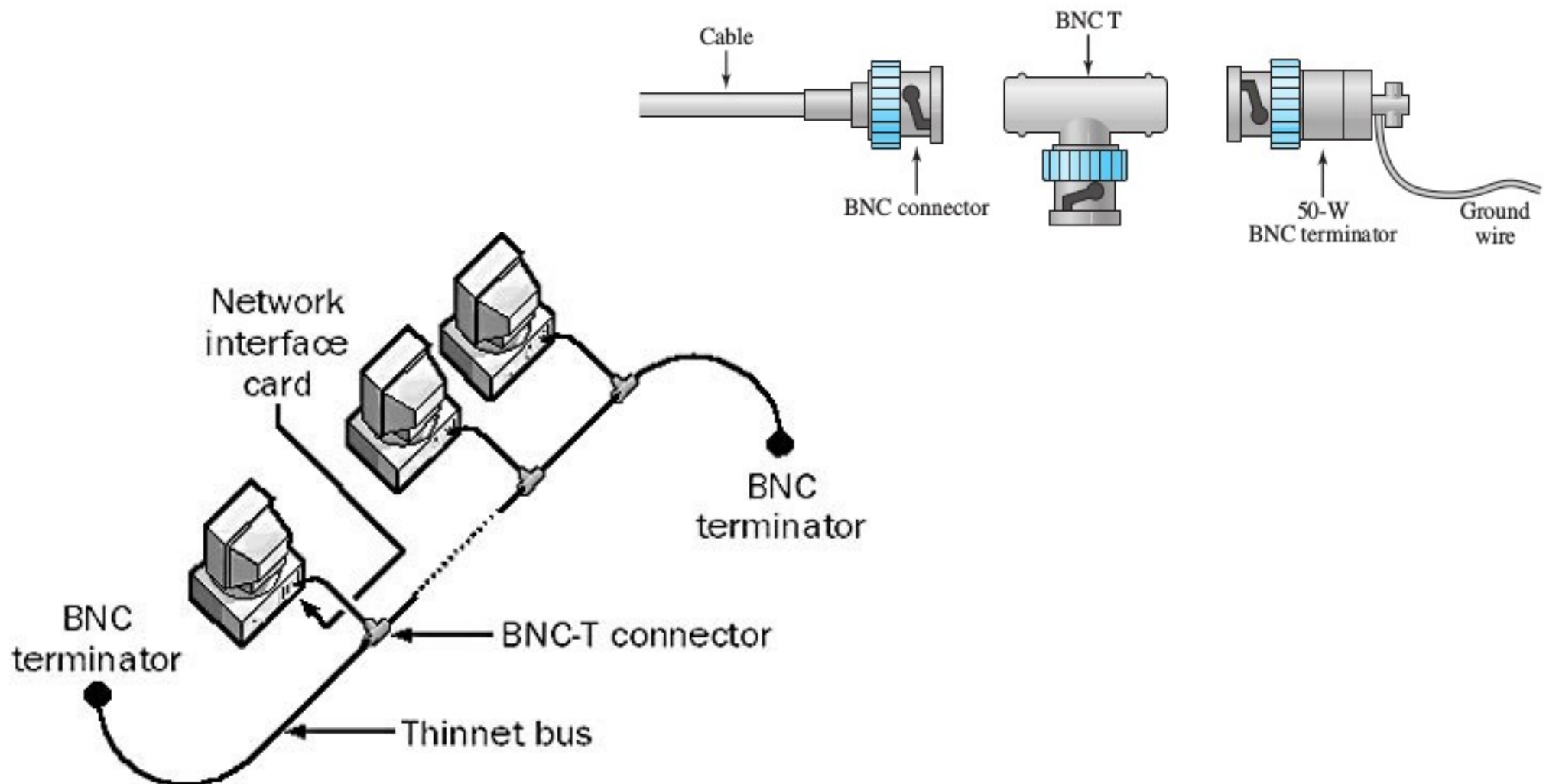www.rfviz.com

Thicknet connectors

>> Use vampire taps for connection. The tap is connected to an external transceiver that in turn has a 15-pin AUI connector (also called DIX or DB15 connector) to which attach a cable that connects to the station. (DIX-Digital, Intel, and Xerox).

