Cisco Networking Academy
Mind Wide Open

Chapter 4:
Network Access

Introduction to Networks v5.1

Section 4.1:
Physical Layer Protocols

Upon completion of this section, you should be able to:

- Identify device connectivity options.
- Describe the purpose and functions of the physical layer in the network.
- Describe basic principles of the physical layer standards.

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Chapter Outline

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

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Topic 4.1.1:
Physical Layer Connection

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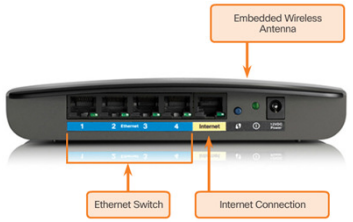
Types of Connections



Home Router

Connecting to the Wired LAN

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Topic 4.1.2: Purpose of the Physical Layer

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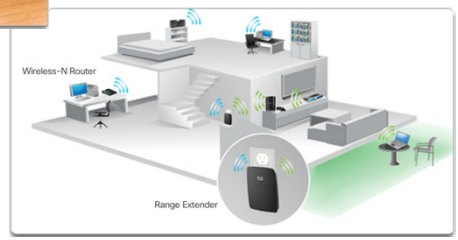
Network Interface Cards

Wired Connection Using an Ethernet NIC

Connecting to the Wireless LAN with Range Extender



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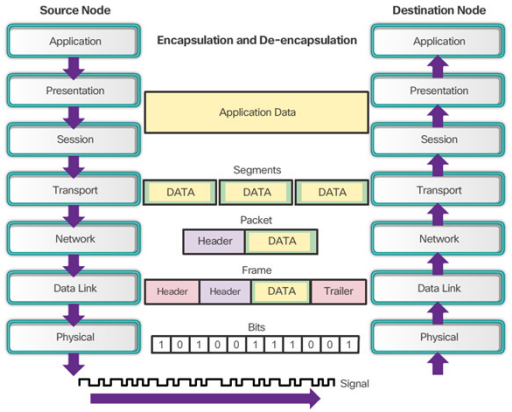
The Physical Layer



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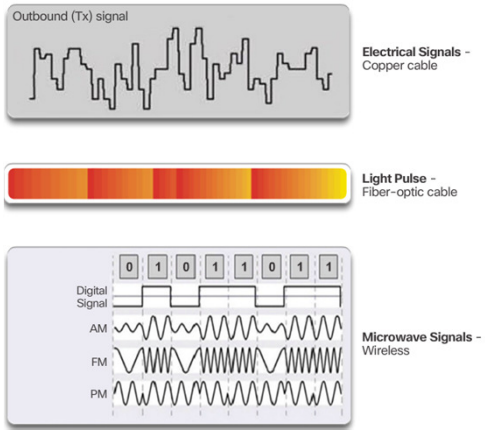
Physical Layer Media



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Topic 4.1.3:
Physical Layer Characteristics

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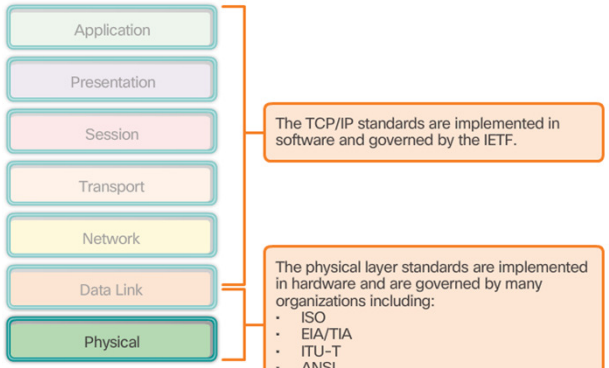
Physical Layer Standards



The TCP/IP standards are implemented in software and governed by the IETF.

The physical layer standards are implemented in hardware and are governed by many organizations including:
- ISO
- EIA/TIA
- ITU-T
- ANSI
- IEEE

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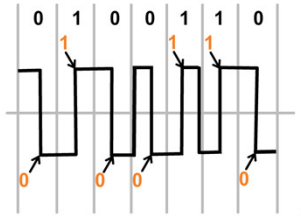
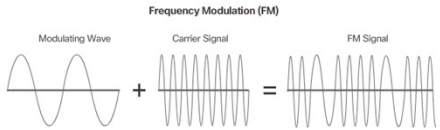
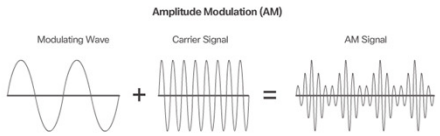
Functions



Manchester Encoding



Modulation



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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

