Chapter 4: Network Access

Introduction to Networks

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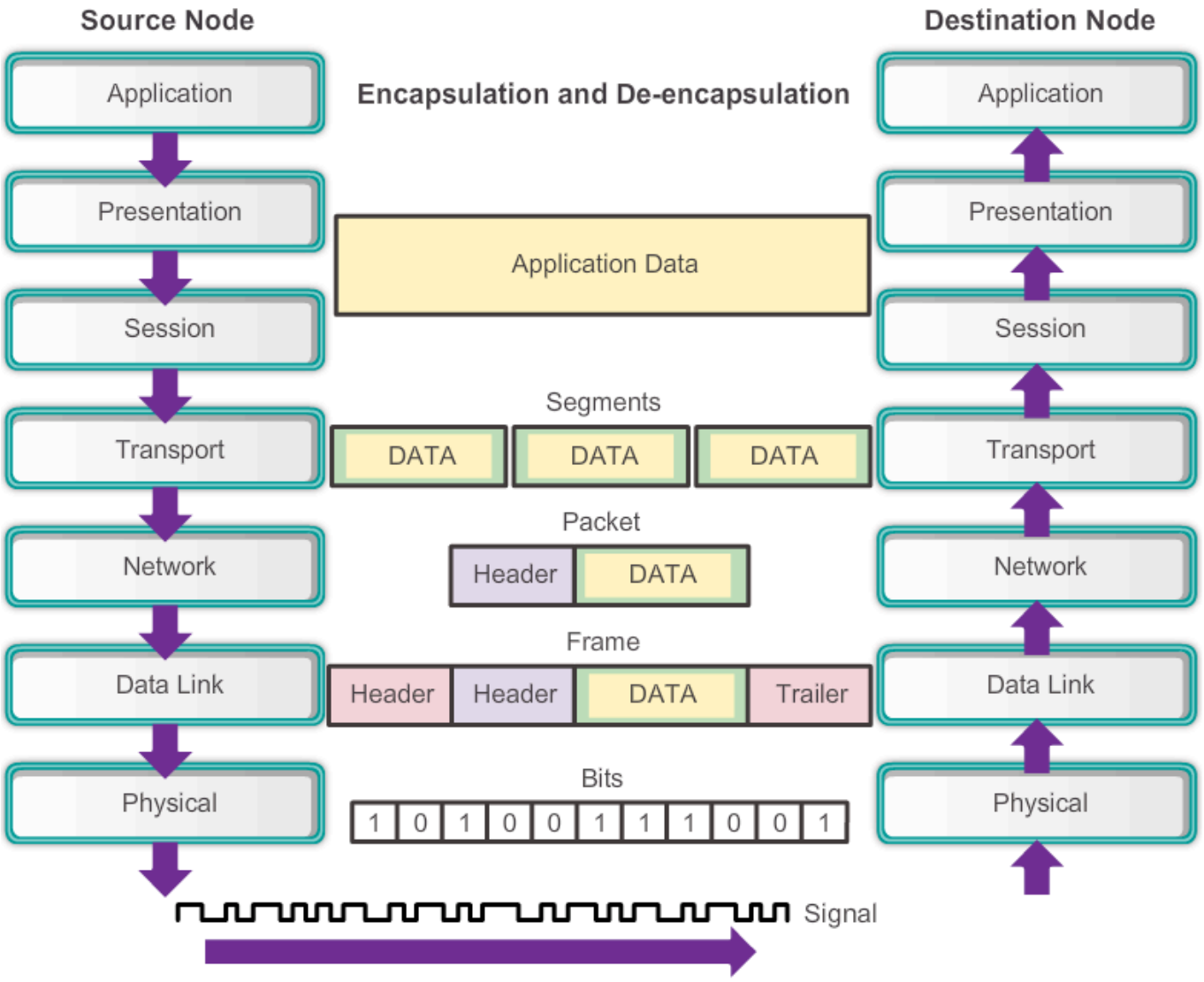
Purpose of the Physical Layer

The Physical Layer



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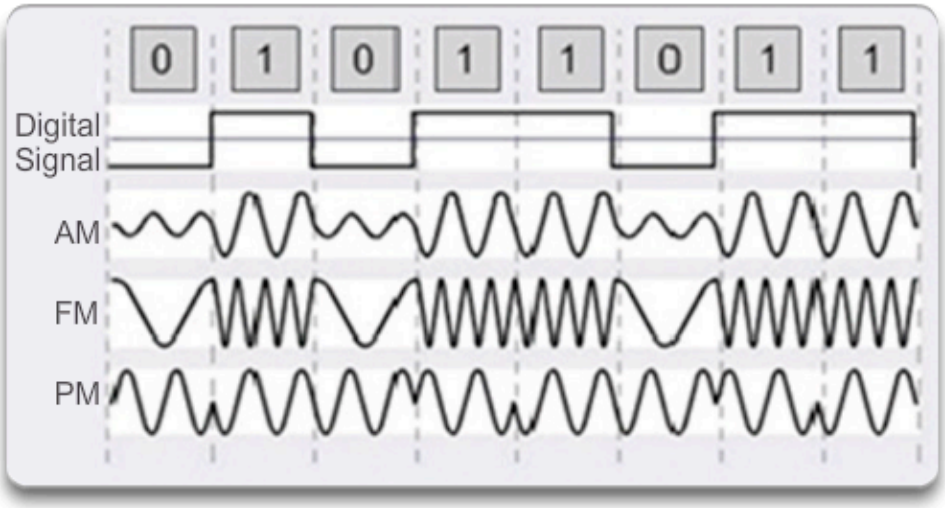
Physical Layer Media