>> AUI: Attachment Unit Interface.

Vampire Cable Taps

Thicknet Segment

DIX Cables

Vampire Tap

Transceiver

Vampire taps

Thicknet

Transceiver

Transceiver cable

to NIC

RG-8

AMP   228752-1
"30 VDC, 100 mA max. – Class 2 circuit"
"FOR USE ONLY WITH LISTED COAXIAL POWER-LIMITED CIRCUIT
CABLES CLASSIFIED FOR FIRE AND SMOKE CHARACTERISTICS
WHEN INSTALLED IN OTHER SPACE (SECTION 300-22 (c) OF THE
NATIONAL ELECTRICAL CODE) USED FOR ENVIRONMENTAL AIR."

REMOVE SCREWS TO
RELEASE CABLE TAP

ST-500 with LANVIEW™

PWR
SQE
XMT
RCV
CLN

CABLETRON

AUI Connector

Thinnet connectors

>> Use different types of BNC (Bayonet Neill-Concelman) connectors.

>> The transceiver is on the network card.

BNC Adapters

44-286-50	**44-286-75**	**44-286-93**	**44-280**	**44-319**
50 Ohm BNC Plug Terminator	75 Ohm BNC Plug Terminator	93 Ohm BNC Plug Terminator	BNC Plug To TNC Jack	BNC Plug Connector To RCA Phone Jack, Nickel Plated
44-327	**44-139**	**44-253**	**44-253IS**	**44-316**
BNC Jack/Jack Inline Splice	3 Jack, BNC "T" Adapter	Dual Chassis Mount F/F Connector, UG-492	Dual Chassis Mount F/F With Isolation Rings	UG-255/U BNC Plug To UHF Jack, Nickel Plated
44-325	**44-325M**	**44-327Y**	**44-325F**	**44-327MM**
BNC Plug To 2 BNC Jack "T"	BNC Plug To 2 BNC Plug "T"	BNC Plug To 2 BNC Jack "Y" Connector	BNC Plug To 2 BNC 90° Jack	BNC Plug To BNC Plug
44-297	**44-292**	**44-318**	**44-326**	**44-274**
BNC Jack To F Plug	BNC Jack To RCA Plug	UG-273 BNC Jack To UHF Plug	BNC Jack To Right Angle Plug	BNC Jack To TNC Plug
44-173	**44-154**	**44-172**	**44-153**	**44-317**
BNC Jack To N Jack	BNC Jack To SMA Plug	BNC Jack To Mini UHF Plug	BNC Jack To SMA Jack	BNC Jack Chassis Mount
44-133	**44-328**	**44-155**	**44-267**	**44-156**
BNC Plug To UHF Plug	BNC Plug To F Jack	BNC Jack To UHF Jack	BNC Jack To N Plug	BNC Plug To N Jack

Twisted Pair Cables

>> Most popular, easy to work with, flexible, low cost.

>> Consists of several pairs of wire twisted around each other within an insulated Jacket.

>> Two types: shielded twisted-pair (STP) and unshielded twisted-pair (UTP)

>> STP has an extra layer of braided foil shielding surrounding the wires to decrease electrical interference.
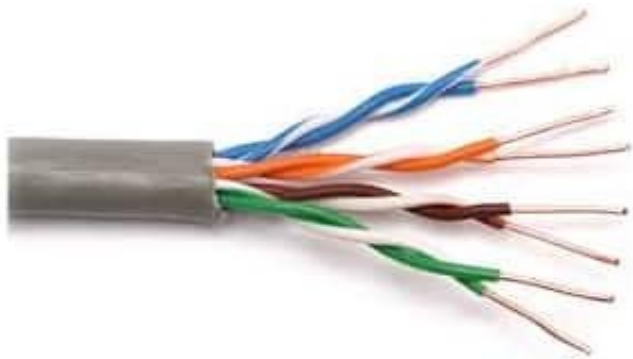
UTP Cable

STP Cable

Unshielded Twisted Pair Cable Specifications...

>> Category 1 contains two twisted pairs. Is for voice-only transmissions and is in many legacy phone systems today.

>> Category 2 is the lowest-grade cable able to have four pairs of wires. It can handle data transmission at speeds up to 4Mbps.