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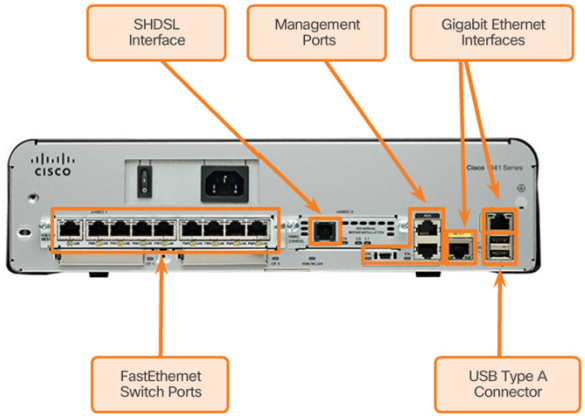
Types of Physical Media



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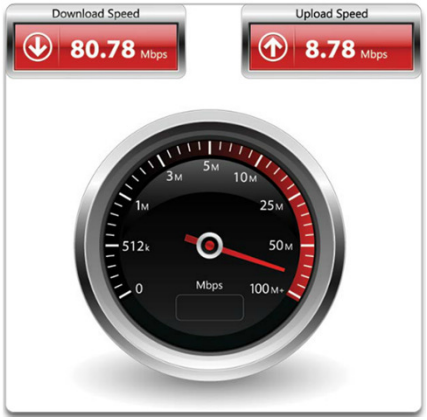
Throughput



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Section 4.2: Network Media

Upon completion of this section, you should be able to:

- Identify the basic characteristics of copper cabling.
- Build a UTP cable used in Ethernet networks (scope – does not include cabling area discussion).
- Describe fiber-optic cabling and its main advantages over other media.
- Connect devices using wired and wireless media.

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Topic 4.2.1: Copper Cabling

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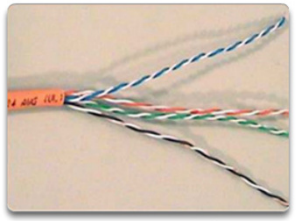
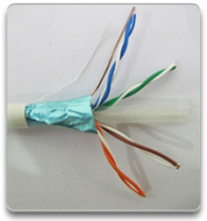
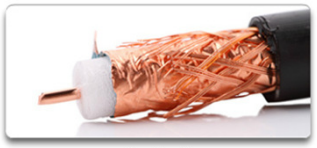
Copper Media



Unshielded Twisted-Pair (UTP) cable



Shielded Twisted-Pair (STP) cable



Coaxial cable

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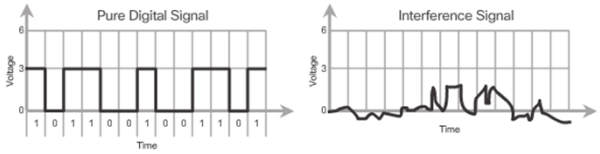
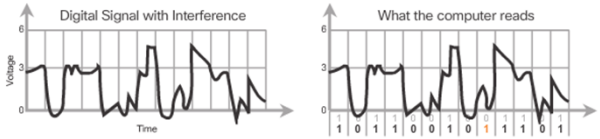
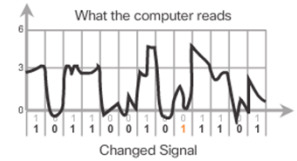
Characteristics of Copper Cabling







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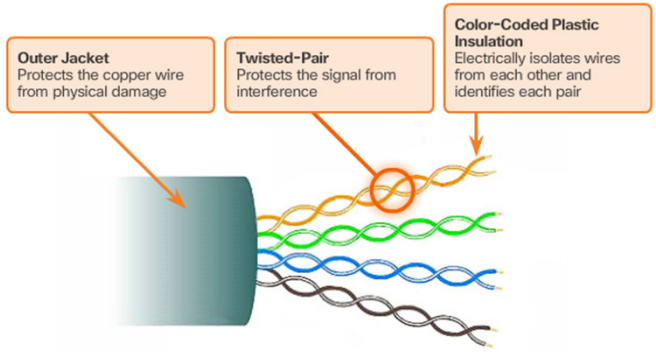
Unshielded Twisted-Pair Cable



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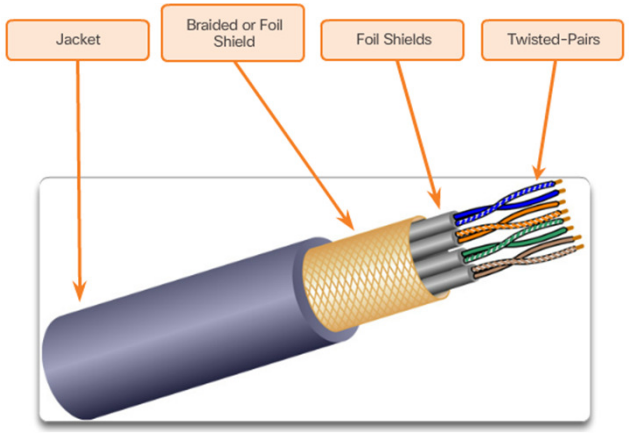
Shielded Twisted-Pair Cable



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Copper 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.

