The Networking Media

LAN Physical Layer

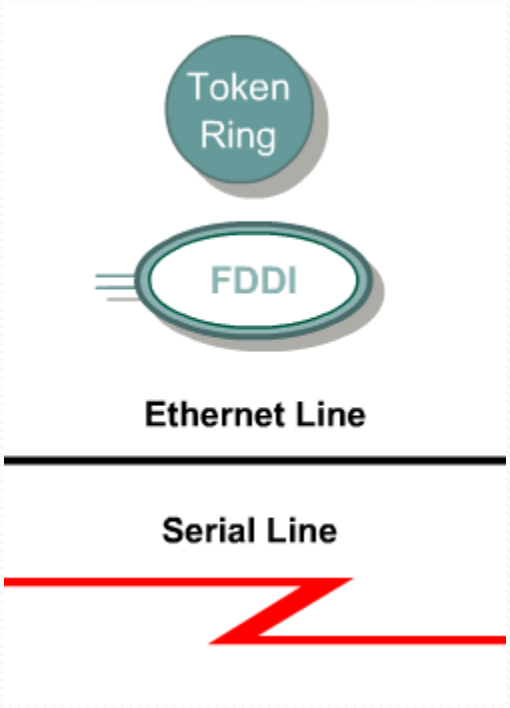
Various symbols are used to represent media types.

The function of media is to carry a flow of information through a LAN.Networking media are considered Layer 1, or physical layer, components of LANs.

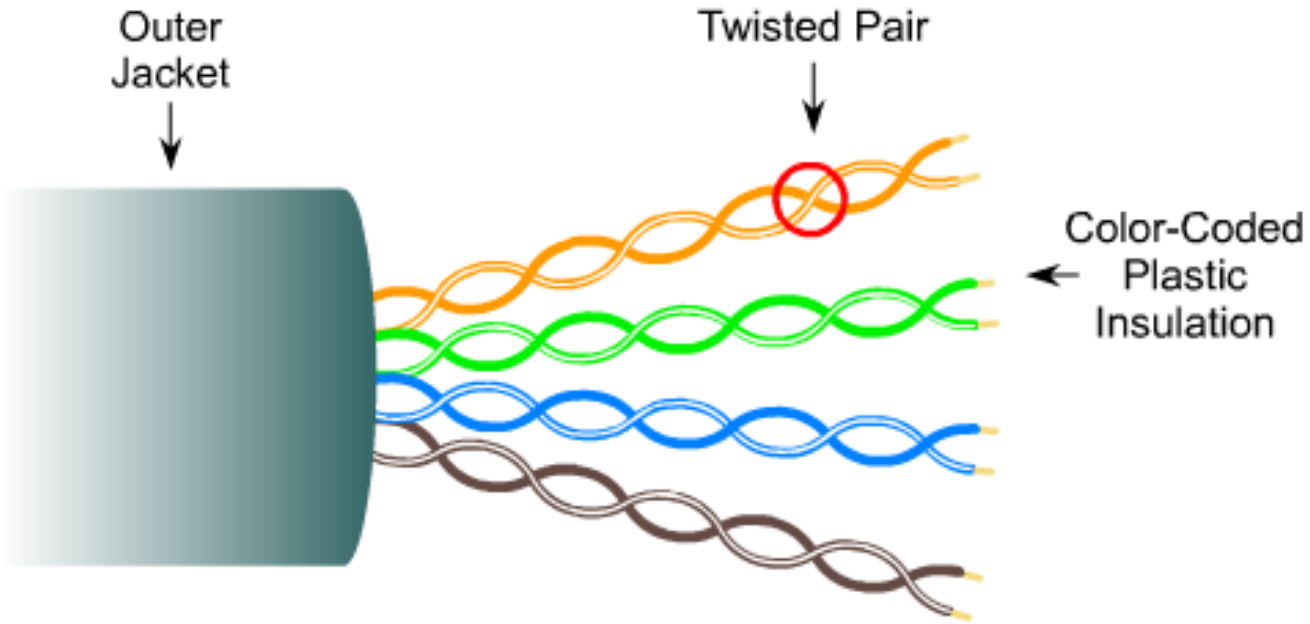
Each media has advantages and disadvantages. Some of the advantage or disadvantage comparisons concern:

- Cable length
- Cost
- Ease of installation
- Susceptibility to interference

Coaxial cable, optical fiber, and even free space can carry network signals. However, the principal medium that will be studied is Category 5 unshielded twisted-pair cable (Cat 5 UTP)



Unshielded Twisted Pair (UTP) Cable



- Speed and throughput: 10 - 100 - 1000 Mbps (depending on the quality/category of cable)
- Average $ per node: Least Expensive
- Media and connector size: Small
- Maximum cable length: 100m

UTP Implementation

EIA/TIA specifies an RJ-45 connector for UTP cable.

The RJ-45 transparent end connector shows eight colored wires.

Four of the wires carry the voltage and are considered “tip” (T1 through T4).
The other four wires are grounded and are called “ring” (R1 through R4).
The wires in the first pair in a cable or a connector are designated as T1 & R1

Connection Media

The registered jack (RJ-45) connector and jack are the most common.

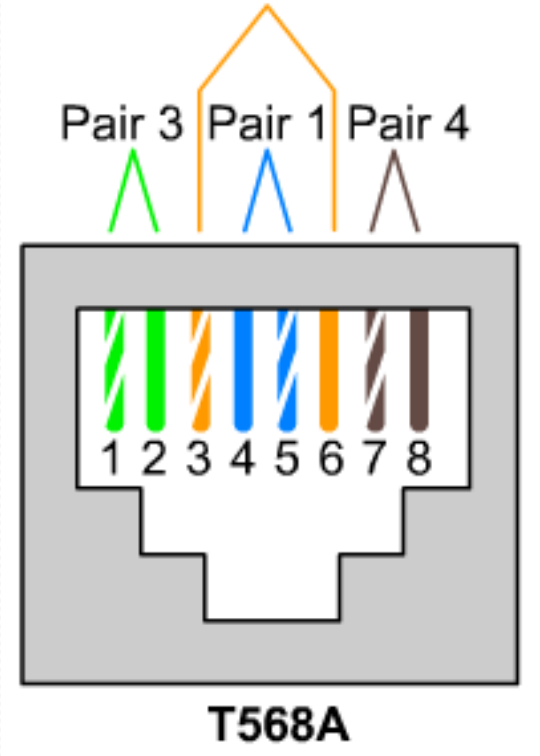
In some cases the type of connector on a network interface card (NIC) does not match the media that it needs to connect to.

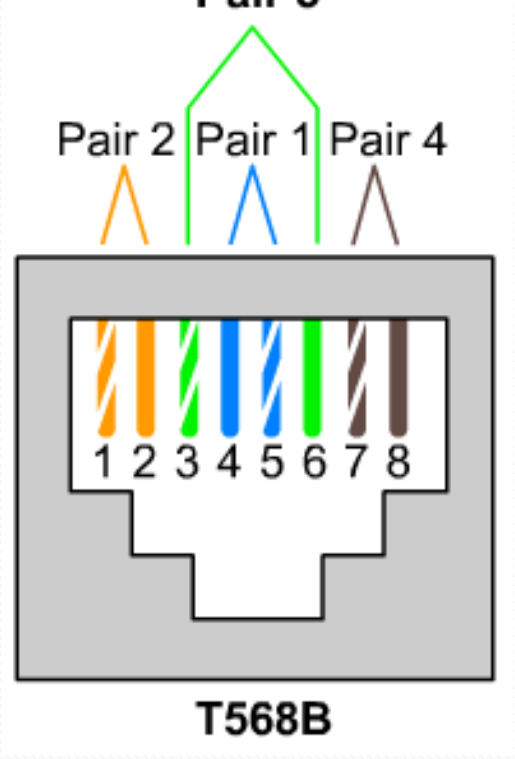
The attachment unit interface (AUI) connector allows different media to connect when used with the appropriate transceiver.

A transceiver is an adapter that converts one type of connection to another.

Ethernet Standards

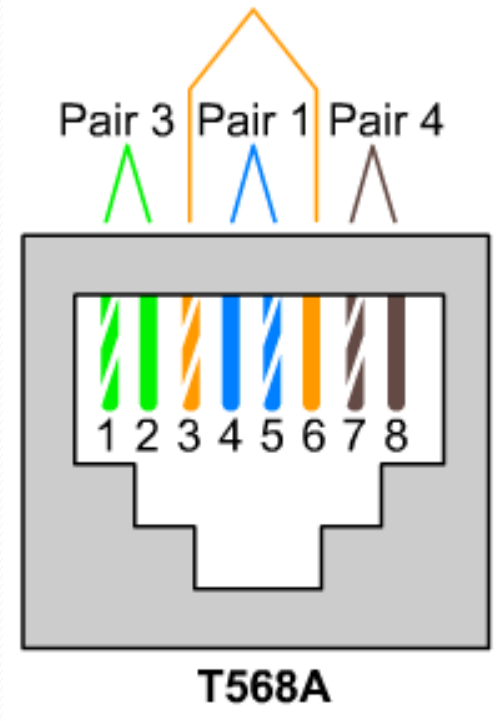
The Ethernet standard specifies that each of the pins on an RJ-45 connector have a particular purpose. A NIC transmits signals on pins 1 & 2, and it receives signals on pins 3 & 6.

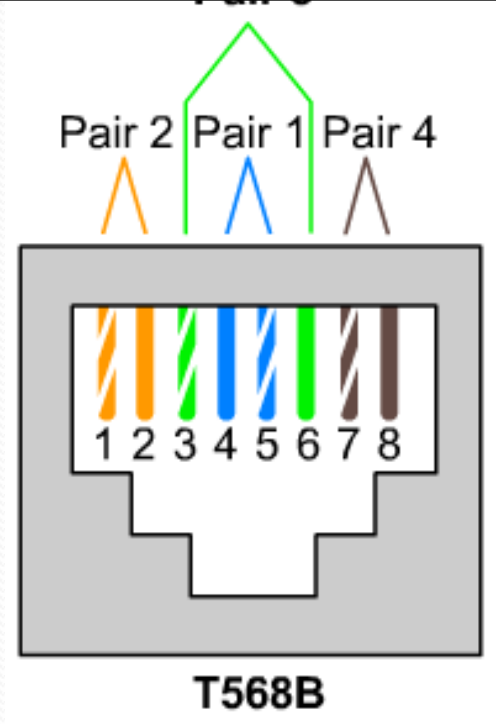




Remember…

A **straight-thru cable** has T568B on both ends. A **crossover** (or **cross-connect**) cable has T568B on one end and T568A on the other. A **console** cable had T568B on one end and reverse T568B on the other, which is why it is also called a **rollover** cable.





