Komunikasi Data dan Jaringan Komputer

D3 – Manajemen Informatika

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- **MATA KULIAH : KOMUNIKASI DATA DAN JARINGAN KOMPUTER**
- **KODE MATA KULIAH : MIN516111**
- **SKS : 3(2-1)**
- **SEMESTER : 2**

NETWORK ACCESS

Chapter 4: Objectives

Students will be able to:

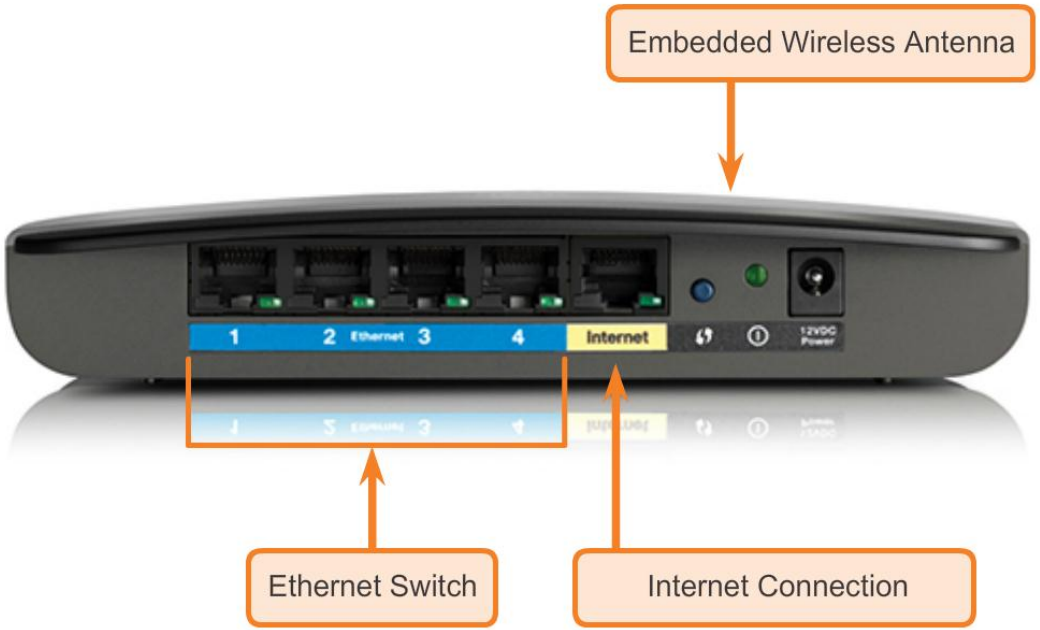
- Explain how physical layer protocols and services support communications across data networks.
- Build a simple network using the appropriate.
- Explain the role of the data link layer in supporting communications across data networks.
- Compare media access control techniques and logical topologies used in networks.

Chapter 4

- 4.1 Physical Layer Protocols
- 4.2 Network Media
- 4.3 Data Link Layer Protocols
- 4.4 Media Access Control
- 4.5 Summary

Connecting to the Network

Home Router

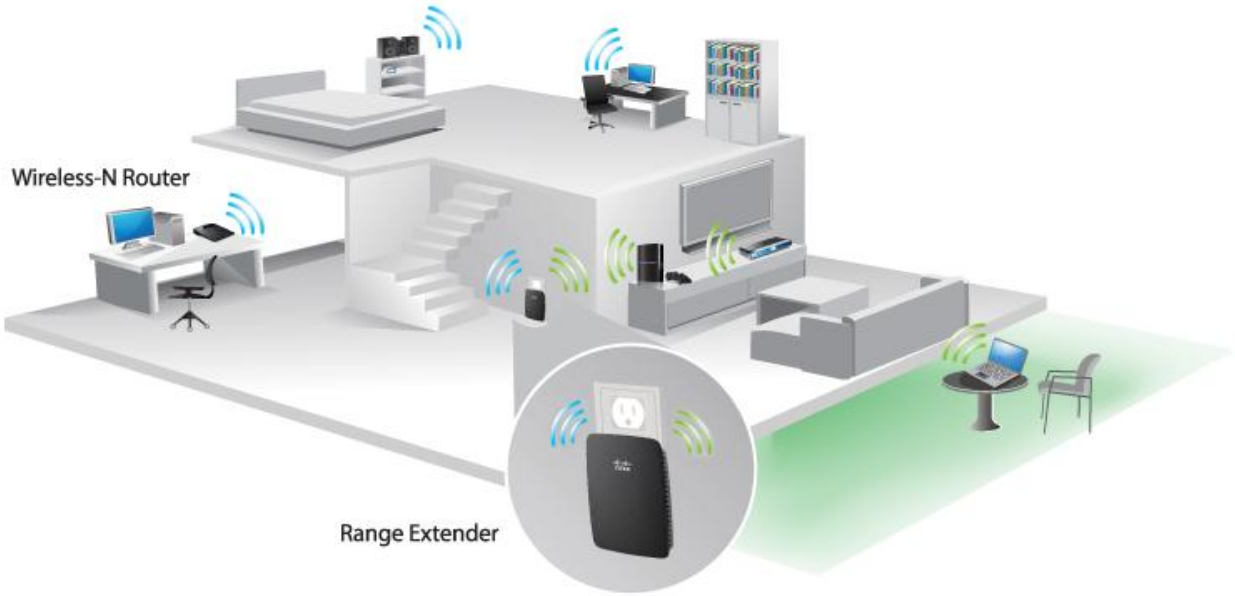


Connecting to the Network

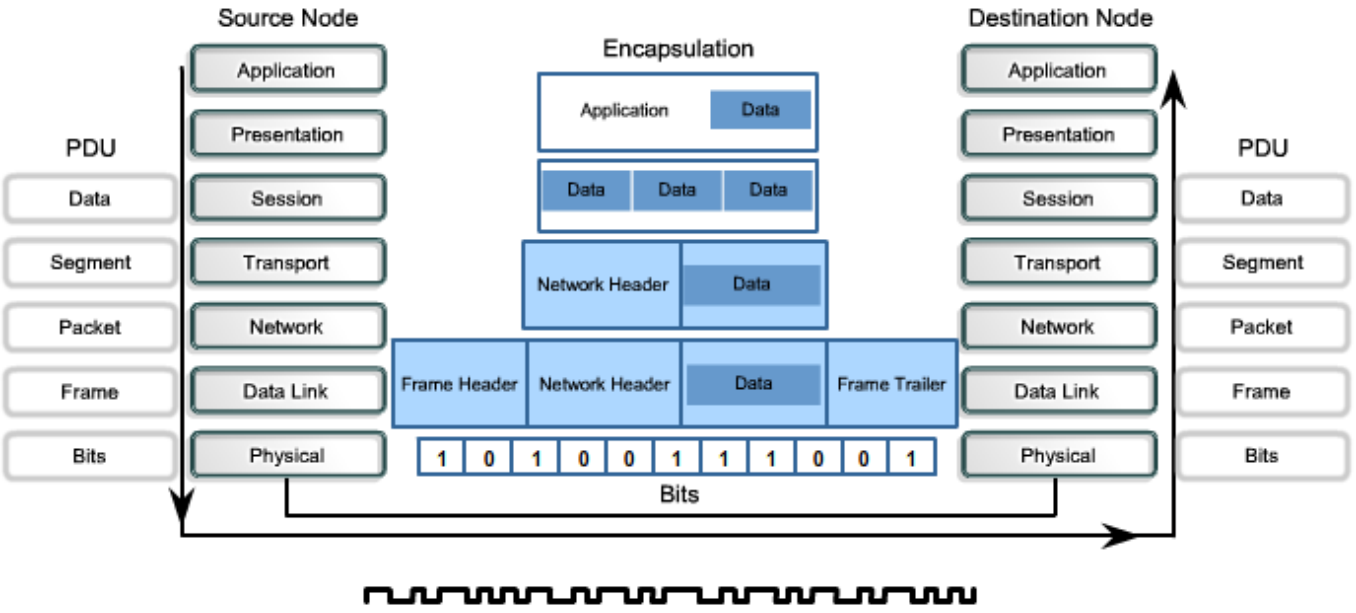
Connecting to the Wired LAN

Network Interface Cards

Connecting to the Wireless LAN with a Range Extender



The Physical Layer

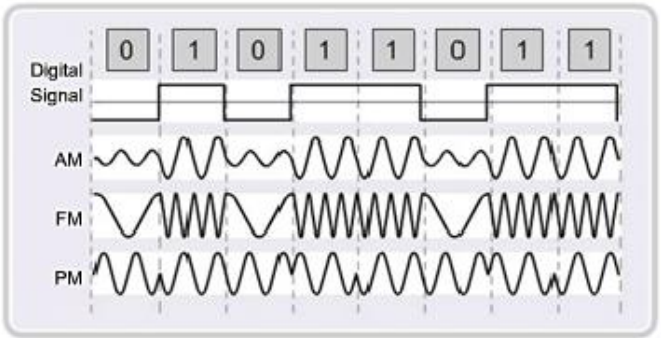


In diagrams, signals on the physical media are depicted by this line symbol.

Physical Layer Media

Sample electrical signals transmitted on copper cable

Representative light pulse fiber signals



Microwave (wireless) signals

Physical Layer Standards

Standard organization	Networking Standards
ISO	• ISO 8877: Officially adopted the RJ connectors (e.g., RJ-11, RJ-45) • ISO 11801: Network cabling standard similar to EIA/TIA 568.
EIA/TIA	• TIA-568-C: Telecommunications cabling standards, used by nearly all voice, video and data networks. • TIA-569-B: Commercial Building Standards for Telecommunications Pathways and Spaces • TIA-598-C: Fiber optic color coding • TIA-942: Telecommunications Infrastructure Standard for Data Centers
ANSI	• 568-C: RJ-45 pinouts. Co-developed with EIA/TIA
ITU-T	• G.992: ADSL
IEEE	• 802.3: Ethernet • 802.11: Wireless LAN (WLAN) & Mesh (Wi-Fi certification) • 802.15: Bluetooth

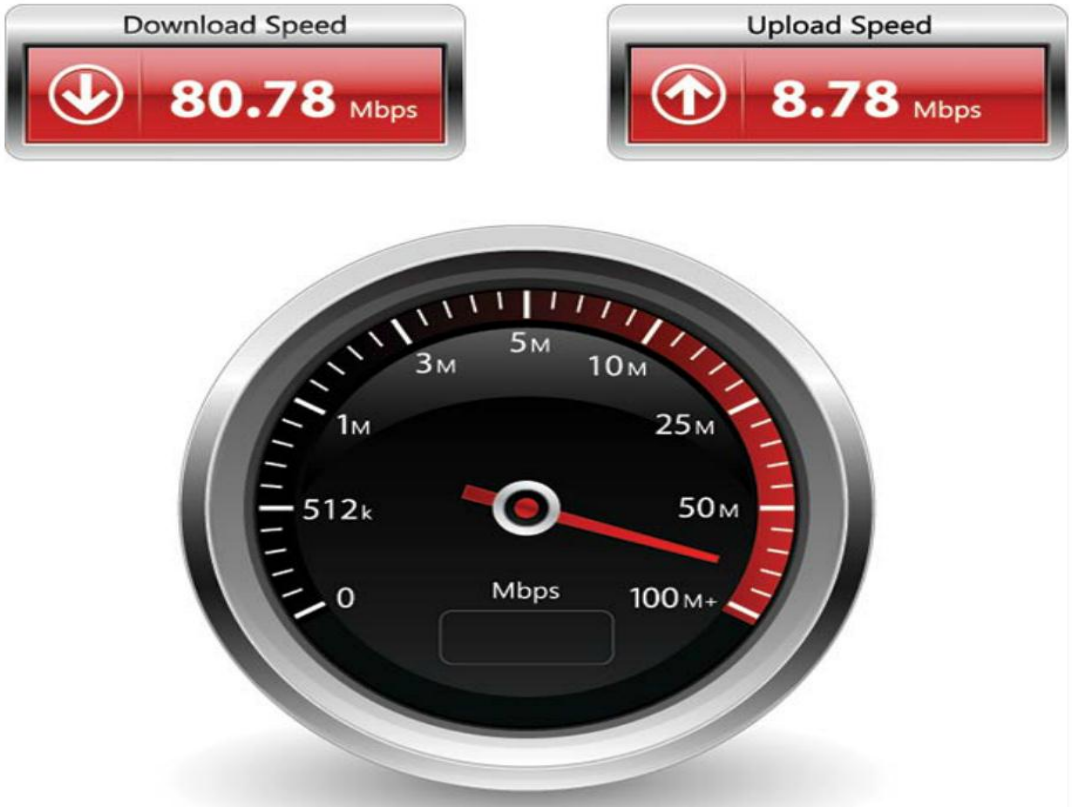
Physical Layer Fundamental Principles

Media	Physical Components	Frame Encoding Technique	Signalling Method
Copper cable	• UTP • Coaxial • Connectors • NICs • Ports • Interfaces	• Manchester Encoding • Non-Return to Zero (NRZ) techniques • 4B/5B codes are used with Multi-Level Transition Level 3 (MLT-3) signaling • 8B/10B • PAM5	• Changes in the electromagnetic field • Intensity of the electromagnetic field • Phase of the electromagnetic wave
Fiber Optic cable	• Single-mode Fiber • Multimode Fiber • Connectors • NICs • Interfaces • Lasers and LEDs • Photoreceptors	• Pulses of light • Wavelength multiplexing using different colors	• A pulse equals 1. • No pulse is 0.
Wireless media	• Access Points • NICs • Radio • Antennae	• DSSS (direct-sequence spread-spectrum) • OFDM (orthogonal frequency division multiplexing)	• Radio waves