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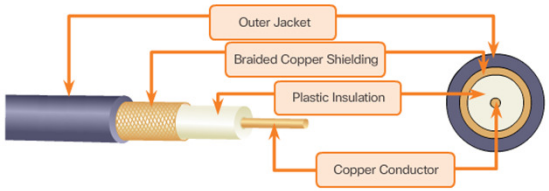
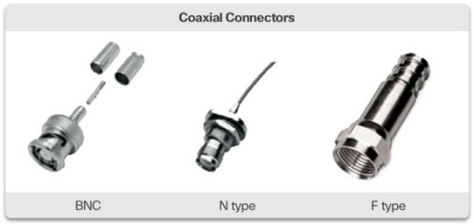
Coaxial Cable





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Topic 4.2.2: UTP Cabling

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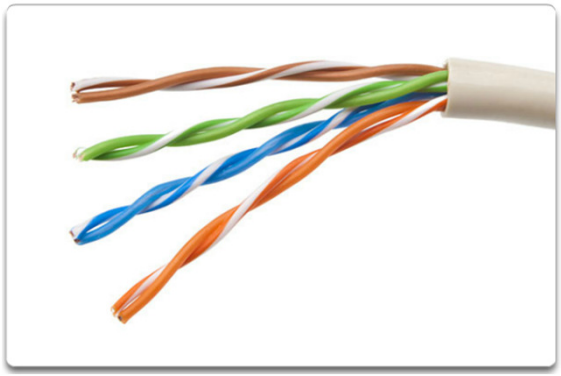
Properties of UTP Cabling



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UTP Connectors

RJ-45 UTP Plugs

RJ-45 UTP Socket

Bad connector – Wires are exposed, untwisted, and not entirely covered by the sheath.

Good connector – Wires are untwisted to the extent necessary to attach the connector.

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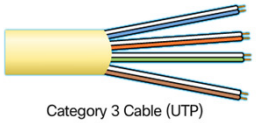
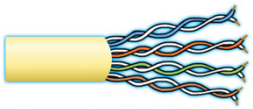
UTP Cabling Standards



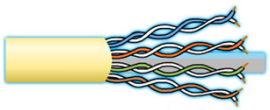
Category 3 Cable (UTP)

- Used for voice communication
- Most often used for phone lines



Category 5 and 5e Cable (UTP)

- Used for data transmission
- Cat5 supports 100 Mb/s and can support 1000 Mb/s, but it is not recommended
- Cat5e supports 1000 Mb/s



Category 6 Cable (UTP)

- Used for data transmission
- An added separator is between each pair of wires allowing it to function at higher speeds
- Supports 1000 Mb/s – 10 Gb/s, though 10 Gb/s is not recommended

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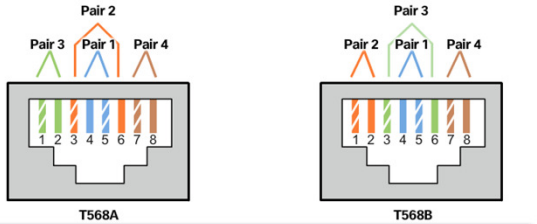
Types of UTP Cable



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

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Testing UTP Cables

UTP Testing Parameters:

- Wire map
- Cable length
- Signal loss due to attenuation
- Crosstalk

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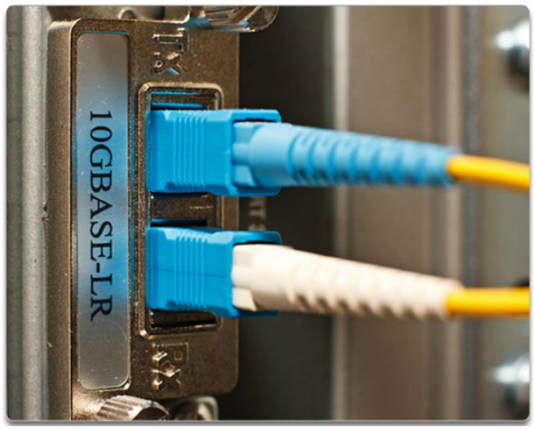
Properties of Fiber Optic Cabling