Electrical Signals -
Copper cable

Light Pulse -
Fiber-optic cable



Microwave Signals -
Wireless

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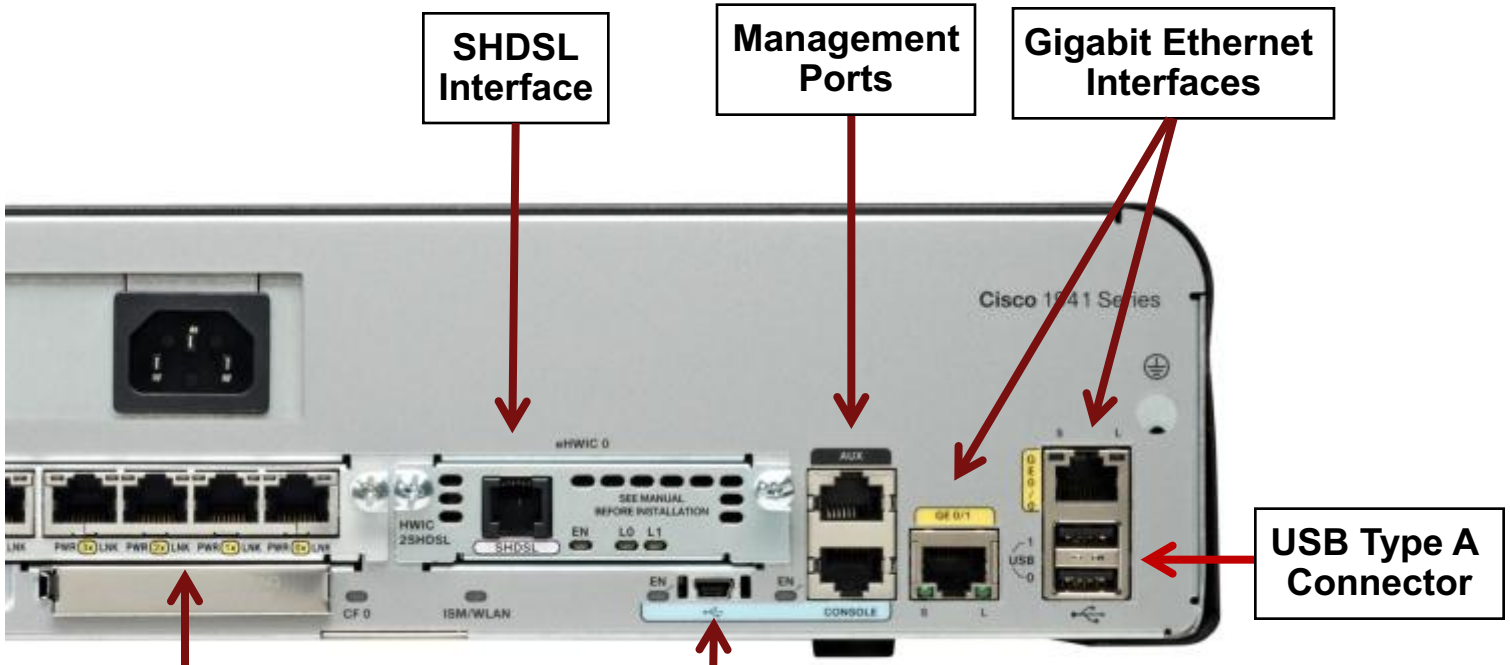
Types of Physical Media



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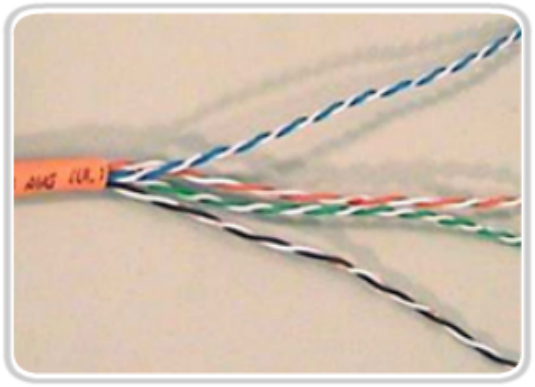
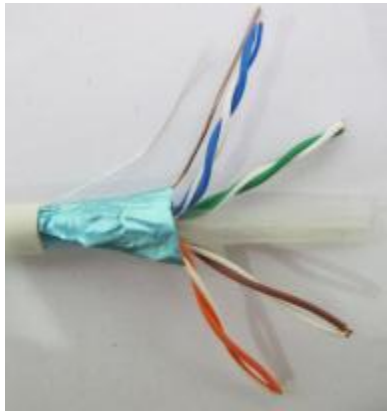
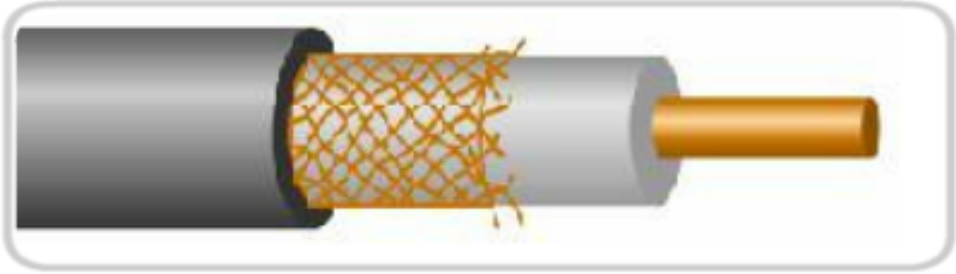
Copper Media