Straight-Thru or Crossover

Use straight-through cables for the following cabling:

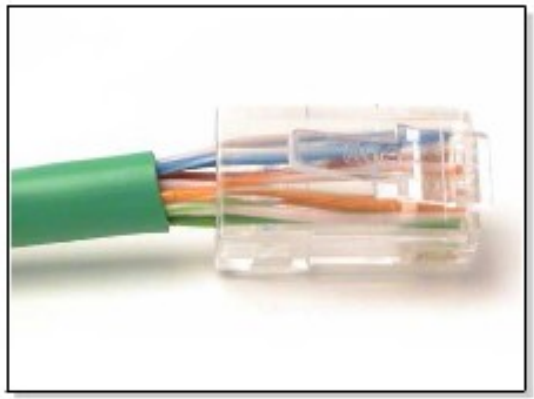
- Switch to router
- Switch to PC or server
- Hub to PC or server

Use crossover cables for the following cabling:

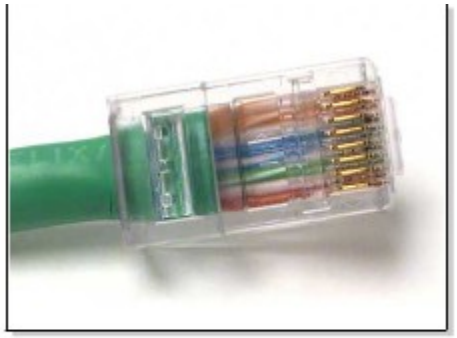
- Switch to switch
- Switch to hub
- Hub to hub
- Router to router
- PC to PC
- Router to PC

Sources of Noise on Copper Media

Noise is any electrical energy on the transmission cable that makes it difficult for a receiver to interpret the data sent from the transmitter. TIA/EIA-568-B certification of a cable now requires testing for a variety of types of noise.***Twisted-pair cable*** is designed to take advantage of the effects of crosstalk in order to minimize noise. In twisted-pair cable, a pair of wires is used to transmit one signal.The wire pair is twisted so that each wire experiences similar crosstalk. Because a noise signal on one wire will appear identically on the other wire, this noise be easily detected and filtered at receiver.Twisting one pair of wires in a cable also helps to reduce crosstalk of data or noise signals from adjacent wires.

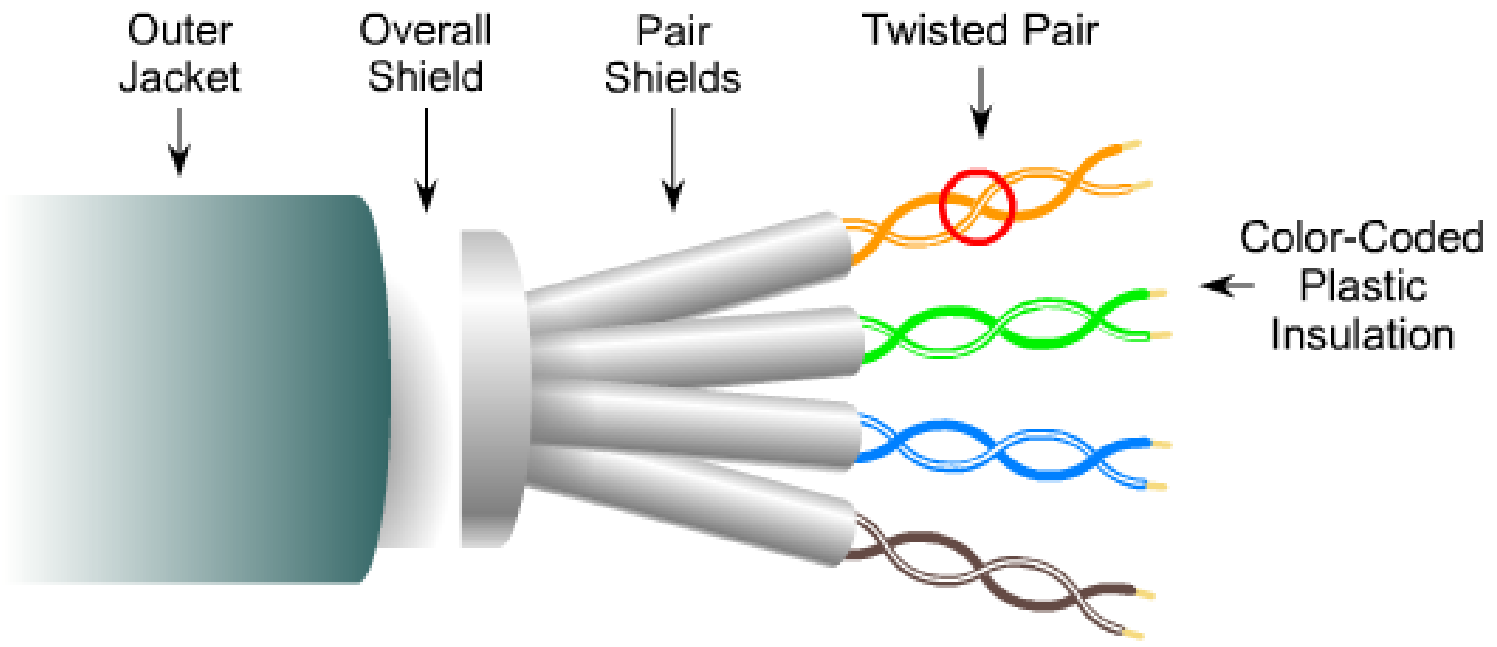


Bad Connector - Wires are untwisted for too great a length.



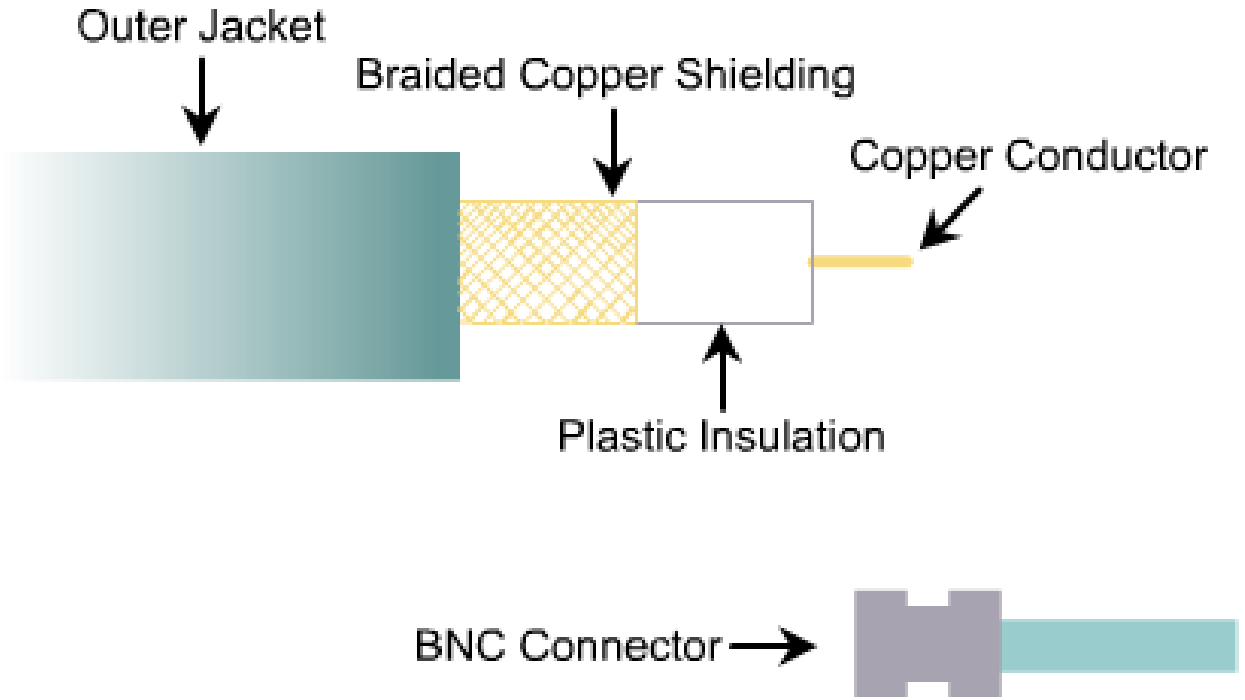
Good Connector - Wires are untwisted to the extent necessary to attach the connector.

