SOMNOG5 Network Infrastructure

Introduction to Networks

Networking Today

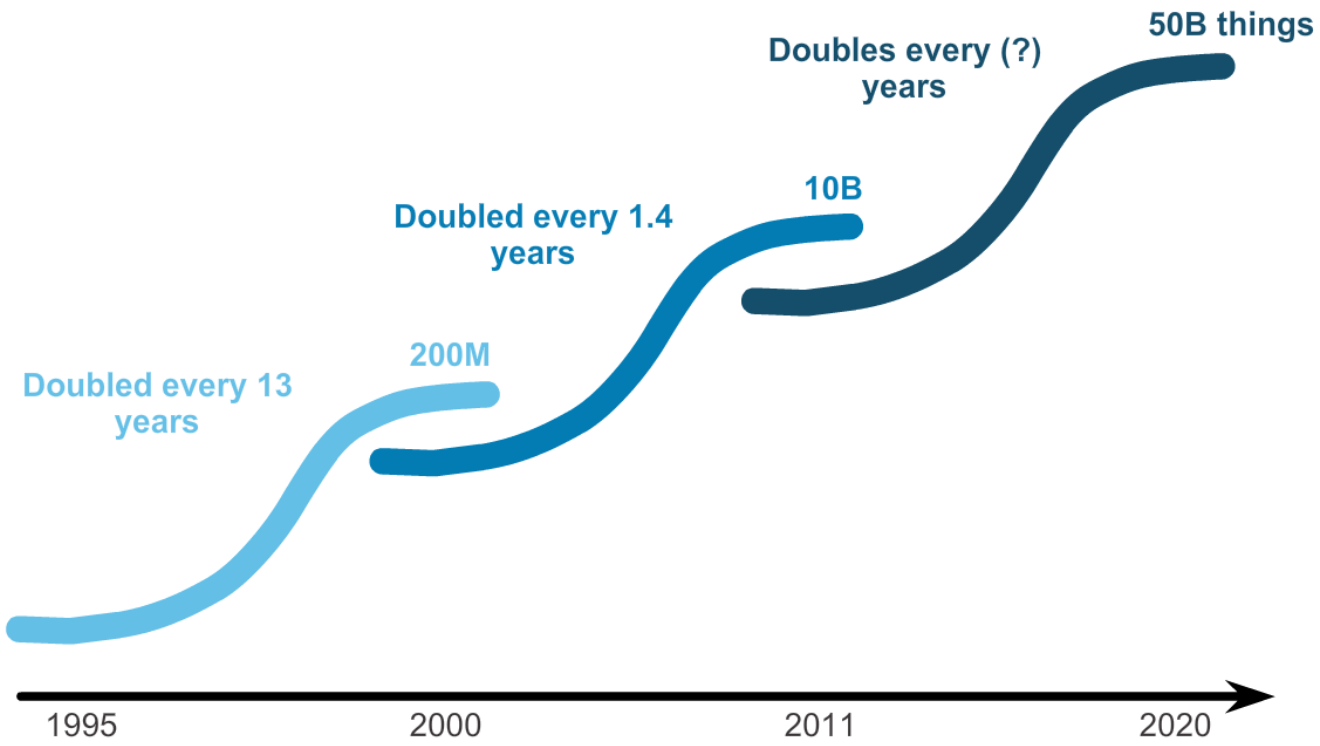
Networks in Our Past and Daily Lives

"Fixed" Computing (You go to the device)

Mobility/BYOD (The device goes with you)

Internet of Things (Age of Devices)

Internet of Everything (People, Process, Data, Things)



Interconnecting Our Lives

Networking Impacts in Our Daily Lives

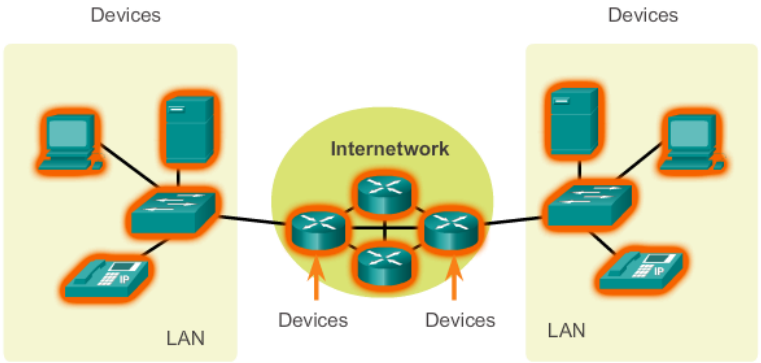
- Networks support the way we learn.
- Networks support the way we communicate.
- Networks support the way we work.
- Networks support the way we play.

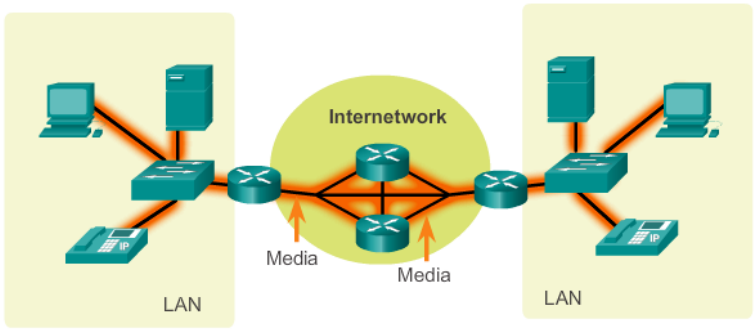
LANs, WANs, and Internets

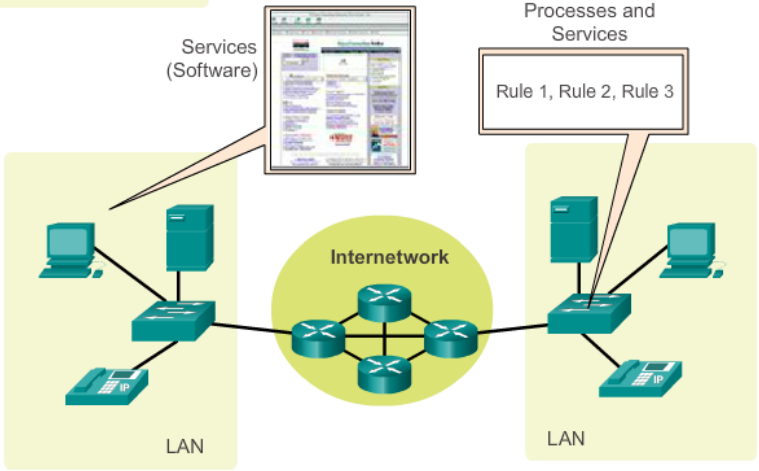
Components of a Network

There are three categories of network components:

- Devices
- Media
- Services







LANs and WANs

Types of Networks

The two most common types of network infrastructures are:

- Local Area Network (LAN)
- Wide Area Network (WAN).

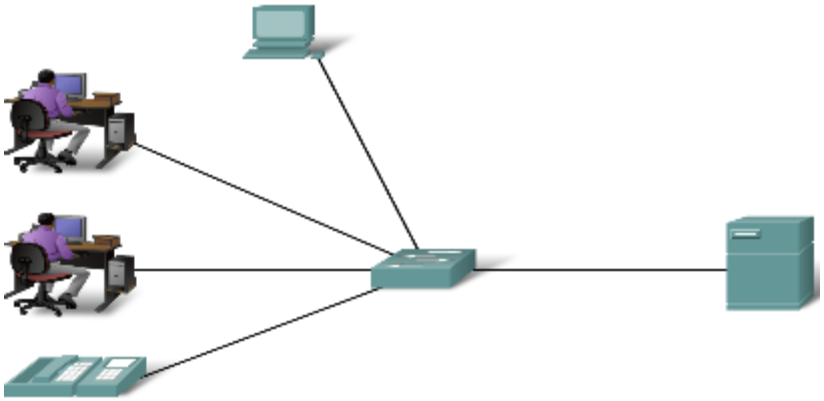
Other types of networks include:

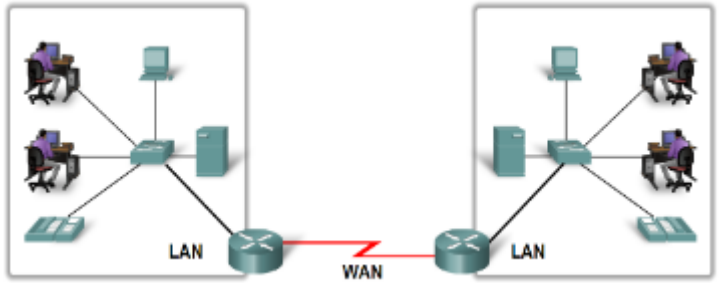
- Metropolitan Area Network (MAN)
- Wireless LAN (WLAN)

- The Local Area Networks (LANs)

  A network serving a home, building or campus is considered a Local Area Network (LAN