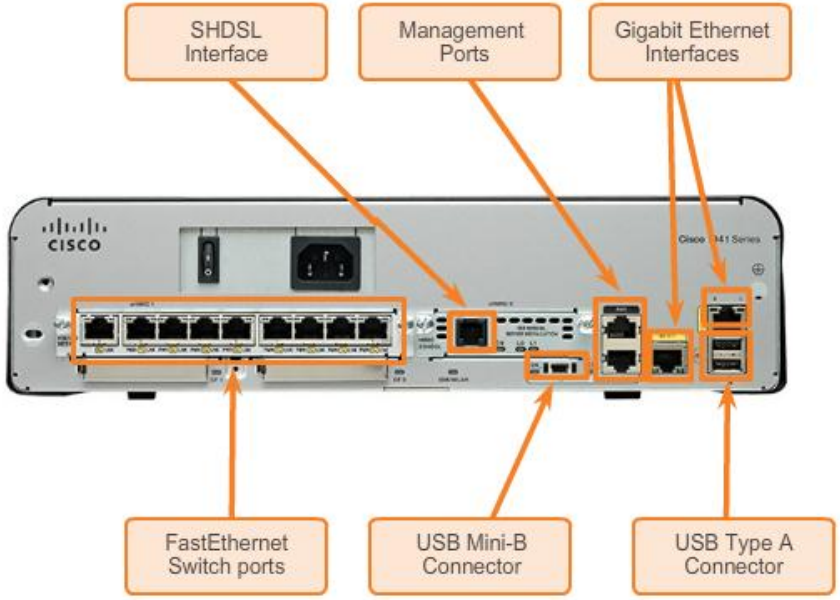
Bandwidth

Unit of Bandwidth	Abbreviation	Equivalence
Bits per second	bps	1 bps = fundamental unit of bandwidth
Kilobits per second	kbps	1 kbps = 1,000 bps = 10^3 bps
Megabits per second	Mbps	1 Mbps = 1,000,000 bps = 10^6 bps
Gigabits per second	Gbps	1 Gbps = 1,000,000,000 bps = 10^9 bps
Terabits per second	Tbps	1 Tbps = 1,000,000,000,000 bps = 10^12 bps

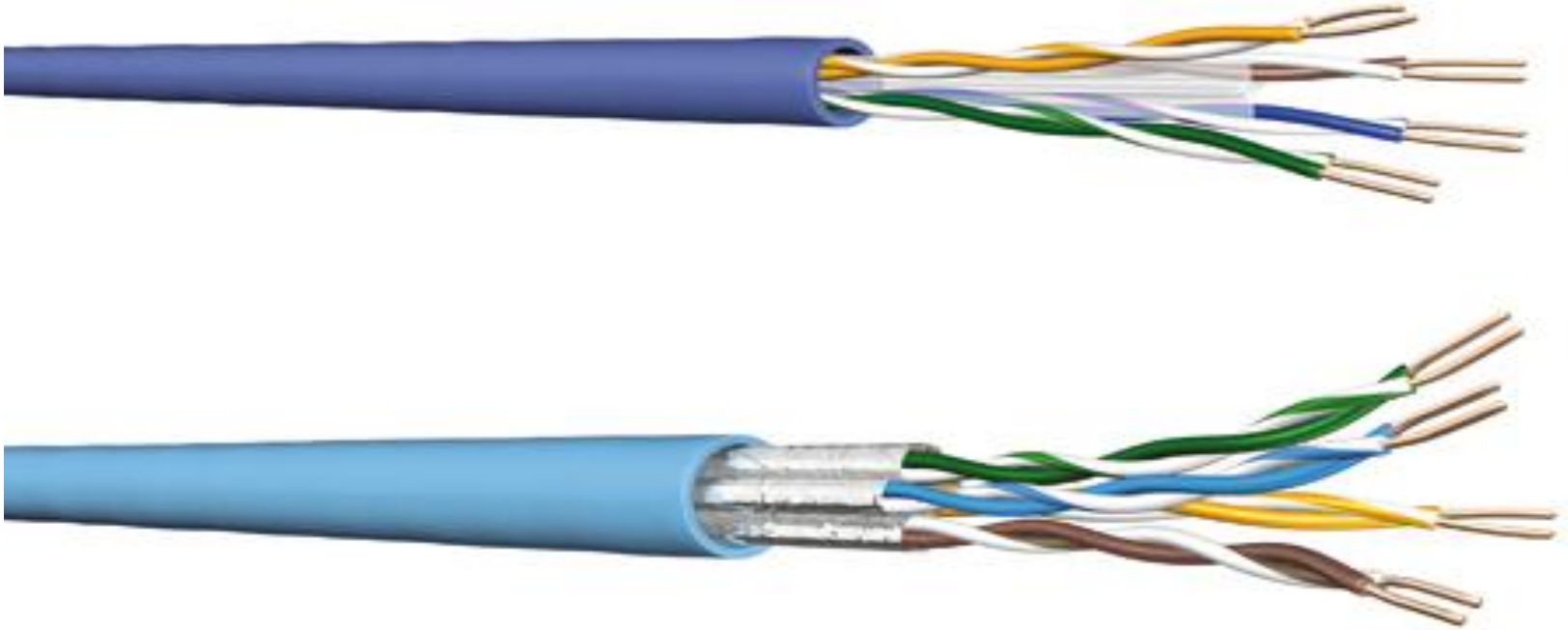
Throughput


Download Speed
80.78 Mbps
Upload Speed
8.78 Mbps
1M
3M
5M
10M
25M
50M
100M+
512k
0
Mbps