Unshielded Twisted Pair (UTP) Cable



Shielded Twisted Pair (STP) Cable



Coaxial Cable

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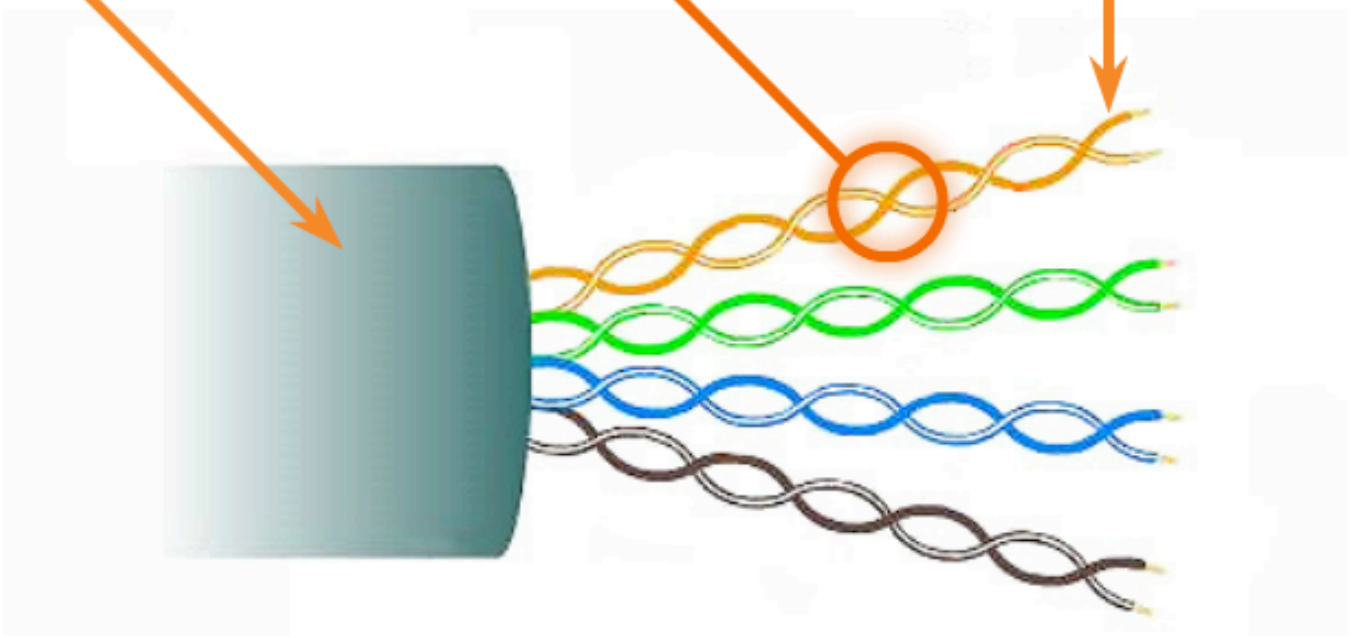
Copper Cabling

UTP Cable

Outer Jacket
Protects the copper wire from physical damage

Twisted-Pair
Protects the signal from interference

Color-Coded Plastic Insulation
Electrically isolates wires from each other and identifies each pair



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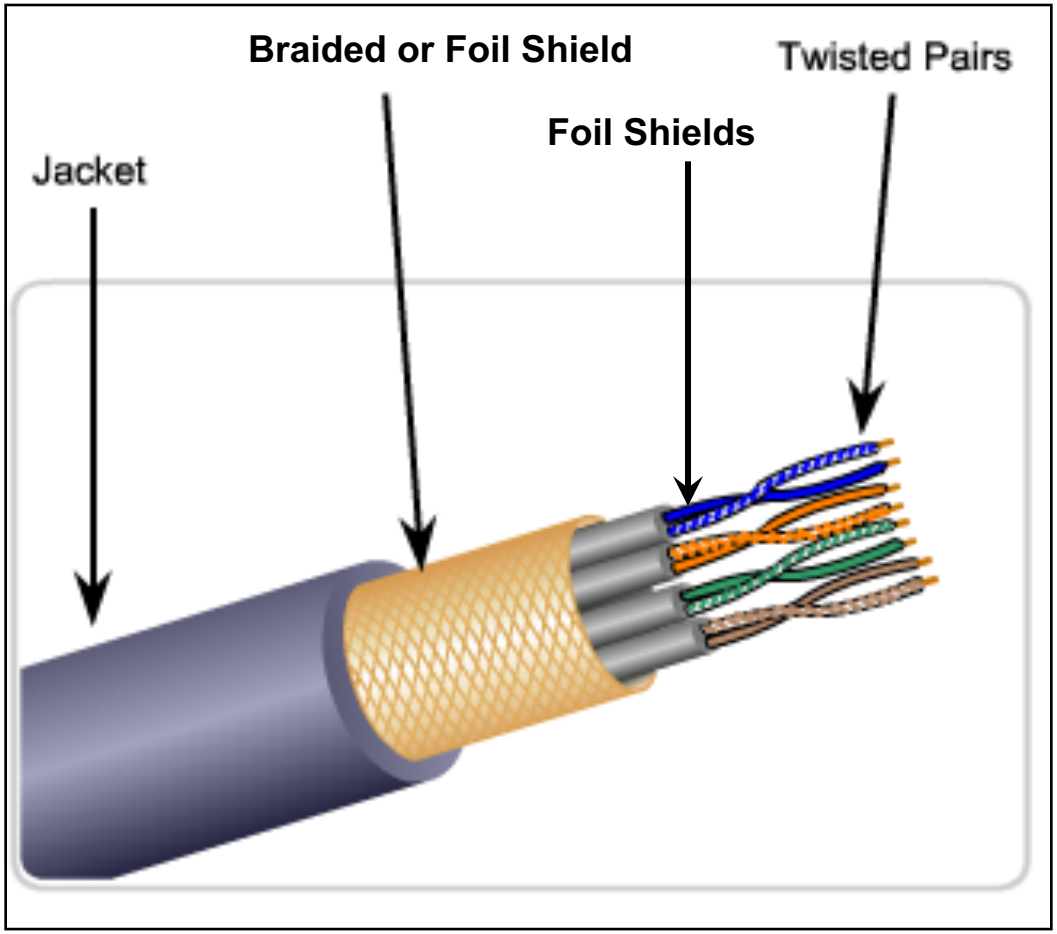
Copper Cabling