Shielded Twisted Pair (STP) Cable



- Speed and throughput: 10 - 100 Mbps
- Average $ per node: Moderately Expensive
- Media and connector size: Medium to Large
- Maximum cable length: 100m

Coaxial Cable

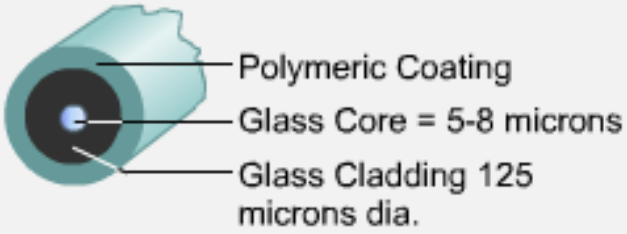


- Speed and throughput: 10 - 100 Mbps
- Average $ per node: Inexpensive
- Media and connector size: Medium
- Maximum cable length: 500m

Fiber Optic Cable

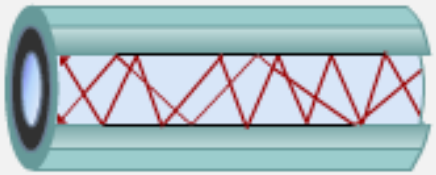
Single-mode

Requires very straight path

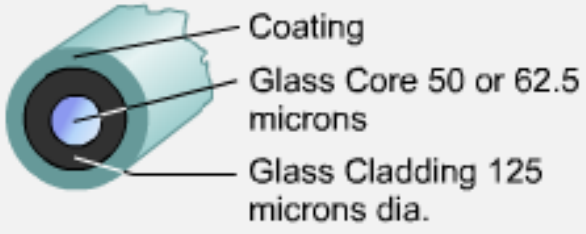


- Small core
- Less dispersion
- Suited for long distance applications (up to ~3km, 9,840 ft)
- Uses lasers as the light source often within campus backbones for distances of several thousand meters

Multimode



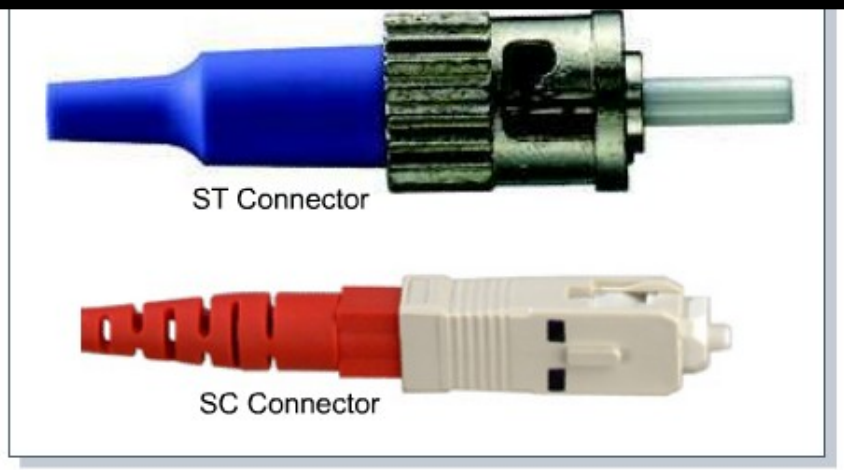
Multiple paths-sloppy



- Larger core than single-mode cable (50 or 62.5 microns or greater)
- Allows greater dipersion and therefore, loss of signal
- Used for long distance application, but shorter than single-mode (up to ~2km, 6,560 ft)
- Uses LEDs as the light source often within LANs or distances of a couple hundred meters within a campus network

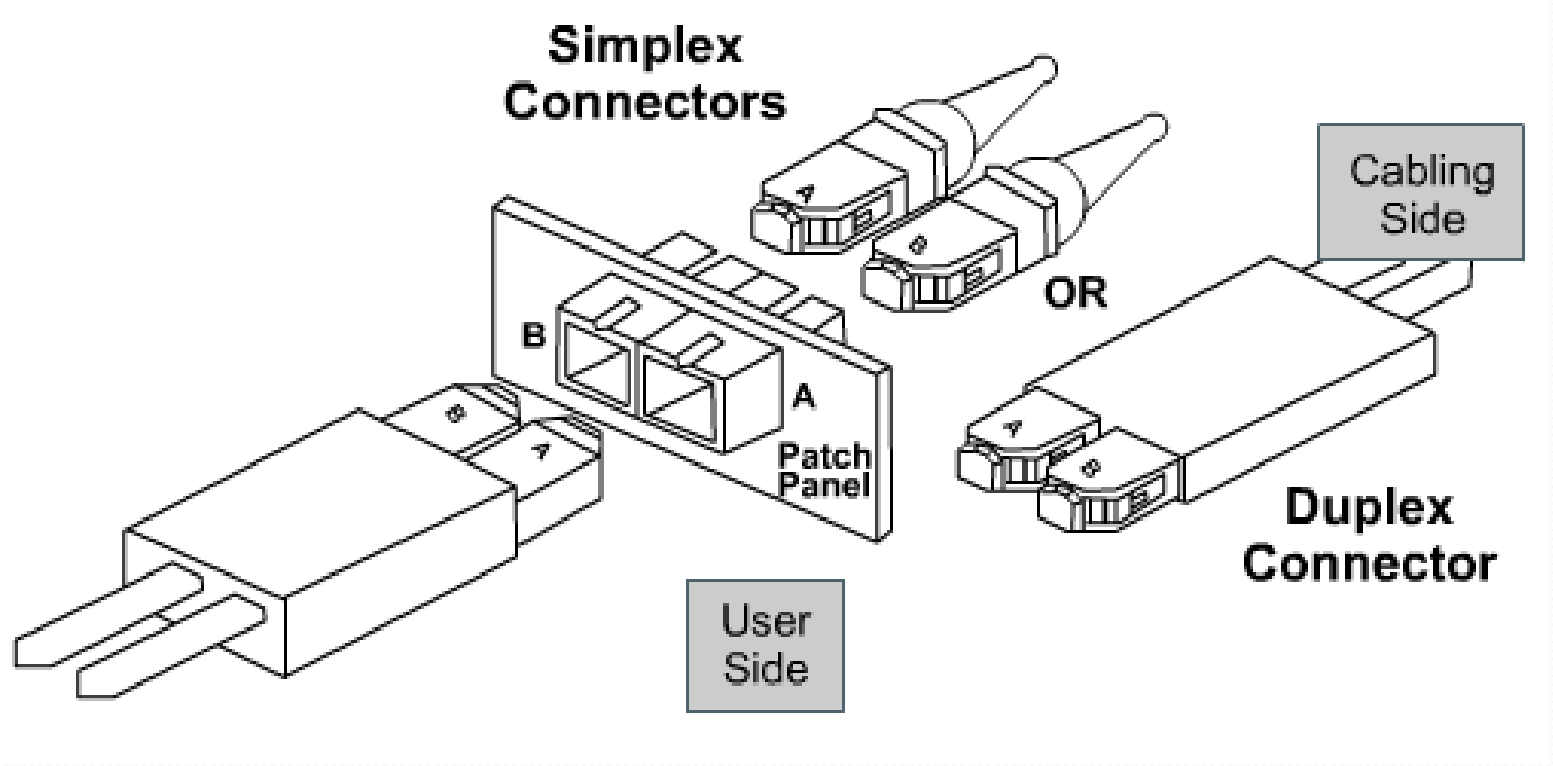
Fiber Optic Connectors

Connectors are attached to the fiber ends so that the fibers can be connected to the ports on the transmitter and receiver.
The type of connector most commonly used with multimode fiber is the Subscriber Connector (SC connector).On single-mode fiber, the Straight Tip (ST) connector is frequently used

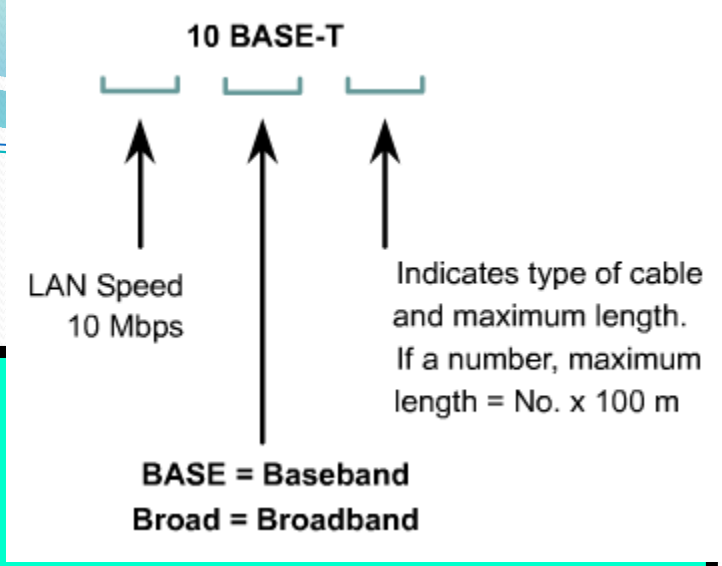


Fiber Optic Patch Panels

Fiber patch panels similar to the patch panels used with copper cable.



Cable Specifications



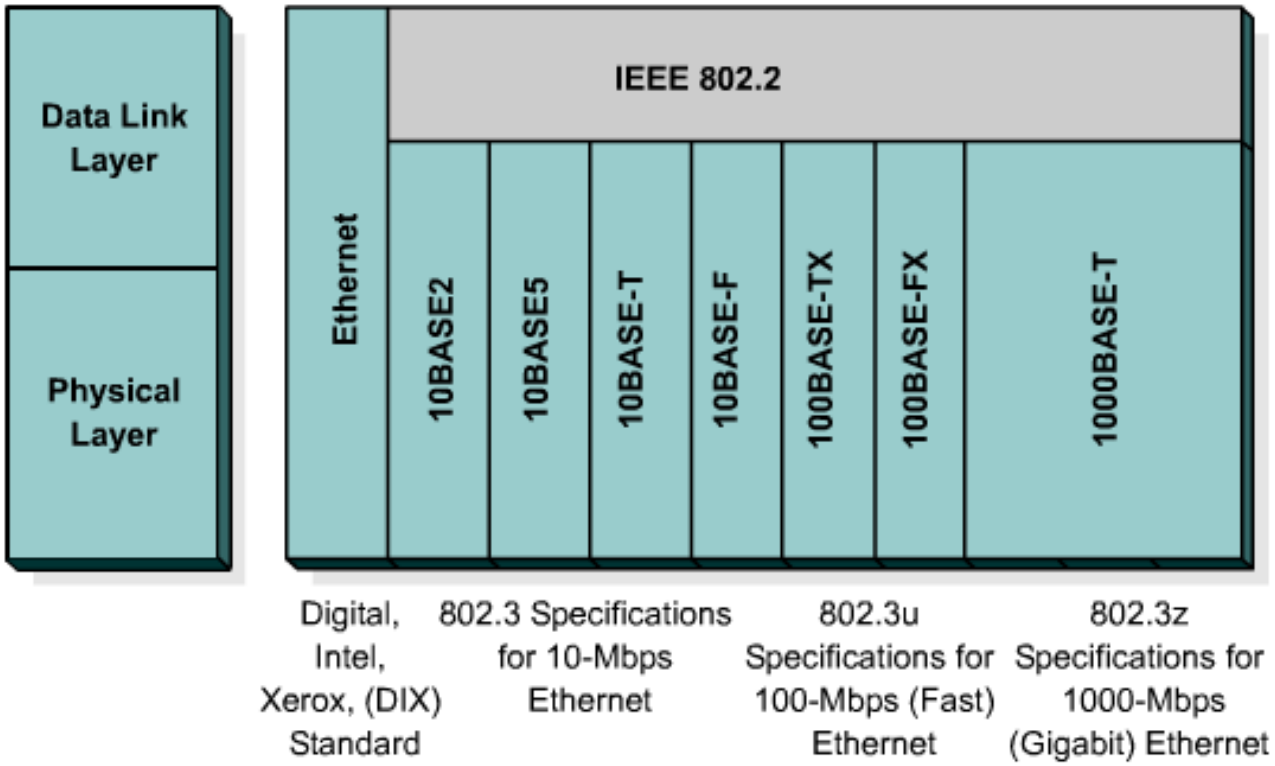
10BASE-T
The T stands for twisted pair.
10BASE5
The 5 represents the fact that a signal can travel for approximately 500 meters 10BASE5 is often referred to as Thicknet.
10BASE2
The 2 represents the fact that a signal can travel for approximately 200 meters 10BASE2 is often referred to as Thinnet.