>> Category 3 is able to transmit data at speeds up to 10Mbps. It was popular for 10BaseT installations before CAT-5 came out.

>> Category 4 is able to transmit data at speeds up to 16Mbps. (Token Ring)

>> Category 5 is able to transmit data at speeds up to 100Mbps.

>> Category 5e ('enhanced') is able to transmit data at speeds up to 1Gbps. The enhancement over CAT-5 is that the four twisted pairs of copper wire are physically separated and contain more twists per foot. This provides maximum interference protection.

>> Category 6 is able to transmit data at speeds up to 10Gbps. Its four twisted pairs of copper wire are oriented differently than in CAT-5e. You can use it as a backbone to connect different parts of your network together, such as those on different floors of a building.

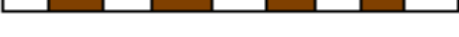>> Category 6a can also handle 10Gbps speed, but at longer distances (up to 100 meters) than CAT-6 can.

Twisted-Pair Connector Types

>> Use RJ (registered jack) connector.

>> The connector used with UTP cable is called RJ-45.

>> The RJ-11 has room for two pairs (four wires), and the RJ-45 has room for four pairs (eight wires).

Wiring Standards

>> 568A and 568B.

>> Older implementations using UTP used only two pairs of wires; 1, 2, 3, and 6 in the connector. Newer applications such as Voice over IP and Gigabit Ethernet use all four pairs of wires.

TIA/EIA 568A Wiring

1 — White and Green
2 — Green
3 — White and Orange
4 — Blue
5 — White and Blue
6 — Orange
7 — White and Brown
8 — Brown

TIA/EIA 568B Wiring

1 — White and Orange
2 — Orange
3 — White and Green
4 — Blue
5 — White and Blue
6 — Green
7 — White and Brown
8 — Brown

\>\> The process of fixing the cable in an RJ45 connector is called crimping.

\>\> Mainly there are three types of crimping for connecting two devices.

1. Straight through crimping

    \>\> Both ends of the cable follow the same standard. Commonly 568B on both sides.

    \>\> Used when dissimilar devices are to be connected (computer to hub/switch).

    \>\> Such cables are also called **patch cables**.

2. Cross over crimping

    \>\> Both ends of the cable will be of the opposite standards. Ie, 568A on one side and 568B on the other side or vice versa.

    \>\> Used when similar devices are to be connected (computer-computer, router-router).

3. Roll over crimping

    \>\> Also called Yost cable.

    \>\> Not used for data transfer.

    \>\> Connect a computer terminal to a router's console port for configuration.

    \>\> Whatever standard is used at one end, the reverse of that colour code will be on the other end.

    \>\> Generally light-blue in colour.

Straight Through Wiring Guide
568-B

1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
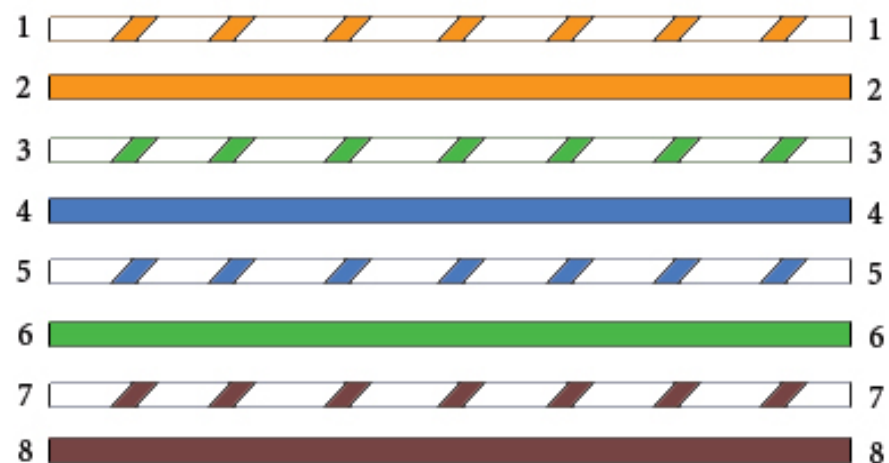
Crossover Wiring Guide
568-B