  - LANs separated by geographic distance are connected by networks known as WAN



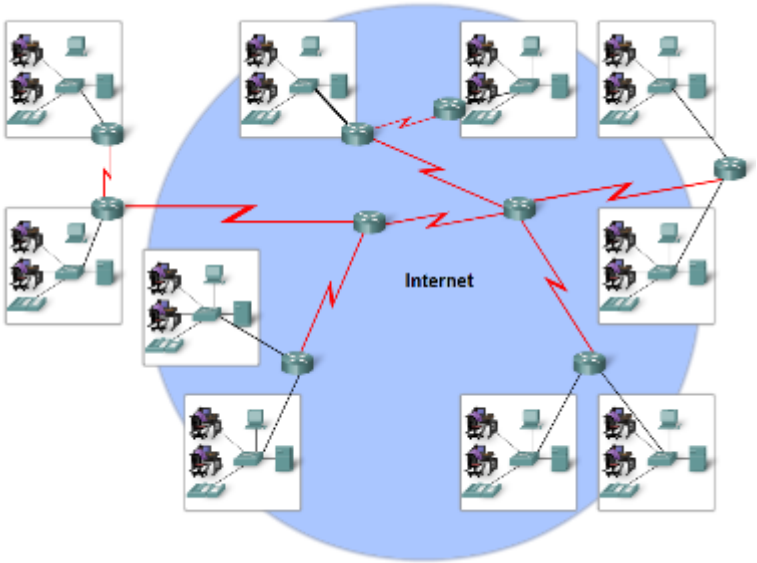


Network Types

- Define the Internet

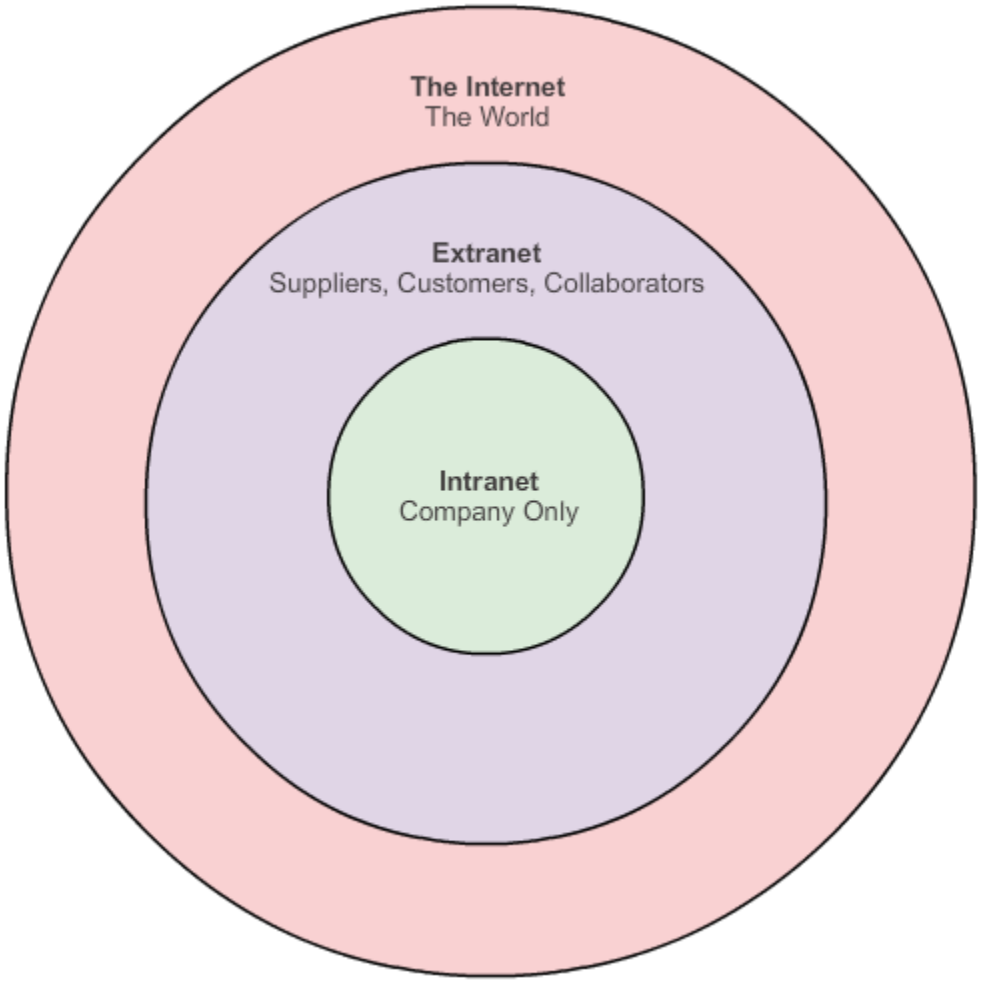
  The internet is defined as a

  global mesh of interconnected networks



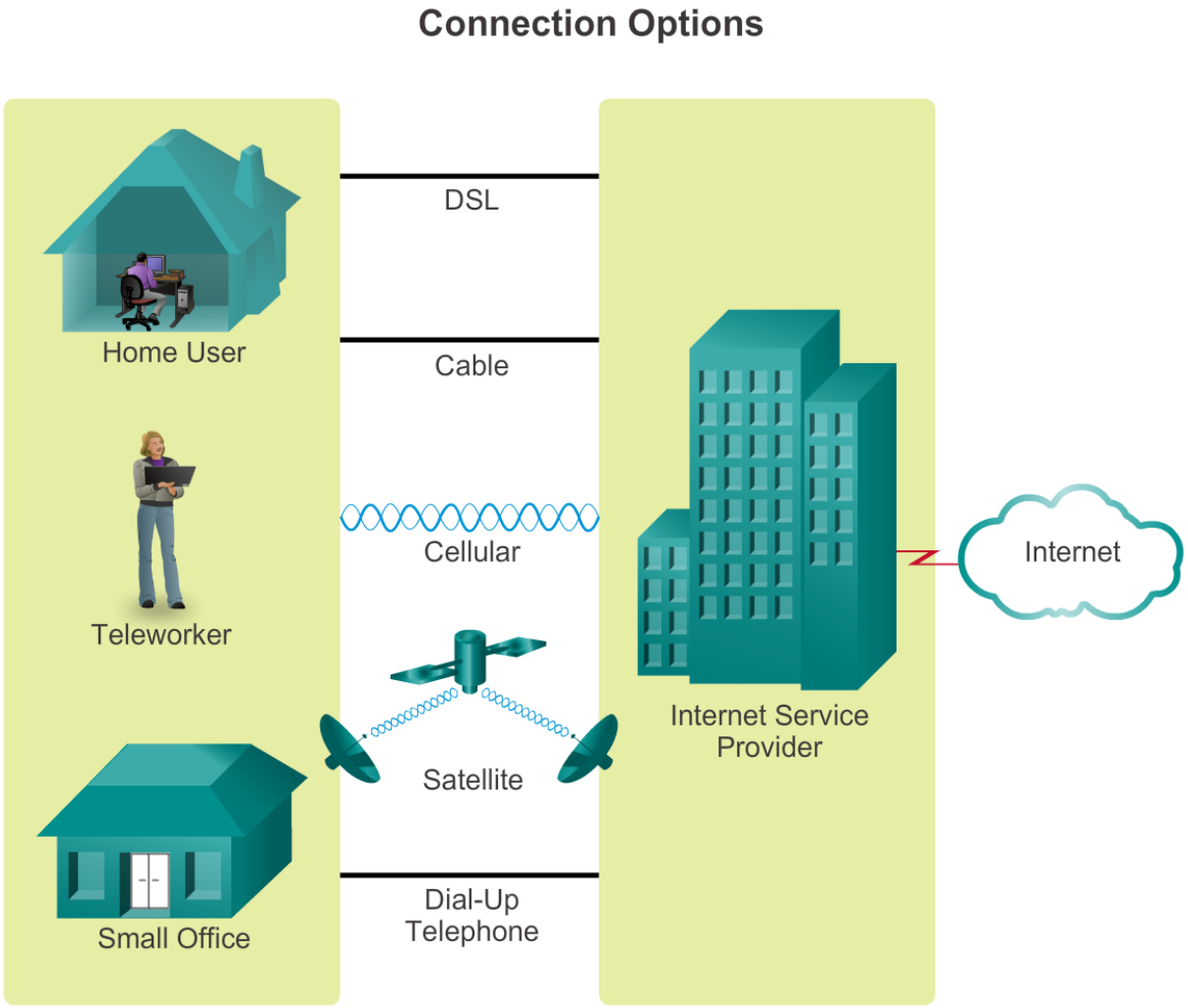
LANs, WANs, and the Internet

Intranet and Extranet



Connecting to the Internet

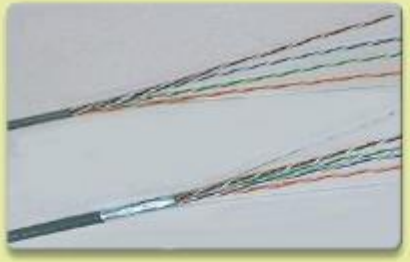
Connecting Remote Users to the Internet



Components of a Network

Network Media

Copper

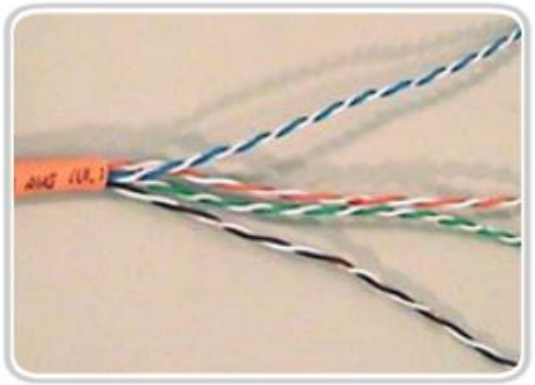


Fiber Optic

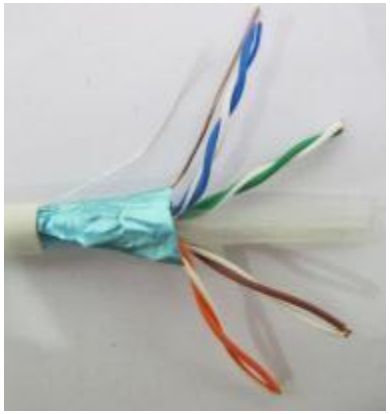
Wireless

Copper Cabling

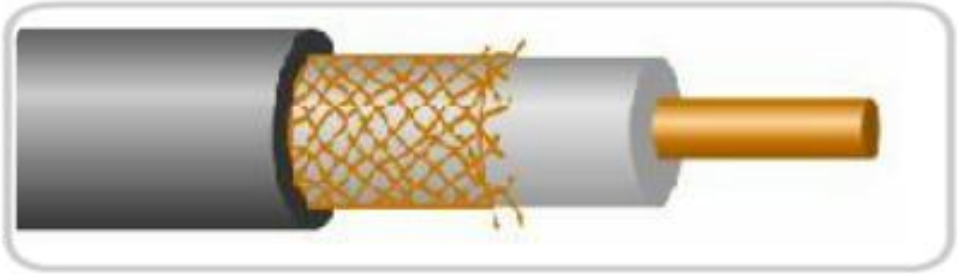
Copper Media



Unshielded Twisted Pair (UTP) Cable



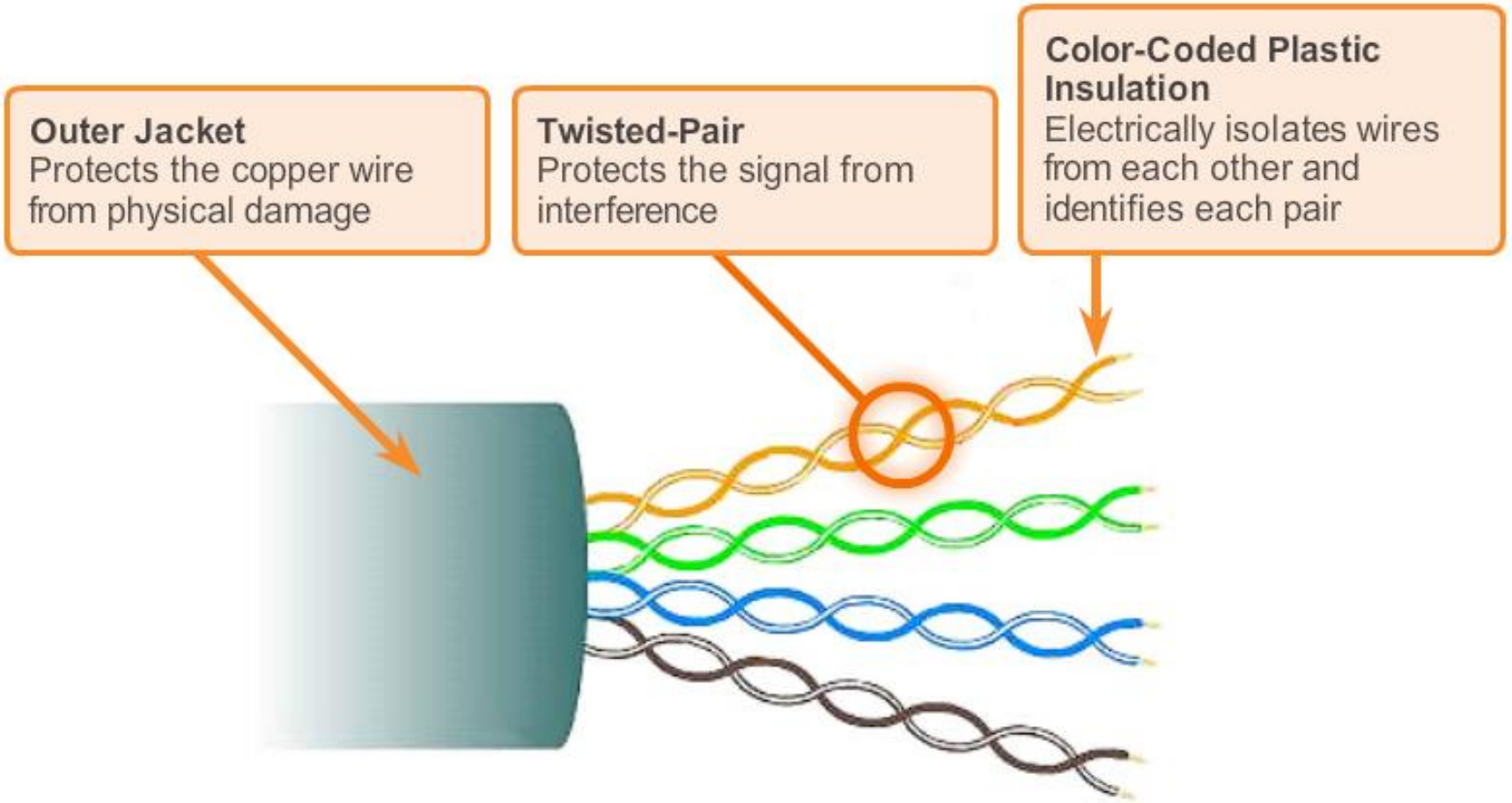
Shielded Twisted Pair (STP) Cable



Coaxial Cable

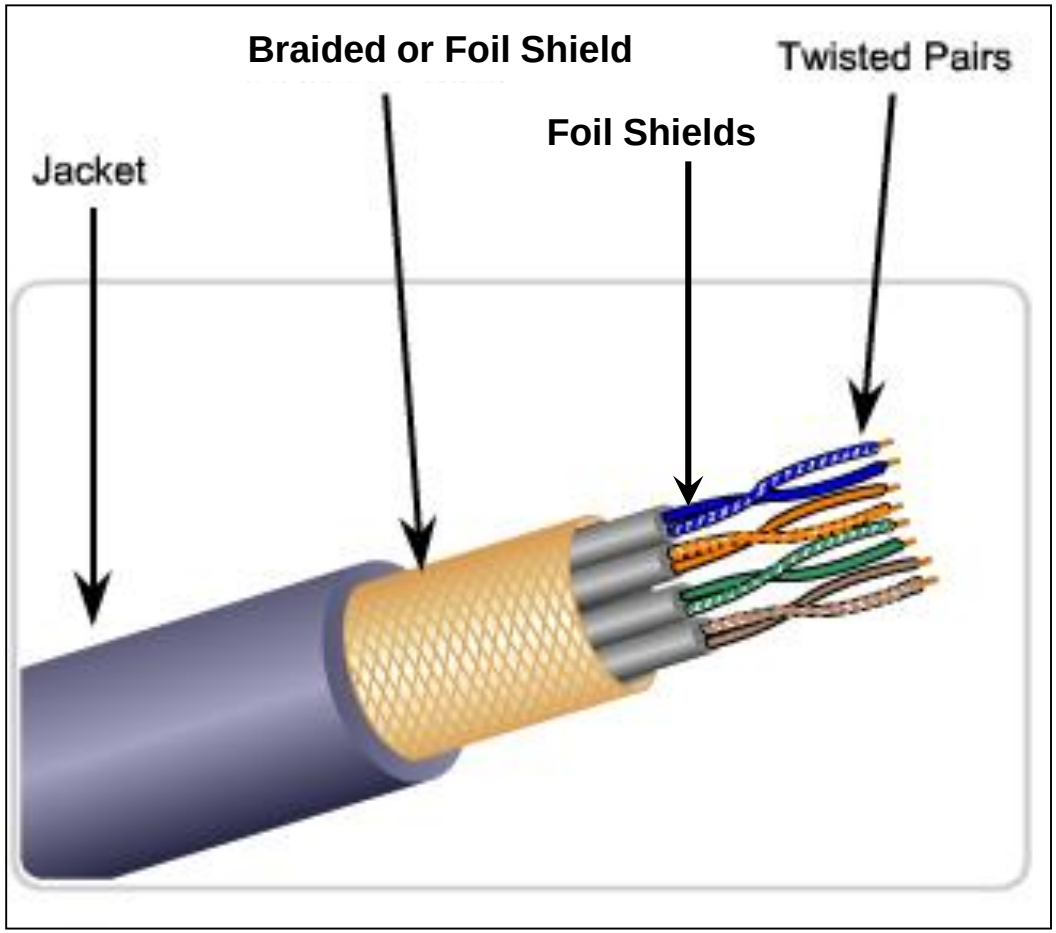
Copper Cabling

UTP Cable



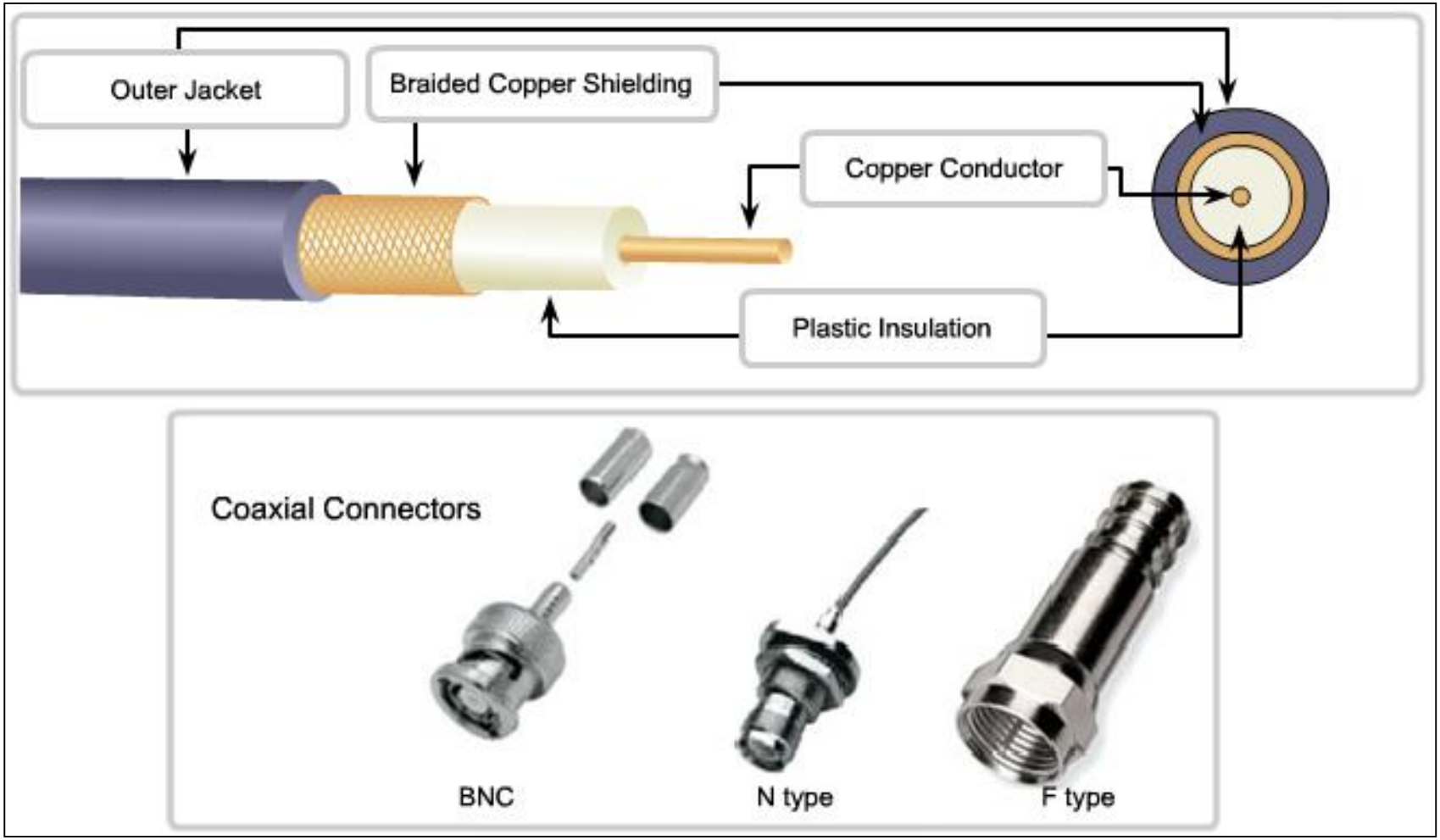
Copper Cabling

STP Cable



Copper Cabling

Coaxial Cable



Copper Cabling

Coop

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