All 3 of these specifications refer to the speed of transmission at 10 Mbps and a type of transmission that is baseband, or digitally interpreted. Thinnet and Thicknet are actually a type of networks, while 10BASE2 & 10BASE5 are the types of cabling

Ethernet Media Connector Requirements

	10BASE2	10BASE5	10BASE-T	100BASE-TX	100BASE-FX
Media	50-ohm coaxial (Thinnet)	50-ohm coaxial (Thicknet)	EIA/TIA Category 3, 4, 5 UTP, two pair	EIA/TIA Category 5 UTP, two pair	62.5/125 multimode fiber
Maximum Segment Length	185 m (606.94 feet)	500 m (1640.4 feet)	100 m (328 feet)	100 m (328 feet)	400 m (1312.3 feet)
Topology	Bus	Bus	Star	Star	Star
Connector	BNC	Attachment unit interface (AUI)	ISO 8877 (RJ-45)	ISO 8877 (RJ-45)	Duplex media interface connector (MIC) ST or SC connector

LAN Physical Layer Implementation



- Physical layer implementations vary.
- Some implementations support multiple physical media.

Ethernet in the Campus

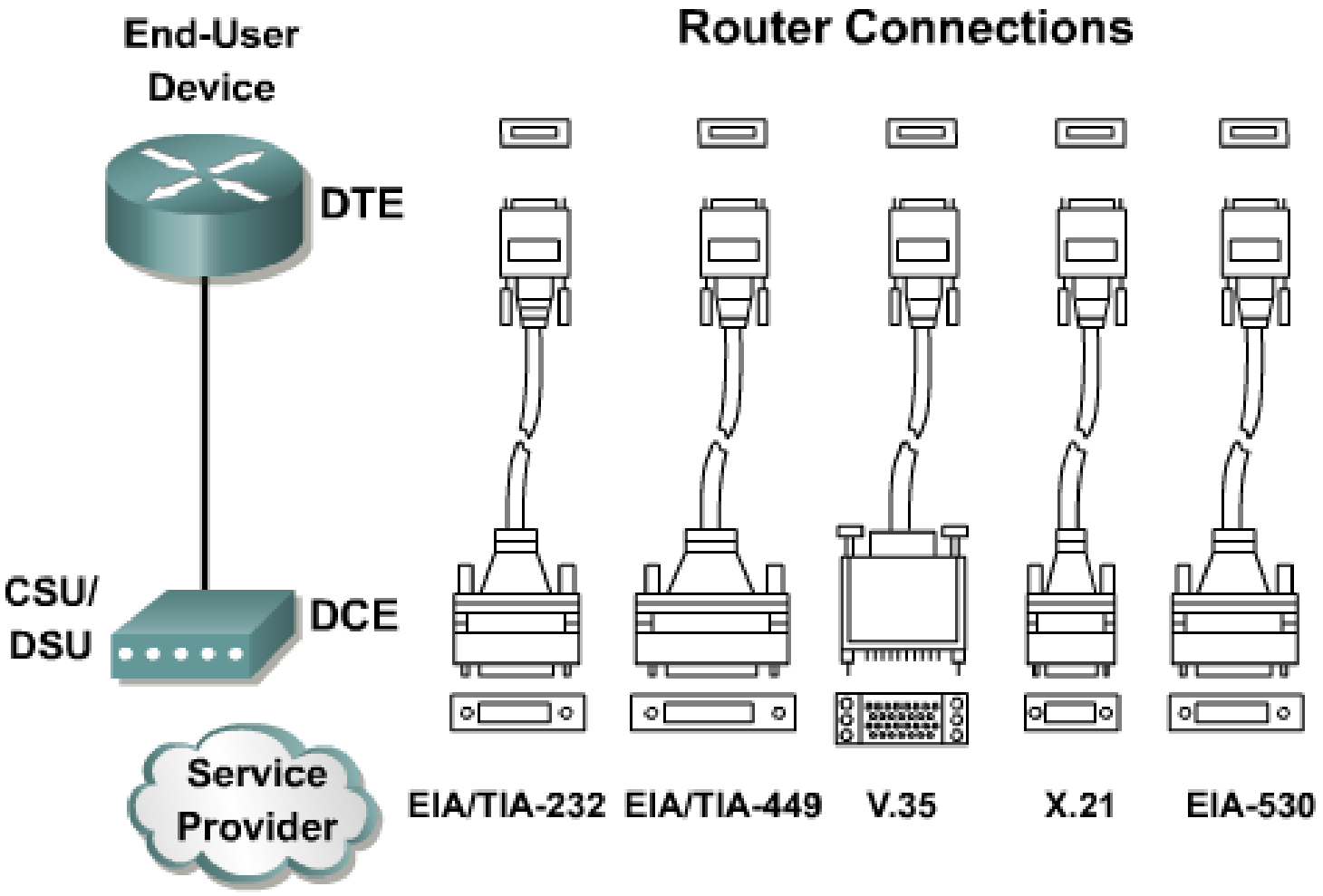
	Ethernet 10BASE-T Implementation	Fast Ethernet Implementation	Gigabit Ethernet Implementation
End-user Level (End-user device to workgroup device)	Provides connectivity for low-to medium-volume applications.	Gives high-performance PC workstations 100-Mbps access to the server.	Not typically used at this level.
Workgroup Level (Workgroup device to backbone)	Not typically used at this level.	Provides connectivity between the end user and workgroups. Provides connectivity from the workgroup to backbone. Provides connectivity from the server block to the backbone layer.	Provides high-performance connectivity to the enterprise server block.
Backbone Level	Not typically used at this level.	Provides connectivity from the workgroup server block to the backbone.	Provides high-speed backbone and network device connectivity.

WAN Physical Layer

Cisco HDLC / PPP / Frame Relay	ISDN BRI (with PPP)	DSL Modem	Cable Modem
EIA/TIA-232 EIA/TIA-449 X.21 V.24 V.35 High Speed Serial Interface (HSSI)	RJ-45 Note: ISDN BRI cable pinouts are different than the pinouts for Ethernet	RJ-11 Note: Works over telephone line	BNC Note: Works over Cable TV line

- Physical Layer implementation vary
- Cable specifications define speed of link

WAN Serial Connection Options



Serial Implementation of DTE & DCE

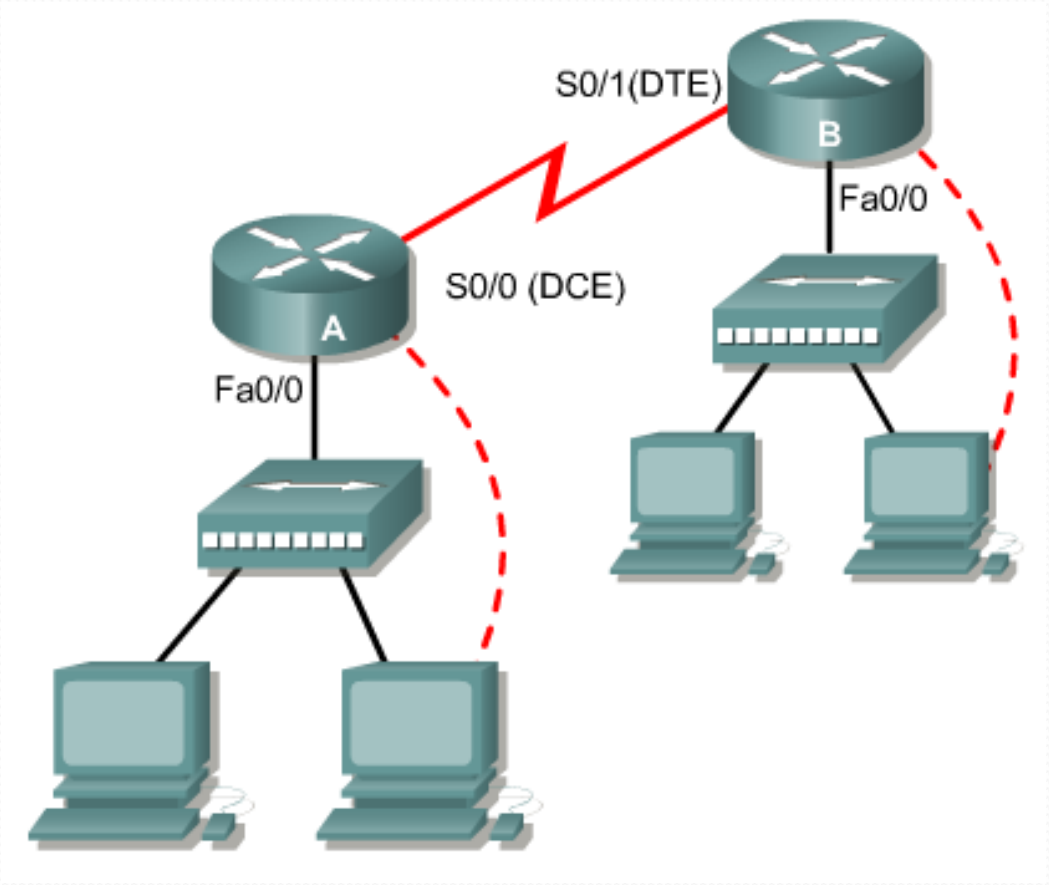
When connecting directly to a service provider, or to a device such as a CSU/DSU that will perform signal clocking, the router is a DTE and needs a DTE serial cable.
This is typically the case for routers.