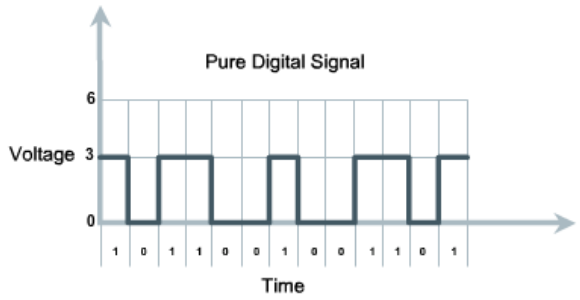
Types of Physical Media

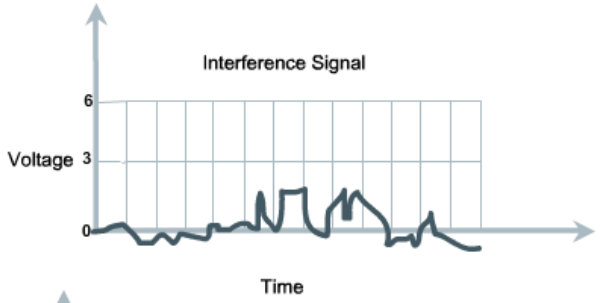


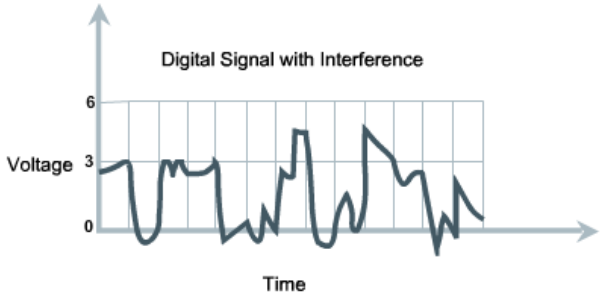
Copper Cabling

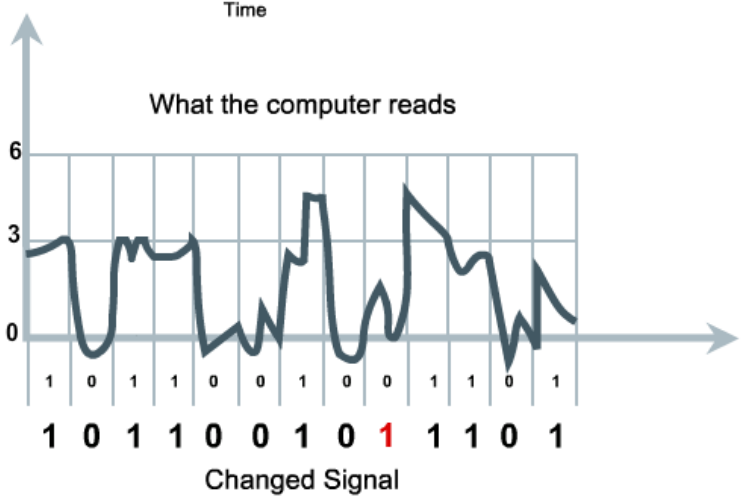


Characteristics of Copper Media

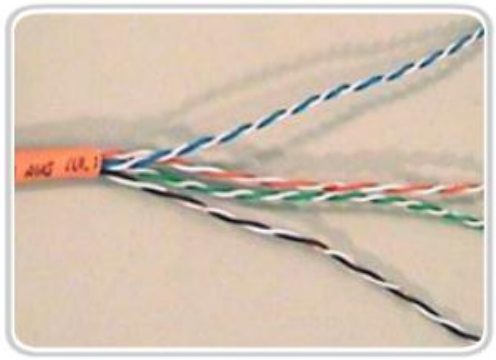




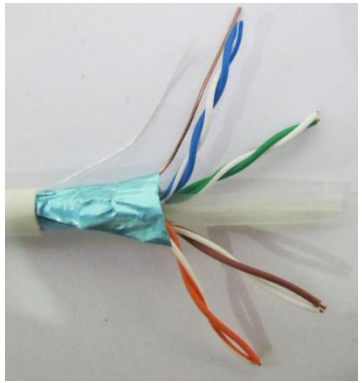




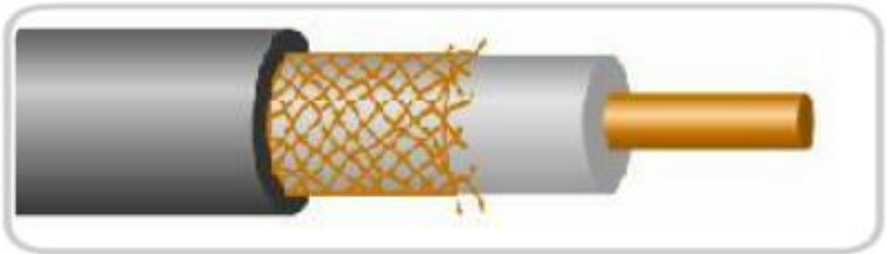
Copper Media



Unshielded Twisted Pair (UTP) cable

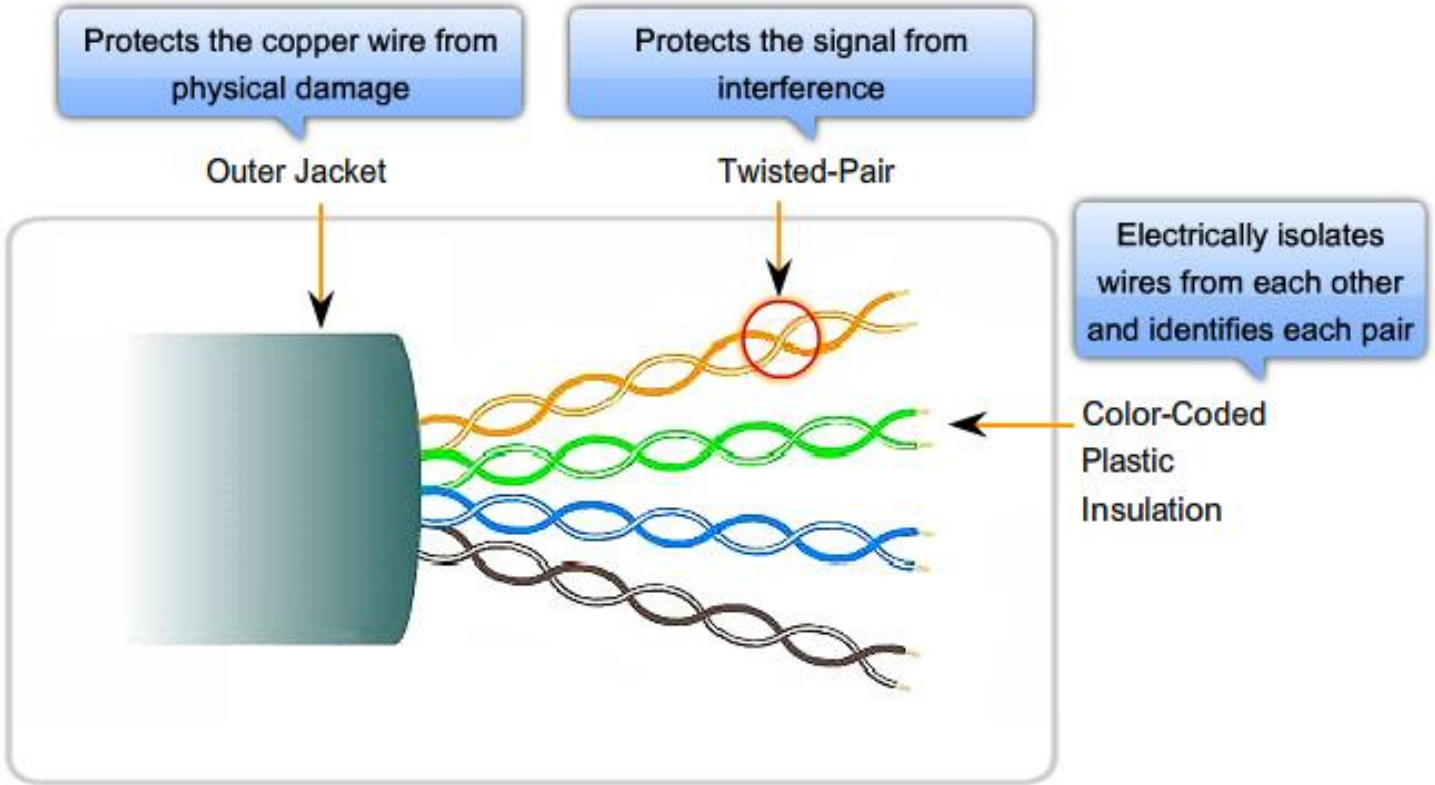


Shielded Twisted Pair (STP) cable

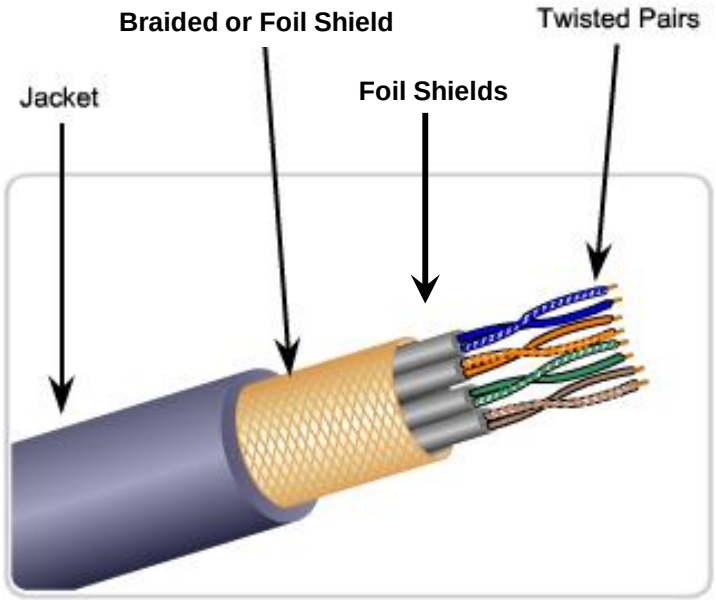


Coaxial cable

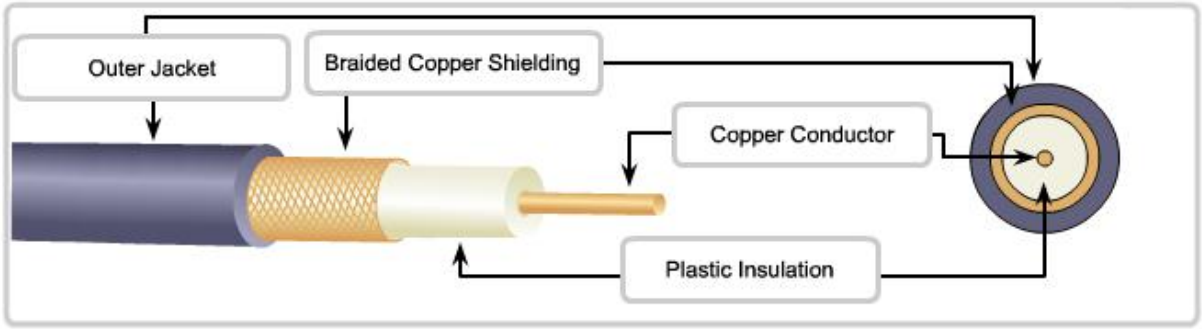
Unshielded Twisted-Pair (UTP) Cable



Shielded Twisted-Pair (STP) Cable



Coaxial Cable



Cooper Media Safety

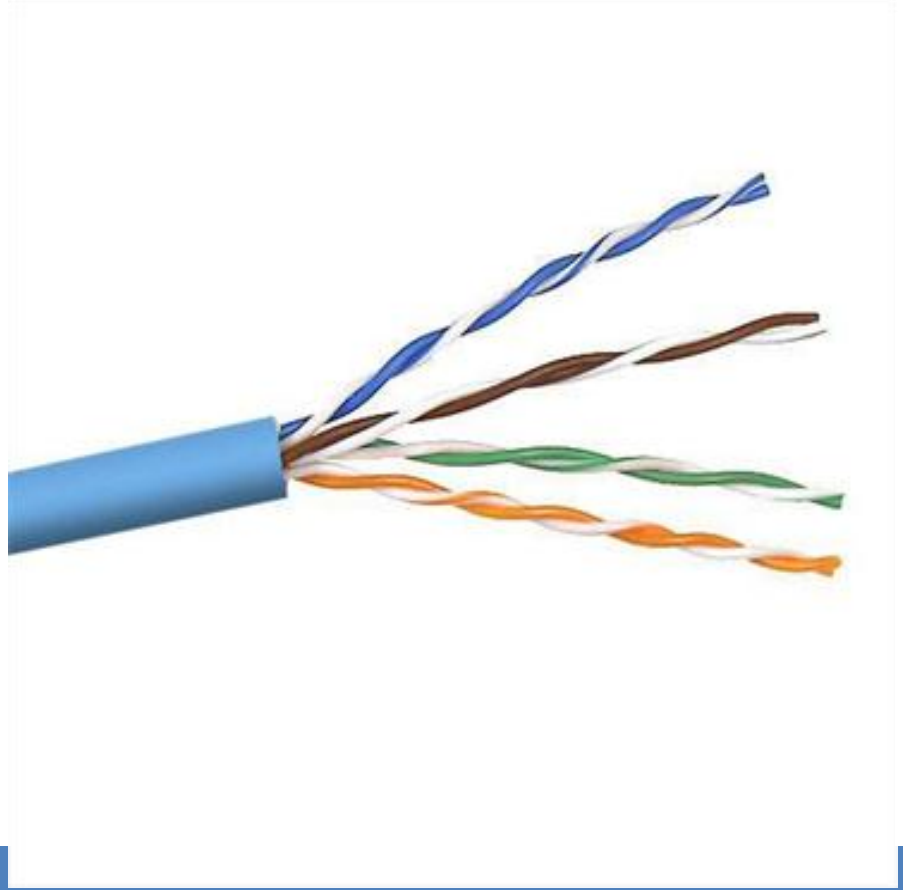
The separation of data and electrical power cabling must comply with safety codes.

Cables must be connected correctly.

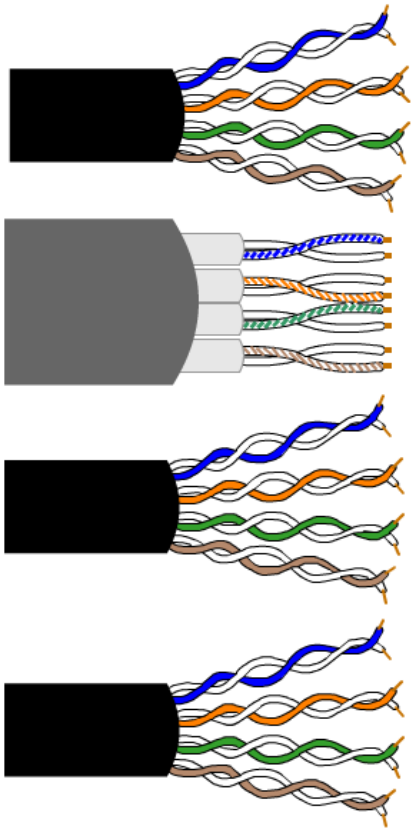
Installations must be inspected for damage.

Equipment must be grounded correctly.

Properties of UTP Cabling



UTP Cabling Standards



Category 3 Cable (UTP)

Category 7 Cable (ScTP)

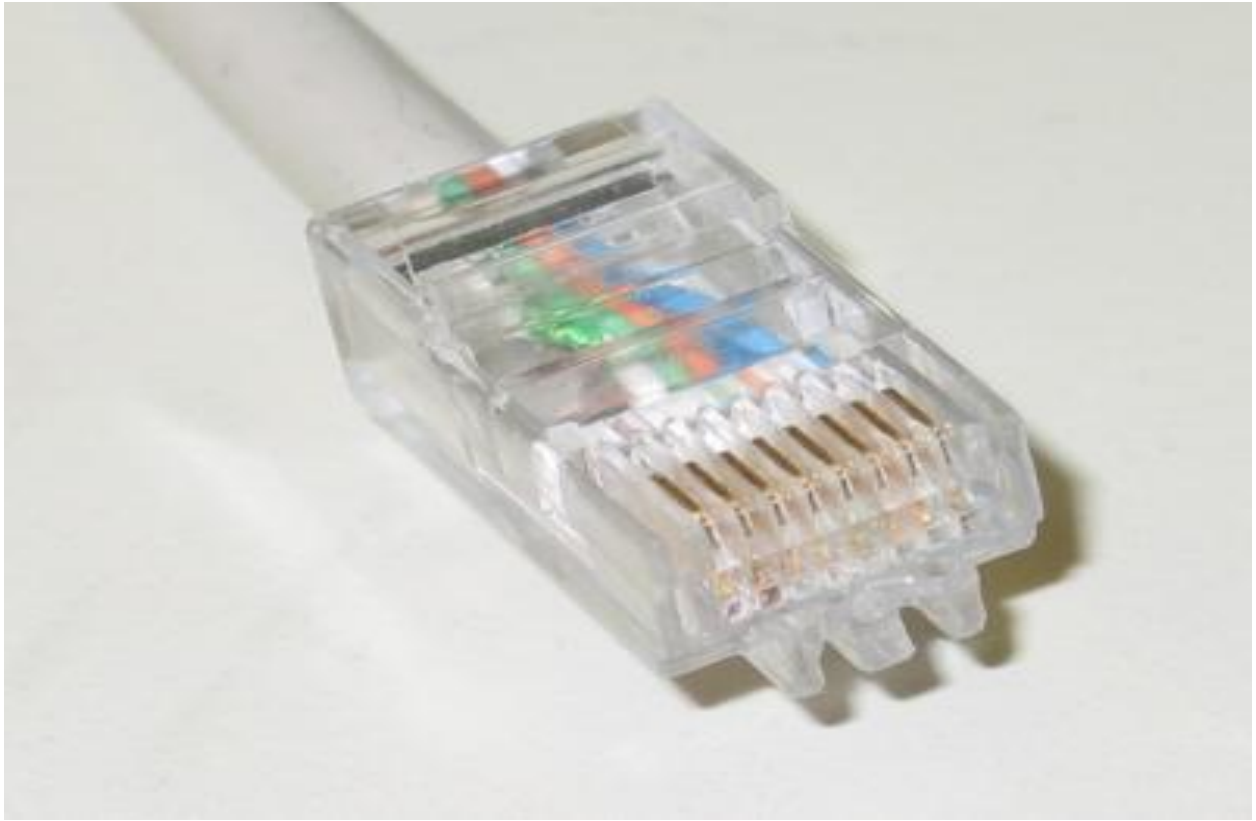
Category 6 Cable (UTP)

Category 5 and 5e Cable (UTP)

Category 5 and 5e Cable (UTP)

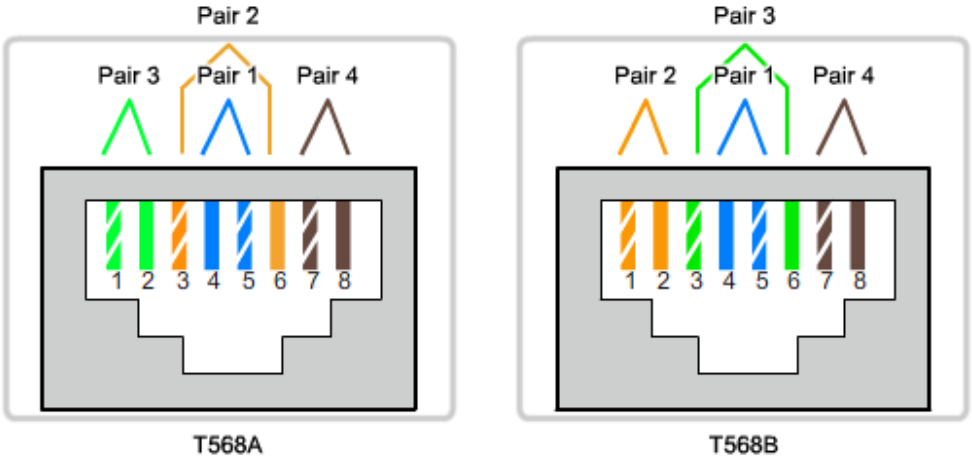
- Used for Data transmission
- Cat 5 supports 100 Mbps and can support 1000 Mbps but it is not recommended
- Cat 5e supports 1000 Mbps