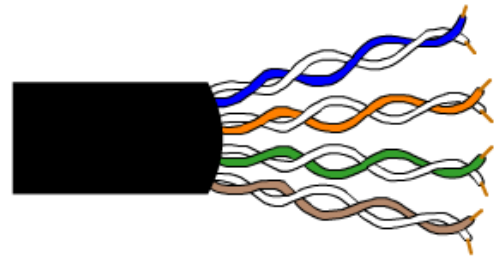
Cables must be connected correctly.

Installations must be inspected for damage.

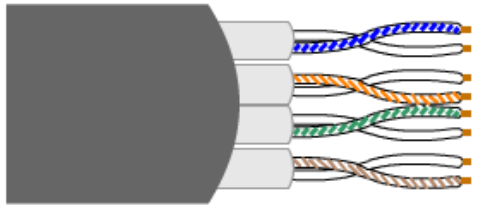
Equipment must be grounded correctly.

UTP Cabling

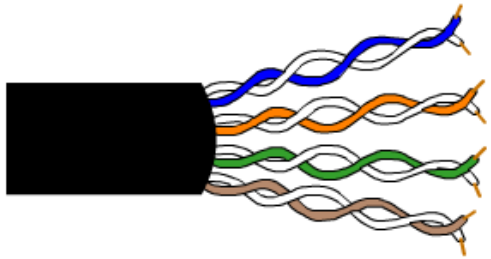
UTP Cabling Standards



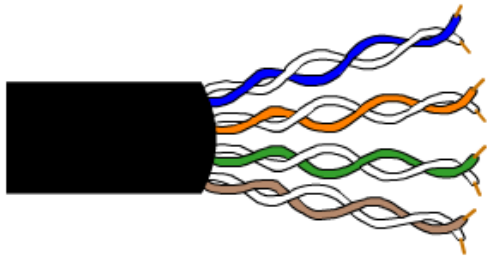
Category 3 Cable (UTP)



Category 7 Cable (ScTP)



Category 6 Cable (UTP)



Category 5 and 5e Cable (UTP)

Category 5 and 5e Cable (UTP)

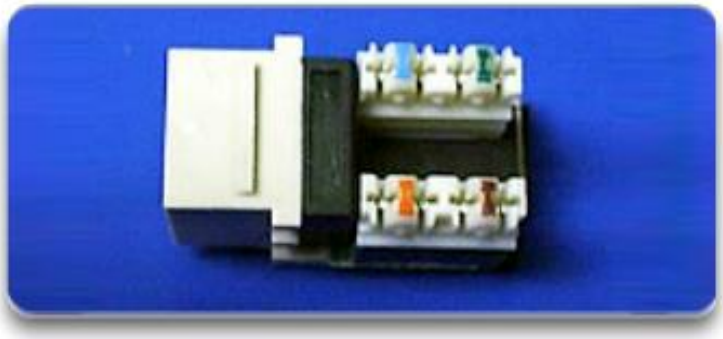
- Used for Data transmission
- Cat 5 supports 100 Mbps and can support 1000 Mbps but it is not recommended
- Cat 5e supports 1000 Mbps

UTP Cabling

UTP Connectors

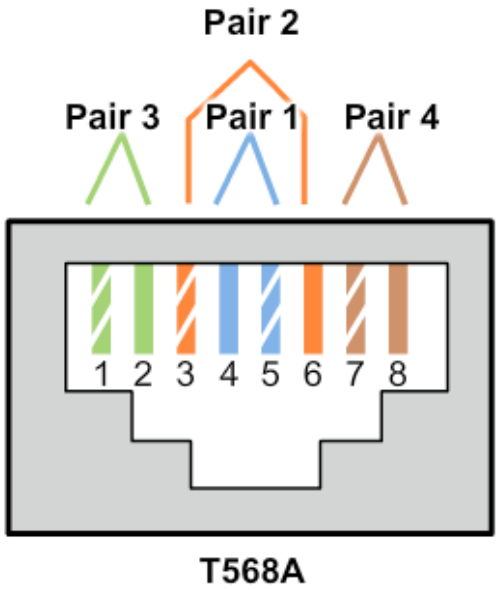
RJ-45 UTP Plugs

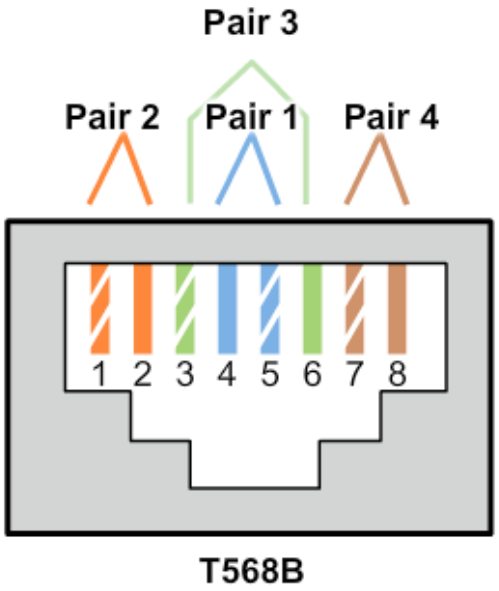
RJ-45 UTP Socket



UTP Cabling

Typ





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.

UTP Cabling

Testing UTP Cables

After installation, a UTP cable tester should be used to test for the following parameters:

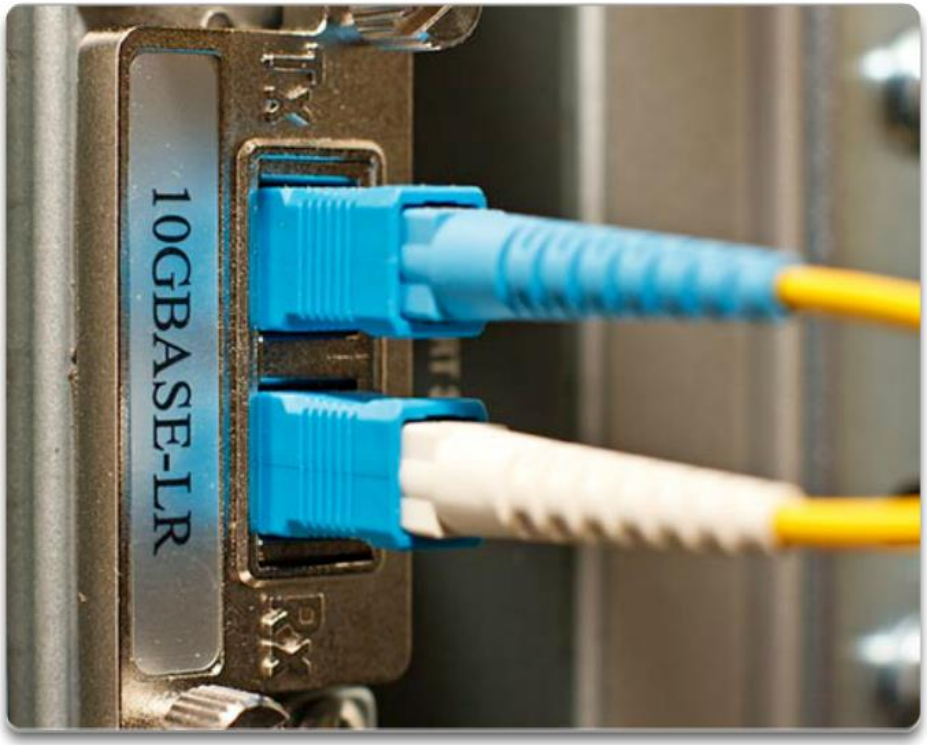
- Wire map
- Cable length
- Signal loss due to attenuation
- Crosstalk