STP Cable



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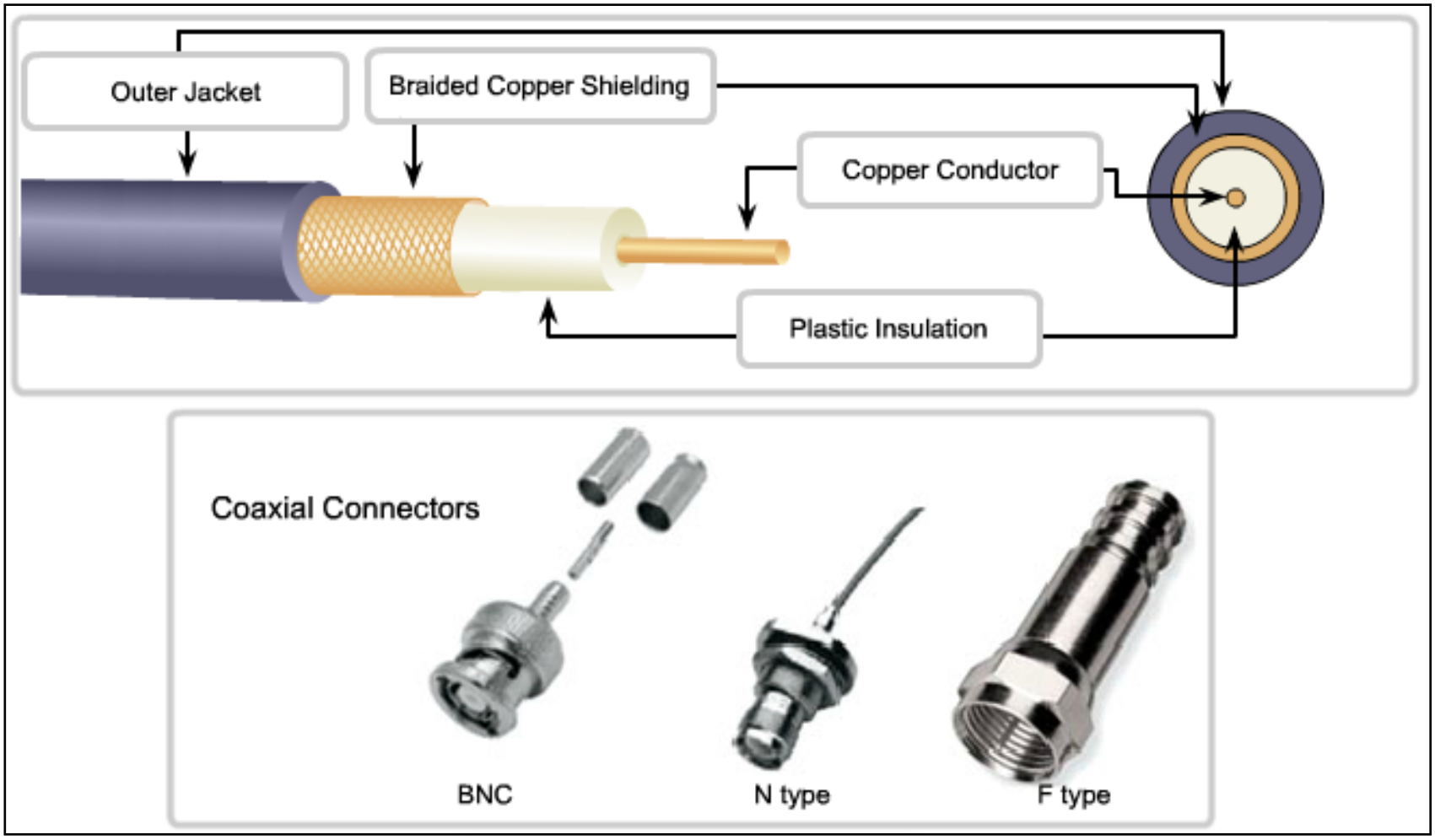
Coaxial Cable



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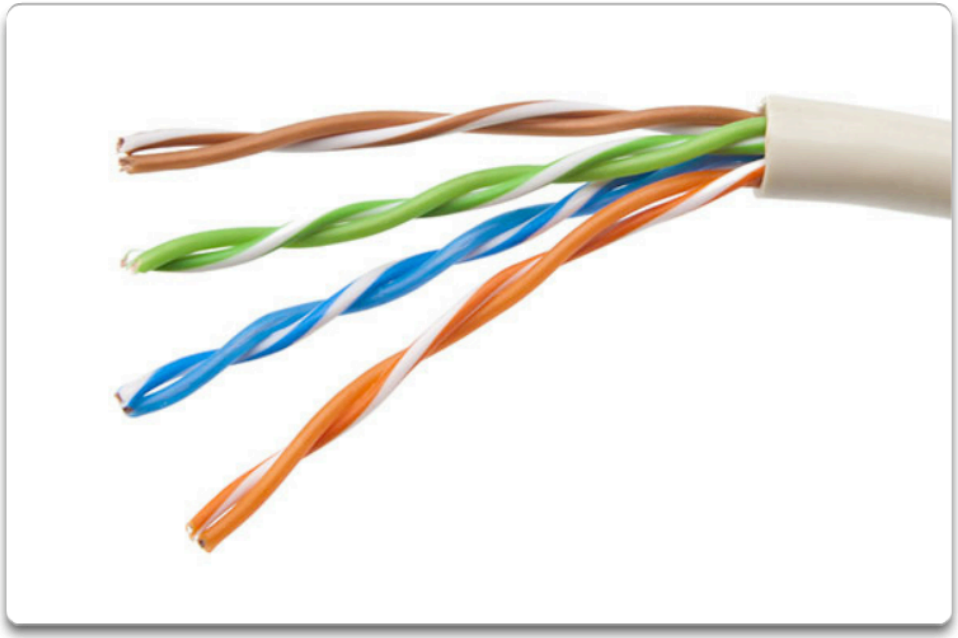
Properties of UTP Cabling