UTP Connectors

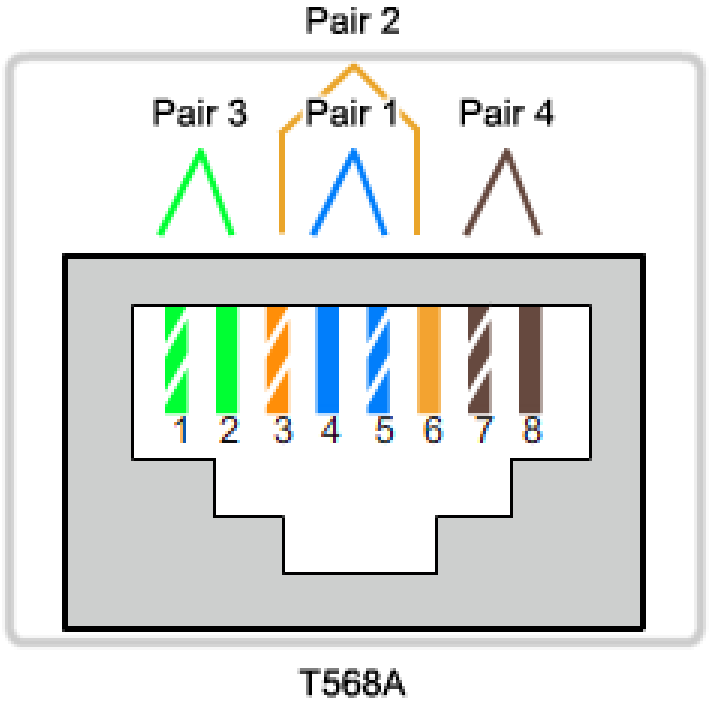


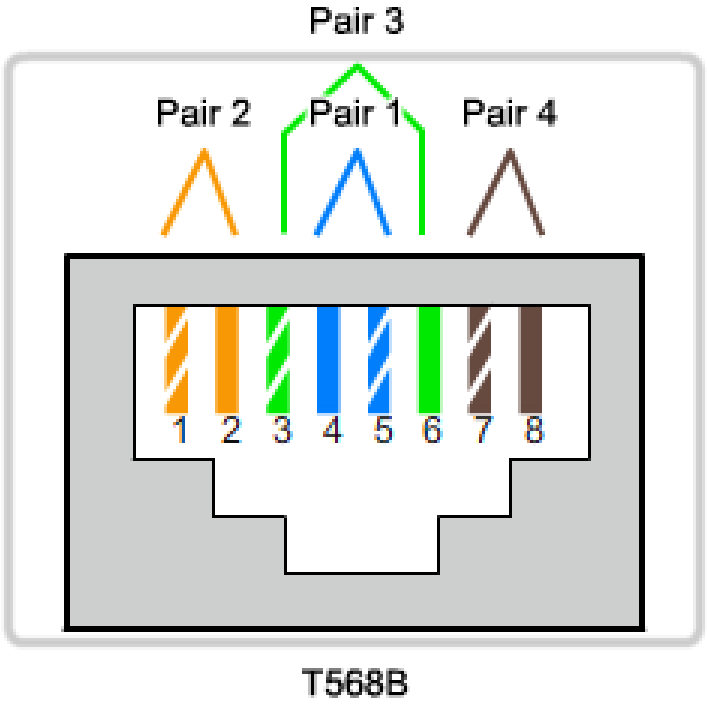
Types of UTP Cable

Cable Type	Standard	Application
Ethernet Straight-through	Both ends T568A or both ends T568B	Connecting a network host to a network device such as a switch or hub.
Ethernet Crossover	One end T568A, other end T568B	Connecting two network hosts. Connecting two network intermediary devices (switch to switch, or router to router).
Rollover	Cisco proprietary	Connect a workstation serial port to a router console port, using an adapter.



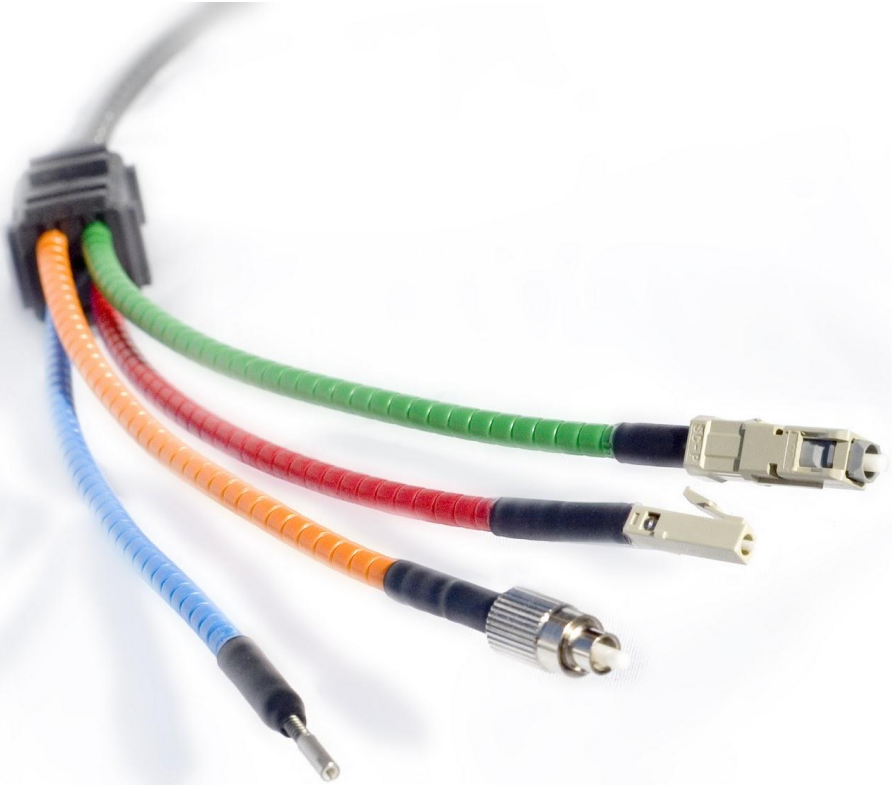
Types of UTP Cable



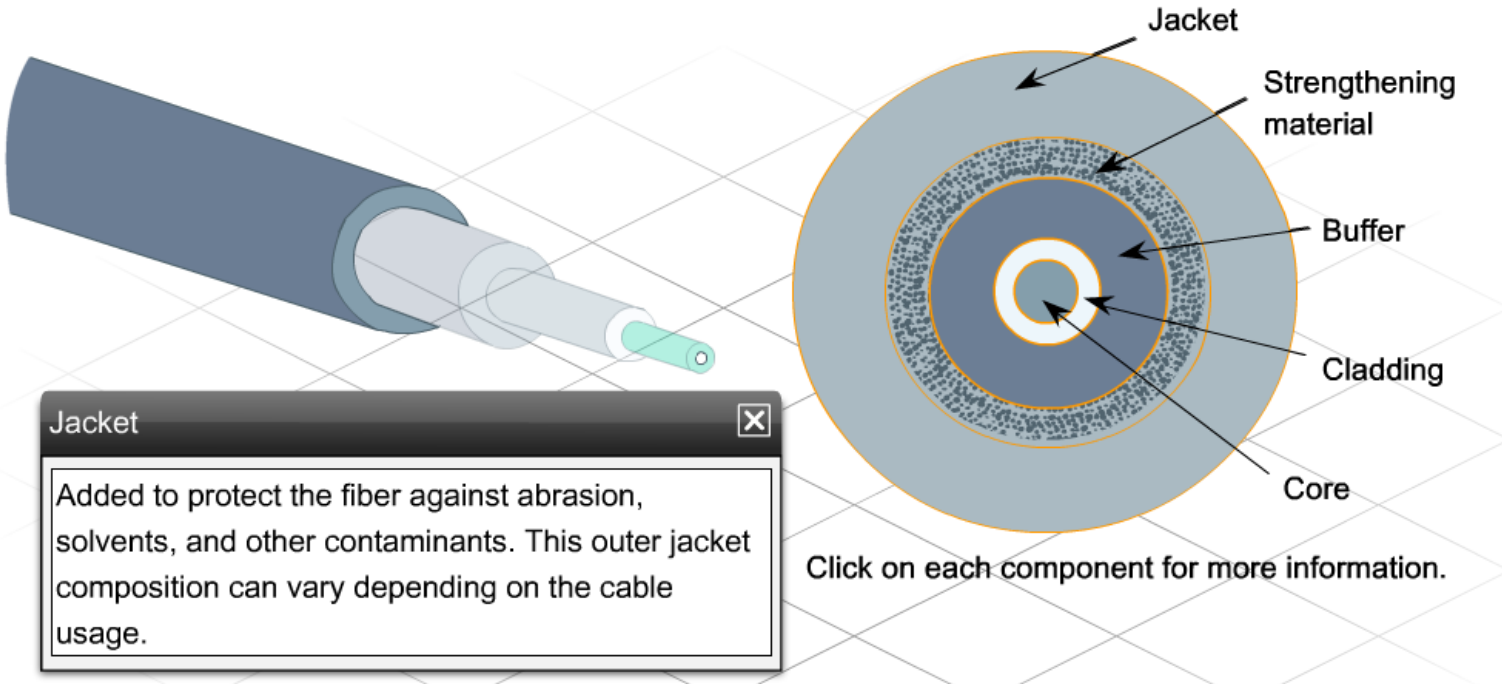


Testing UTP Cables

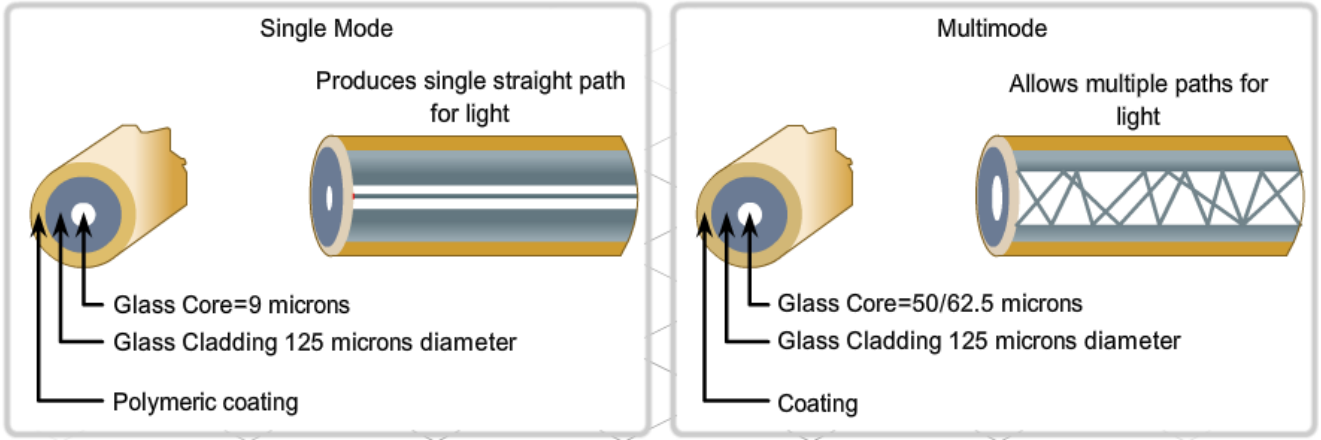
Properties of Fiber Optic Cabling



Fiber Media Cable Design



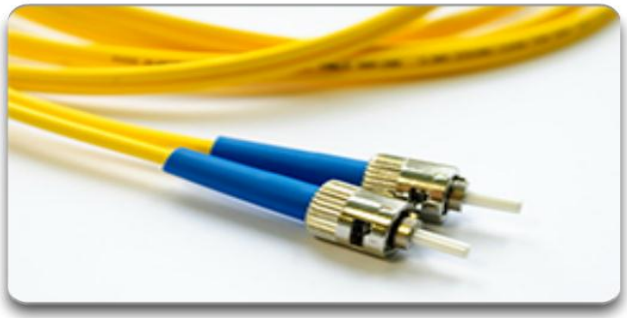
Types of Fiber Media



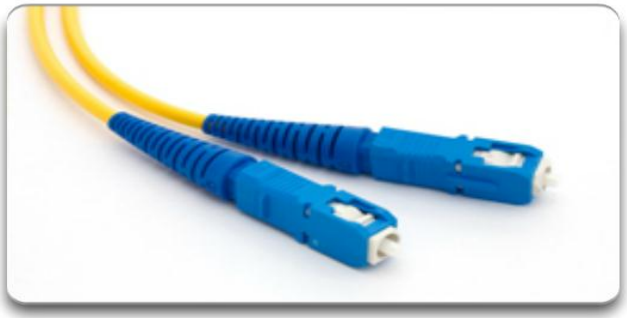
- Small Core
- Less Dispersion
- Suited for long distance applications
- Uses lasers as the light source
- Commonly used with campus backbones for distances of several thousand meters

- Larger core than single mode cable
- Allows greater dispersion and therefore, loss of signal
- Suited for long distance applications, but shorter than single mode
- Uses LEDs as the light source
- Commonly used with LANs or distances of a couple hundred meters within a campus network

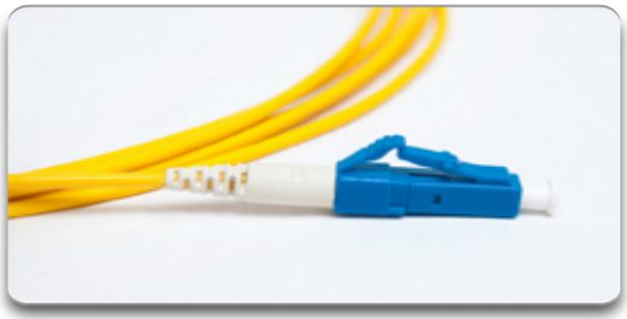
Network Fiber Connectors



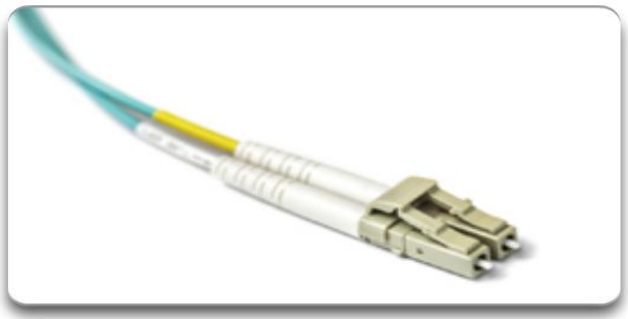
ST Connectors



SC Connectors



LC Connector



Duplex Multimode LC Connectors

Testing Fiber Cables

Optical Time Domain Reflectometer (OTDR)

Fiber versus Copper

Implementation issues	Copper media	Fibre-optic
Bandwidth supported	10 Mbps – 10 Gbps	10 Mbps – 100 Gbps
Distance	Relatively short (1 – 100 meters)	Relatively High (1 – 100,000 meters)
Immunity to EMI and RFI	Low	High (Completely immune)
Immunity to electrical hazards	Low	High (Completely immune)
Media and connector costs	Lowest	Highest
Installation skills required	Lowest	Highest
Safety precautions	Lowest	Highest

Properties of Wireless Media

Types of Wireless Media

	• IEEE 802.11 standards
	• Commonly referred to as Wi-Fi.
	• Uses CSMA/CA
	• Variations include:
	  • 802.11a: 54 Mbps, 5 GHz
	  • 802.11b: 11 Mbps, 2.4 GHz
	  • 802.11g: 54 Mbps, 2.4 GHz
	  • 802.11n: 600 Mbps, 2.4 and 5 GHz
	  • 802.11ac: 1 Gbps, 5 GHz
	  • 802.11ad: 7 Gbps, 2.4 GHz, 5 GHz, and 60 GHz

	• IEEE 802.15 standard • Supports speeds up to 3 Mbps • Provides device pairing over distances from 1 to 100 meters.
	• IEEE 802.16 standard • Provides speeds up to 1 Gbps • Uses a point-to-multipoint topology to provide wireless broadband access.

