Networking

Networking Questions …

- How will each computer be identified?
- If two or more computers want to talk at the same time, how do you ensure all conversations are understood?
- What kind of wire? What gauge? How many wires in the cable? Which wires do which things?
- How long can the cable be?
- What type of connectors?
- If more than one PC accesses the same file, how can they be prevented from destroying each other's changes to that file?
- How can access to data and peripherals be controlled?

Ref: CompTIA A+ Certification all in one exams

Networking – Whats required …

- Most commonly, you have a *client machine, a PC that requests information* or services.
- It needs a *network interface card (NIC) that defines or labels the client on the* network.
- A NIC also helps break files into smaller data units, called *packets, to send* across the network, and it helps reassemble the packets it receives into whole files.
- Secondly A medium is required for delivering the packets between two or more PCs— most often this is a wire that can carry electrical pulses; sometimes it's radio waves or other wireless methods.

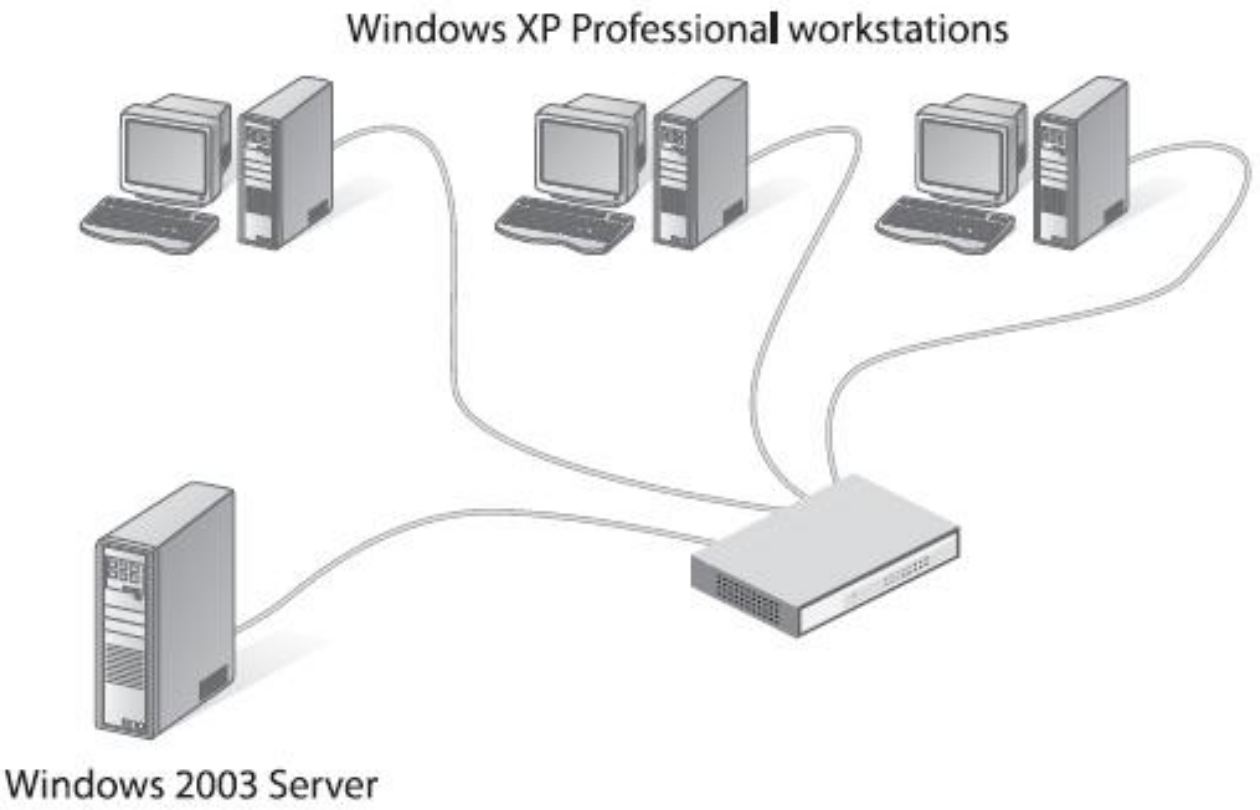
Ref: CompTIA A+ Certification all in one exams

Networking - Whats required …

- Third, your PC's operating system has to be able to communicate with its own networking hardware and with other machines on the network.
- Finally, modern PC networks often employ a *server machine that provides information or* services.

Ref: CompTIA A+ Certification all in one exams

Networking – What's required



Ref: CompTIA A+ Certification all in one exams

Packets/Frames and NICs

- Data is moved from one PC to another in discrete chunks called packets or frames.
- The terms packet and frame are interchangeable. Every NIC in the world has a built-in identifier,a binary address unique to that single network card, called a media access control(MAC) address.
- Every network card in the world has its own unique MAC addres!

Ref: CompTIA A+ Certification all in one exams

Packets/Frames and NICs ..

- The MAC address is 48 bits long, providing more than 281 trillion MAC
- addresses, so there are plenty of MAC addresses to go around.
- MAC addresses may be binary, but we represent them using 12 hexadecimal characters.
- These MAC addresses are burned into every NIC, and some NIC makers print the MAC address on the card.

Ref: CompTIA A+ Certification all in one exams

Packets/Frames and NICs ..

- Packets contain the MAC address of the network card to which the data is being sent.
- Second, they have the MAC address of the network card that sent the data.

- Third is the data itself which can vary in size depending on the type of frame.