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Topic 4.2.3: Fiber Optic Cabling

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Fiber Media Cable Design

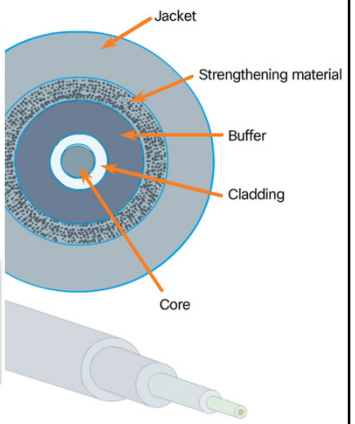
Jacket
Typically a PVC jacket that protects the fiber against abrasion, moisture, and other contaminants. This outer jacket composition can vary depending on the cable usage.

Buffer
Used to help shield the core and cladding from damage.

Cladding
Made from slightly different chemicals than those used to create the core. It tends to act like a mirror by reflecting light back into the core of the fiber. This keeps light in the core as it travels down the fiber.

Core
The core is actually the light transmission element at the center of the optical fiber. This core is typically silica or glass. Light pulses travel through the fiber core.

Strengthening Material
Surrounds the buffer, prevents the fiber cable from being stretched when it is being pulled. The material used is often the same material used to produce bulletproof vests.



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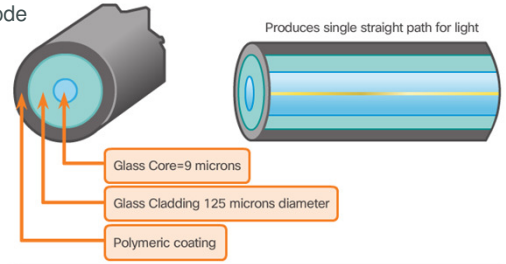
Types of Fiber Media

Single Mode



- 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

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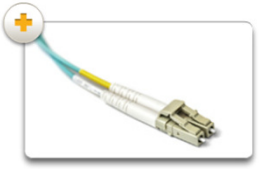
Network Fiber Connectors

Fiber Optic Connectors

ST Connectors

SC Connectors

LC Connector


Duplex Multimode LC Connectors

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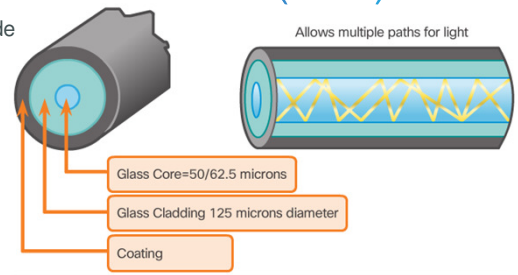
Types of Fiber Media (cont.)

Multimode



- 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

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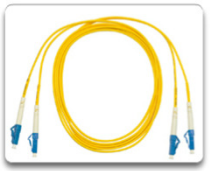
Network Fiber Connectors (cont.)

Common Fiber Patch Cords

SC-SC Multimode Patch Cord


LC-LC Single-mode Patch Cord

ST-LC Multimode Patch Cord

SC-ST Single-mode Patch Cord

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Testing Fiber Cables

Optical Time Domain Reflectometer (OTDR)

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Topic 4.2.4: Wireless Media

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Fiber versus Copper

Implementation Issues	UTP Cabling	Fiber-optic Cabling
Bandwidth supported	10 Mb/s - 10 Gb/s	10 Mb/s - 100 Gb/s
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

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Properties of Wireless Media

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Types of Wireless Media

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Section 4.3: Data Link Layer Protocols

Upon completion of this section, you should be able to:

- Describe the purpose and function of the data link layer in preparing communication for transmission on specific media.

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Wireless LAN

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Topic 4.3.1: Purpose of the Data Link Layer

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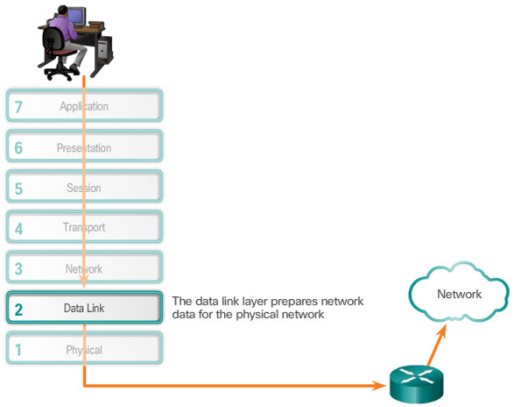
The Data Link Layer