Fiber Optic Cabling

Properties of Fiber Optic Cabling

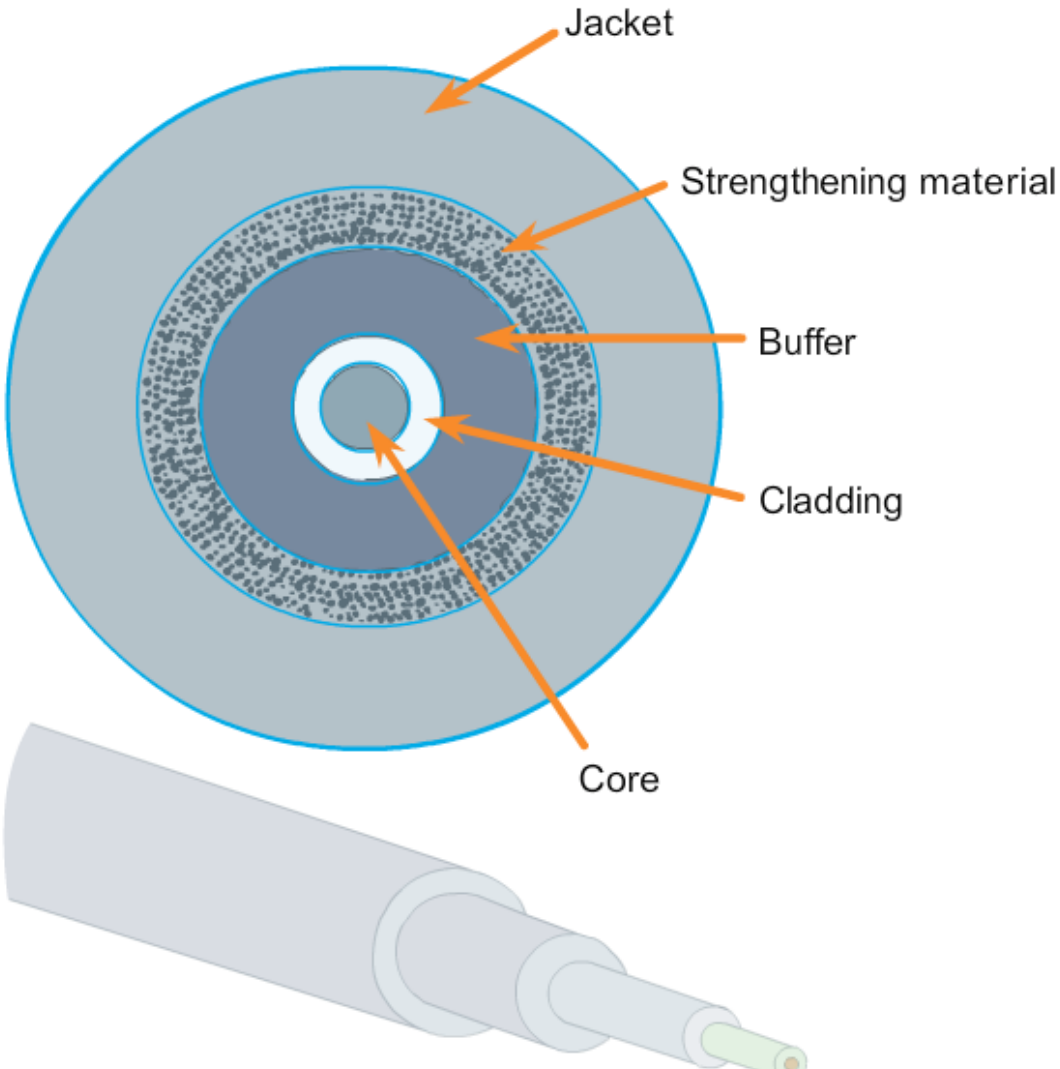
Fiber-optic cabling is now being used in four types of industry:

- Enterprise Networks
- Fiber-to-the-home (FTTH) and Access Networks
- Long-Haul Networks
- Submarine Networks



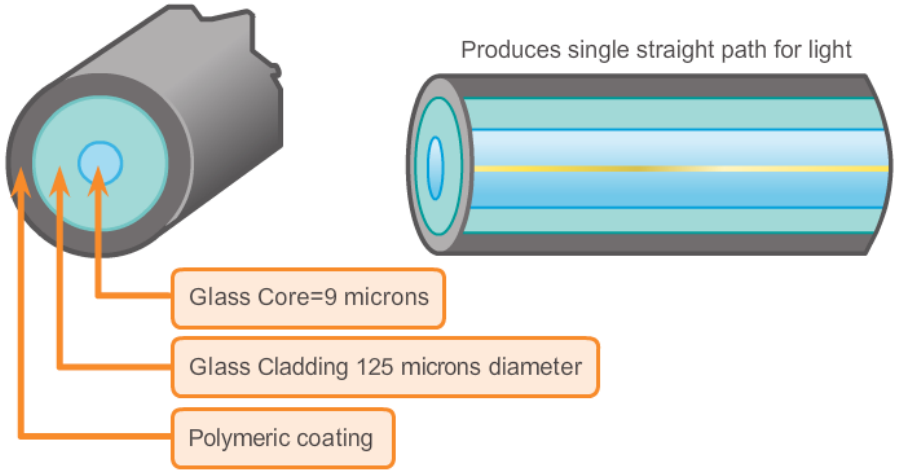
Fiber Optic Cabling

Fiber Media Cable Design



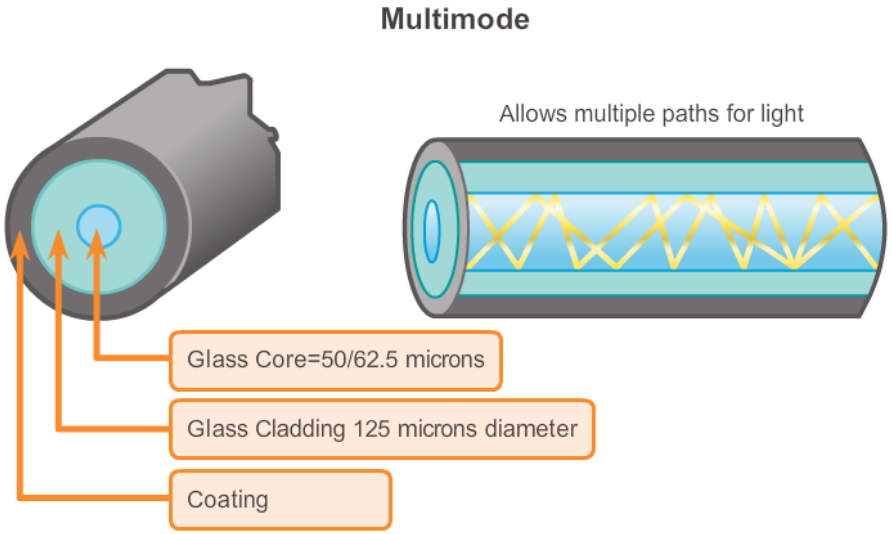
Fiber Optic Cabling

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

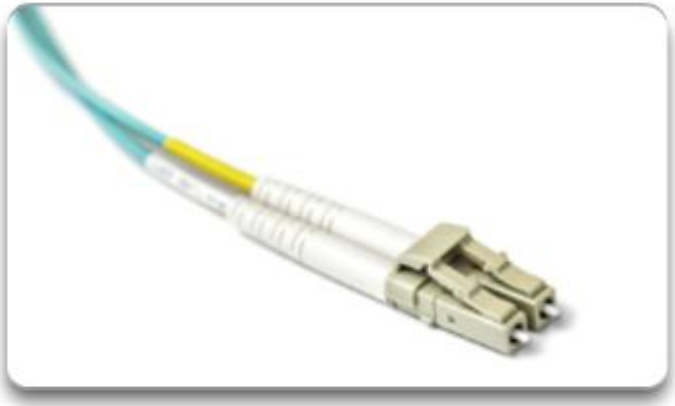
Fiber Optic Cabling

Network Fiber Connectors

ST Connectors

SC Connectors

LC Connector



Duplex Multimode LC Connectors

Fiber Optic Cabling

Testing Fiber Cables

Optical Time Domain Reflectometer (OTDR)

Fiber Optic Cabling

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

Wireless Media

Properties of Wireless Media

Wireless does have some areas of concern including:

- Coverage area
- Interference
- Security

Wireless Media

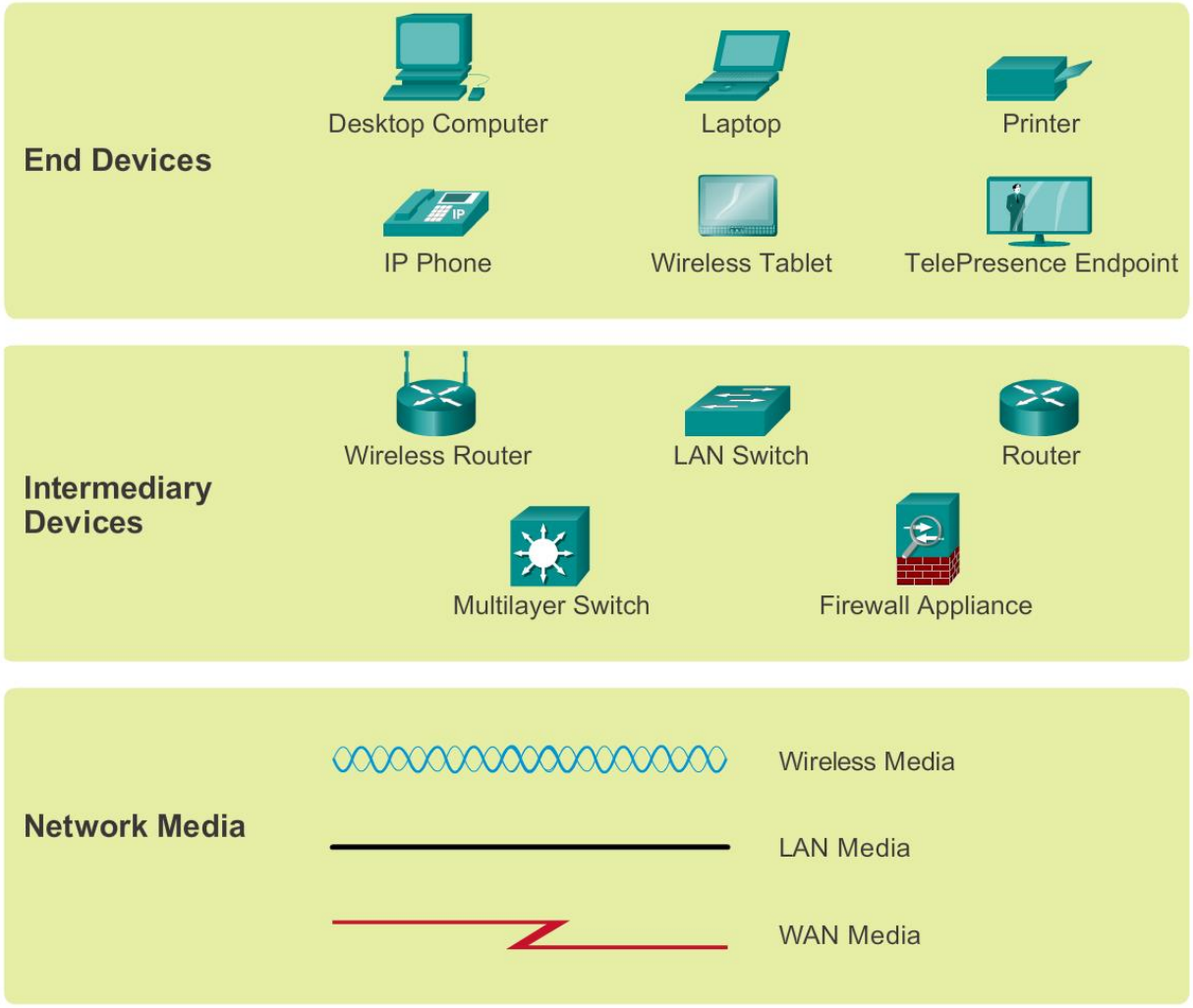
Types of Wireless Media

	• 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 Mb/s • 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.