1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
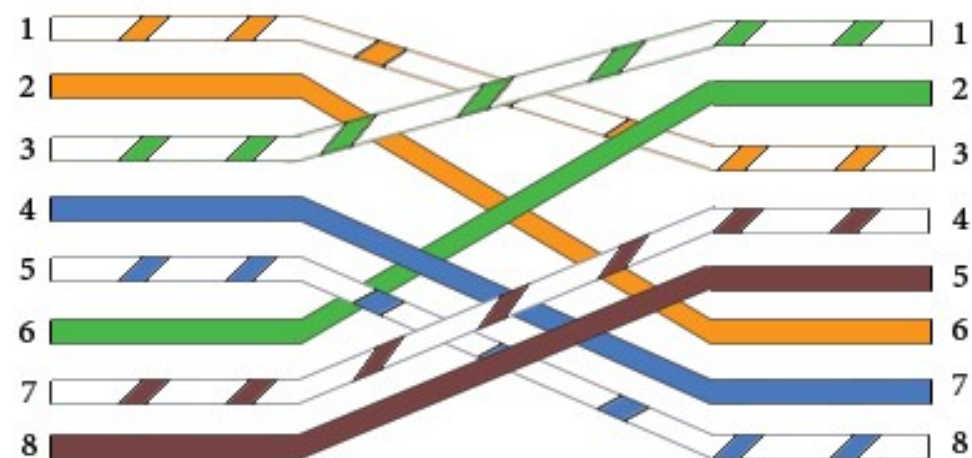
Rollover Wiring Guide
568-B

1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
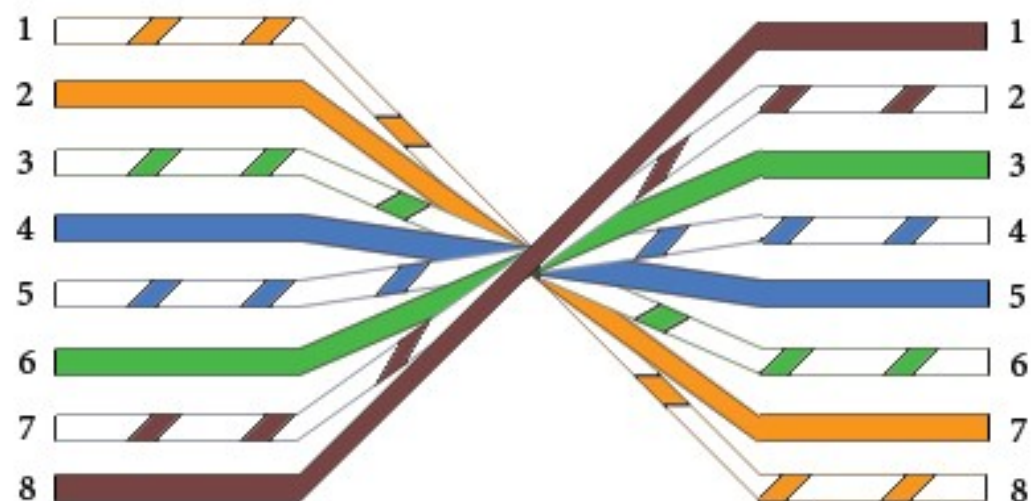
Color Standard EIA/TIA T568A

Ethernet Patch Cable

		RJ45 Pin#			Pin# RJ45		
TX+		Green/White Tracer	1	1	Green/White Tracer		PR 3
TX−		Green	2	2	Green		
RX+		Orange/White Tracer	3	3	Orange/White Tracer		PR 2
		Blue	4	4	Blue		PR 1
		Blue/White Tracer	5	5	Blue/White Tracer		
RX−		Orange	6	6	Orange		PR 2
		Brown/White Tracer	7	7	Brown/White Tracer		PR 4
		Brown	8	8	Brown		

Color Standard EIA/TIA T568B

Ethernet Patch Cable

		RJ45 Pin#			Pin# RJ45		
TX+		Orange/White Tracer	1	1	Orange/White Tracer		PR 2
TX−		Orange	2	2	Orange		
RX+		Green/White Tracer	3	3	Green/White Tracer		PR 3
		Blue	4	4	Blue		PR 1
		Blue/White Tracer	5	5	Blue/White Tracer		
RX−		Green	6	6	Green		PR 3
		Brown/White Tracer	7	7	Brown/White Tracer		PR 4
		Brown	8	8	Brown		

Fiber-Optic Cables

>> Consists of a thin, flexible glass or plastic fiber surrounded by a rubberized outer coating.