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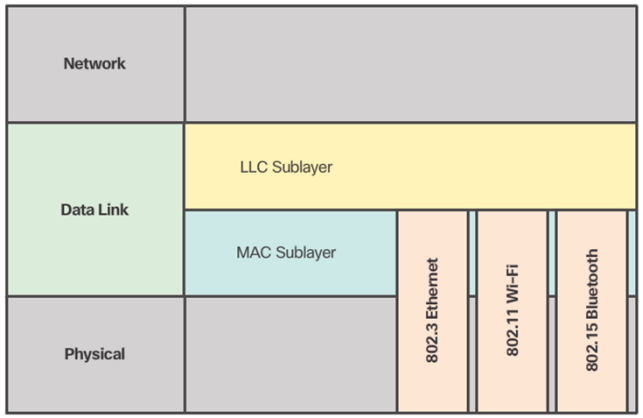
Data Link Sublayers



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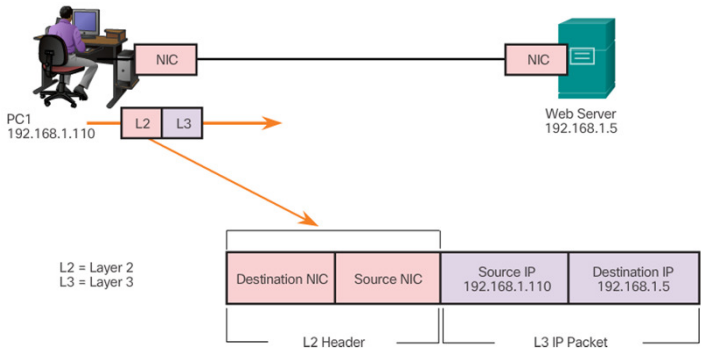
The Data Link Layer (cont.)

Layer 2 Data Link Address



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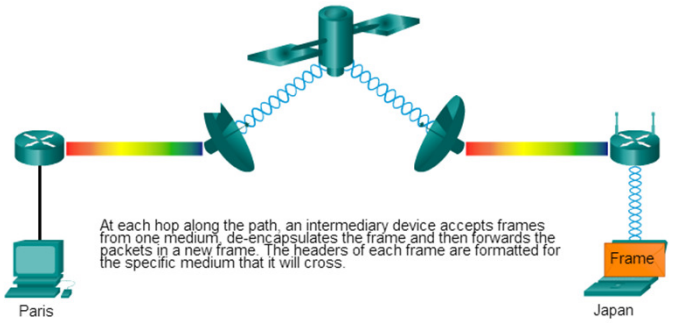
Media Access Control

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, de-encapsulates 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.

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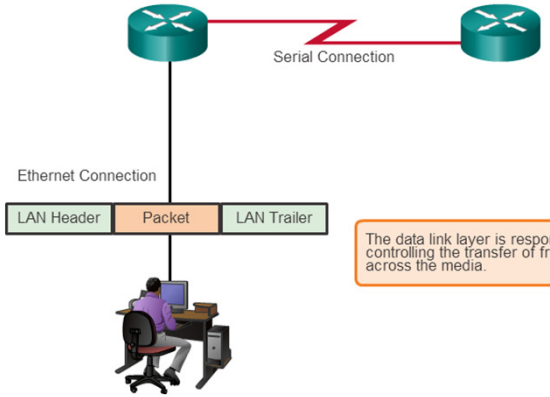
Providing Access to Media



The data link layer is responsible for controlling the transfer of frames across the media.

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Section 4.4: Media Access Control

Upon completion of this section, you should be able to:

- Compare the functions of logical topologies and physical topologies.
- Describe the basic characteristics of media access control methods on WAN topologies.
- Describe the basic characteristics of media access control methods on LAN topologies.
- Describe the characteristics and functions of the data link frame.

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Data Link Layer Standards

IEEE

ANSI

ITU

ISO

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Topic 4.4.1: Topologies

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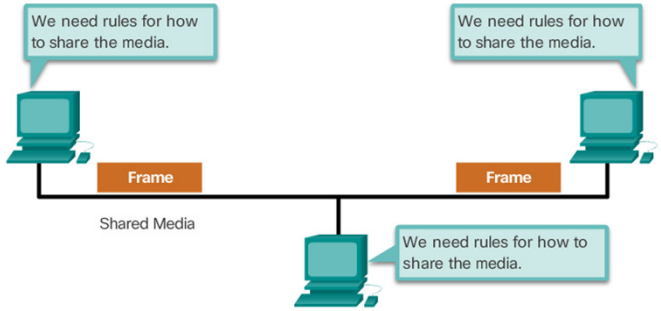
Controlling Access to the Media