Components of a Network

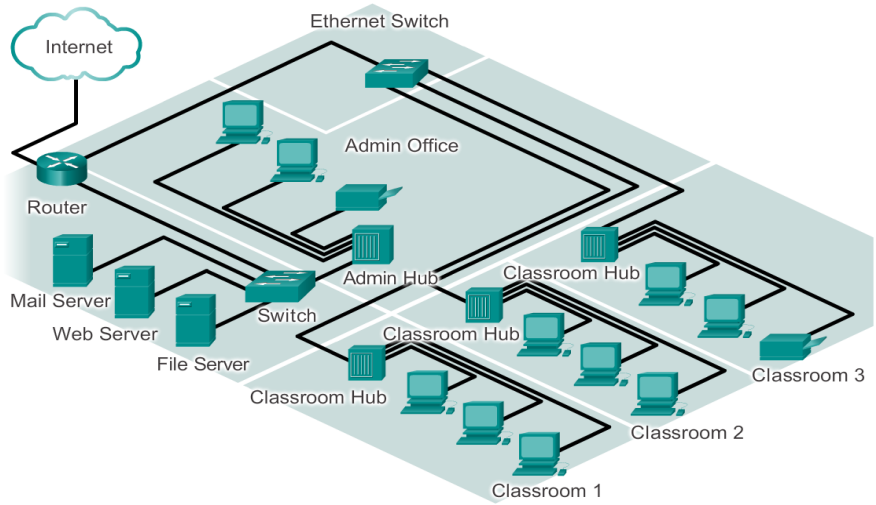
Network Representations



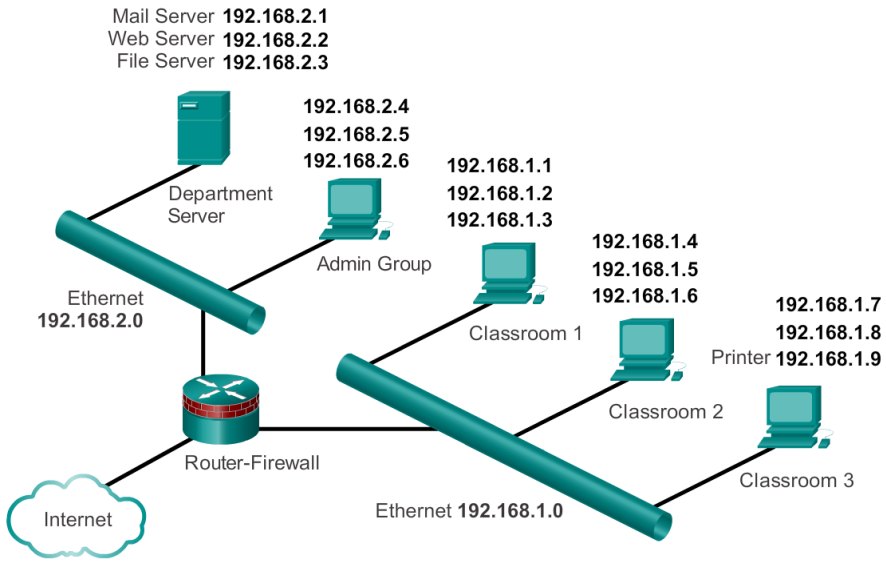
Components of a Network

Topology Diagrams

Physical Topology



Logical Topology



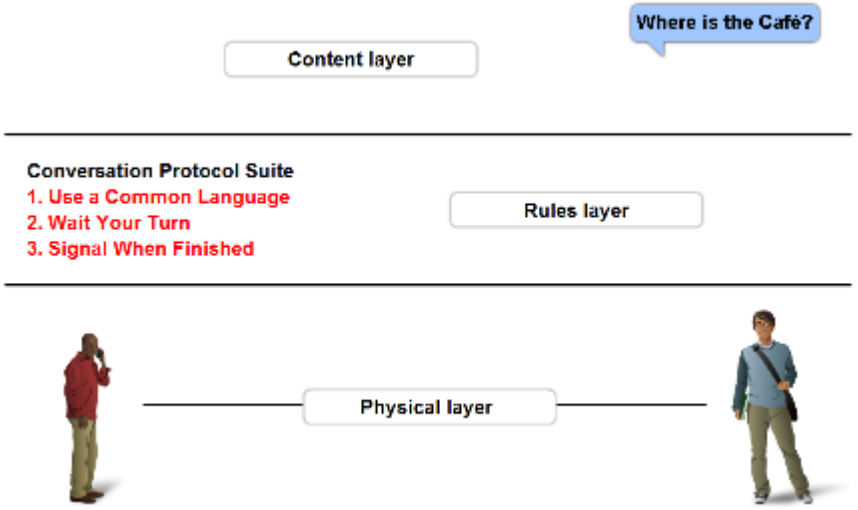
Network Protocols and Communications

Function of Protocol in Network Communication

A protocol is a set of predetermined rules

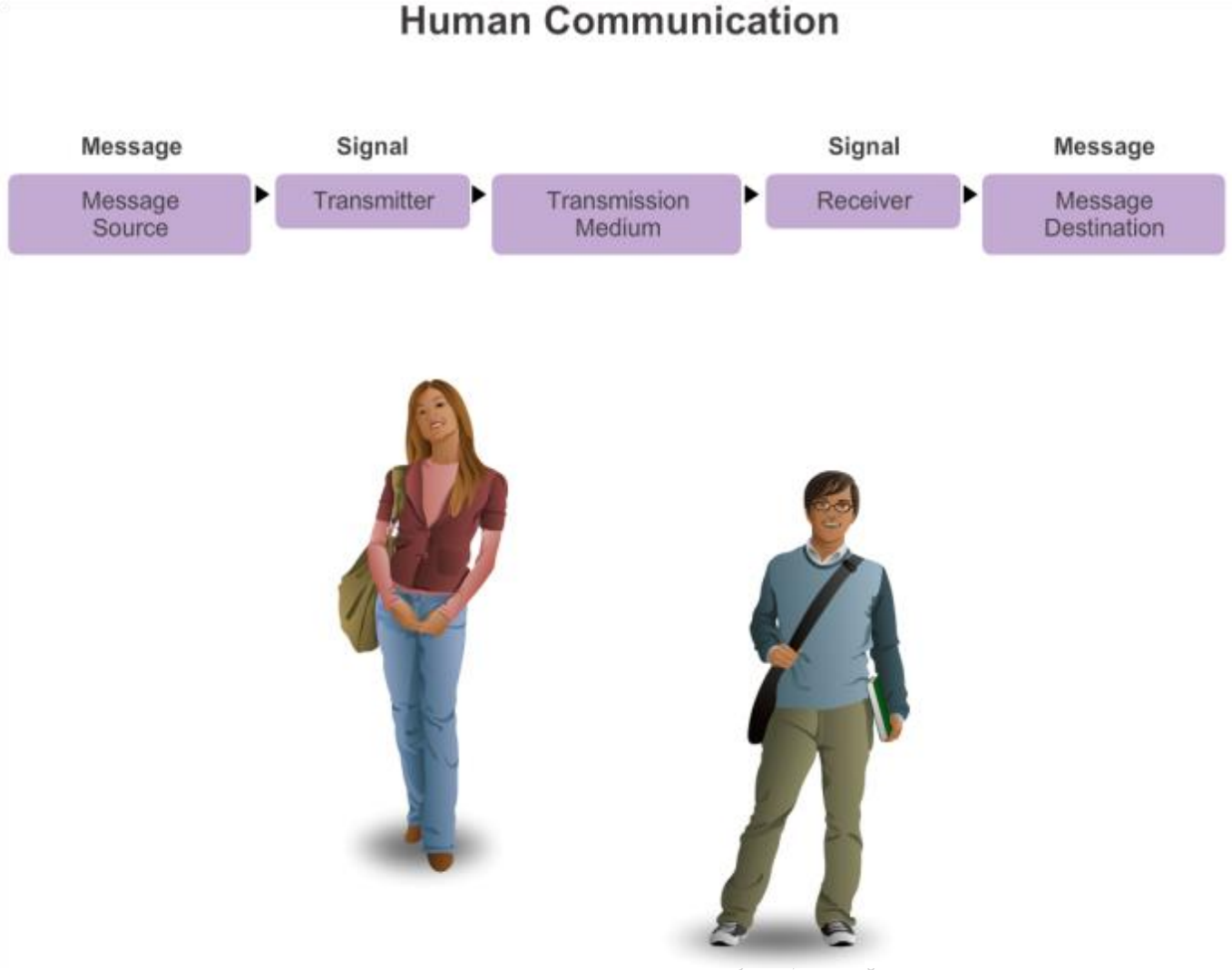
All communication, whether face-to-face or over a network, is governed by predetermined rules called protocols.

These protocols are specific to the characteristics of the conversation.



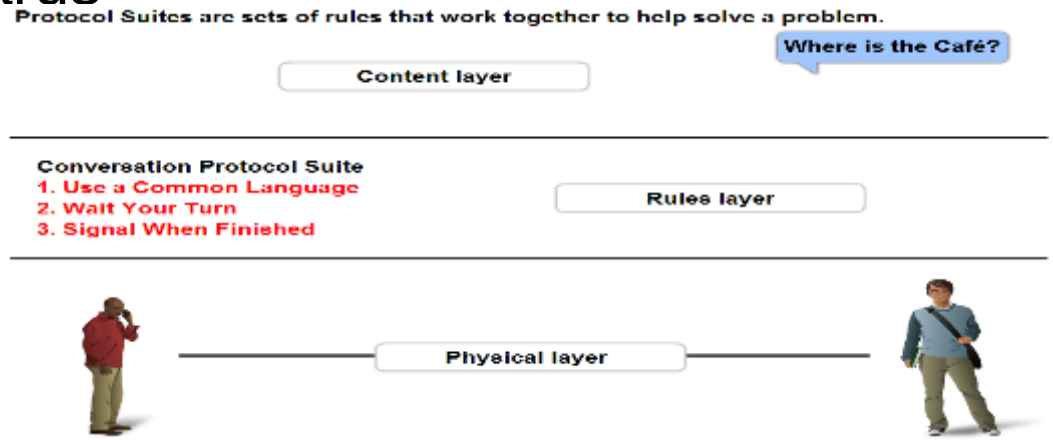
The Rules

What is Communication?



Function of Protocol in Network Communication

- Describe Protocol suites and industry standards



A standard is

a process or protocol that has been endorsed by the networking industry and ratified by a standards organization, Such as the **Institute of Electrical and Electronics Engineers (IEEE)** or the **Internet Engineering Task Force (IETF).**

Protocols

Network Protocols

- How the message is formatted or structured
- The process by which networking devices share information about pathways with other networks
- How and when error and system messages are passed between devices
- The setup and termination of data transfer sessions

Protocols

Interaction of Protocols

- Application Protocol – Hypertext Transfer Protocol (HTTP)
- Transport Protocol – Transmission Control Protocol (TCP)
- Internet Protocol – Internet Protocol (IP)
- Network Access Protocols – Data link & physical layers