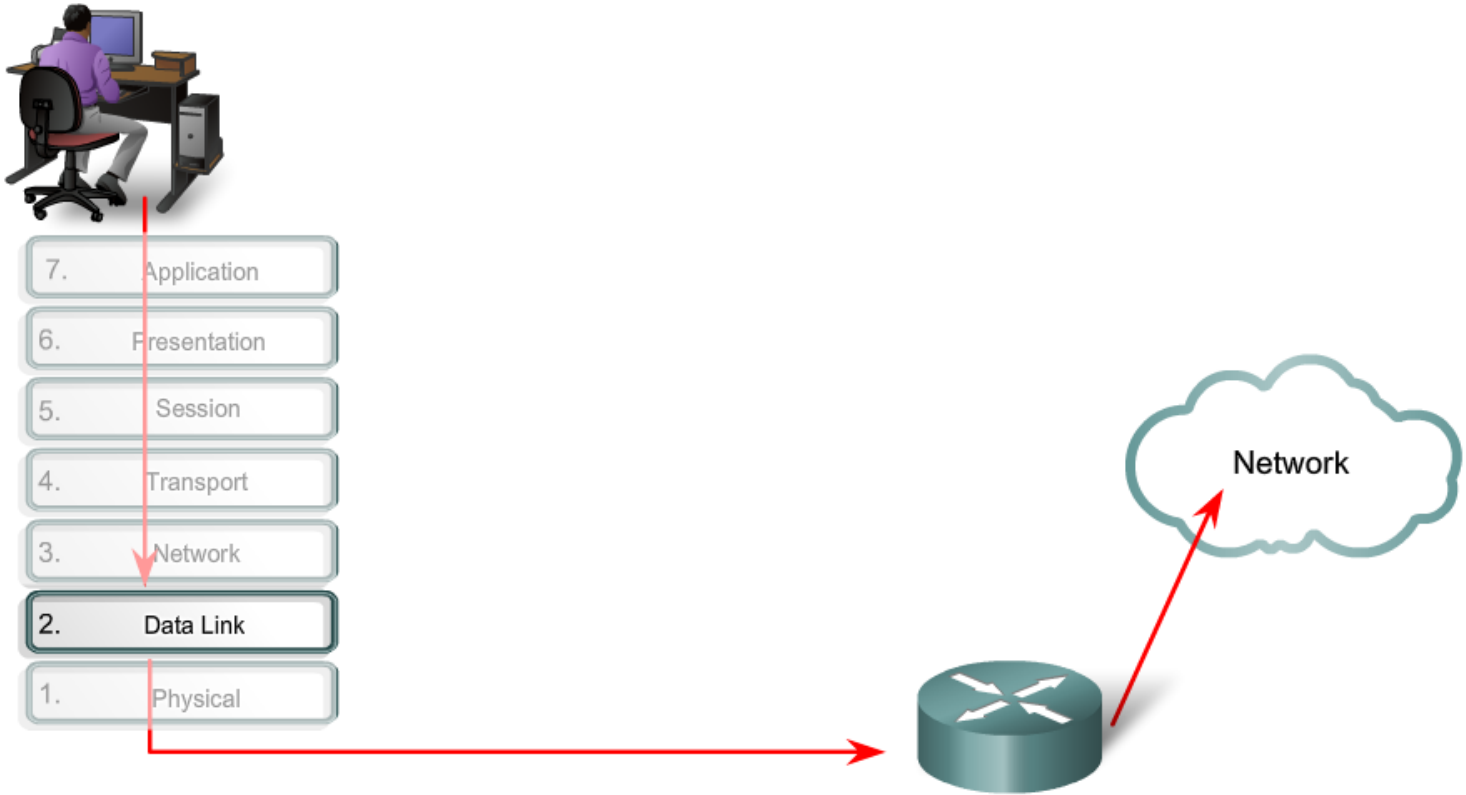
Wireless LAN

Cisco Linksys EA6500 802.11ac wireless router

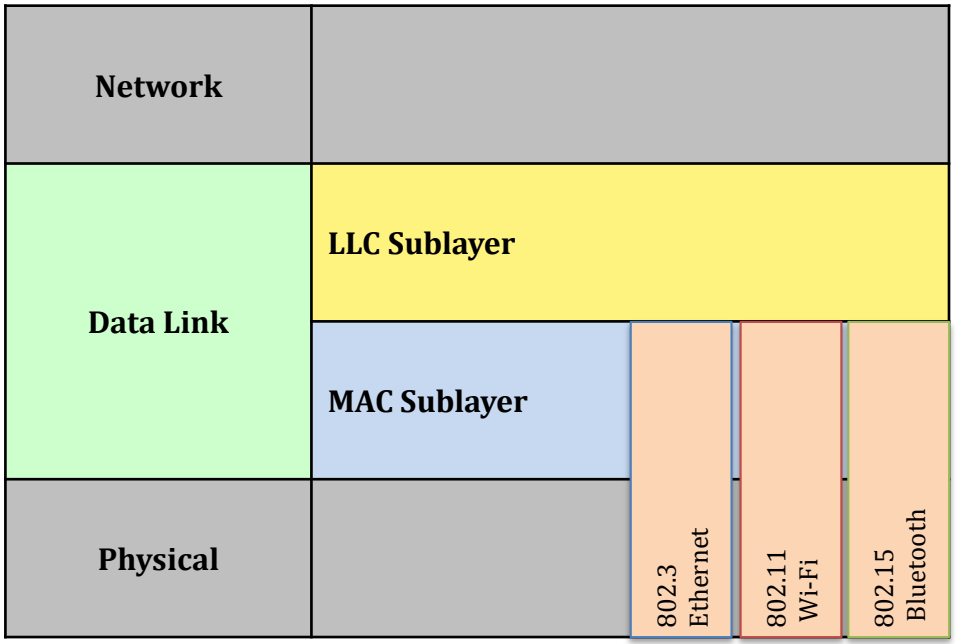
802.11 Wi-Fi Standards

Standard	Maximum Speed	Frequency	Backwards compatible
802.11a	54 Mbps	5 GHz	No
802.11b	11 Mbps	2.4 GHz	No
802.11g	54 Mbps	2.4 GHz	802.11b
802.11n	600 Mbps	2.4 GHz or 5 GHz	802.11b/g
802.11ac	1.3 Gbps (1300 Mbps)	2.4 GHz and 5.5 GHz	802.11b/g/n
802.11ad	7 Gbps (7000 Mbps)	2.4 GHz, 5 GHz and 60 GHz	802.11b/g/n/ac

The Data Link Layer



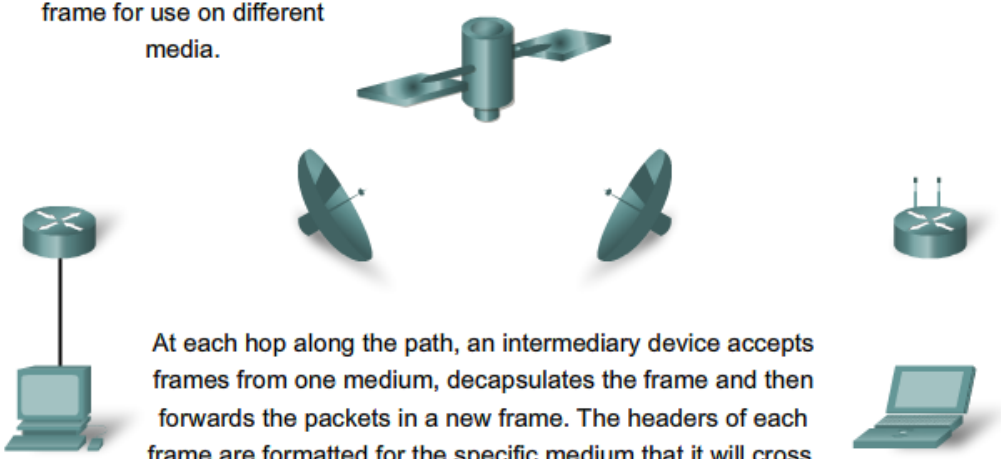
Data Link Sublayers



Media Access Control

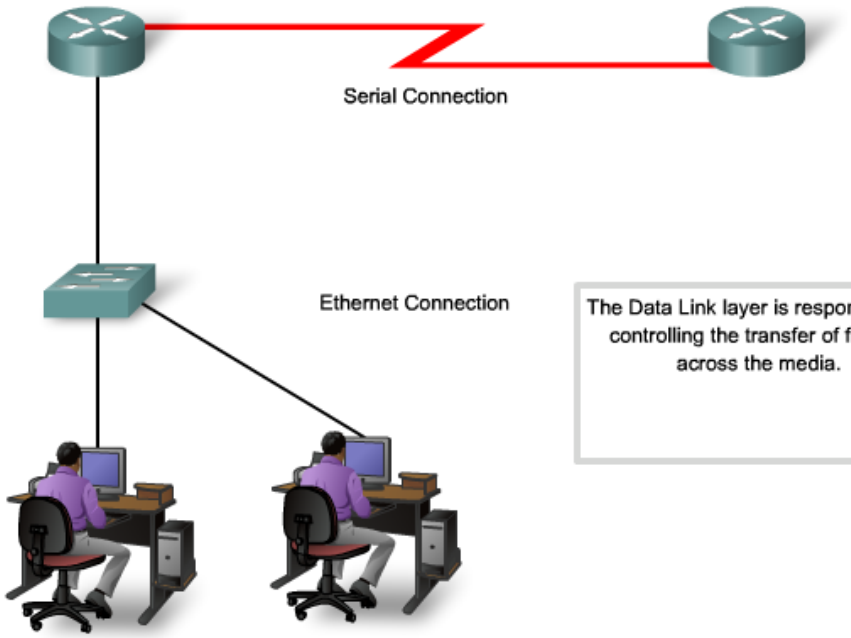
Data link layer protocols govern how to format a frame for use on different media.

Different protocols may be in use for different media.



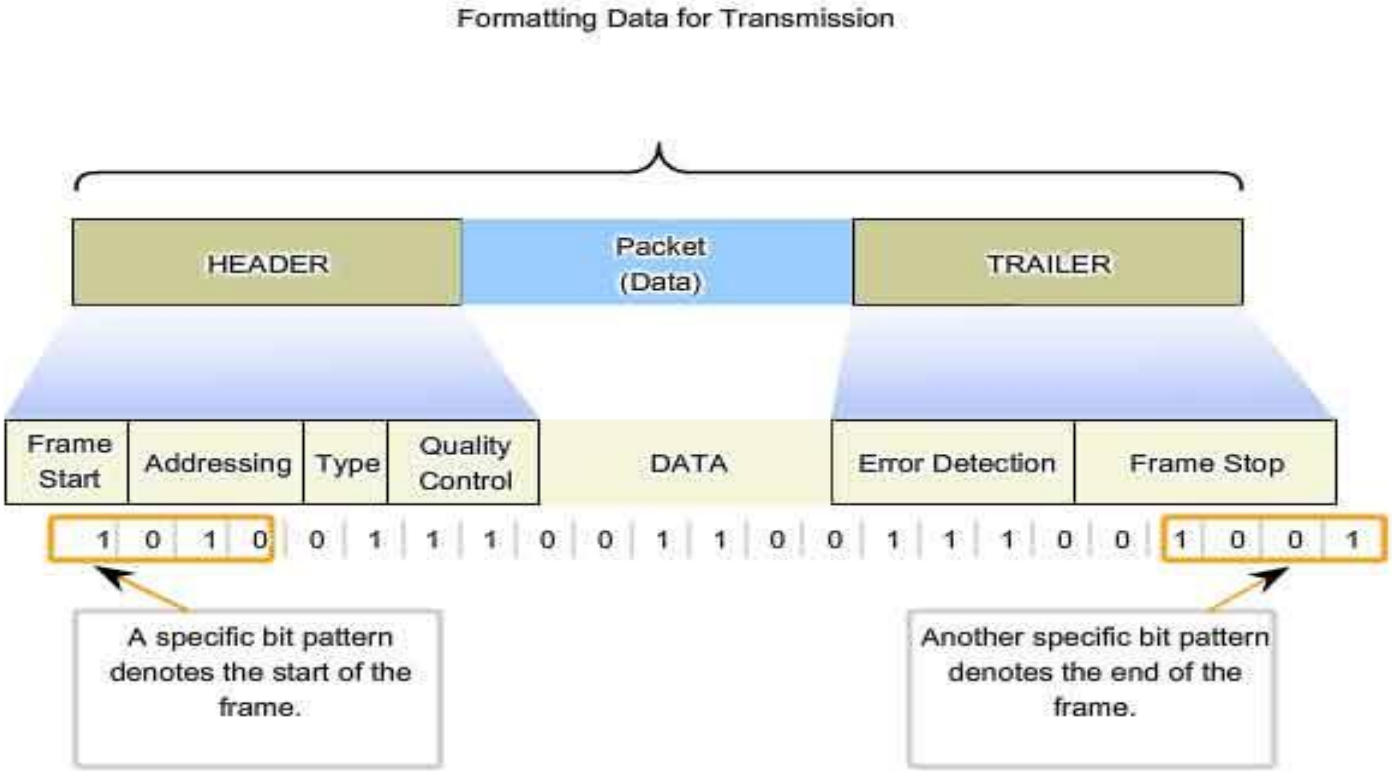
At each hop along the path, an intermediary device accepts frames from one medium, decapsulates the frame and then forwards the packets in a new frame. The headers of each frame are formatted for the specific medium that it will cross.