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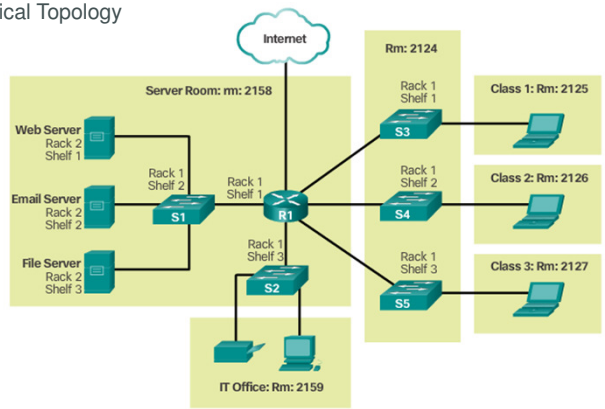
Physical and Logical Topologies

Physical Topology



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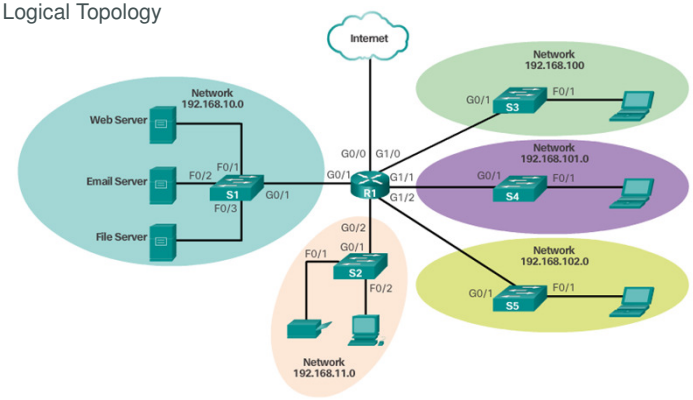
Physical and Logical Topologies (cont.)

Logical Topology



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Topic 4.4.2: WAN Topologies

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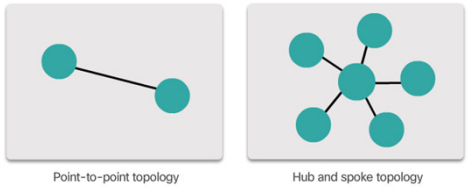
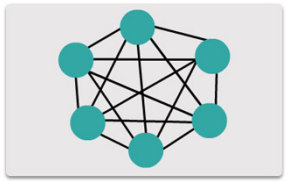
Common Physical WAN Topologies



Point-to-point topology

Hub and spoke topology



Full mesh topology

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Logical Point-to-Point Topology

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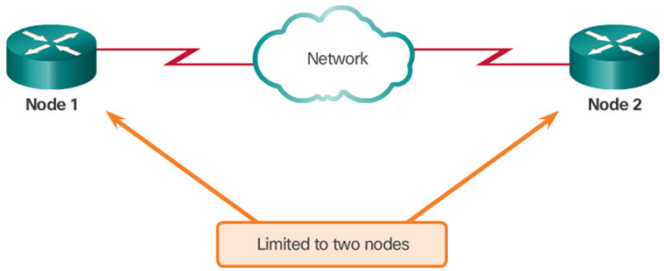
Physical Point-to-Point Topology



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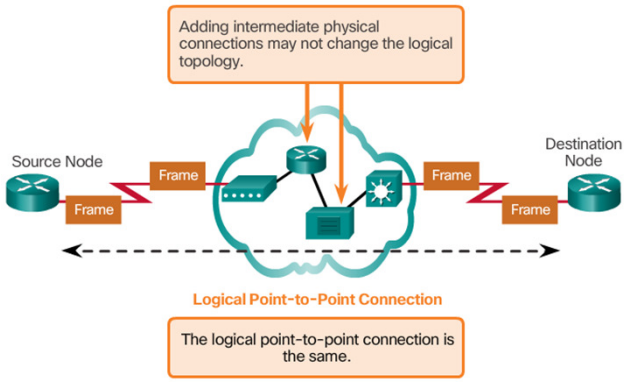
Logical Point-to-Point Topology (cont.)