UTP cable does not use shielding to counter the effects of EMI and RFI. Instead, cable designers have discovered that they can limit the negative effect of crosstalk by:

- Cancellation
- Varying the number of twists per wire pair



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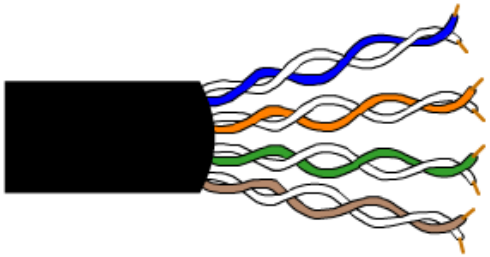
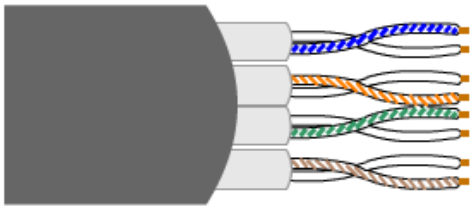
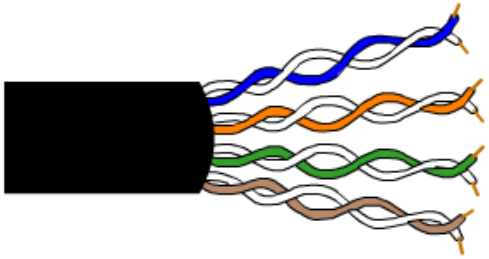
UTP Cabling Standards



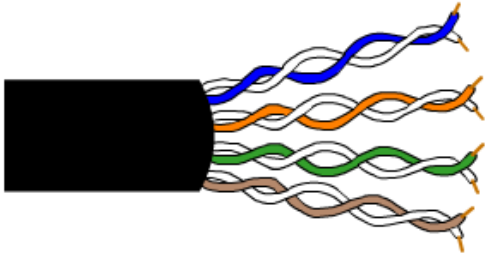
Category 3 Cable (UTP)



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

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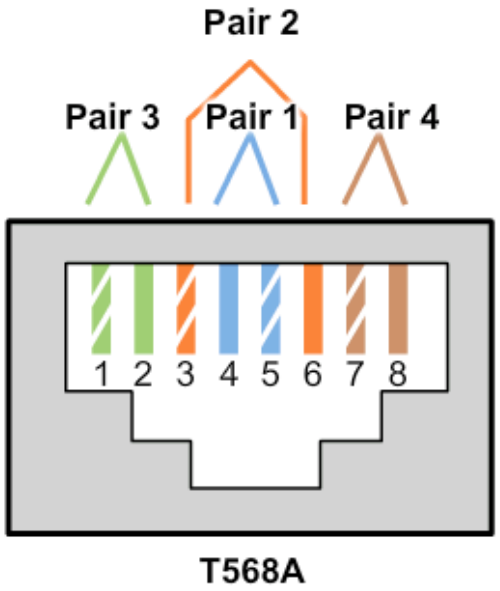
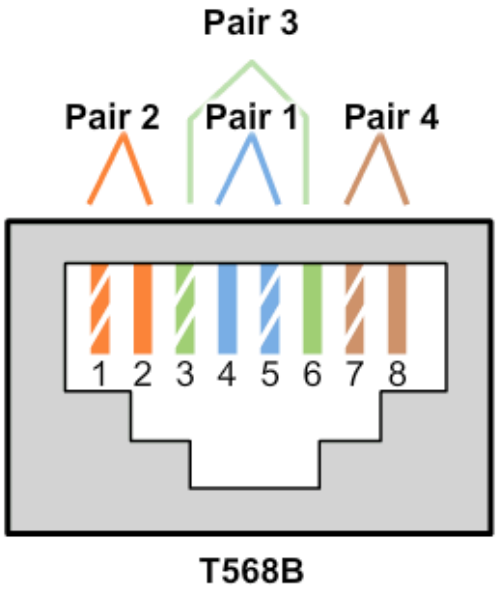
Types of UTP Cable



T568A



T568B

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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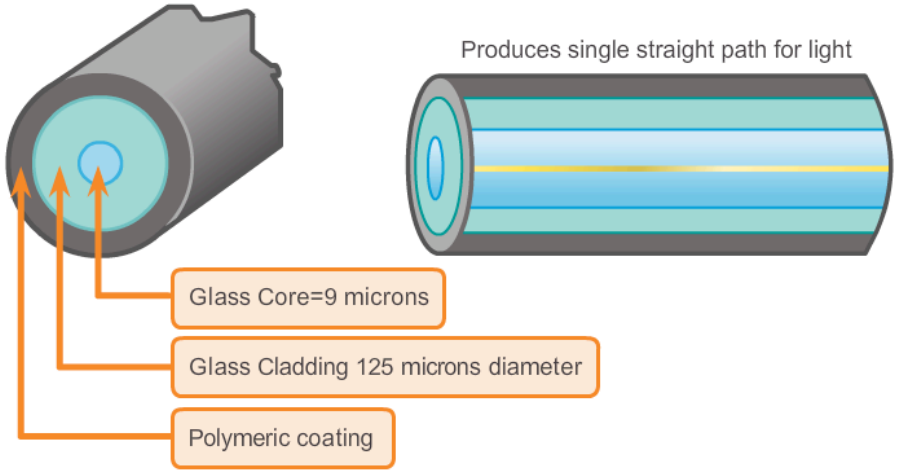
Fiber Optic Cabling