Data Terminal Equipment:
- End of the user's device on the WAN Link

Data Communications Equipment:
- End of the WAN provider's side of the communication facility
- Responsible for clocking

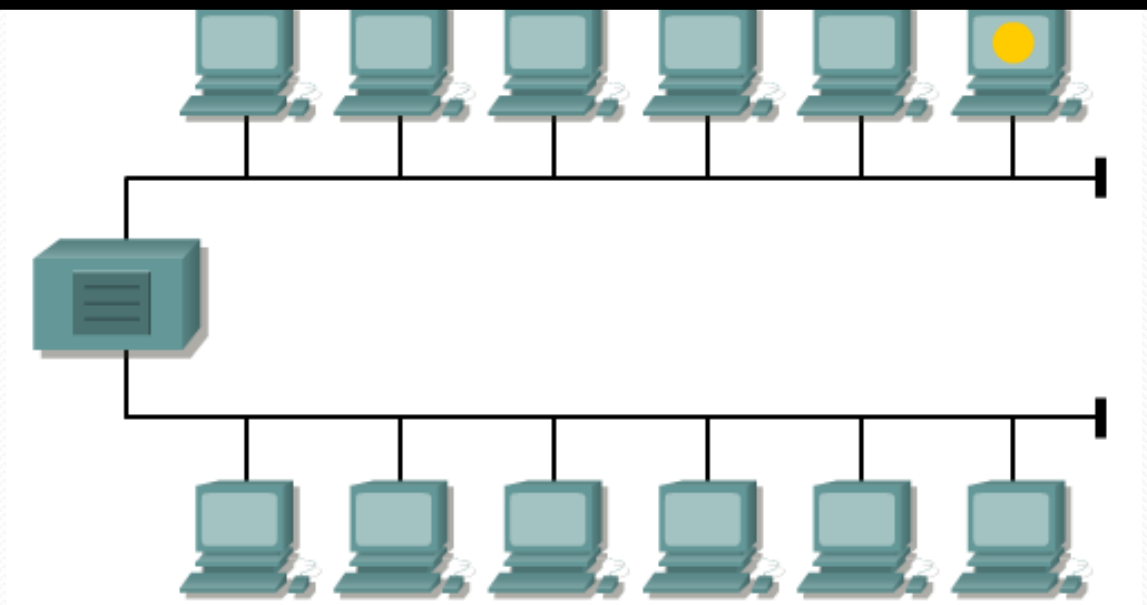
Back-to-Back Serial Connection

When performing a back-to-back router scenario in a test environment, one of the routers will be a DTE and the other will be a DCE.



Repeater

A repeater is a network device used to regenerate a signal.
Repeaters regenerate analog or digital signals distorted by transmission loss due to attenuation.**Repeater is a Physical Layer device**



The 4 Repeater Rule

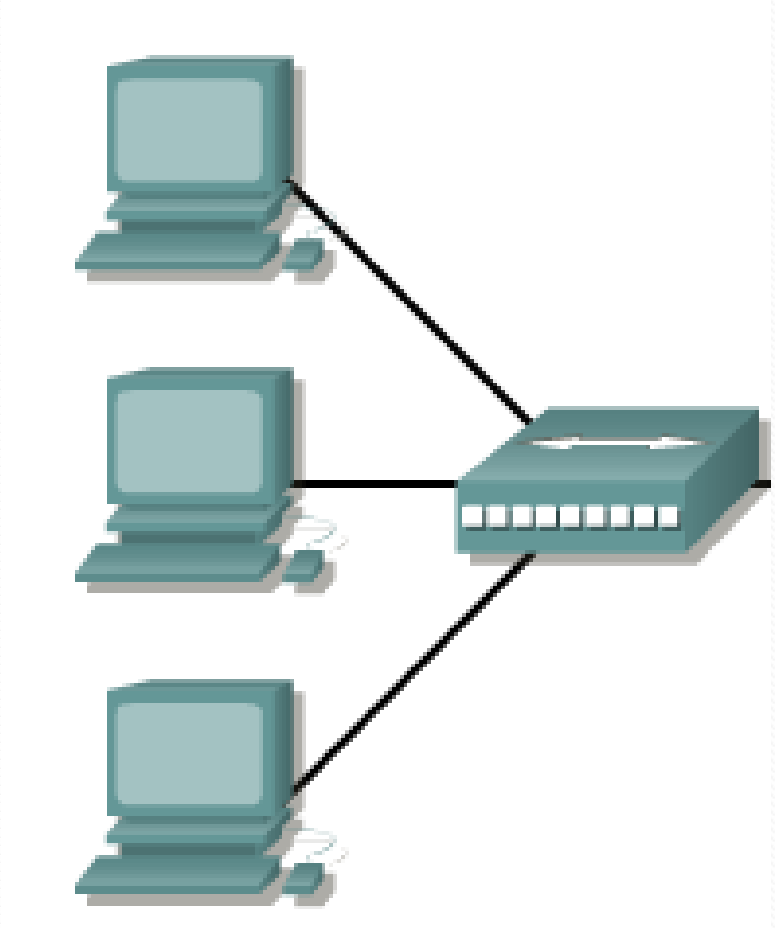
The Four Repeater Rule for 10-Mbps Ethernet should be used as a standard when extending LAN segments.

This rule states that no more than four repeaters can be used between hosts on a LAN.

This rule is used to limit latency added to frame travel by each repeater.

Hub

Hubs concentrate connections.In other words, they take a group of hosts and allow the network to see them as a single unit.
Hub is a physical layer device.

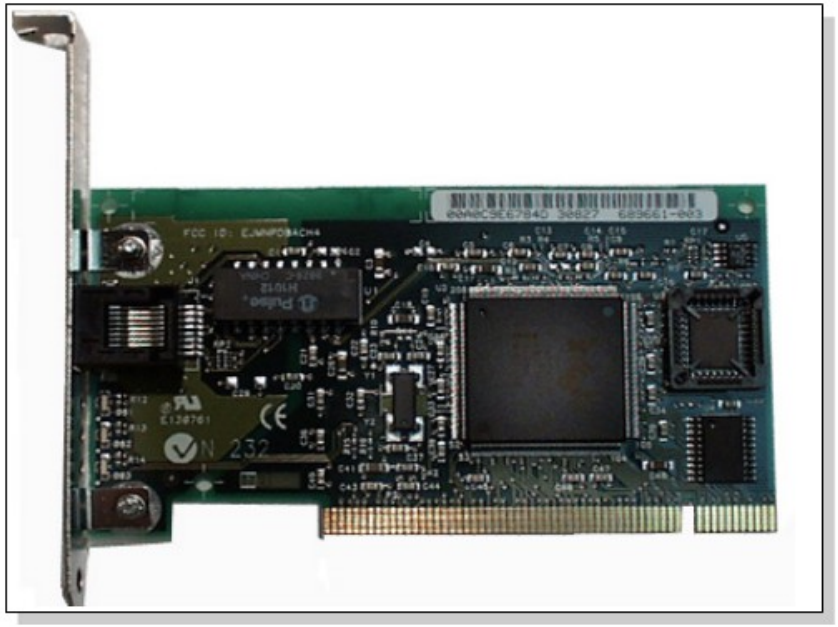


Network Interface Card

The function of a NIC is to connect a host device to the network medium.

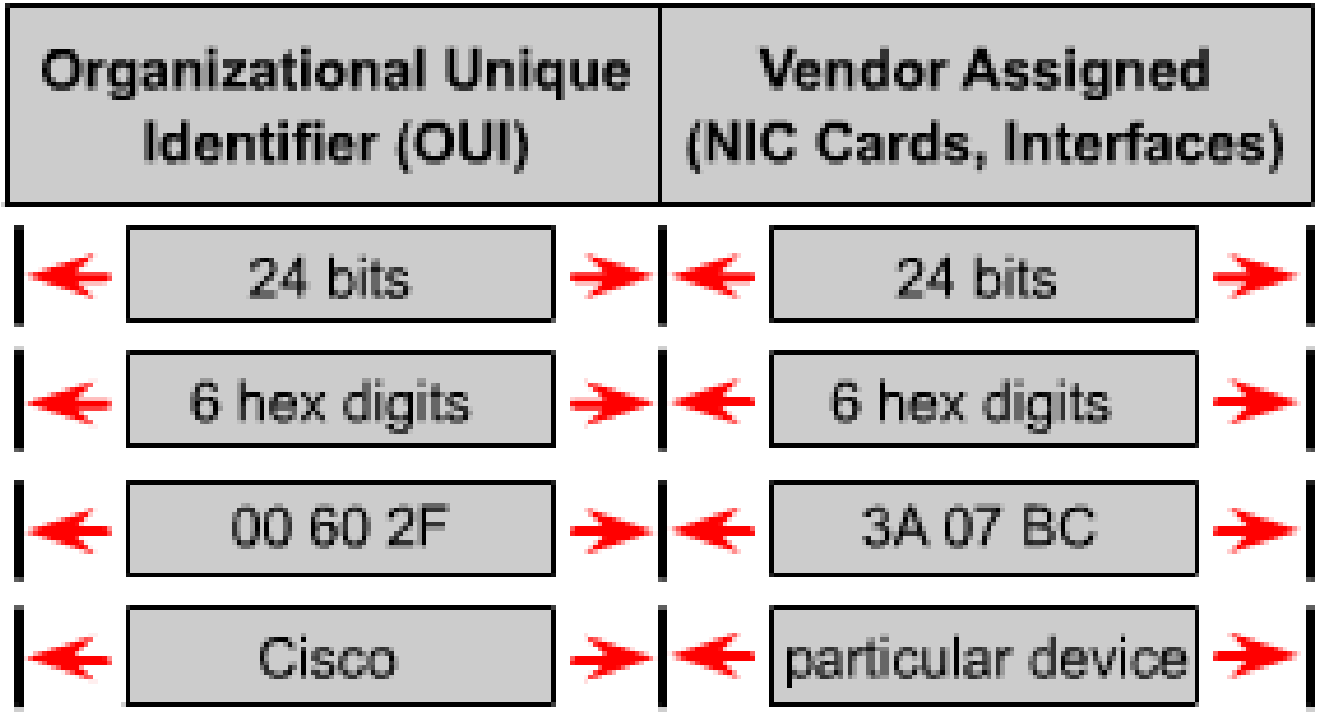
A NIC is a printed circuit board that fits into the expansion slot on the motherboard or peripheral device of a computer. The NIC is also referred to as a network adapter.