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Topic 4.4.3:
LAN Topologies

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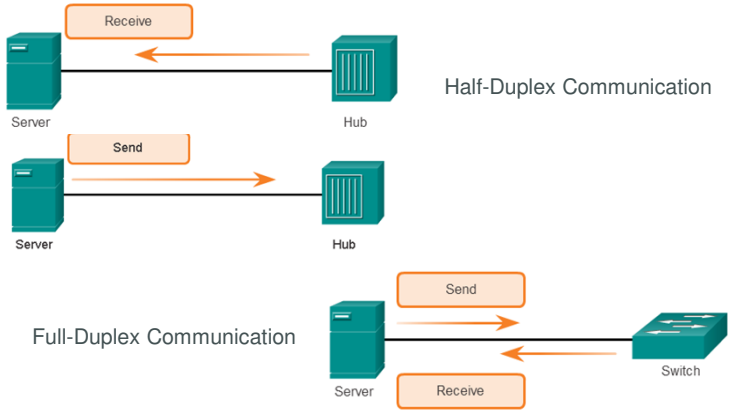
Half and Full Duplex



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Physical LAN Topologies

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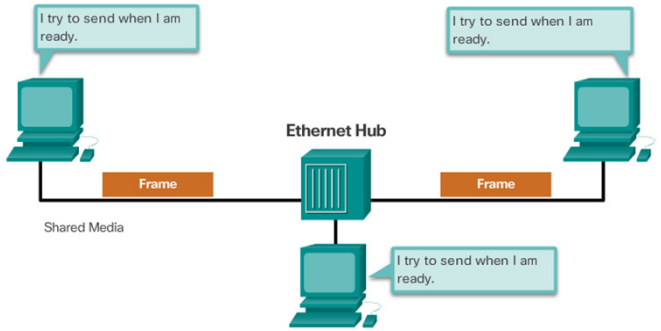
Media Access Control Methods

Contention-Based Access



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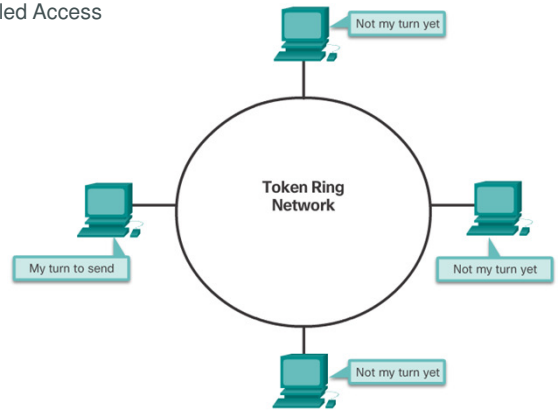
Media Access Control Methods (cont.)

Controlled Access



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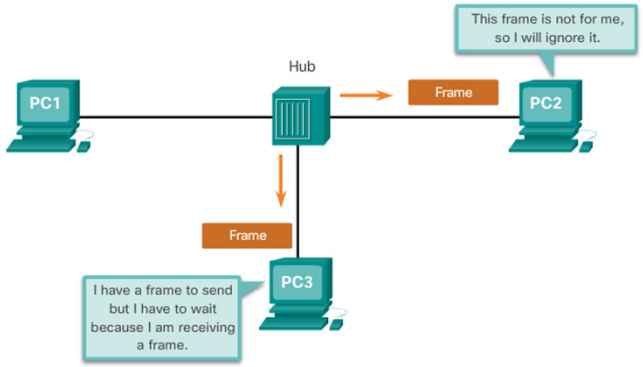
Contention Based Access – CSMA/CD (cont.)



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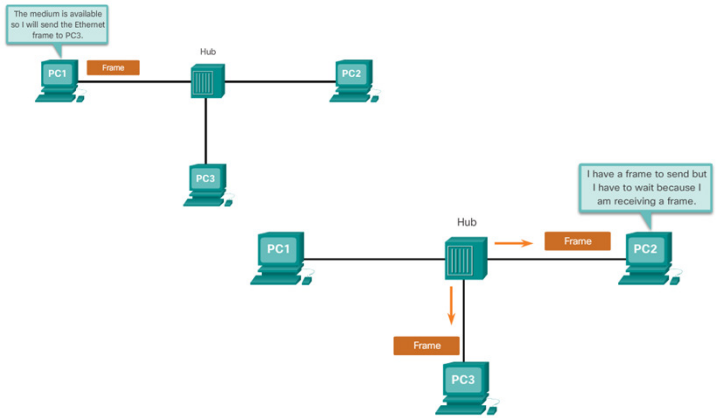
Contention Based Access – CSMA/CD