Providing Access to Media

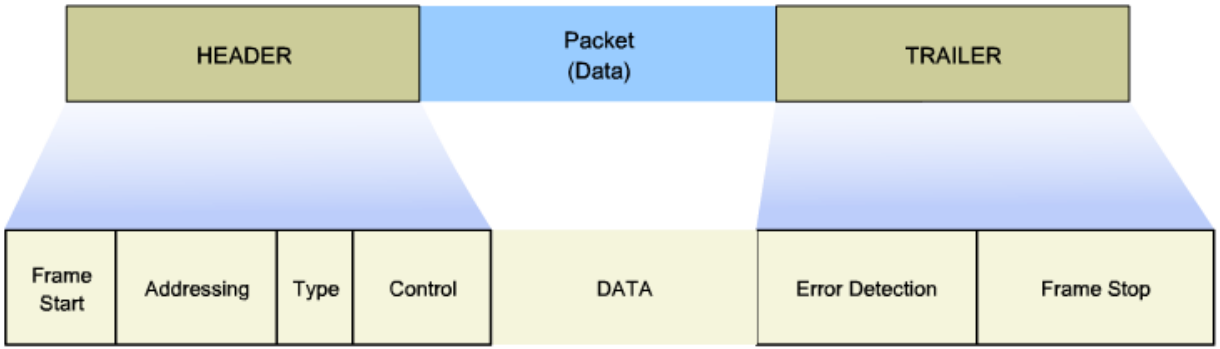


The Data Link layer is responsible for controlling the transfer of frames across the media.

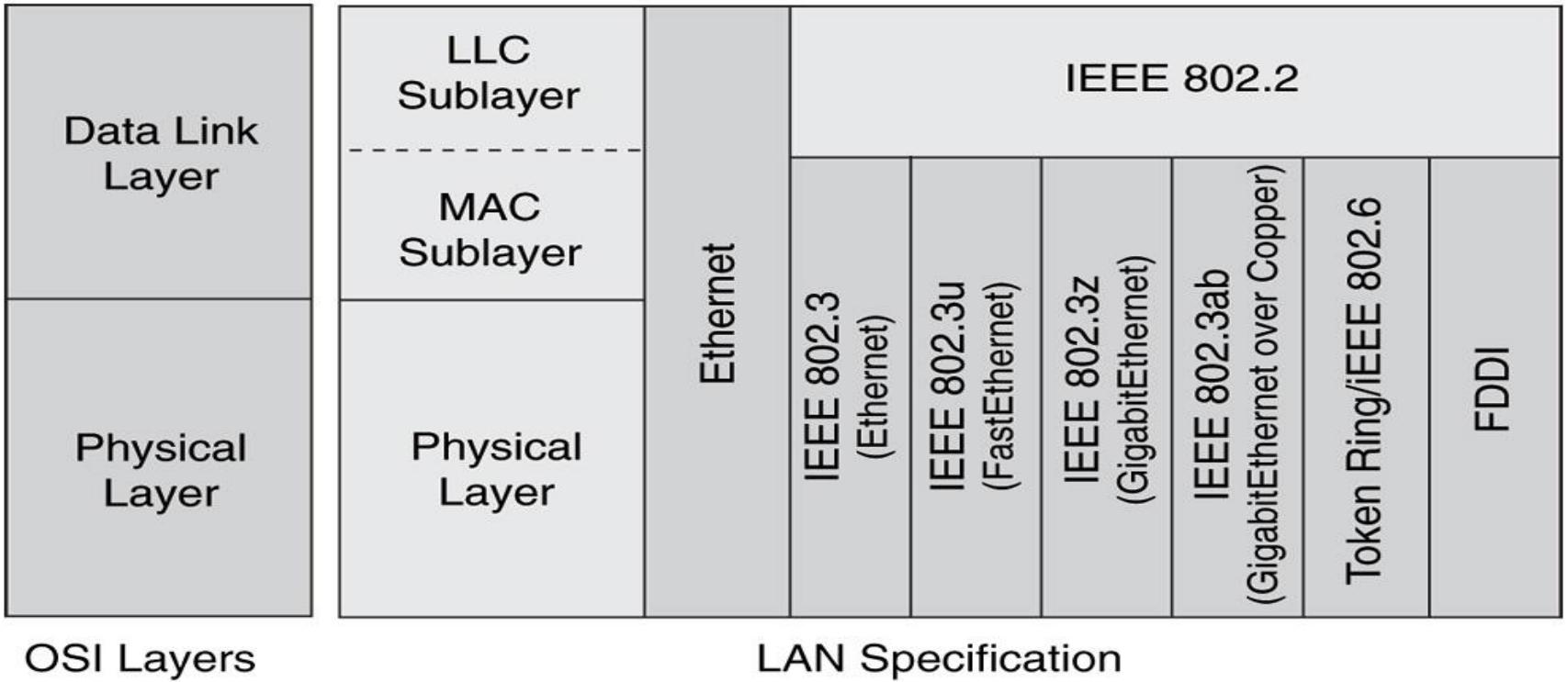
Layer 2 Frame Structure



Creating a Frame



Layer 2 Standards

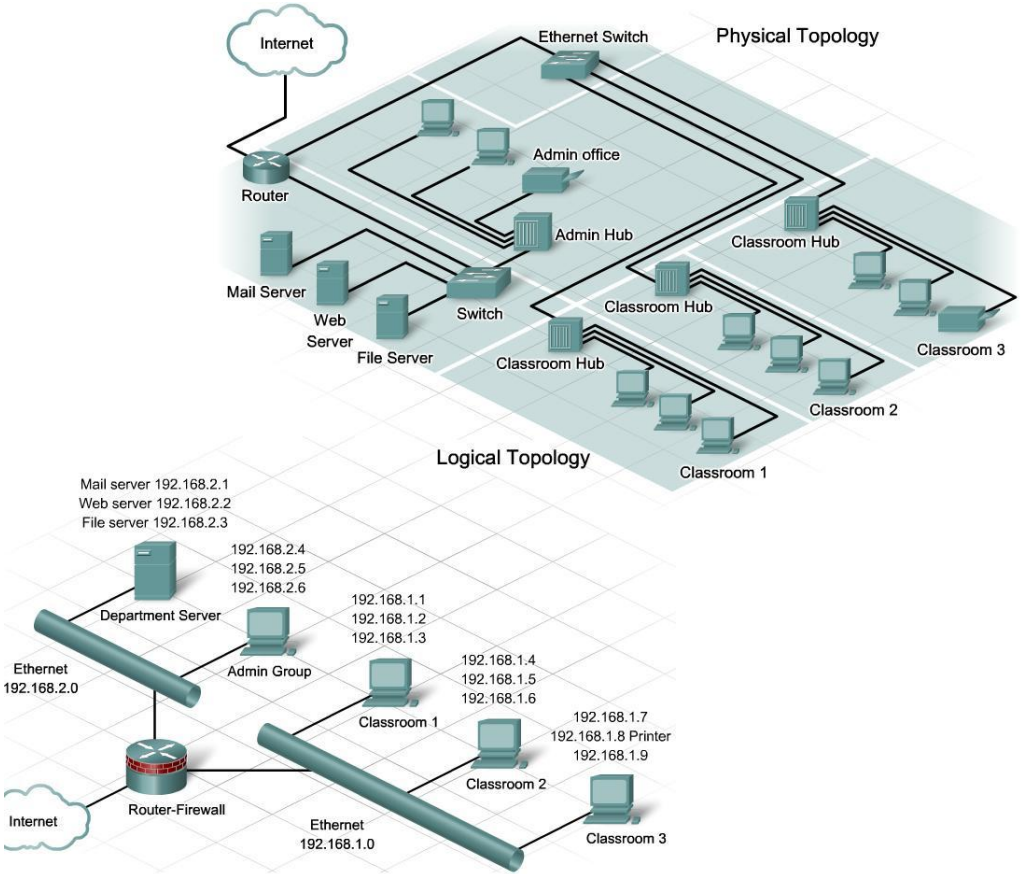


Data Link Layer Standards

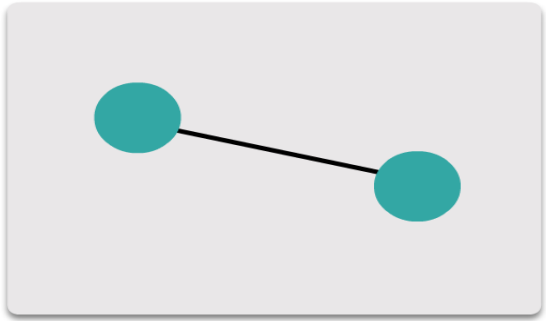
Standard organization	Networking Standards
IEEE	• 802.2: Logical Link Control (LLC) • 802.3: Ethernet • 802.4: Token bus • 802.5: Token passing • 802.11: Wireless LAN (WLAN) & Mesh (Wi-Fi certification) • 802.15: Bluetooth • 802.16: WiMax
ITU-T	• G.992: ADSL • G.8100 - G.8199: MPLS over Transport aspects • Q.921: ISDN • Q.922: Frame Relay
ISO	• HDLC (High Level Data Link Control) • ISO 9314: FDDI Media Access Control (MAC)
ANSI	• X3T9.5 and X3T12: Fiber Distributed Data Interface (FDDI)