Protocol Suites

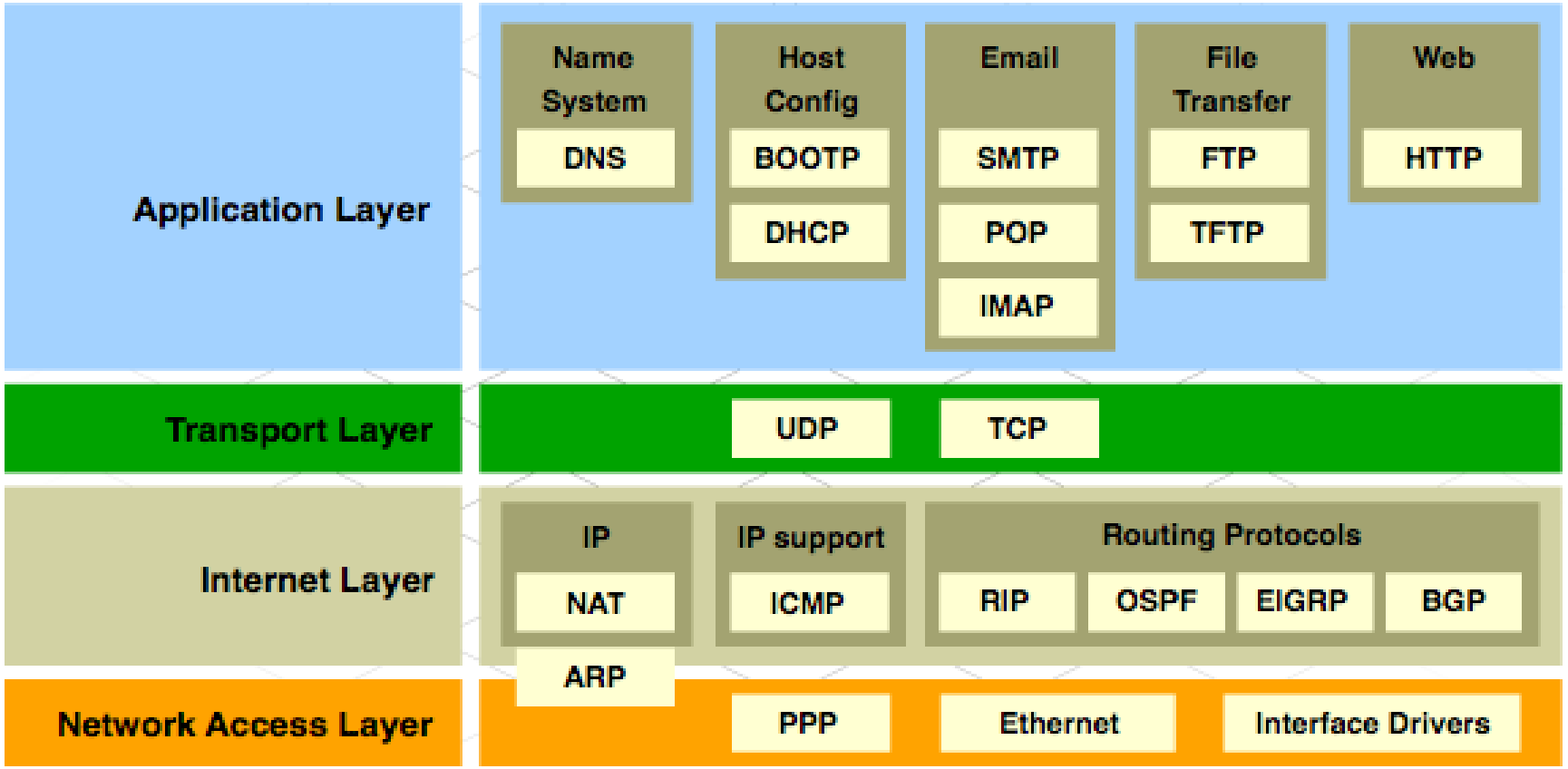
Protocol Suites and Industry Standards

Protocol Suites and Industry Standards

TCP/IP	ISO	AppleTalk	Novell Netware
HTTP DNS DHCP FTP	ACSE ROSE TRSE SESE	AFP	NDS
TCP UDP	TP0 TP1 TP2 TP3 TP4	ATP AEP NBP RTMP	SPX
IPv4 IPv6 ICMPv4 ICMPv6	CONP/CMNS CLNP/CLNS	AARP	IPX
Ethernet PPP Frame Relay ATM WLAN			

Protocol Suites

TCP/IP Protocol Suite and Communication



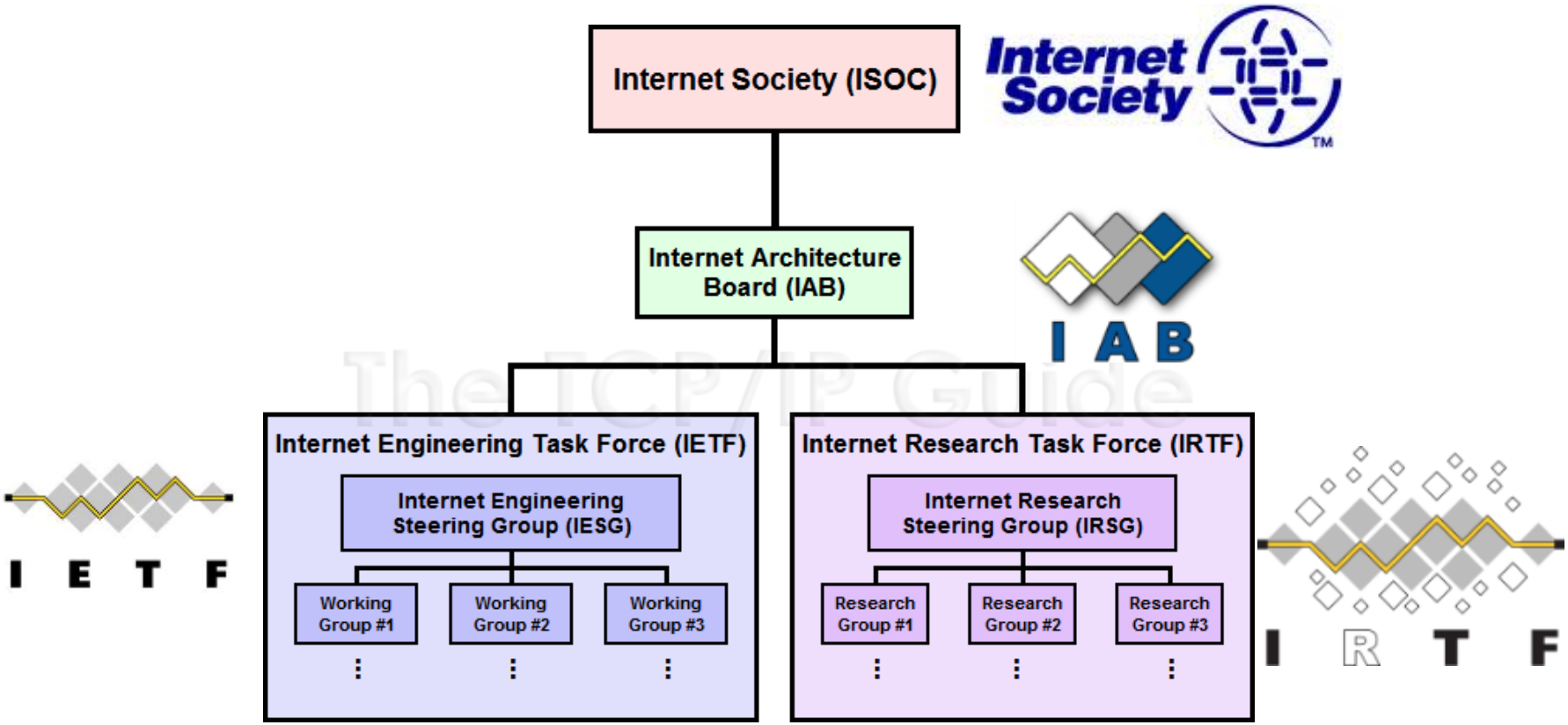
Standards Organizations

Open Standards

- The Internet Society (ISOC)
- The Internet Architecture Board (IAB)
- The Internet Engineering Task Force (IETF)
- Institute of Electrical and Electronics Engineers (IEEE)
- The International Organization for Standards (ISO)

Standards Organizations

ISOC, IAB, and IETF



Standards Organizations

ISO

OSI Model

7. Application
6. Presentation
5. Session
4. Transport
3. Network
2. Data link
1. Physical

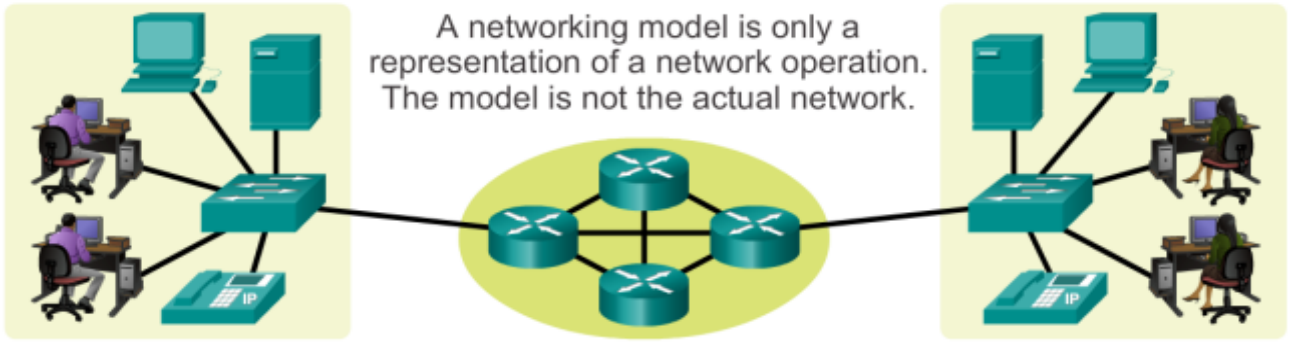
Standards Organizations

Other Standards Organization

- The Electronic Industries Alliance (EIA)
- The Telecommunications Industry Association (TIA)
- The International Telecommunications Union – Telecommunications Standardization Sector (ITU-T)
- The Internet Corporation for Assigned Names and Numbers (ICANN)
- The Internet Assigned Numbers Authority (IANA)

Reference Models

Benefits of Using a Layered Model



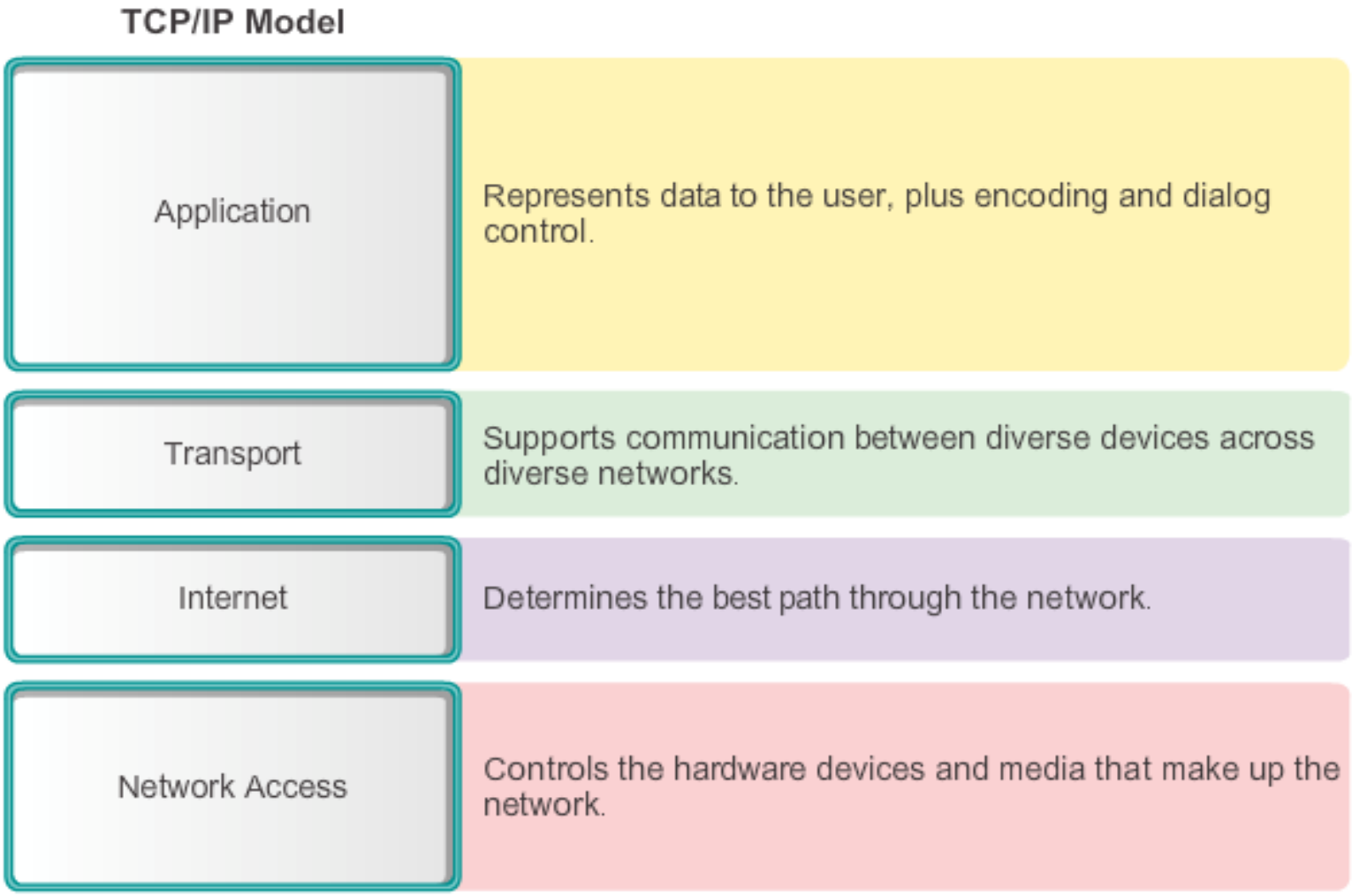
OSI Model	TCP/IP Protocol Suite	TCP/IP Model
Application	HTTP, DNS, DHCP, FTP	Application
Presentation		
Session		
Transport	TCP, UDP	Transport
Network	IPv4, IPv6, ICMPv4, ICMPv6	Internet
Data Link	PPP, Frame Relay, Ethernet	Network Access
Physical		