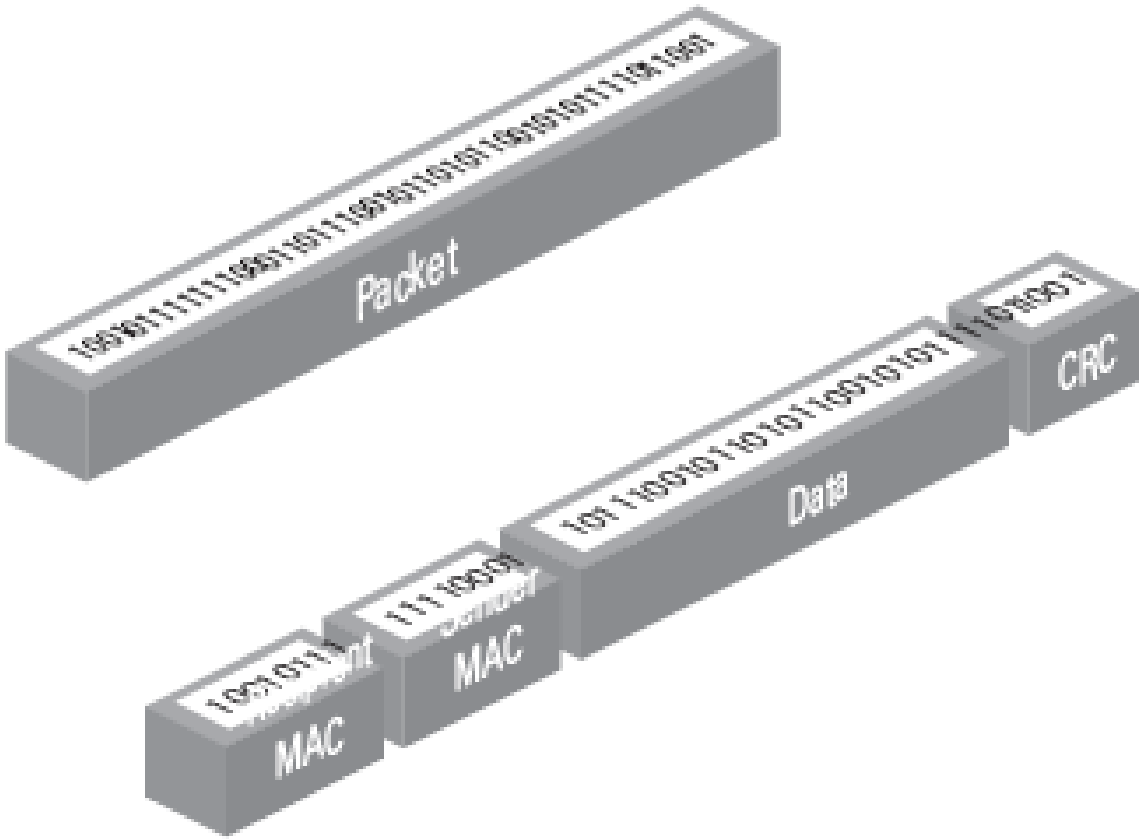
Ref: CompTIA A+ Certification all in one exams

Packets/Frames and NICs ..

- Finally, some type of data check (cyclic redundancy check or CRC) is performed and information is stored in the packet to enable the receiving network card to verify if the data was received in good order.

Ref: CompTIA A+ Certification all in one exams

Packets/Frames and NICs ..



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Hardware Protocol

- To make a successful network, you need the sending and receiving PCs to use the same hardware protocol.
- A *hardware protocol defines many aspects of a network, from* the topology, to the packet type, to the cabling and connectors used.
- A hardware protocol defines everything necessary to get data from one computer to another.

Ref: CompTIA A+ Certification all in one exams

UTP Ethernet (10/100/100BaseT)

- Most modern Ethernet networks employ one of three technologies and sometimes all three, *10BaseT, 100BaseT, or 1000BaseT.*
- 10BaseT networks run at 10 Mbps,
- 100BaseT networks run at 100 Mbps,
- 1000BaseT networks—called Gigabit Ethernet—run at 1000 Mbps, or 1 Gbps.

Ref: CompTIA A+ Certification all in one exams

Ethernet..

- A consortium of companies centered on Digital Equipment, Intel, and Xerox invented the first network in the mid-1970s.
- More than just creating a network, they wrote a series of standards that defined everything necessary to get data from one computer to another.

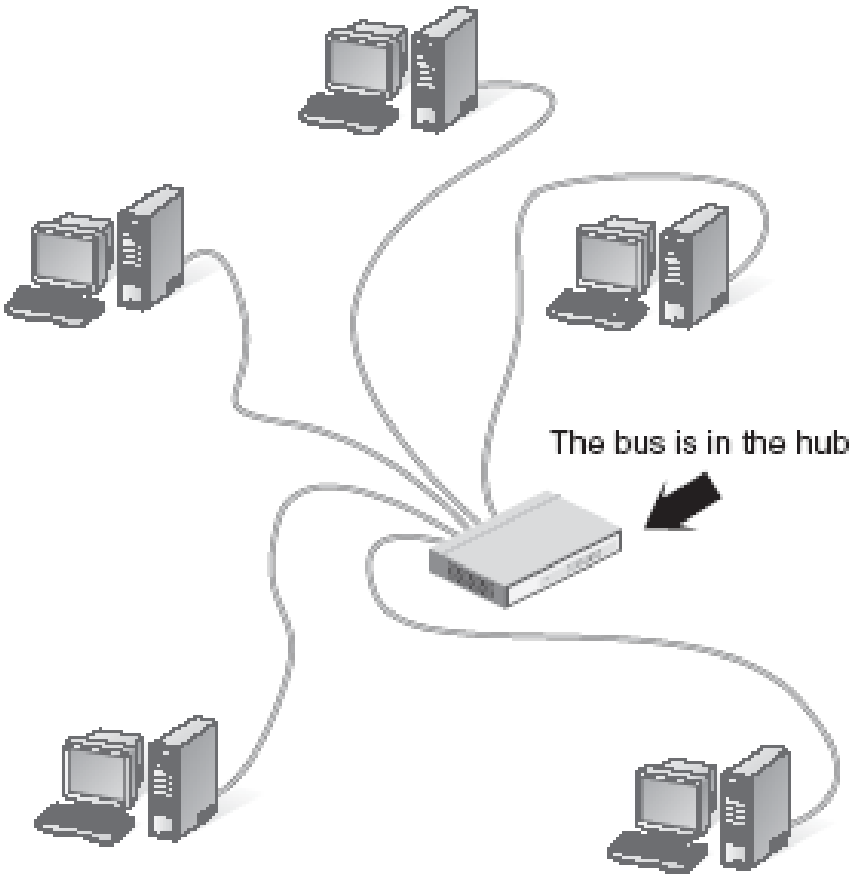
Ref: CompTIA A+ Certification all in one exams

Ethernet..