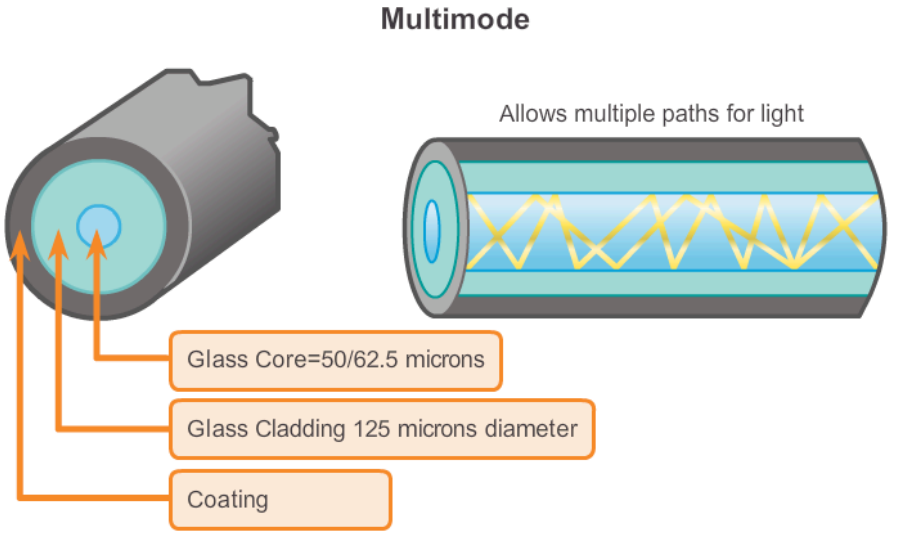
Types of Fiber Media

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

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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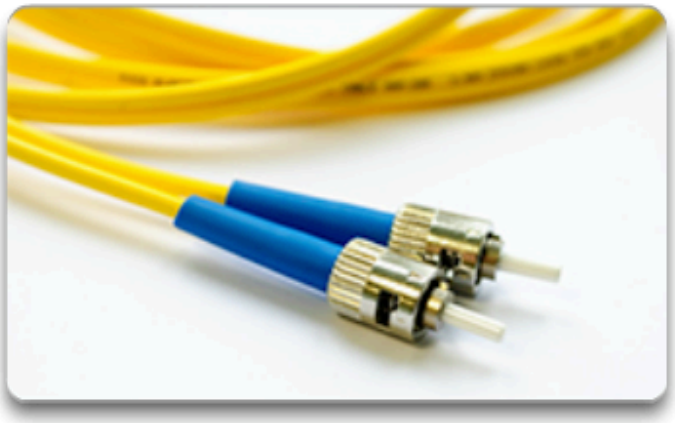
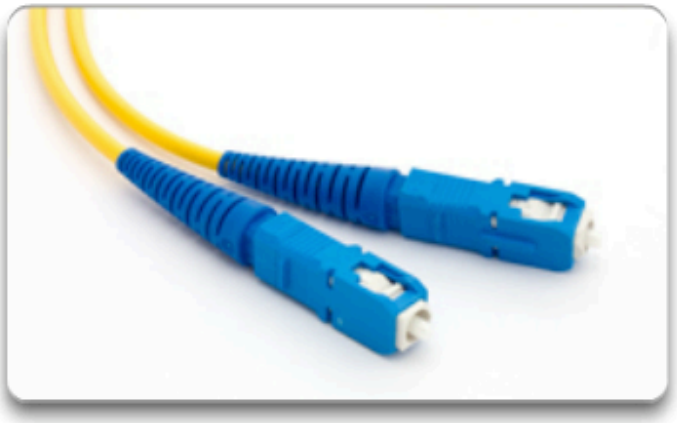
Network Fiber Connectors



ST Connectors



SC Connectors

LC Connector

Duplex Multimode LC Connectors

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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

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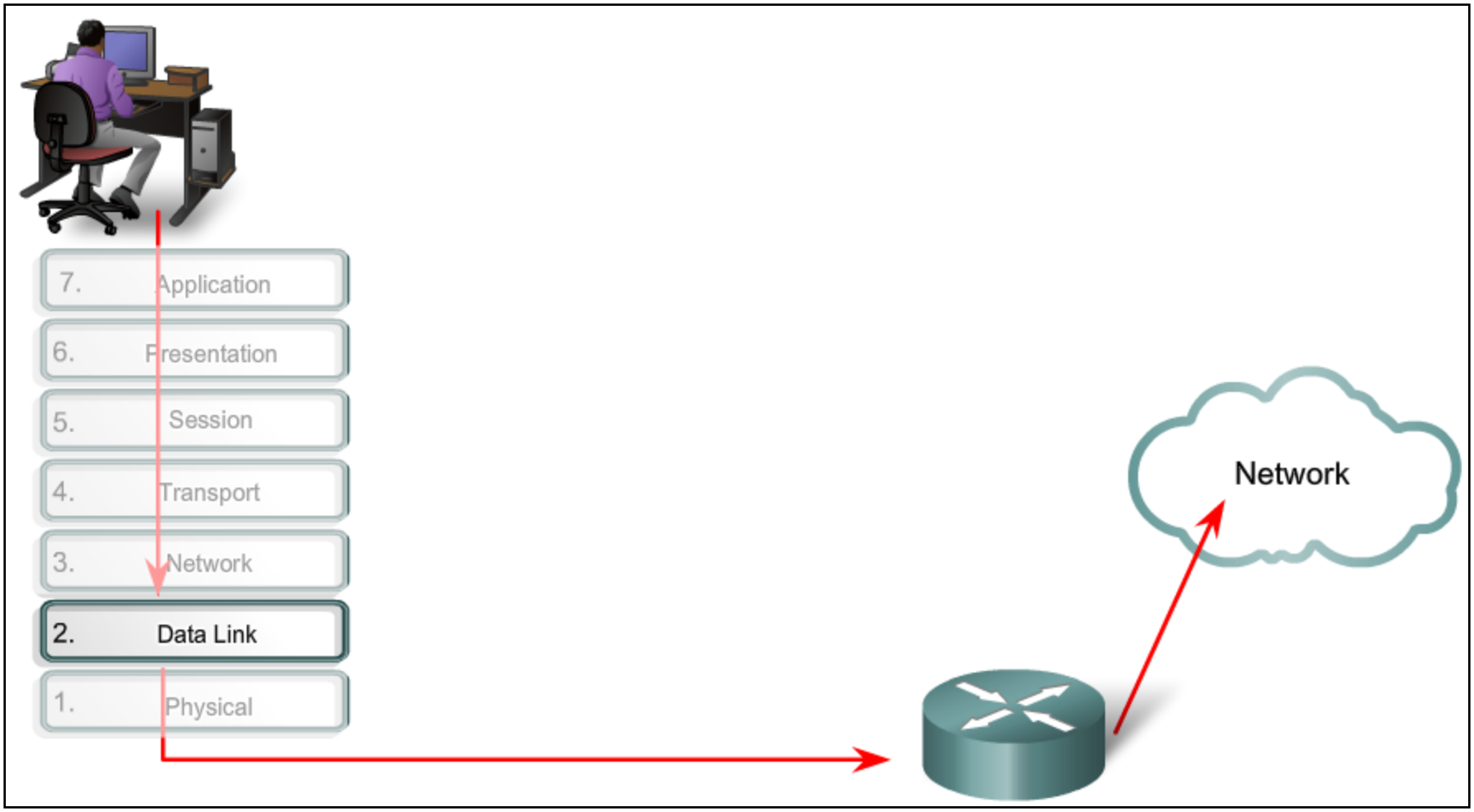
The Data Link Layer