Reference Models

The OSI Reference Model

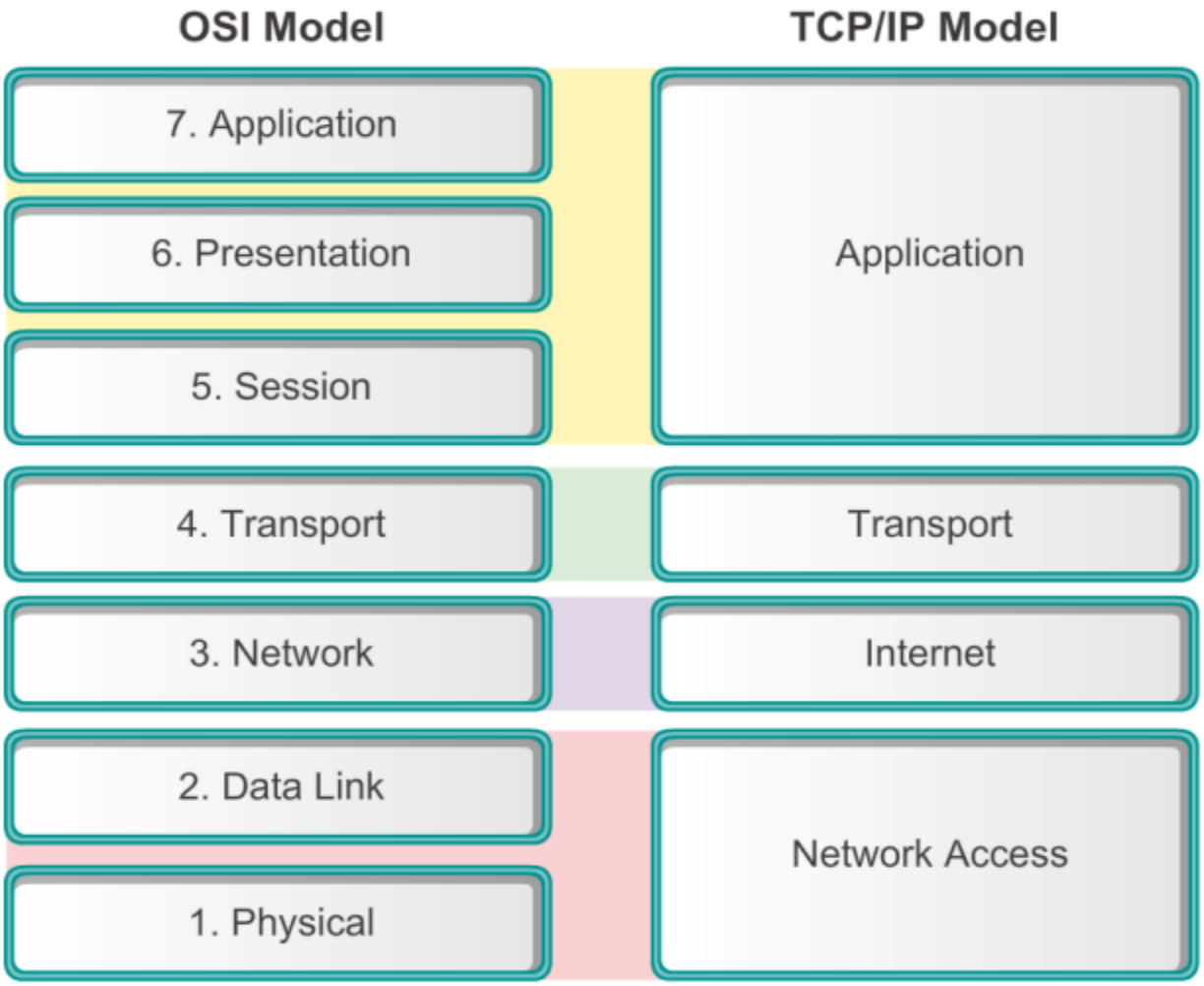
Reference Models

The TCP/IP Reference Model



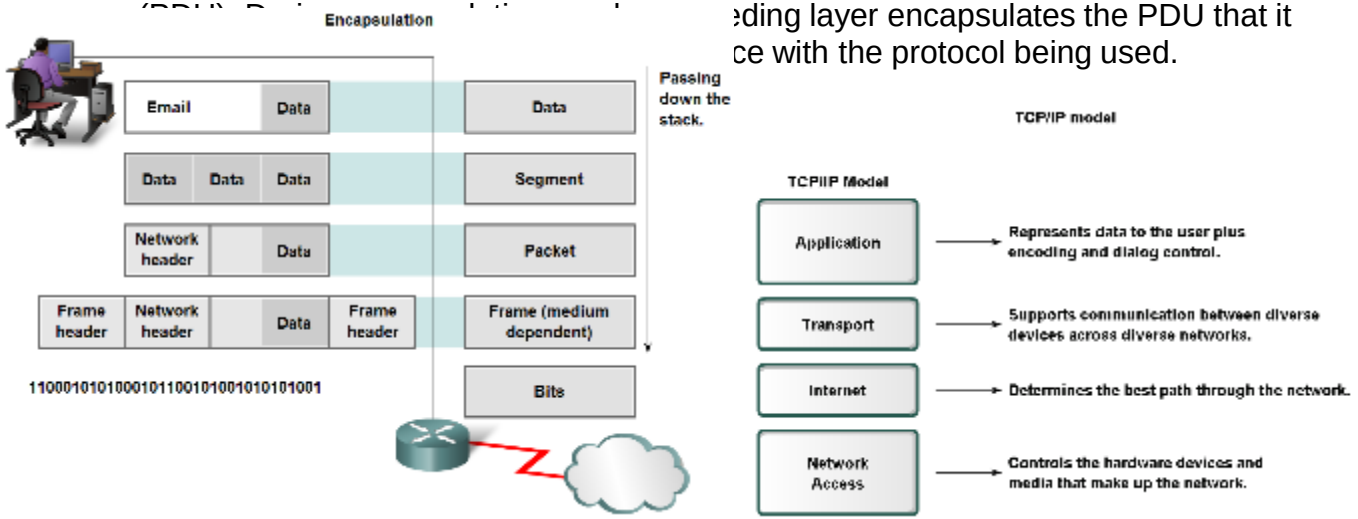
Reference Models

Comparing the OSI and TCP/IP Models



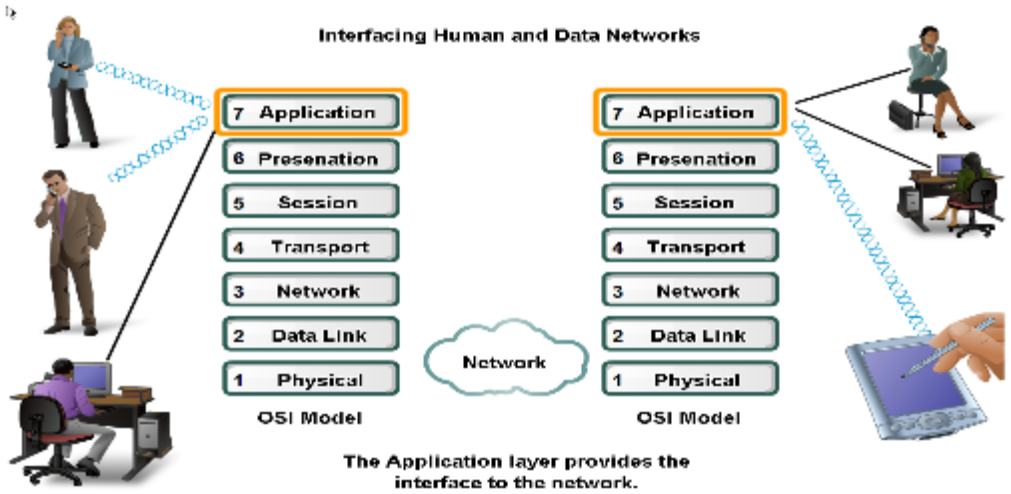
Layers with TCP/IP and OSI Model

- Explain protocol data units (PDU) and encapsulation
- As application data is passed down the protocol stack on its way to be transmitted across the network media, various protocols add information to it at each level. This is commonly known as the encapsulation process.
- The form that a piece of data takes at any layer is called a Protocol Data Unit (PDU). During encapsulation, each succeeding layer encapsulates the PDU that it receives with the protocol being used.



The Application Layer

- The Application layer provides the interface to the network.
- The application layer prepares human communication to be transmitted over the data network.



The Presentation Layer

The Presentation layer has three primary functions:

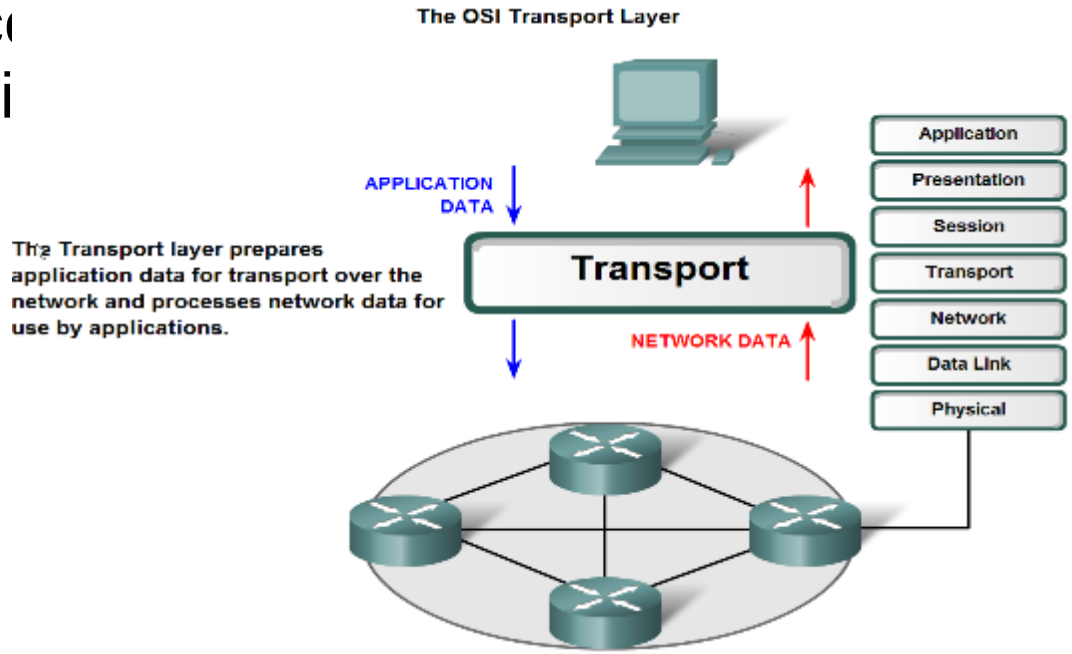
- **Coding** and conversion of Application layer data to ensure that data from the source device can be interpreted by the appropriate application on the destination device.
- **Compression** of the data in a manner that can be decompressed by the destination device.
- **Encryption** of the data for transmission and the decryption of data upon receipt by the destination.

The Session Layer

- As the name of the Session layer implies, functions at this layer create and maintain dialogs between source and destination applications.
- The Session layer handles the exchange of information to initiate **dialogs**, keep them **active**, and to restart sessions that are disrupted or idle for a long period of time.

The Transport Layer:

- The transport layer prepares the application data for transport over the network and proc
  appli



The Role of Transport Layer

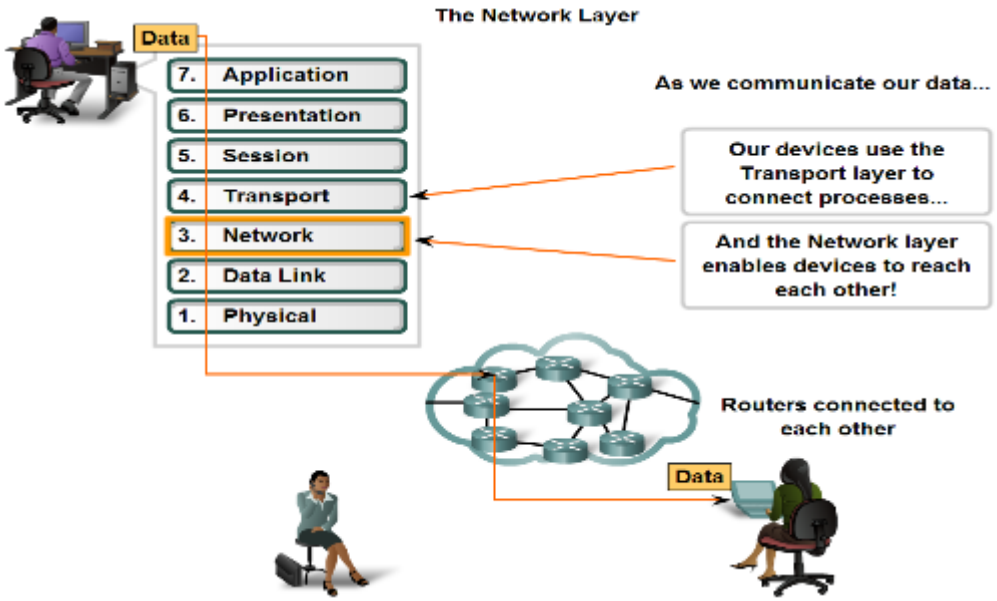
The Transport layer provides for the segmentation of data and the control necessary to reassemble these pieces into the various communication streams. Its primary responsibilities to accomplish this are:

- Tracking the individual communication between applications on the source and destination hosts
- Segmenting data and managing each piece
- Reassembling the segments into streams of application data
- Identifying the different applications

Network Layer Protocols and Internet Protocol (IP)

The basic role of the Network Layer in data networks

- The Network layer encapsulation allows its contents to be passed to the destination within a network or on another network with minimum overhead.