- This series of standards was called *Ethernet, and it is the dominant standard for* today's networks.
- Ethernet comes in three main flavors defined by cabling type: coaxial, unshielded twisted pair, and fiber optic.
- Ethernet use the same packet type, you can have any combination of hardware devices and cabling systems on an Ethernet network and all the PCs will be able to communicate.

Ref: CompTIA A+ Certification all in one exams

Star Bus Topology



Star Bus

Ref: CompTIA A+ Certification all in one exams

UTP Ethernet (10/100/100BaseT) ..

- All three technologies— sometimes referred to collectively as *10/100/1000BaseT—use a star bus topology.*
- They connect via a type of cable called *unshielded twisted pair (UTP).*

Ref: CompTIA A+ Certification all in one exams

UTP Ethernet (10/100/100BaseT)

- UTP cabling is the specified cabling for 10/100/1000BaseT and is the predominant cabling system used today.
- Many different types of twisted pair cabling are available, and the type used depends on the needs of the network.
- Twisted pair cabling consists of AWG 22—26 gauge wire twisted together into colour-coded pairs.
- Each wire is individually insulated and encased as a group in an common jacket.

Ref: CompTIA A+ Certification all in one exams

UTP Ethernet

CAT Levels UTP cables come in categories that define the maximum speed at which data can be transferred (also called *bandwidth*). The major categories (CATs) are as follows:

CAT 1	Standard phone line	**CAT 2**	Data speeds up to 4 Mbps (ISDN and T1 lines)
CAT 3	Data speeds up to 16 Mbps	**CAT 4**	Data speeds up to 20 Mbps
CAT 5	Data speeds up to 100 Mbps	**CAT 5e**	Data speeds up to 1 Gbps
CAT 6	Data speeds up to 10 Gbps		

Ref: CompTIA A+ Certification all in one exams

TIA/EIA

- The *Telecommunication Industry Association/Electronics Industries Alliance (TIA/EIA)* establishes the UTP categories, which fall under the TIA/EIA 568 specification.

- Currently, most installers use CAT 5e or CAT 6 cable. Although many networks run at 10Mbps, the industry standard has shifted to networks designed to run at 100 Mbps and faster.

Ref: CompTIA A+ Certification all in one exams

TIA/EIA

- Only CAT 5 or better handles these speeds, just about everyone is installing the higher rated cabling, even if they are running at speeds that CAT 3 or CAT 4 would do.
- Consequently, it is becoming more difficult to get anything but CAT 5, CAT5e, or CAT 6 cables.

Ref: CompTIA A+ Certification all in one exams

Implementing 10/100/1000BaseT

- The 10BaseT, 100BaseT, and 1000BaseT cabling standards require two pairs of wires: a pair for sending and a pair for receiving.
- 10BaseT runs on CAT 3, CAT 4, or CAT 5 cable.
- 100BaseT requires at least CAT 5 to run. 1000BaseT is a special case because it needs all four pairs of wires in a CAT 5e or CAT 6 cable.
- These cables use a connector called an *RJ-45 connector.*

Ref: CompTIA A+ Certification all in one exams

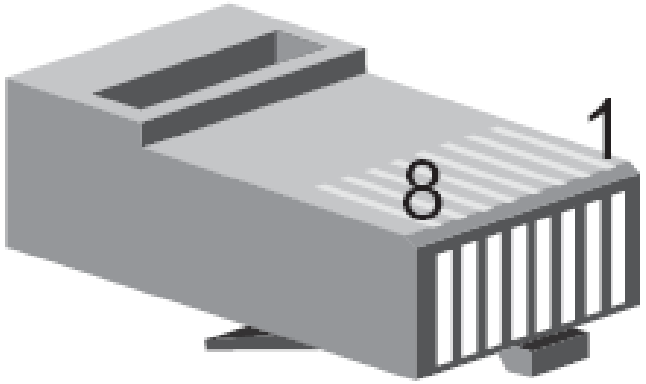
Implementing 10/100/1000BaseT

- *The RJ designation was invented by Ma Bell* years ago and is still used today.
- Currently, only two types of RJ connectors are used for networking: RJ-11 and RJ-45
- RJ-11 is the connector that hooks your telephone to the telephone jack.
- It supports up to two pairs of wires, though most phone lines use only one pair.
- The other pair is used to support a second phone line. RJ-11 connectors are primarily used for dial-up networking

Ref: CompTIA A+ Certification all in one exams

Implementing 10/100/1000BaseT

- RG-11and are not used in any common LAN installation,
- RJ-45 is the standard for UTP connectors.
- RJ-45 has connections for up to four pairs and is visibly much wider than RJ-11.



Ref: CompTIA A+ Certification all in one exams

RJ-11 and RG-45

Ref: CompTIA A+ Certification all in one exams

TIA/EIA Standards

- The TIA/EIA has two standards for connecting the RJ-45 connector to the UTP cable:
- the TIA/EIA 568A and the TIA/EIA 568B. Both are acceptable.
- You do not have to follow any standard as long as you use the same pairings on each end of the cable

Ref: CompTIA A+ Certification all in one exams

TIA/EIA Standards

- It will make work simpler if you choose a standard. Make sure that all of your cabling uses the same standard and you will save a great deal of work in the end.