>> Uses the principle of total internal reflection.

>> Electrical signals are converted to light pulses, transmit them over the fibre and converted back to electricals signals at the receiver with the help of media converters.

>> Provides transmission speeds from 100Mbps to 10Gbps and a maximum distance of several miles.

>> Because it uses pulses of light instead of electric voltages to transmit data, it is immune to electrical interference and to wiretapping.

>> Due to high cost, it is not used for LAN, but used for extremely fast transmission rates over long distances or have had problems with electrical interference.

>> Specification: Single mode fibre (SMF - only one bean of light in a cable) and multimode fibre (MMF - a number of light beams in a cable).

>> SMF is used for longer distance (10Gbps for up to 40 kilometers); MMF signal weakens quickly hance used for shorter distance (10Gbps for up to 550 meters).

>> Multi-fibre cables will have colour coded fibre strands to distinguish whether SMF or MMF and diameter.

Inner insulation (cladding)

Optical fiber

Outer insulation
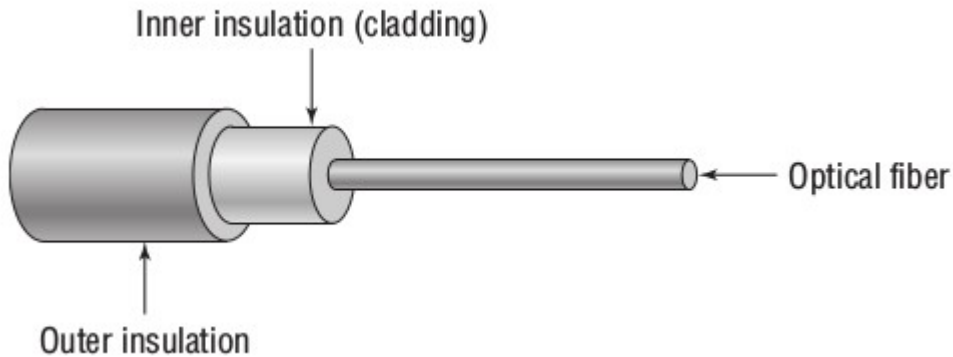
Fiber-Optic Connector Types

>> A lot of connectors available; most common are ST, SC and LC

>> ST (Straight Tip) connector: Most widely used. Easy connection and disconnection. BNC-like connector.
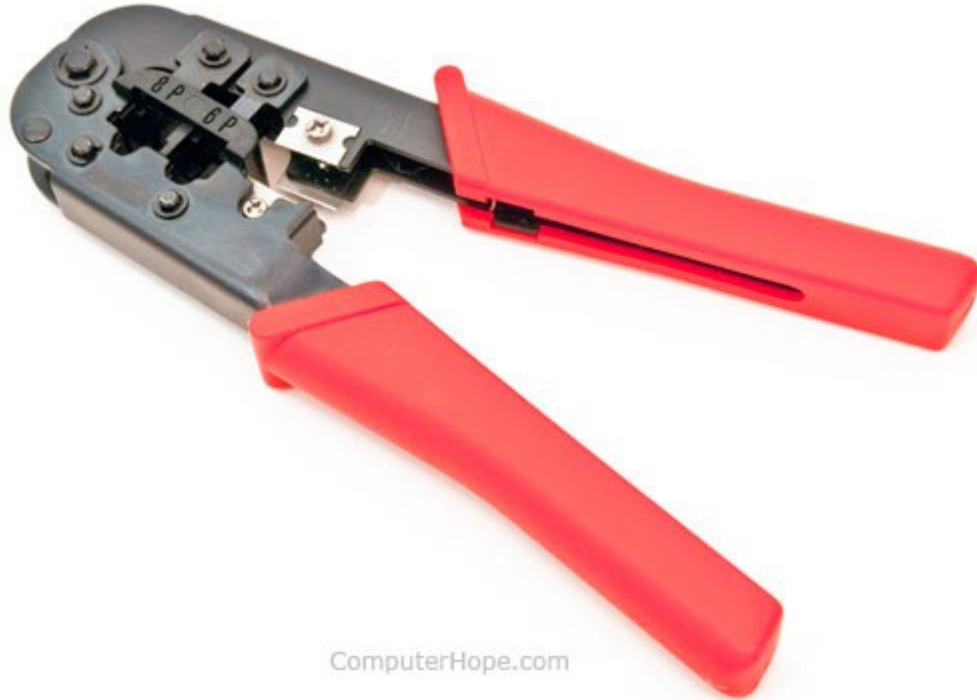
>> SC (Subscriber Connector): A square/standard connector. Uses latch for firmness.