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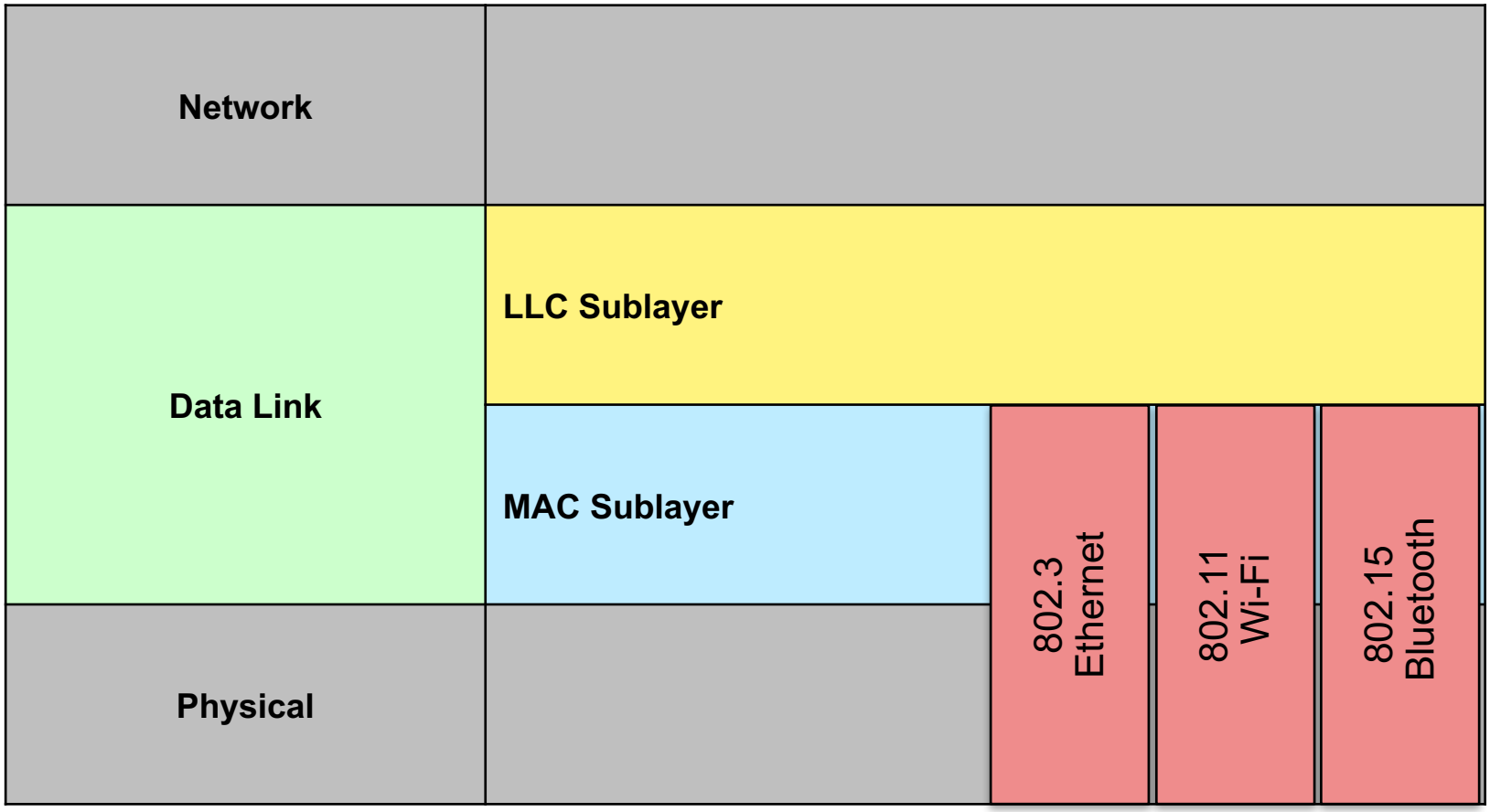
Data Link Sublayers