- Like all wires, the wires in UTP are numbered. However, a number does not appear on each wire. Instead, each wire has a standardized colour.

Ref: CompTIA A+ Certification all in one exams

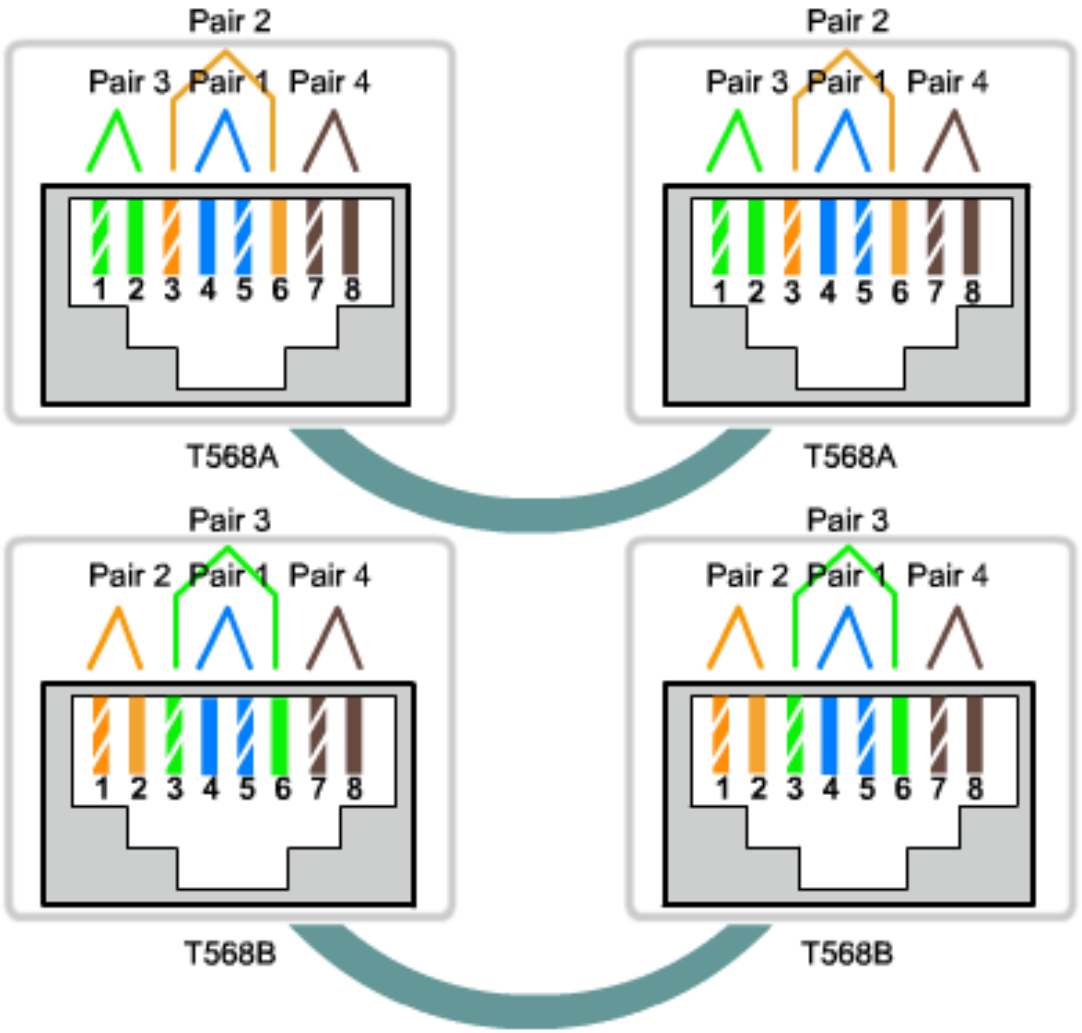
UTP Cabling Color Chart

Pin	568A	568B	Pin	568A	568B
1	White/Green	White/Orange	5	White/Blue	White/Blue
2	Green	Orange	6	Orange	Green
3	White/Orange	White/Green	7	White/Brown	White/Brown
4	Blue	Blue	8	Brown	Brown