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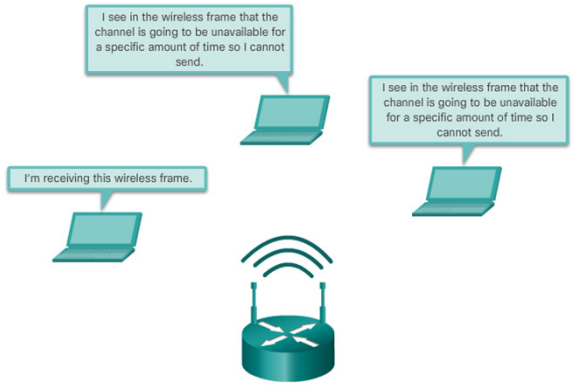
Contention Based Access – CSMA/CA



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Topic 4.4.4:
Data Link Frame

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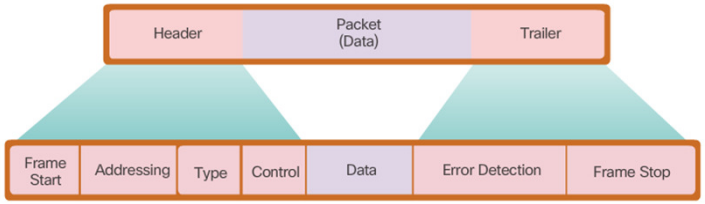
Frame Fields



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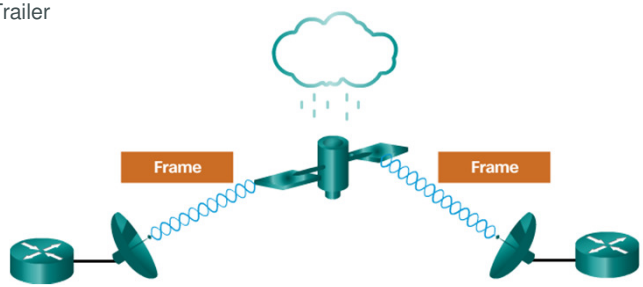
The Frame

Frames have three basic parts:

- Header
- Data
- Trailer



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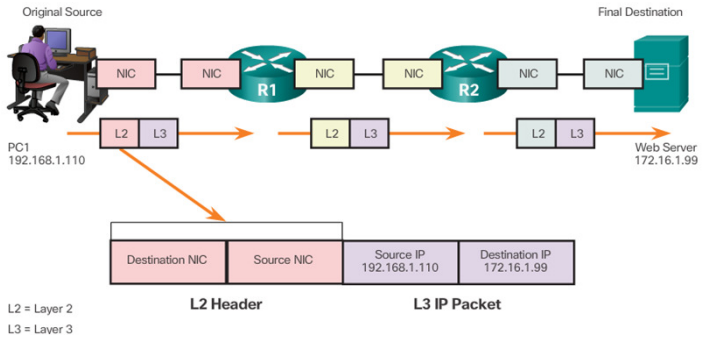
Layer 2 Address



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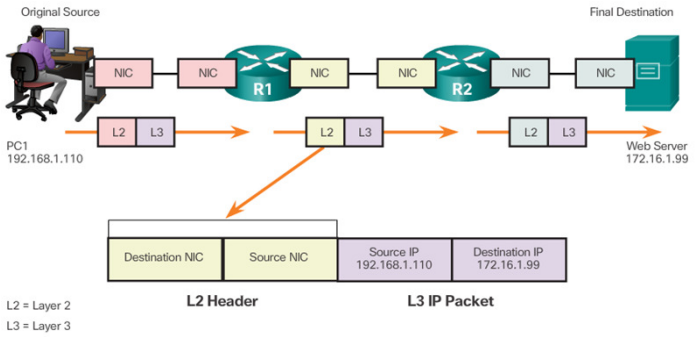
Layer 2 Address (cont.)



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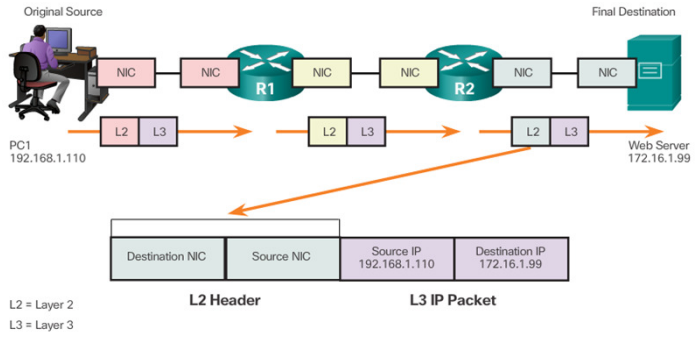
Layer 2 Address (cont.)



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LAN and WAN Frames

Examples of Layer 2 protocols:

- 802.11 Wireless Frame
- PPP Frame
- HDLC
- Frame Relay
- Ethernet Frame

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Section 4.5: Summary

Chapter Objectives:

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

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Thank you.

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