Controlling Access to the Media

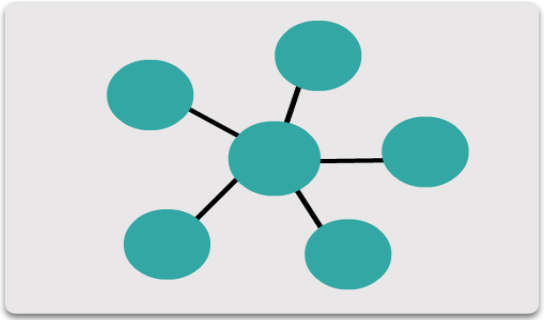
Physical and Logical Topologies



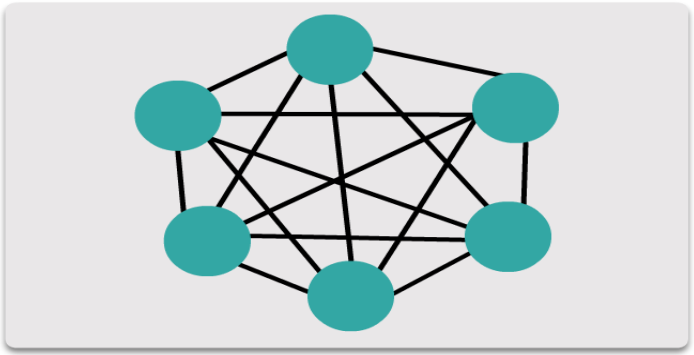
Common Physical WAN Topologies



Point-to-point topology

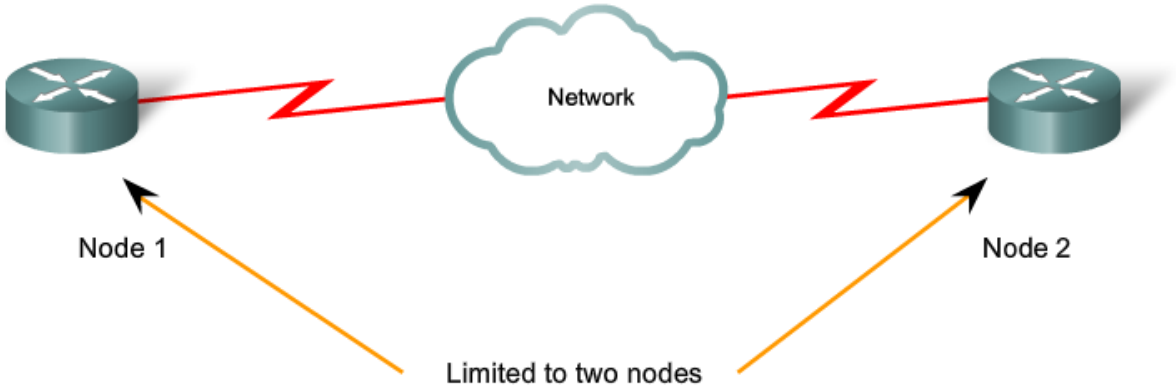


Hub and spoke topology



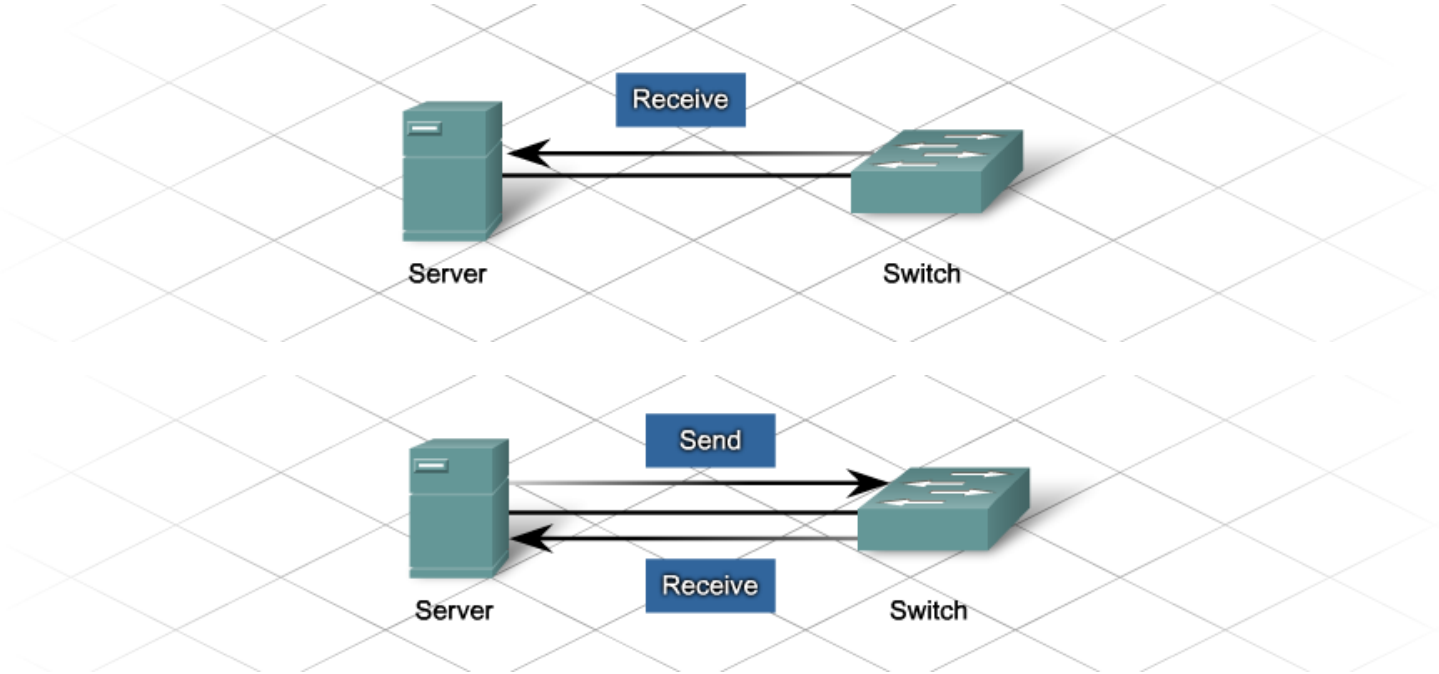
Full mesh topology

Physical Point-to-Point Topology

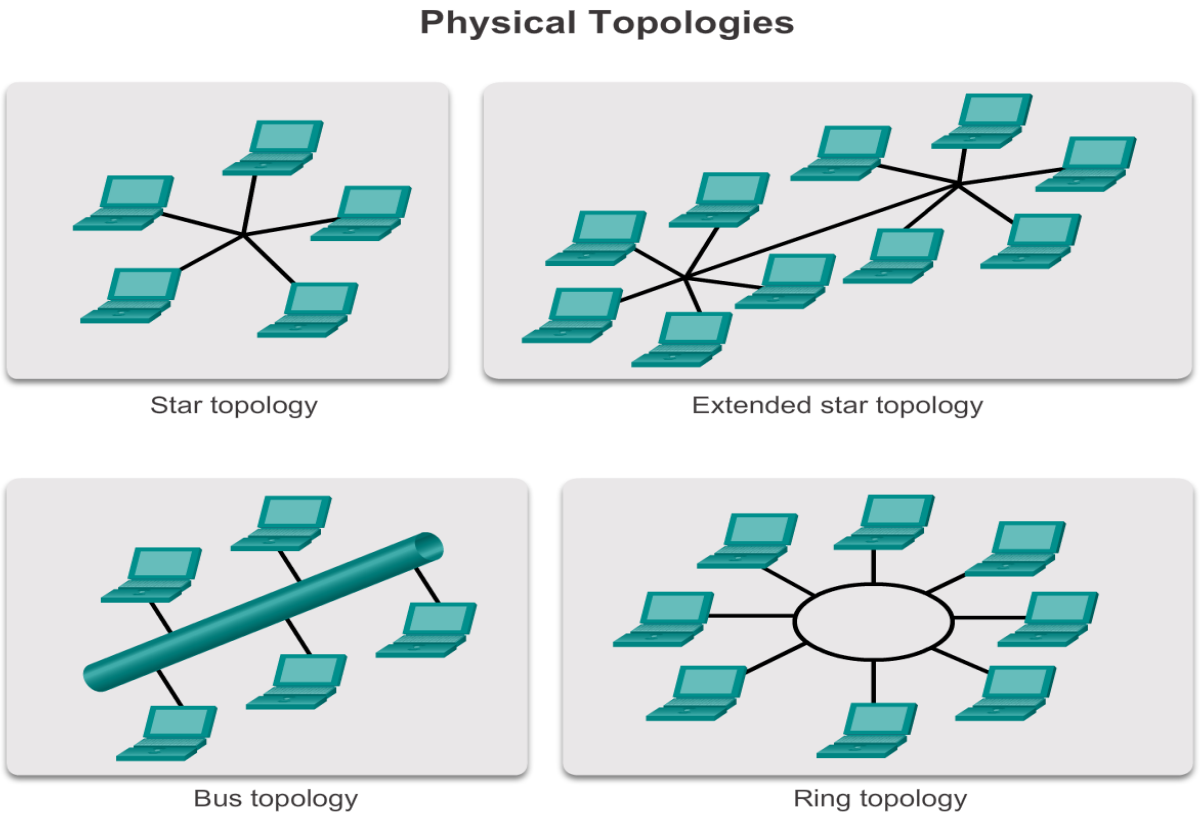


Logical Point-to-Point Topology

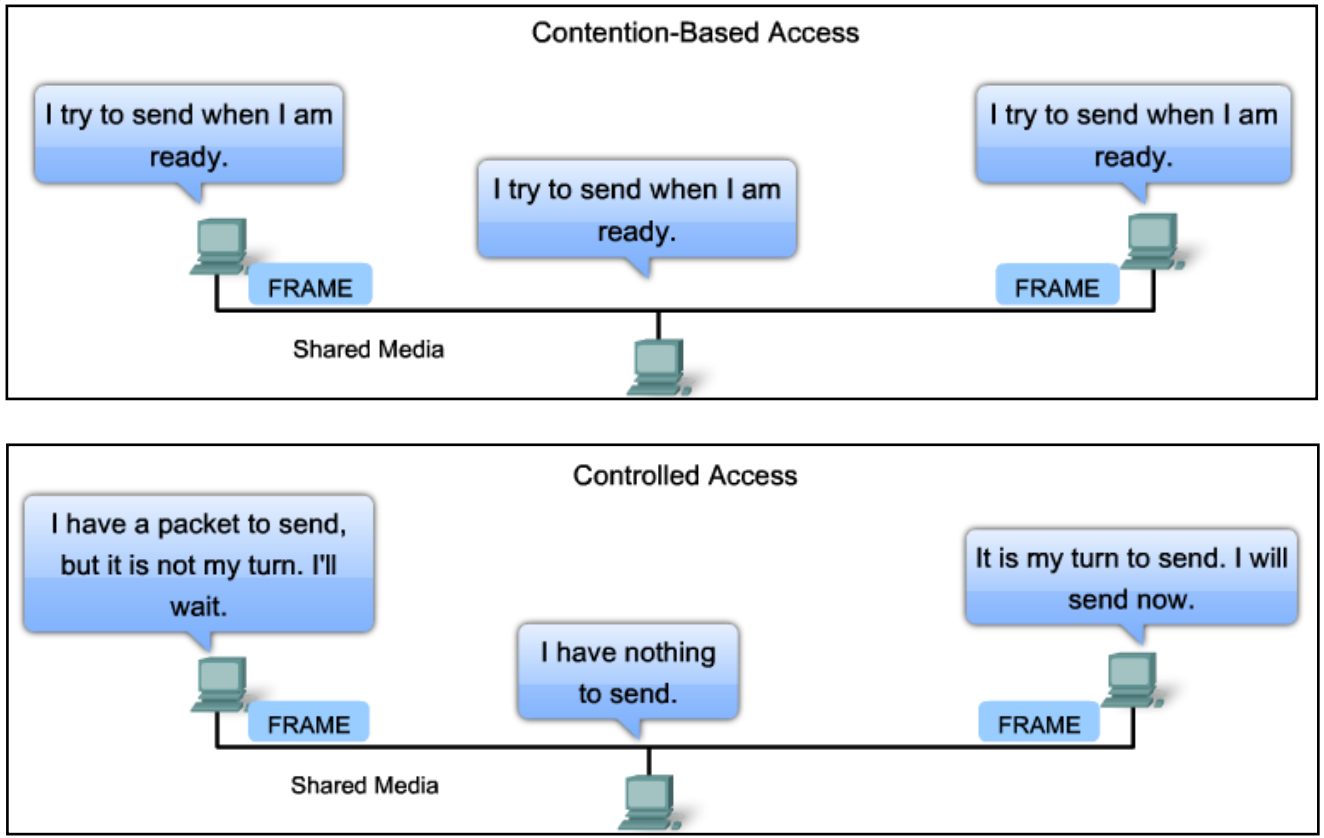
Half and Full Duplex



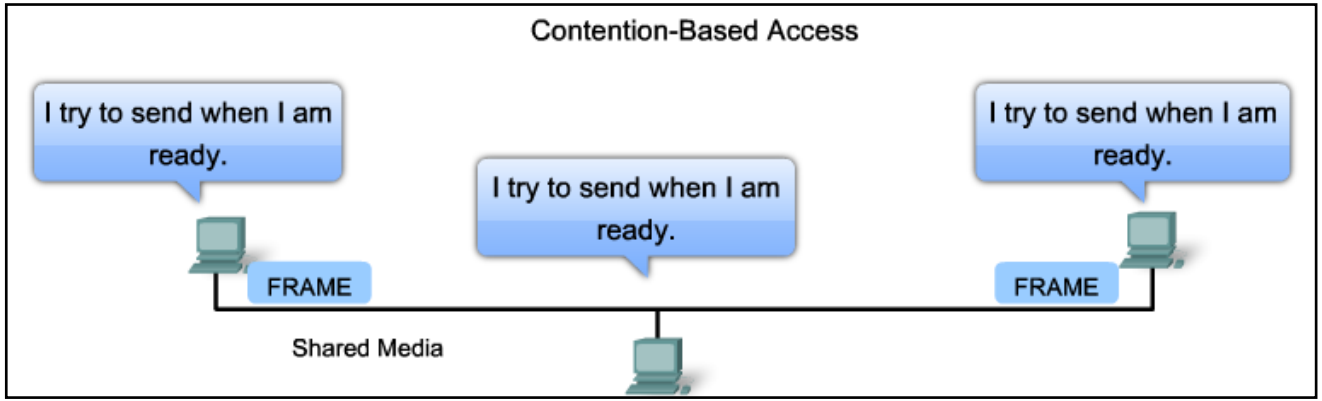
Physical LAN Topologies



Logical Topology for Shared Media

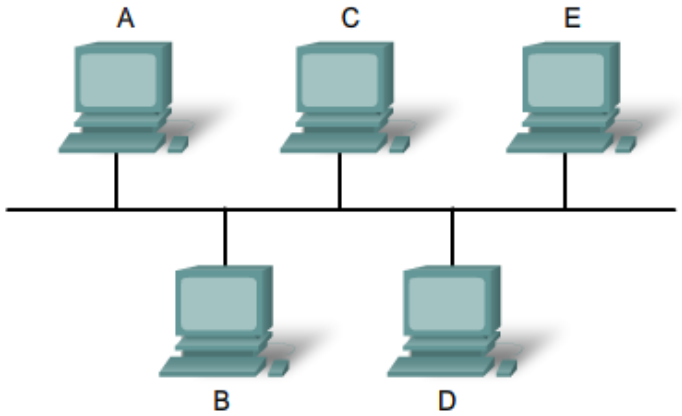


Contention-Based Access

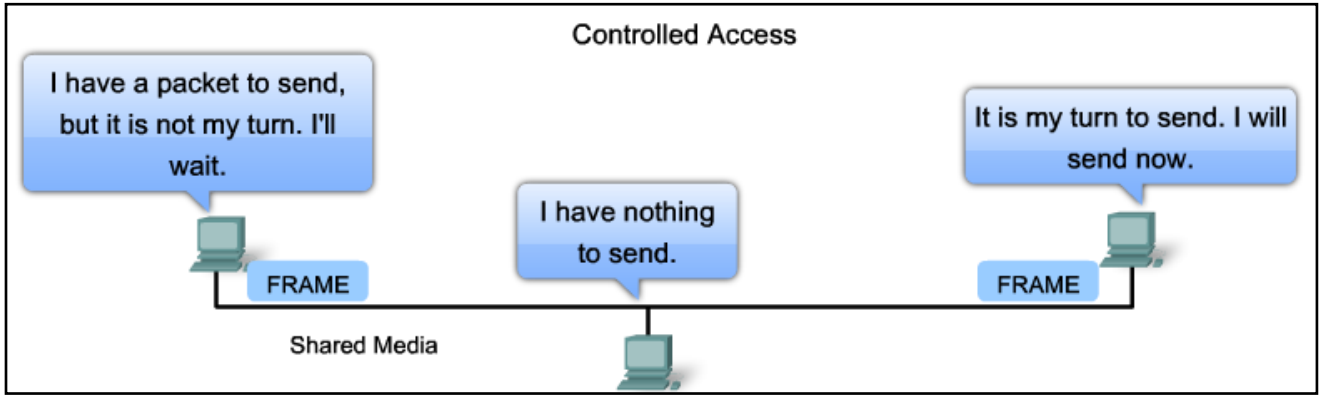


Characteristics	Contention-Based Technologies
• Stations can transmit at any time • Collision exist • There are mechanisms to resolve contention for the media	• CSMA/CD for 802.3 Ethernet networks • CSMA/CA for 802.11 wireless networks