Ref: CompTIA A+ Certification all in one exams

Straight-Through Cable

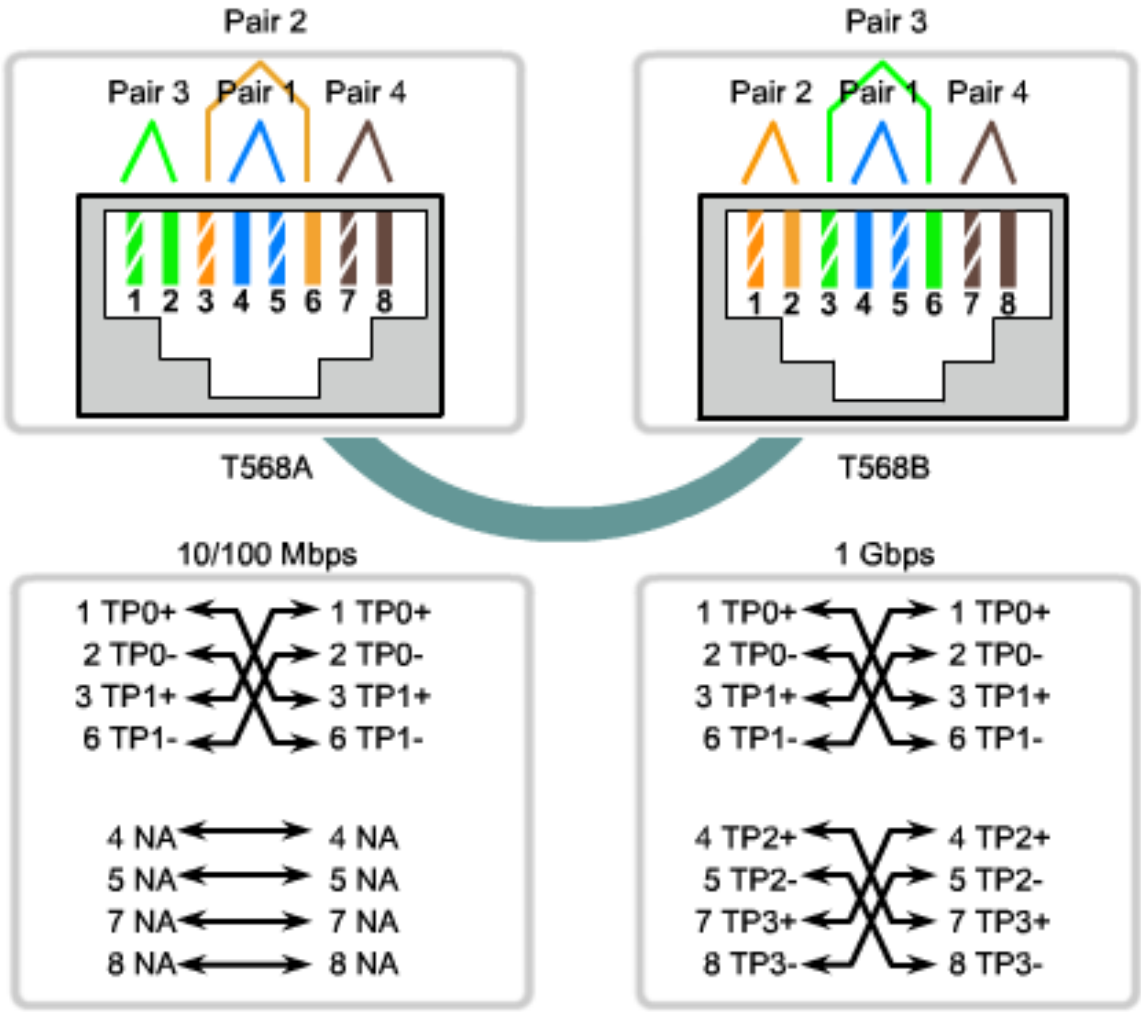
Straight-through cables have the same termination at each end - T568A or T568B.



Ref: www.cisco.com

Crossover Cable

Crossover cables have a T568A termination at one end and a T568B termination at the other end.



Transmit pins at each end connect to the receive pins at the other end.