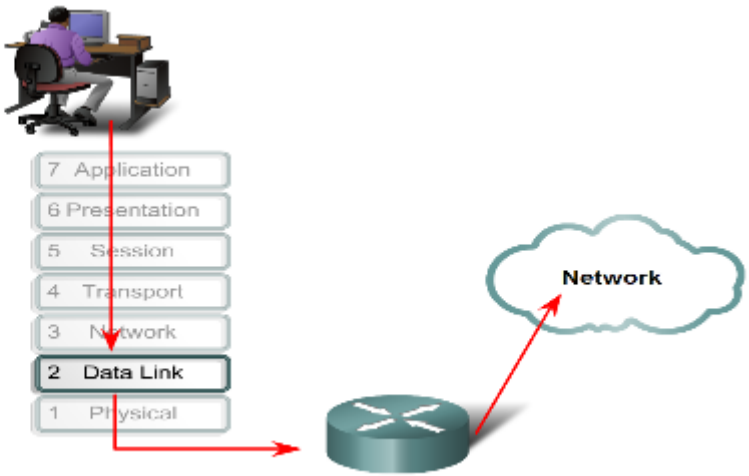


To accomplish this end-to-end transport, Layer 3 uses four basic processes:

- Addressing
- Encapsulation
- Routing
- Decapsulation

The Data Link Layer

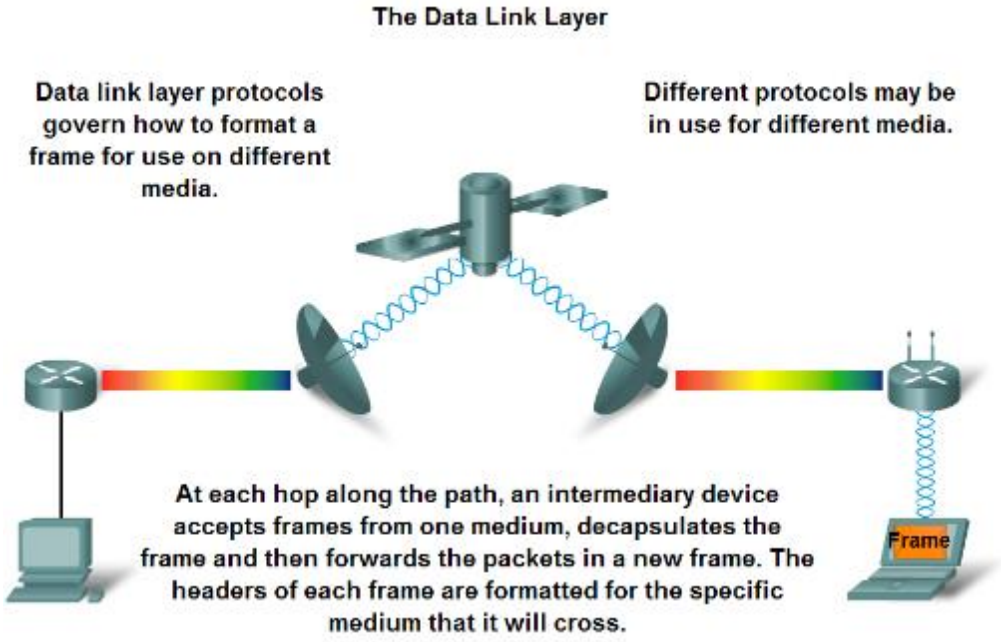
- The data link layer provides a means for exchanging data over a common local media.



The Data Link layer prepares network data for the physical network.

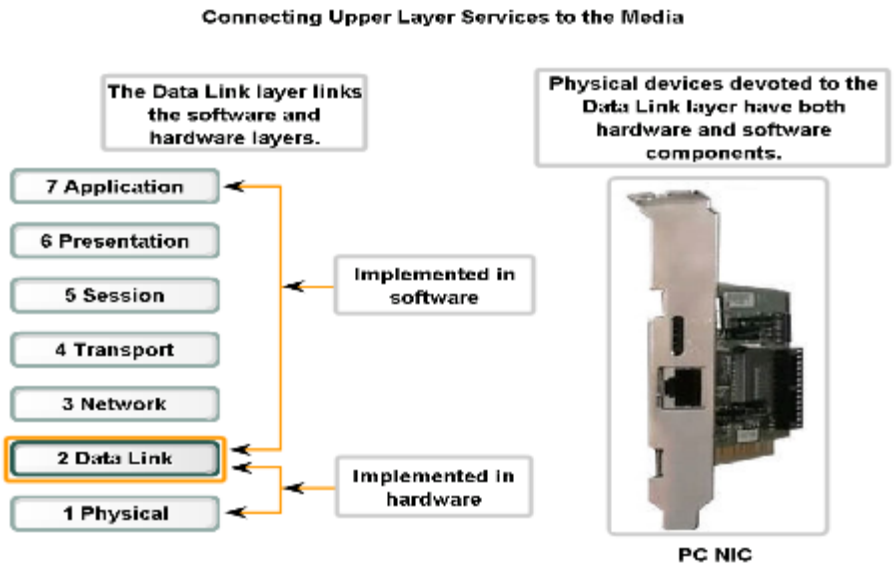
Data Link Layer – Accessing the Media

why Data Link layer protocols are required to control media access?



Data Link Layer – Accessing the Media

- Describe the role the Data Link layer plays in linking the software and hardware layers
- The Data Link layer exists as a connecting layer between the software processes of the layers above it and the Physical layer below it. As such, it prepares the Network layer packets for transmission across some form of media, be it copper, fiber, or the atmosphere.



Data Link Sublayers

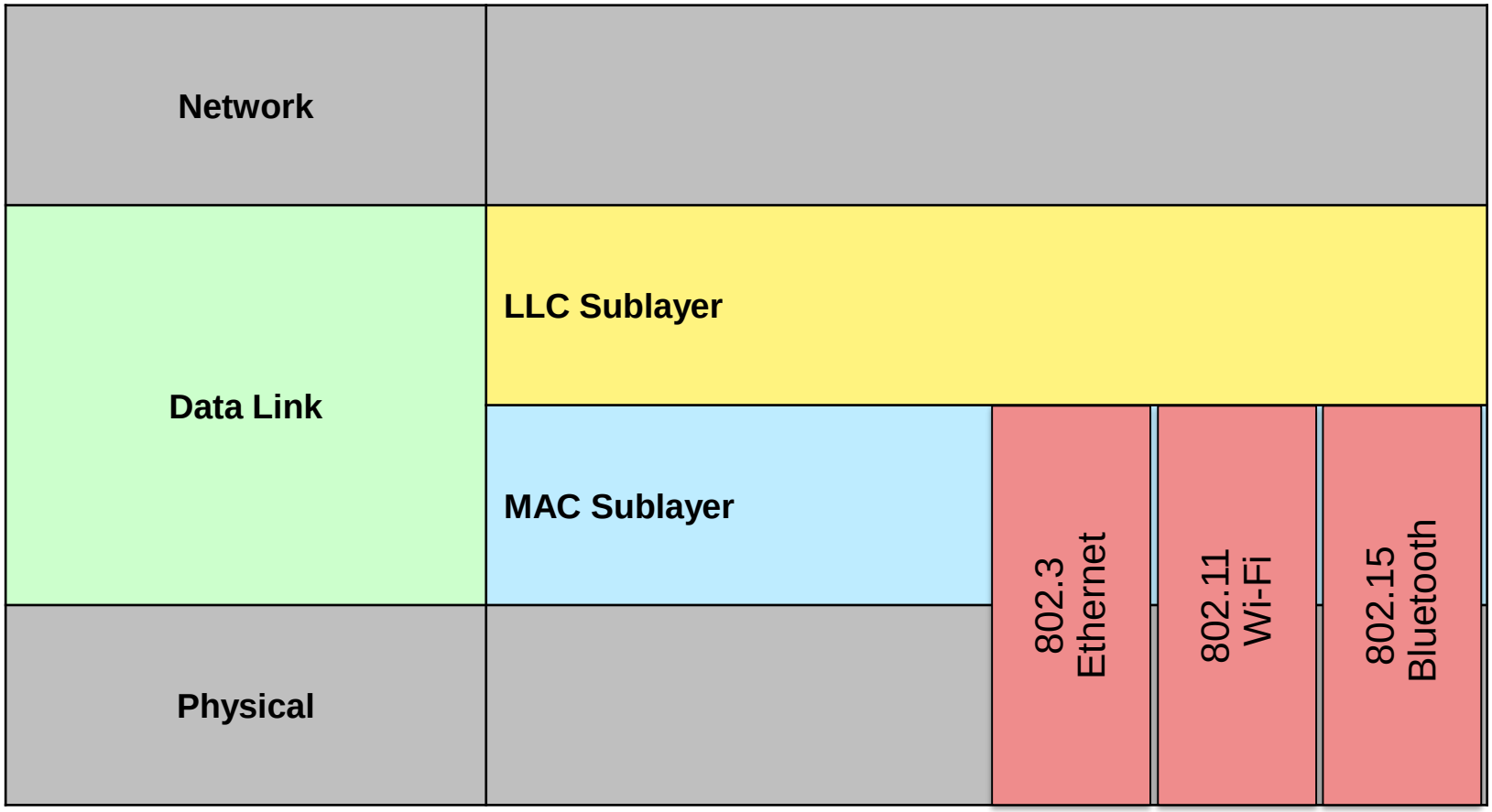
- To support a wide variety of network functions, the Data Link layer is often divided into two sublayers: an upper sublayer and an lower sublayer.
- The **upper sublayer** defines the software processes that provide services to the Network layer protocols.
- The **lower sublayer** defines the media access processes performed by the hardware.

The two common LAN sublayers are:

- **Logical Link Control**
- Logical Link Control (LLC) places information in the frame that identifies which Network layer protocol is being used for the frame. This information allows multiple Layer 3 protocols, such as IP and IPX, to utilize the same network interface and media.
- **Media Access Control**
- Media Access Control (MAC) provides Data Link layer addressing and delimiting of data according to the physical signaling requirements of the medium and the type of Data Link layer protocol in use.

Purpose of the Data Link Layer

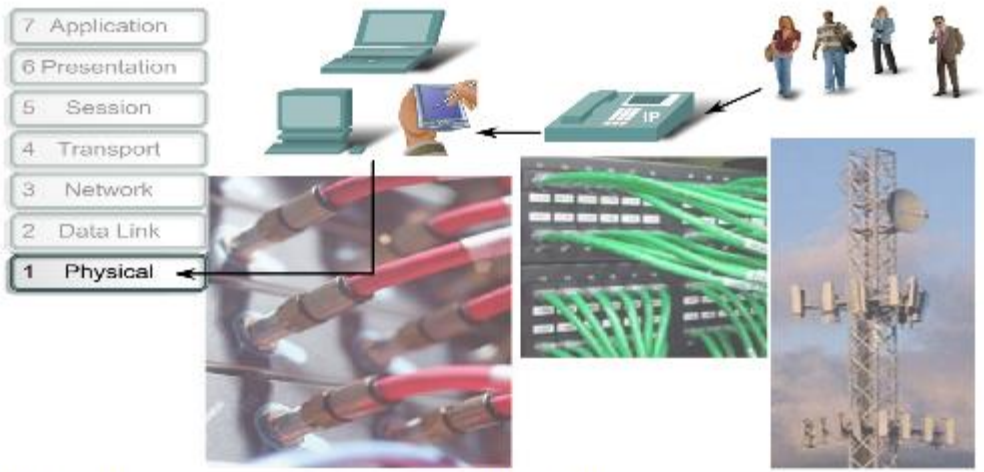
Data Link Sublayers



Physical Layer Protocols & Services

Purpose of the Physical Layer

- The role of the OSI physical layer is to encode the binary digits that represent data link layer frames into signals and to transmit and receive these signals across the physical media—copper wires, optical fiber, and wireless—that connect network devices.



The Physical layer interconnects our data networks.

Purpose of Physical Layer

To prepare a data-link frame for the journey across the medium, the physical layer ***encodes*** the logical frame with patterns of data that will make it recognizable to the device that will pick it up on the other end of the medium. The device can be a router that will forward the frame or the destination device.

The delivery of frames across the local media requires the following physical layer elements:

- The physical media and associated connectors
- A representation of bits on the media
- Encoding of data and control information
- Transmitter and receiver circuitry on the network devices

After the signals traverse the medium, they are decoded to their original bit representations of data and given to the data link layer as a complete frame.