Multi-Access Topology

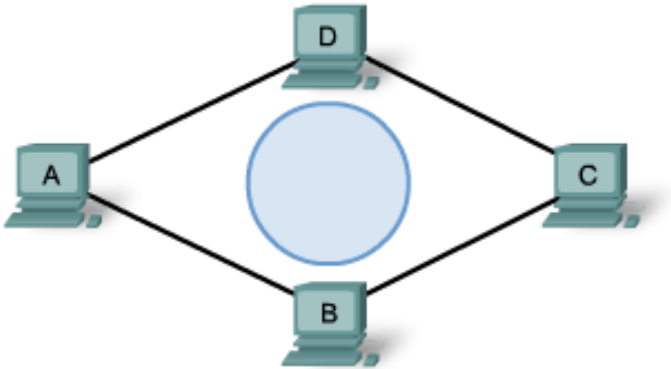


Controlled Access



Characteristics	Controlled Access Technologies
• Only one station can transmit at a time • Devices wishing to transmit must wait their turn • No collisions • May use a token passing method	• Token Ring (IEEE 802.5) • Fiber Distributed Data Interface (FDDI)

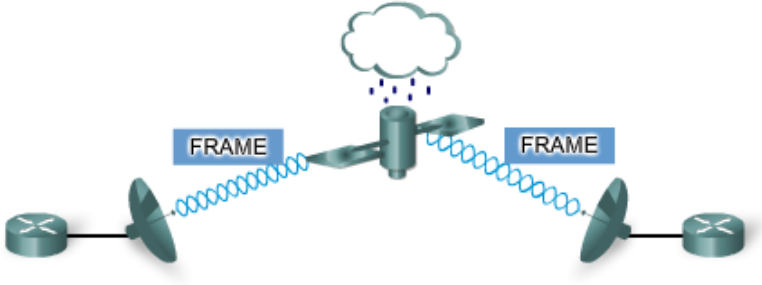
Ring Topology



The Frame

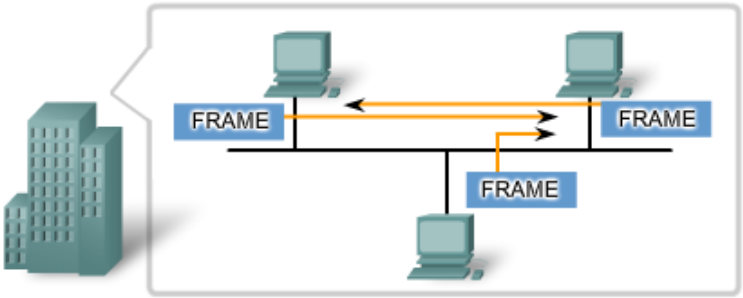
In a fragile environment, more controls are needed to ensure delivery. The header and trailer fields are larger as more control information is needed.

Greater effort needed to ensure delivery = higher overhead = slower transmission rates



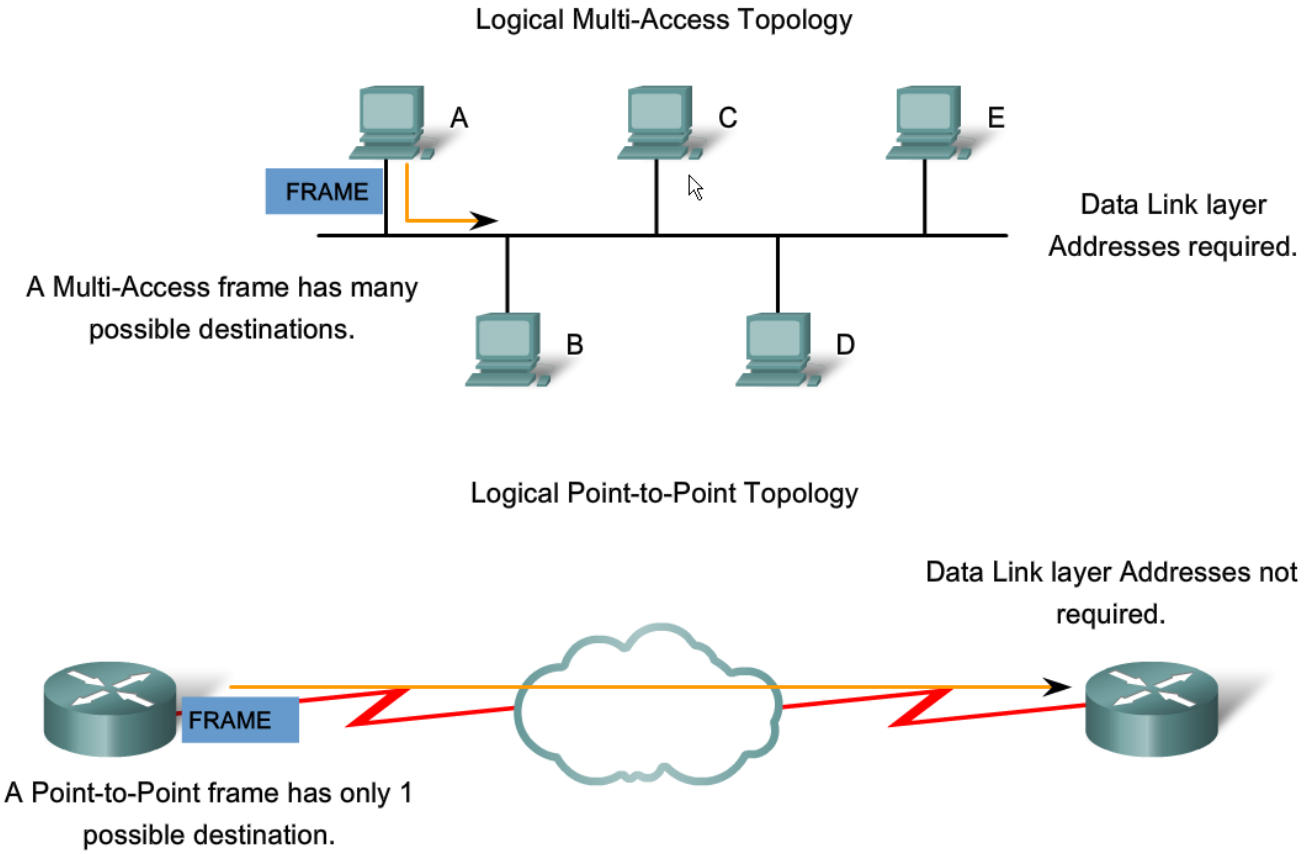
In a protected environment, we can count on the frame arriving at its destination. Fewer controls are needed, resulting in smaller fields and smaller frames.

Less effort needed to ensure delivery = lower overhead = faster transmission rates



The Header

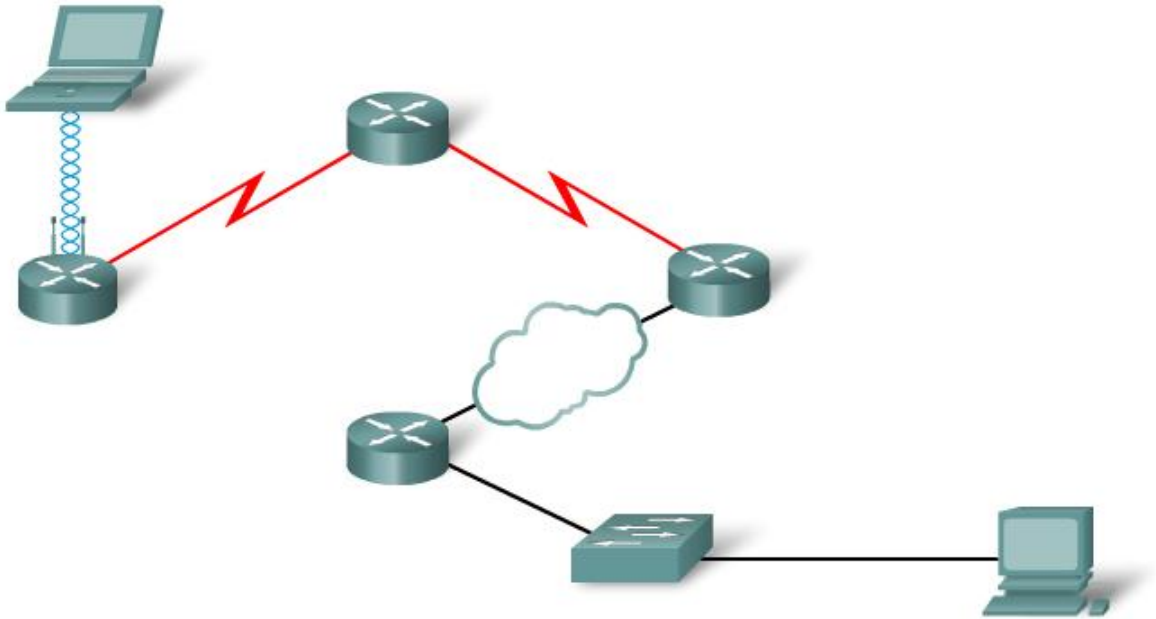
Layer 2 Address



The Trailer


START FRAME
ADDRESS
TYPE/ LENGTH
Data
Trailer
FCS
Stop Frame

LAN and WAN Frames



Ethernet Frame

A Common Data Link Layer Protocol for LANs

Frame

Field name	Preamble	Destination	Source	Type	Data	Frame Check Sequence
Size	8 bytes	6 bytes	6 bytes	2 bytes	46 - 1500 bytes	4 bytes

Preamble - used for synchronization; also contains a delimiter to mark the end of the timing information.
Destination Address - 48 bit MAC address for the destination node.
Source Address- 48 bit MAC address for the source node.
Type - value to indicate which upper layer protocol will receive the data after the Ethernet process is complete.
Data or payload - this is the PDU, typically an IPv4 packet, that is to be transported over the media.
Frame Check Sequence (FCS) - A value used to check for damaged frames.

Point-to-Point Protocol Frame

A Common Data Link Protocol for WANs

Frame

Field name	Flag	Address	Control	Protocol	Data	FCS
Size (bytes)	1 byte	1 byte	1 byte	2 bytes	variable	2 or 4 bytes

Flag - A single byte that indicates the beginning or end of a frame. The flag field consists of the binary sequence 01111110.

Address - A single byte that contains the standard PPP broadcast address. PPP does not assign individual station addresses.

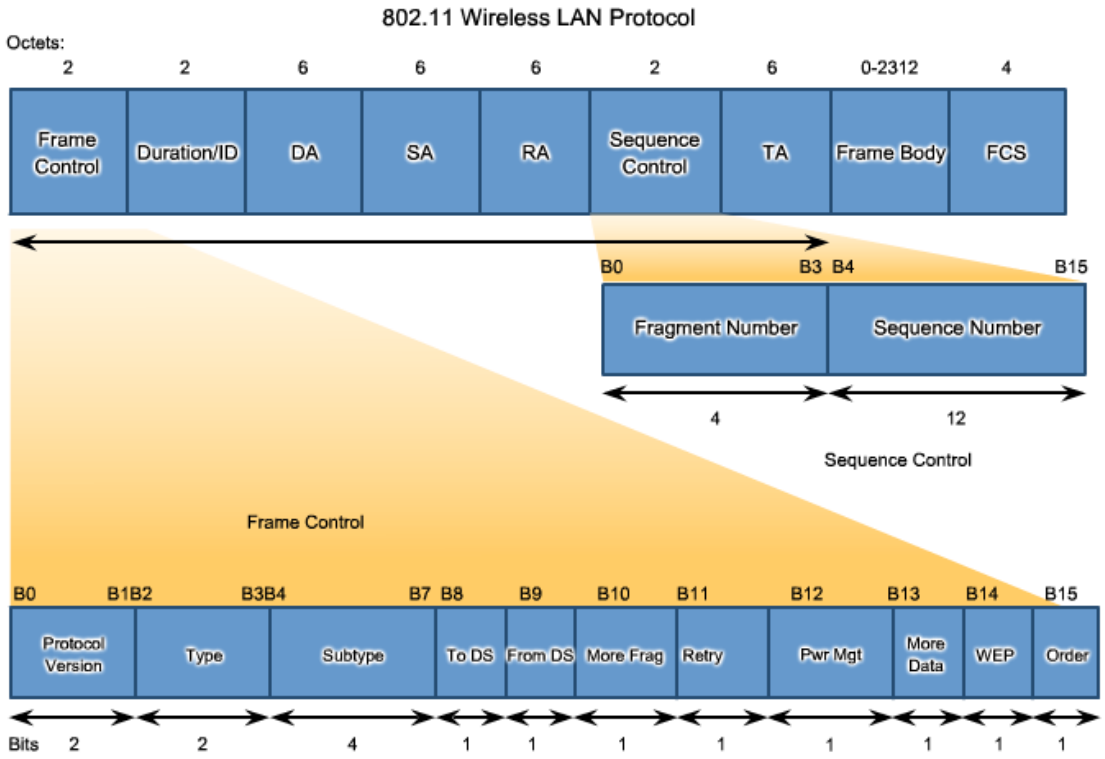
Control- A single byte that contains the binary sequence 00000011, which calls for transmission of user data in an unsequenced frame.

Protocol- Two bytes that identify the protocol encapsulated in the data field of the frame. The most up-to-date values of the protocol field are specified in the most recent Assigned Numbers Request For Comments (RFC).

Data - Zero or more bytes that contain the datagram for the protocol specified in the protocol field.

Frame Check Sequence (FCS) - Normally 16 bits (2 bytes). By prior agreement, consenting PPP implementations can use a 32-bit (4-byte) FCS for improved error detection.

802.11 Wireless Frame



Summary

- Physical Layer Protocols
- Network Media
- Data Link Layer Protocols
- Media Access Control

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