Ref: www.cisco.com

TIA/EIA 568B CAT 5 UTP

Straight Through

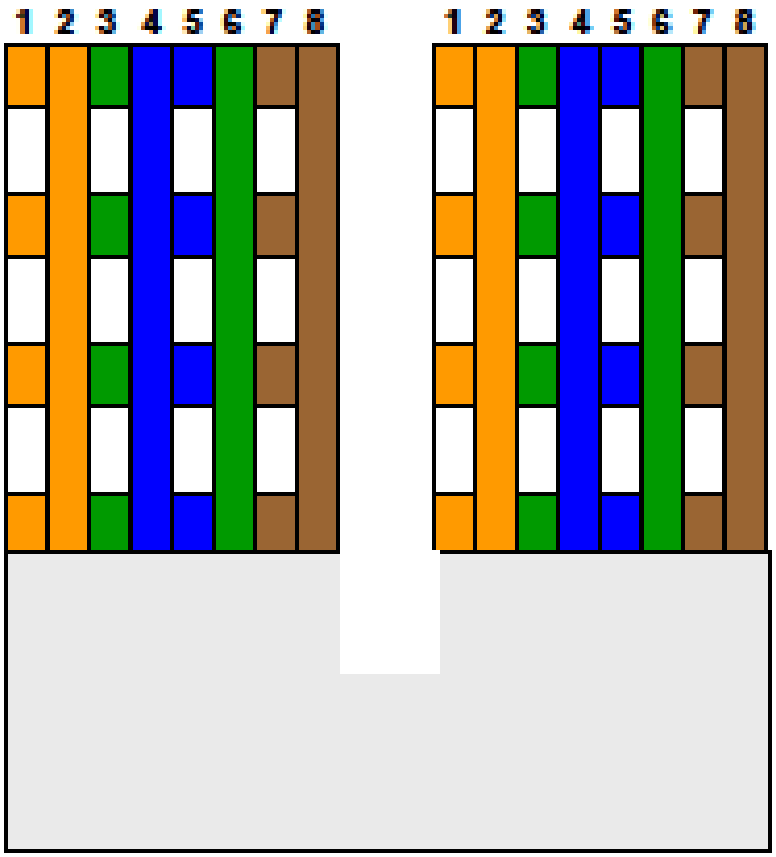


Figure 1. Straight-through Wire Location

TIA/EIA 568B CAT 5 UTP

Crossover

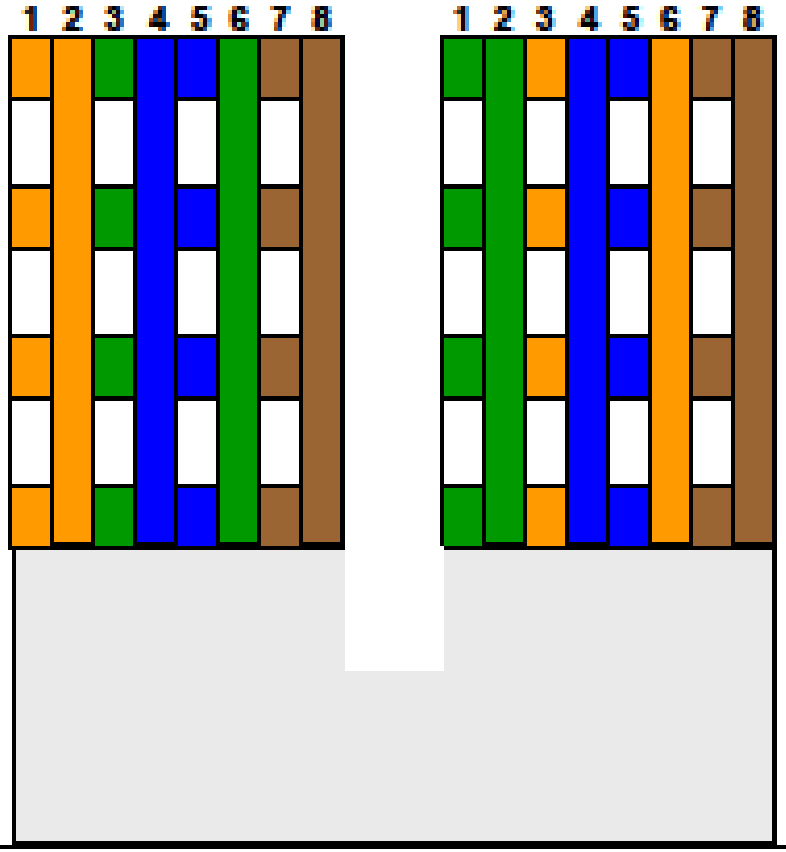


Figure 2. Crossover Wire Location

Ref: www.cisco.com

What is a WAN?

- A wide-area network (WAN) is a data communications network that connects user networks over a large geographical area. WANs have several important characteristics that distinguish them from LANs

- A WAN is a data communications network that spans a large geographic area such as a state, province, or country. WANs often use transmission facilities provided by common carriers such as telephone companies.

Characteristics of WANs

- They connect devices that are separated by wide geographical areas.
- They use the services of carriers such as the Regional Bell Operating Companies (RBOCs), Sprint, MCI, and VPM Internet Services, Inc. to establish the link or connection between sites.
- They use serial connections of various types to access bandwidth over large geographic areas.

Wide Area Networks (WANs)

- A WAN differs from a LAN in several ways. For example, unlike a LAN, which connects workstations, peripherals, terminals, and other devices in a single building, a WAN makes data connections across a broad geographic area. Companies use a WAN to connect various company sites so that information can be exchanged between distant offices.

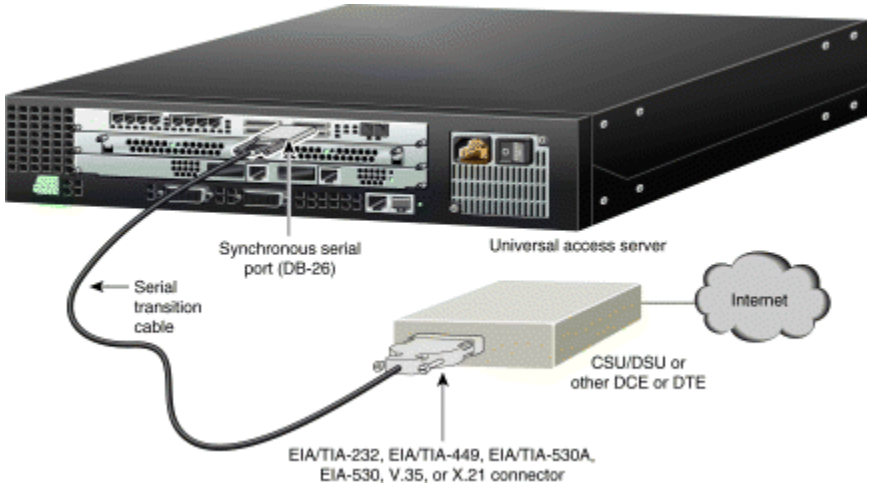
Wide Area Networks

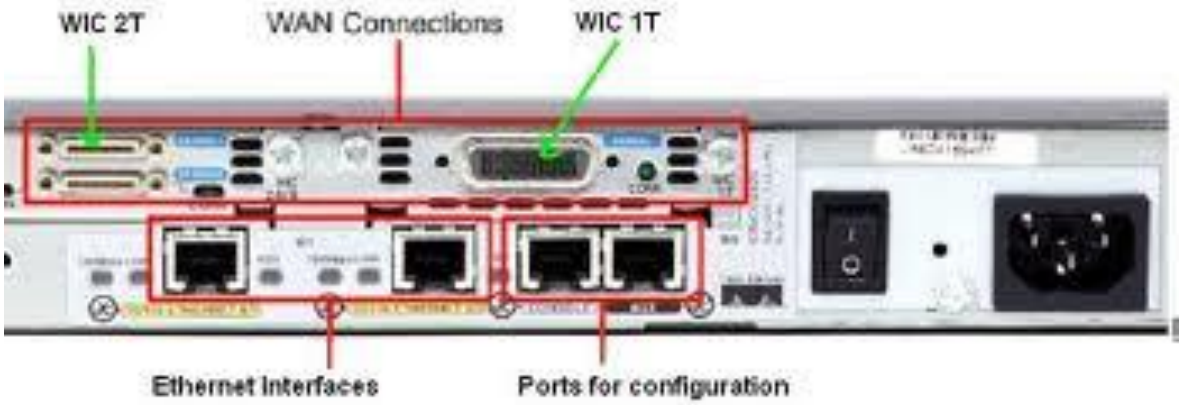
- A WAN operates at the physical layer and the data link layer of the OSI reference model. It interconnects LANs that are usually separated by large geographic areas. WANs provide for the exchange of data packets and frames between routers and switches and the LANs they support.