NICs are considered Data Link Layer devices because each NIC carries a unique code called a MAC address.



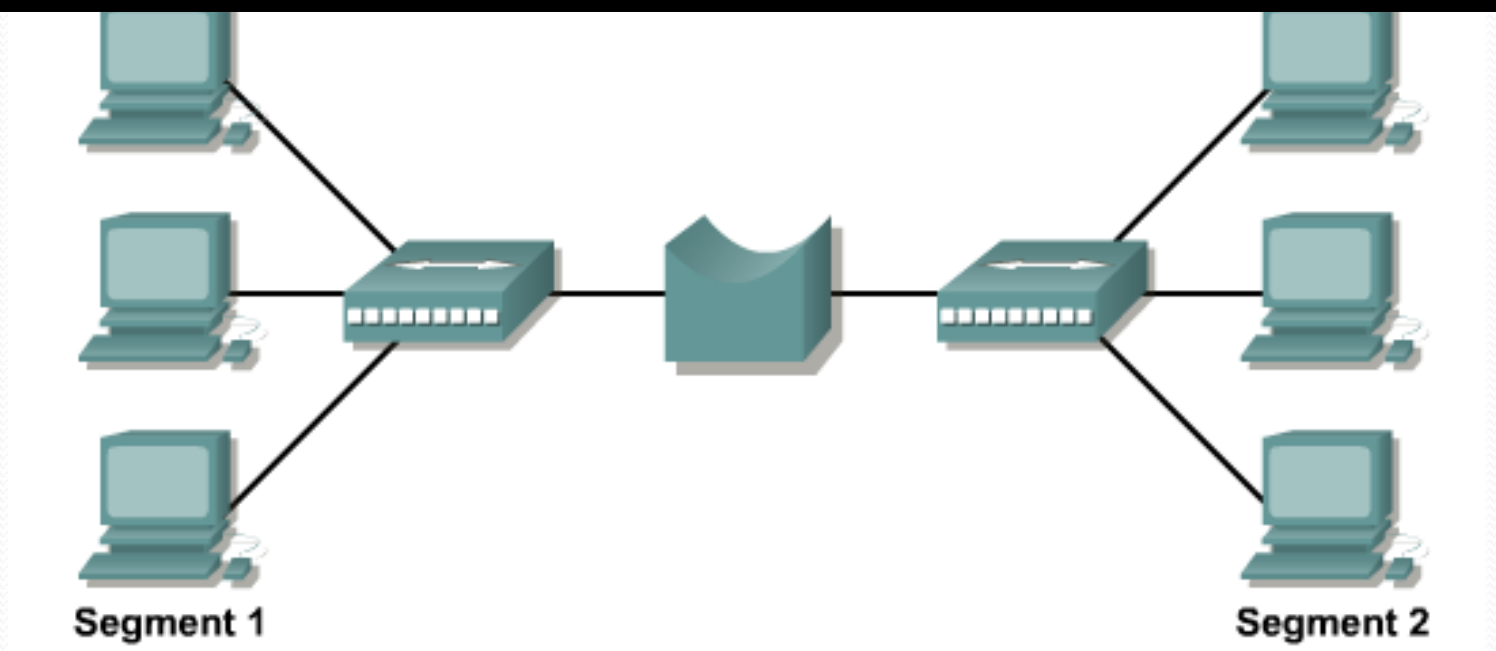
MAC Address

MAC address is 48 bits in length and expressed as twelve hexadecimal digits.MAC addresses are sometimes referred to as burned-in addresses (BIA) because they are burned into read-only memory (ROM) and are copied into random-access memory (RAM) when the NIC initializes.