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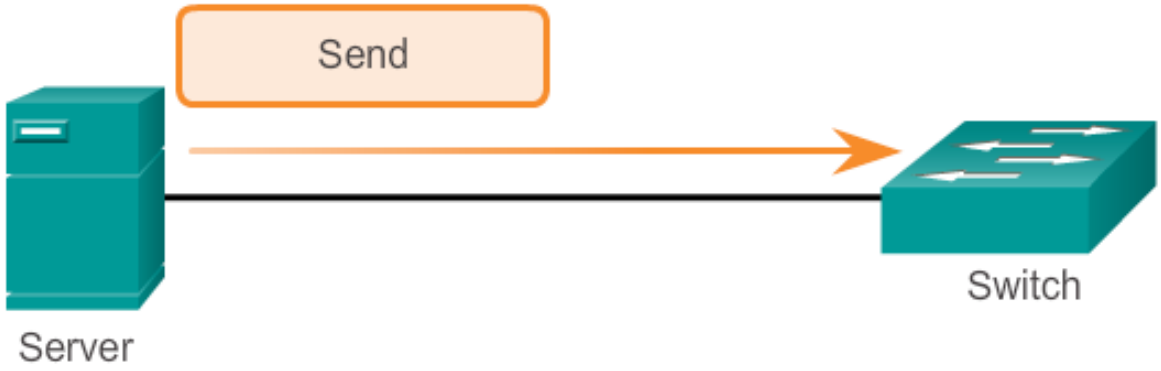
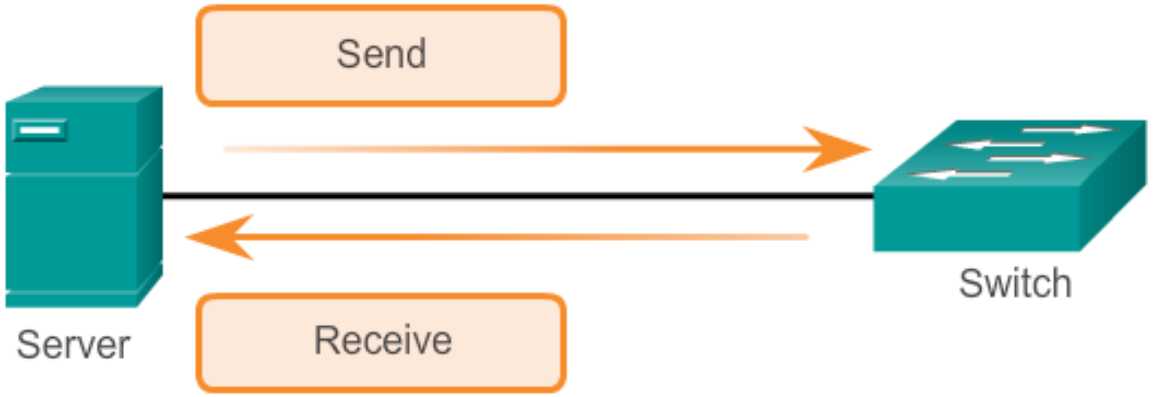
Half- and Full-Duplex

Half-Duplex



Full-Duplex



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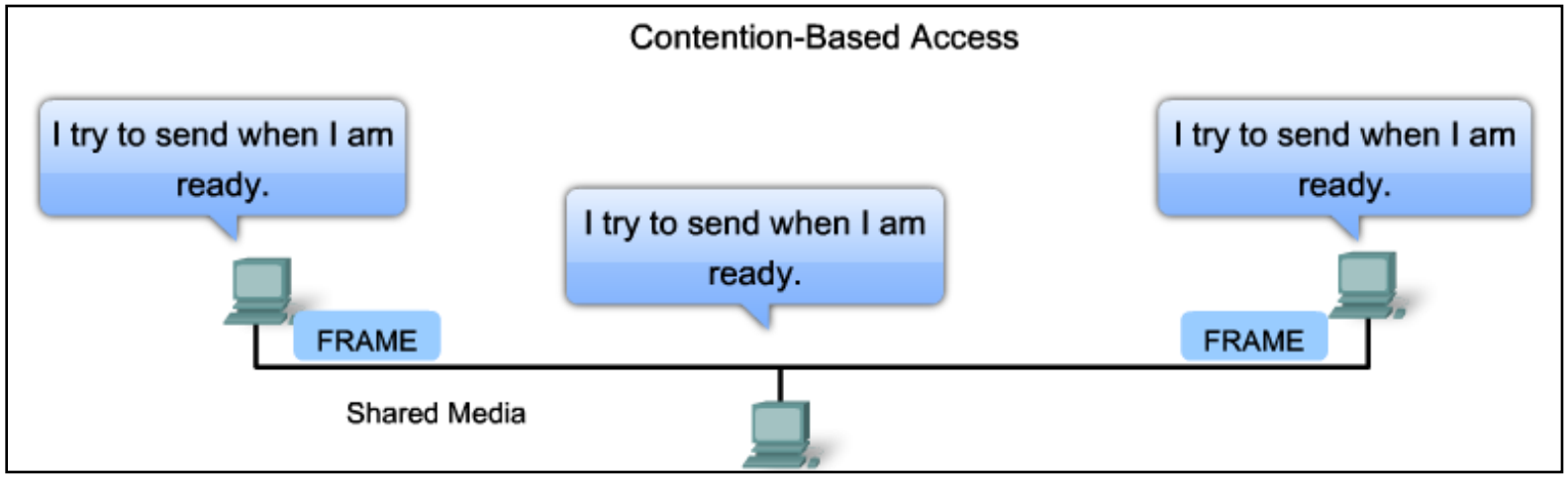
Contention-Based Access



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

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Ethernet Frame

Ethernet Protocol

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

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Point-to-Point Protocol Frame

Point-to-Point Protocol

A Common Data Link Protocol for WANs

	Frame					
Field name	Flag	Address	Control	Protocol	Data	FCS
Size	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.

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