WAN Devices …

- The following devices are used in WANs:
- Routers offer many services, including internetworking and WAN interface ports.
- Modems include interface voice-grade services, channel service units/digital service units (CSU/DSUs) that interface T1/E1 services, and Terminal Adapters/Network Termination 1 (TA/NT1s) that interface Integrated Services Digital Network (ISDN) services.
- Communication servers concentrate dial in and dial out user communication.

WAN Connections





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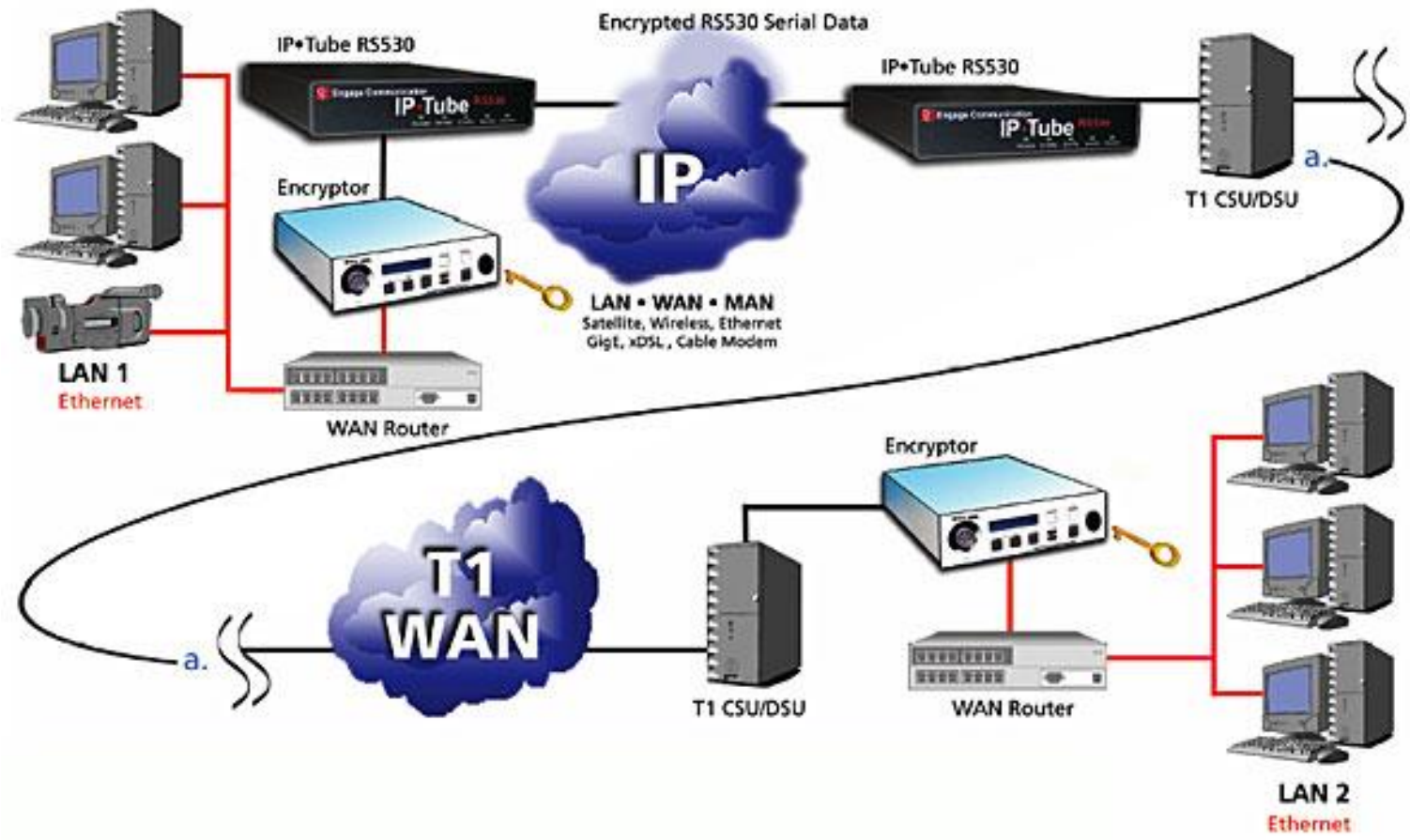
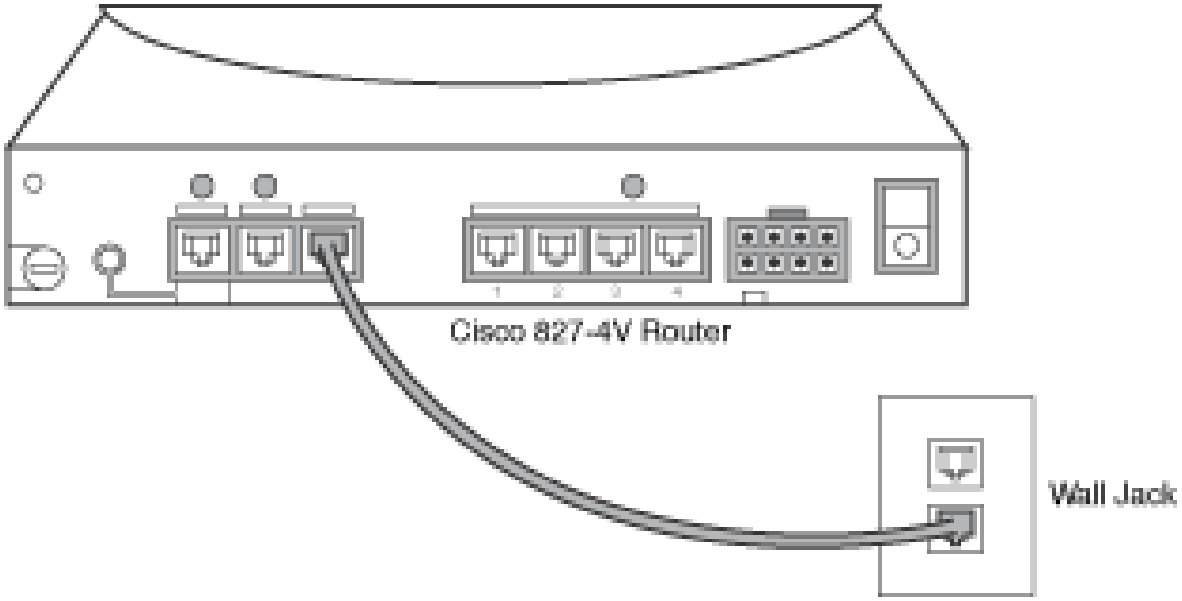
WAN Connections ….