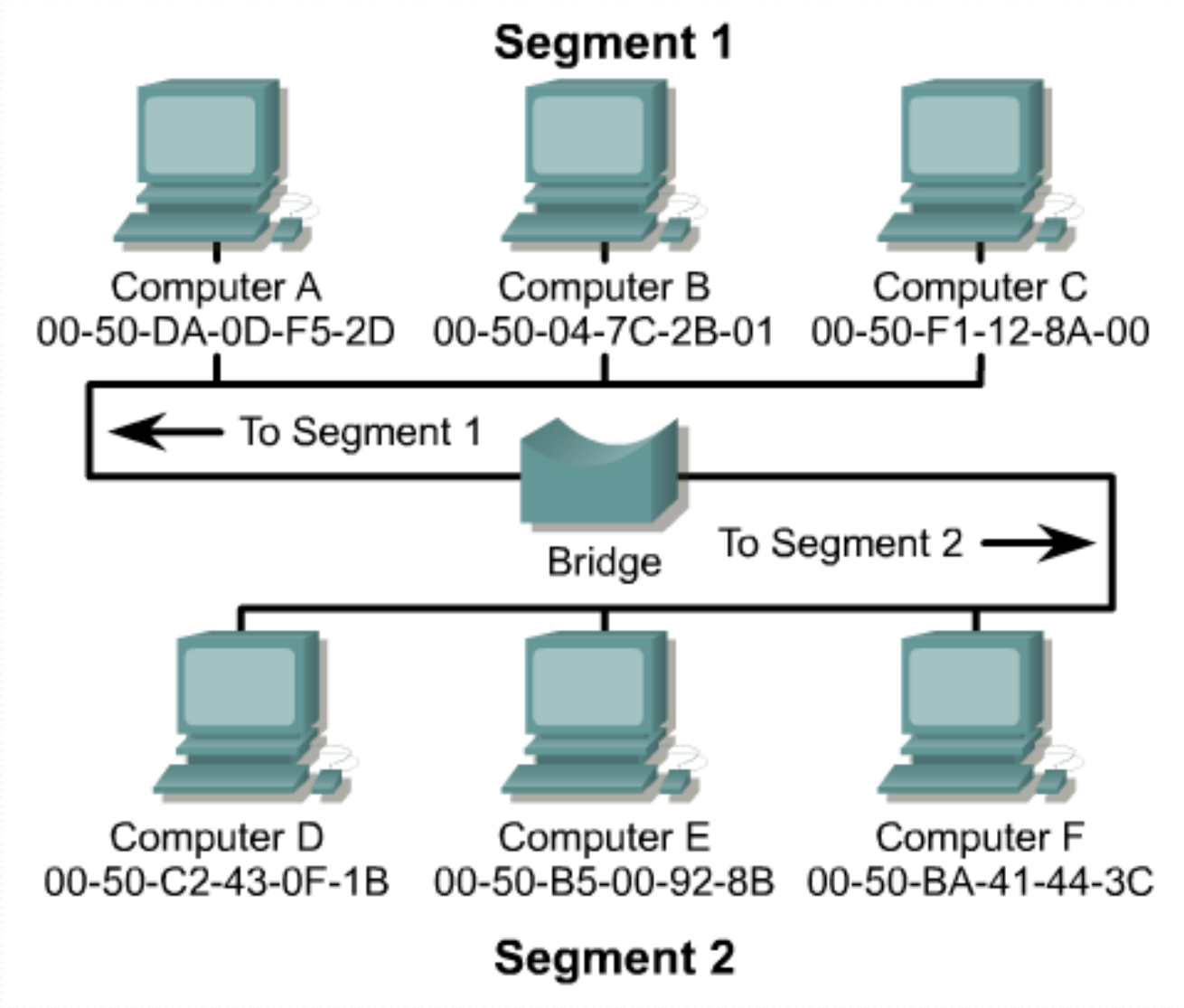


Bridge

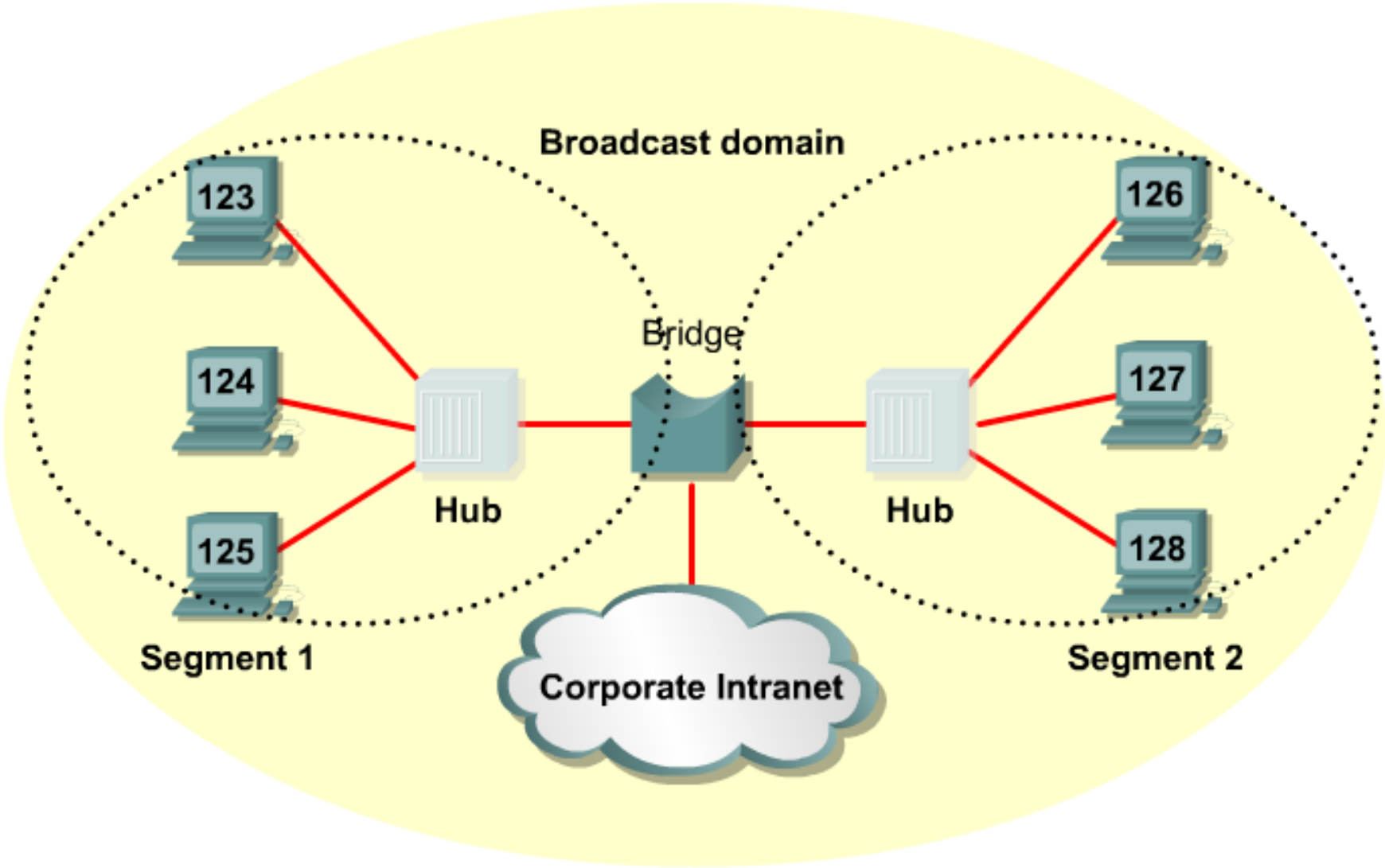
Bridges are Data Link layer devices. Connected host addresses are learned and stored on a MAC address table.Each bridge port has a unique MAC address



Bridges


Segment 1
Computer A
00-50-DA-0D-F5-2D
Computer B
00-50-04-7C-2B-01
Computer C
00-50-F1-12-8A-00
To Segment 1
Bridge
To Segment 2
Computer D
00-50-C2-43-0F-1B
Computer E
00-50-B5-00-92-8B
Computer F
00-50-BA-41-44-3C
Segment 2

Bridging Graphic

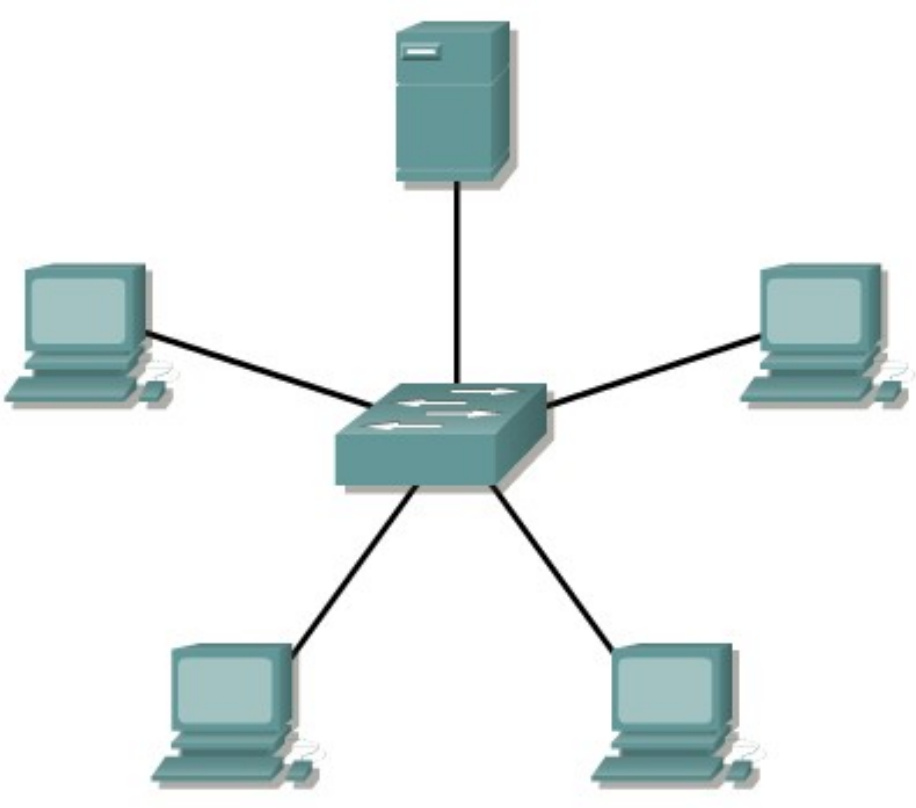


Switch

Switches are Data Link layer devices.

Each Switch port has a unique MAC address.

Connected host MAC addresses are learned and stored on a MAC address table.



Switching Modes

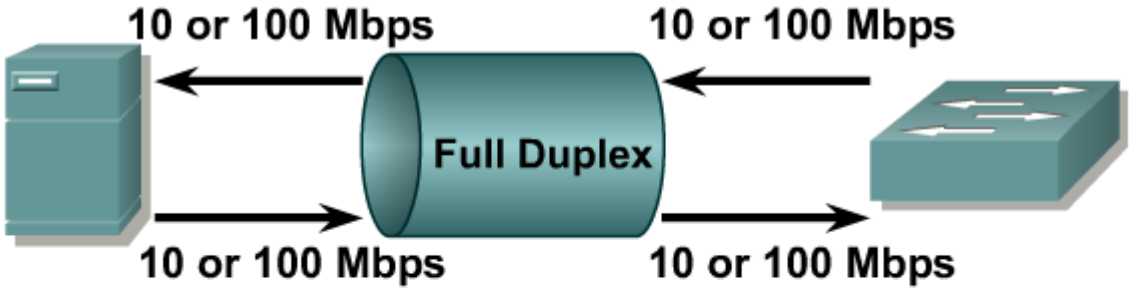
cut-through
A switch starts to transfer the frame as soon as the destination MAC address is received. No error checking is available.
Must use synchronous switching.

store-and-forward
At the other extreme, the switch can receive the entire frame before sending it out the destination port. This gives the switch software an opportunity to verify the Frame Check Sum (FCS) to ensure that the frame was reliably received before sending it to the destination.
Must be used with asynchronous switching.

fragment-free
A compromise between the cut-through and store-and-forward modes.
Fragment-free reads the first 64 bytes, which includes the frame header, and switching begins before the entire data field and checksum are read.

Full Duplex

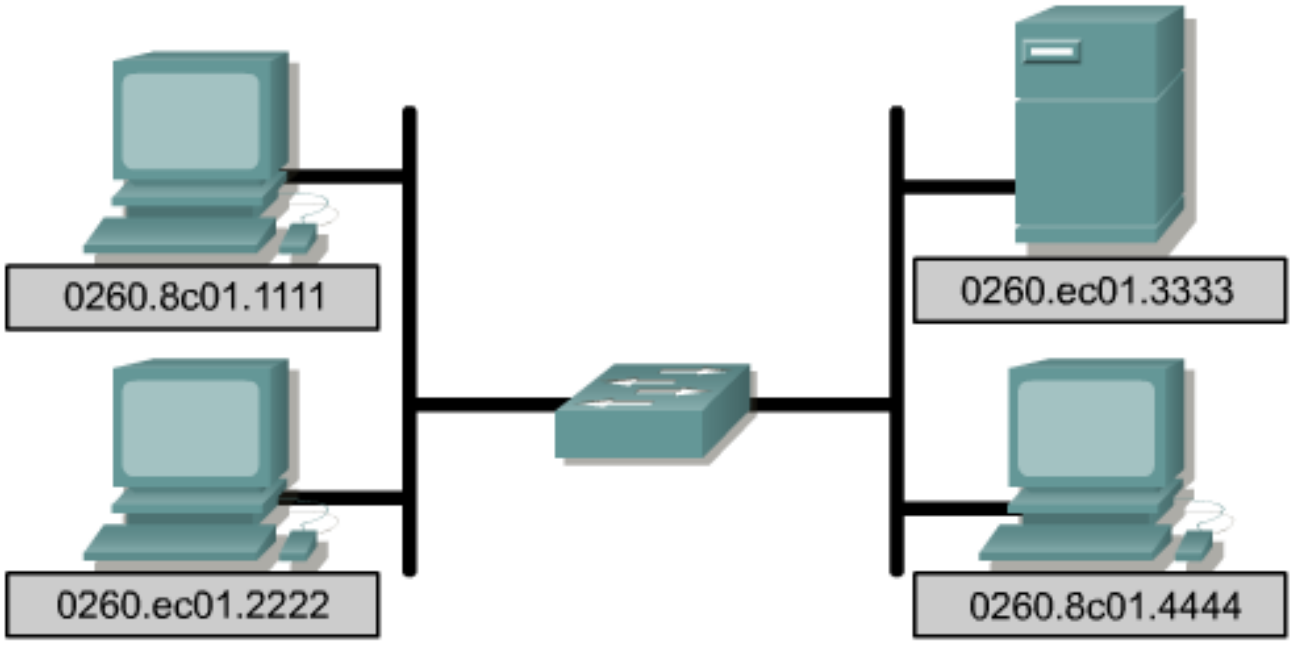
Another capability emerges when only two nodes are connected. In a network that uses twisted-pair cabling, one pair is used to carry the transmitted signal from one node to the other node. A separate pair is used for the return or received signal. It is possible for signals to pass through both pairs simultaneously. The capability of communication in both directions at once is known as full duplex.