>> LC (Local Connector or Lucent Connector): By Lucent Technologies. A mini form factor (MFF) connector.

ST
type connector

SC
type connector

LC
type connector
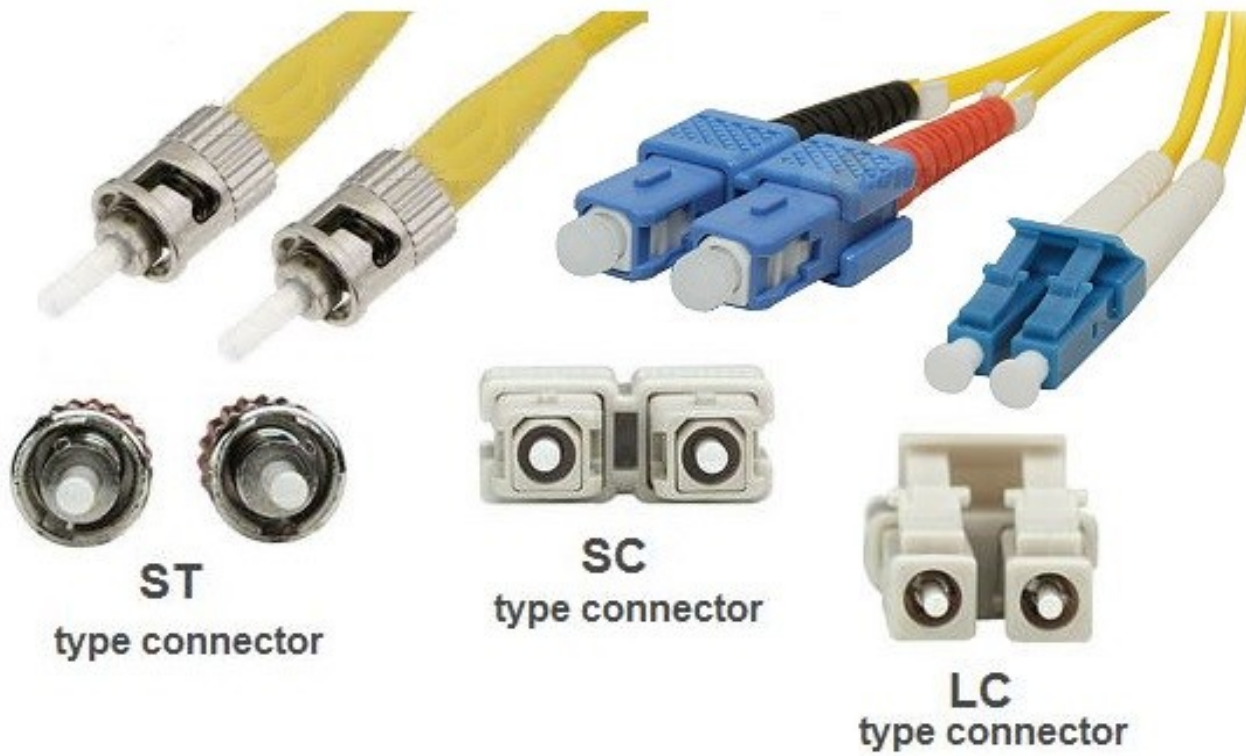
Crimping Tool

RJ-11 (6-Pin) and RJ-45 (8-Pin) Crimping Tool

Network Cable Tester

Punch-Down Tool