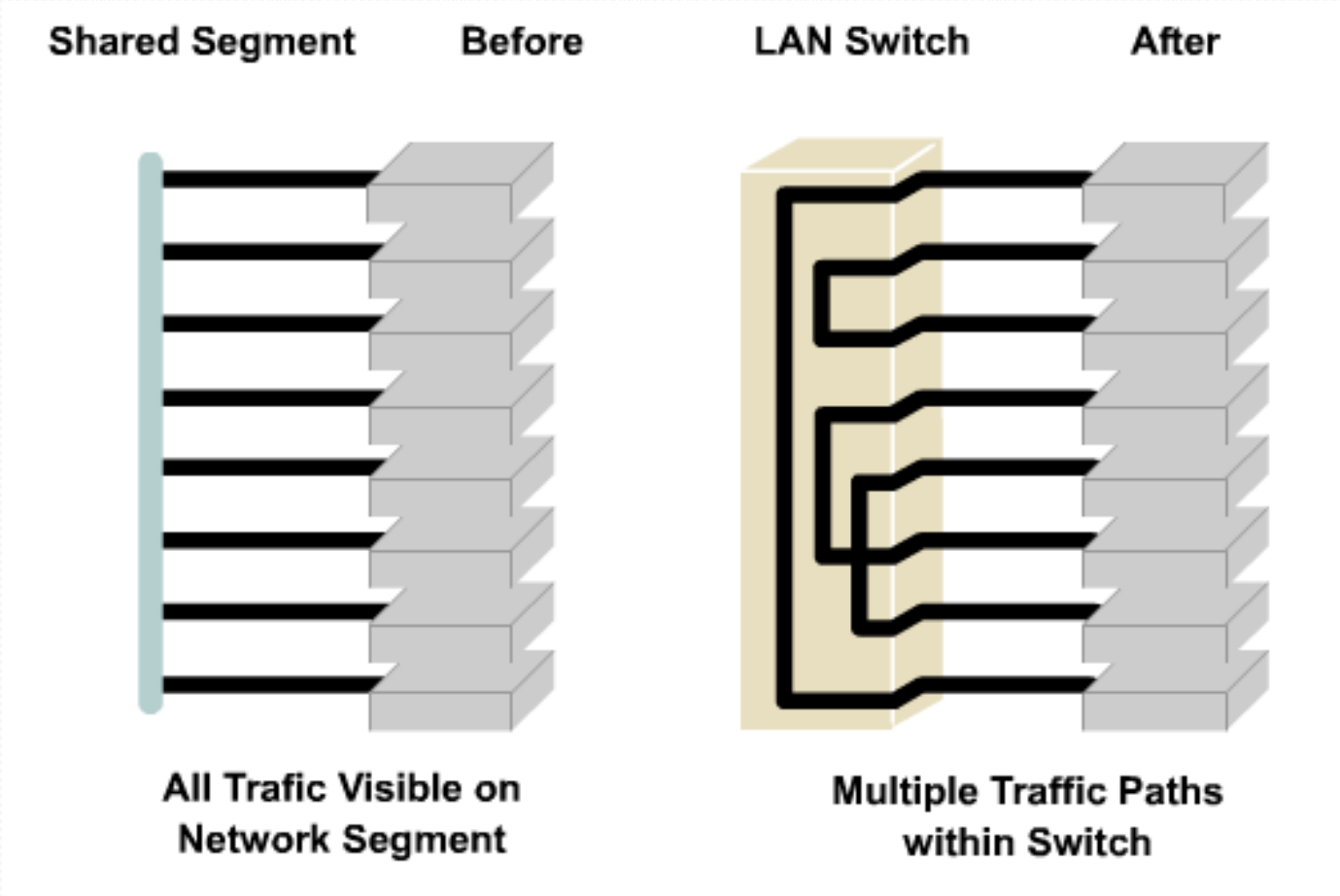
- Doubles bandwidth between nodes
- Collision-free transmission
- Two 10- or 100- Mbps data paths

Switches – MAC Tables

Interface	MAC Address
E0	0260.8c01.1111
E0	0260.ec01.2222
E1	0260.ec01.3333
E1	0260.8c01.4444



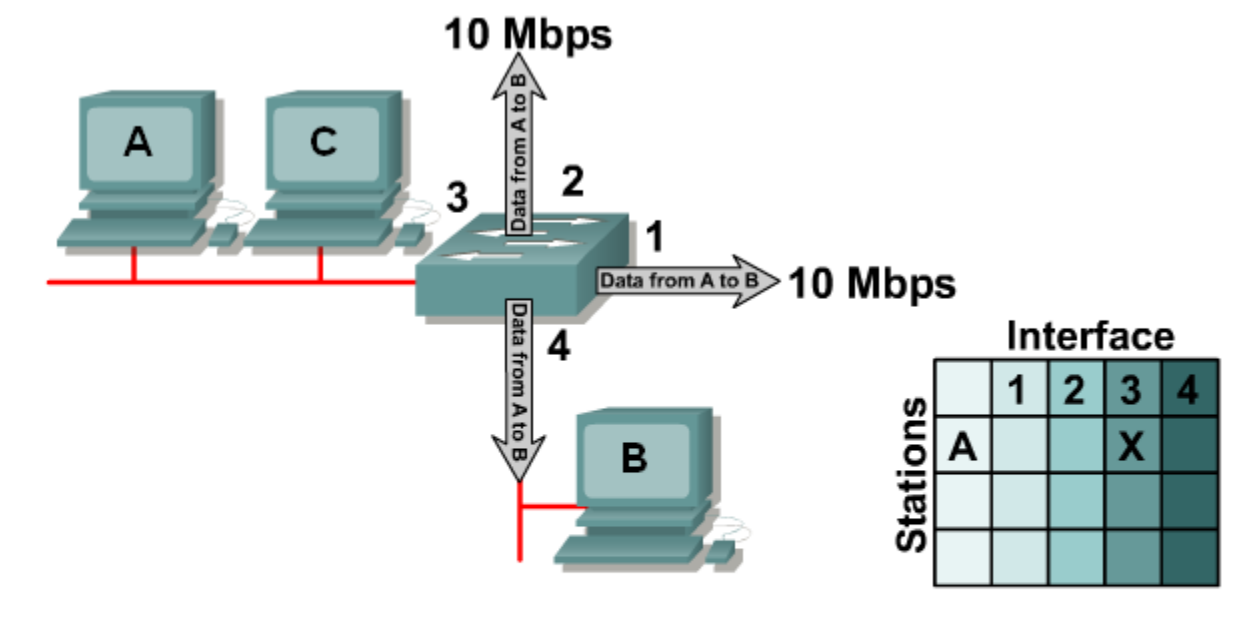
Switches – Parallel Communication



Dedicated paths between sender and receiver hosts.

Microsegmentation

A switch is simply a bridge with many ports. When only one node is connected to a switch port, the collision domain on the shared media contains only two nodes. The two nodes in this small segment, or collision domain, consist of the switch port and the host connected to it. These small physical segments are called micro segments.



- Forward packets based on MAC address in forwarding table
- Operates at OSI Layer 2
- Learns a station's location by examining source address

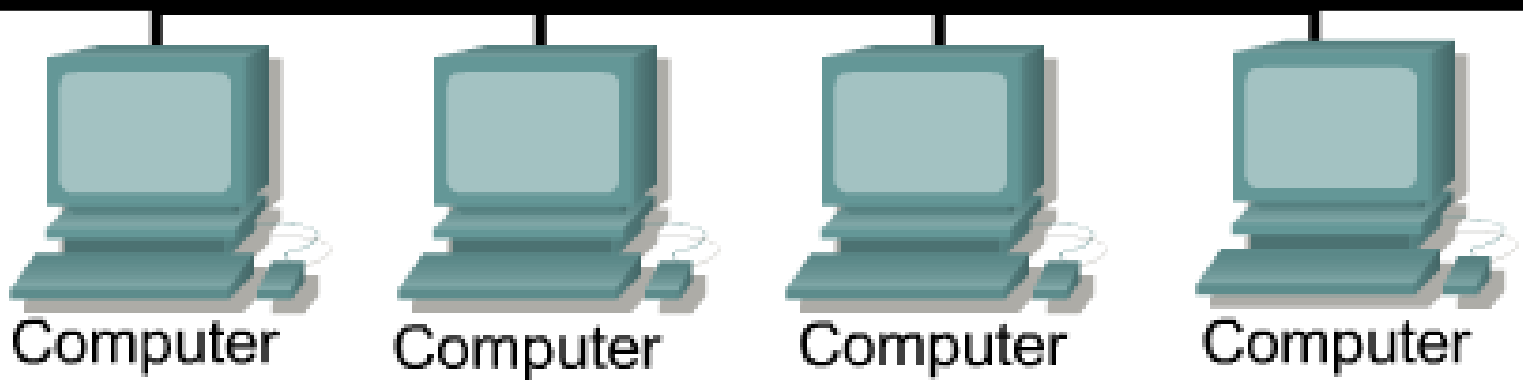
Peer-to-Peer Network

In a peer-to-peer network, networked computers act as equal partners, or peers.

As peers, each computer can take on the client function or the server function.

At one time, computer A may make a request for a file from computer B, which responds by serving the file to computer A. Computer A functions as client, while B functions as the server. At a later time, computers A and B can reverse roles.

In a peer-to-peer network, individual users control their own resources. Peer-to-peer networks are relatively easy to install and operate. As networks grow, peer-to-peer relationships become increasingly difficult to coordinate.



Client/Server Network

In a client/server arrangement, network services are located on a dedicated computer called a server.

The server responds to the requests of clients.

The server is a central computer that is continuously available to respond to requests from clients for file, print, application, and other services.

Most network operating systems adopt the form of a client/server relationship.