https://www.google.ie/search?q=serial+ports&source=lnms&tbm=isch&sa=X&ei=e8T4UvXsJoKjhgeMsIDIBg&ved=0CAcQ_AUoAQ&biw=1280&bih=509#q=wan+serial+ports&tbm=isch

DSL Connections



Ref: http://www.ciscopress.com/articles/article.asp?p=169686&seqNum=5 Page

DSL Connections …

Routers can also be connected to an asymmetric digital subscriber line (ADSL). The Cisco 827 ADSL router has one ADSL interface. To connect an ADSL to the ADSL port on a router, one end of the phone cable is connected to the ADSL port on the router. The other end of the phone cable is connected to the external wall phone jack.

Ref: http://www.ciscopress.com/articles/article.asp?p=169686&seqNum=5 Page

DSL Connections …

To connect a router for DSL service, you need a phone cable with RJ-11 connectors. The RJ-11 connector is the same one used on a traditional telephone connection and is slightly smaller than a RJ-45 connector. Figure 4-22 shows a connection to a phone jack with DSL services. DSL works over standard telephone lines. It uses only two pins on the RJ-11 connector.

Wide Area Networks

- Operates over a wide geographic area
  - Interconnect LAN's
  - Provide Business Communication
  - Real time information
- Allows access over serial interfaces operating a lower speeds

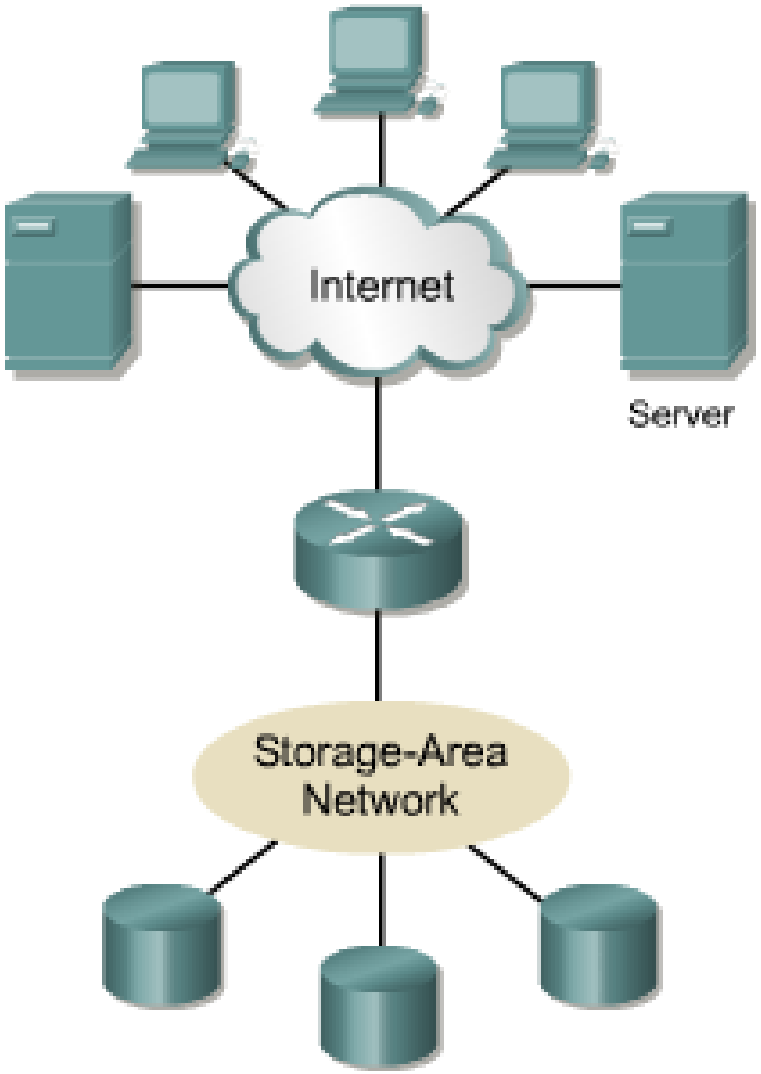
WAN Continued…

- Provides full-time and part-time connectivity
- Services provided
  - e-mail, WWW, file transfer, and e-commerce services
- Devices used
  - Router
  - Communication server
  - Modem

Storage Area Networks (SAN)

- A dedicated, high-performance network used to move data between servers and storage resources
- It avoids any traffic conflict between clients and servers
- Allows high-speed
  - server-to-storage
  - storage-to-storage
  - or server-to-server connectivity

Storage Area Network



Service Area Network Features

- **Performance**
  - Concurrent access of disk or tape arrays by two or more servers at high speeds
- **Availability**
  - Disaster tolerance built in
  - Data can be mirrored
- **Scalability**
  - Can use a variety of technologies
  - Allows backup data, file migration, and data replication

Virtual Private Network

A telecommuter can access the network of the company headquarters

through the Internet

by building a secure tunnel between the telecommuter's PC and a VPN router in the headquarters

OSI Model

Open Systems Interconnection

Released in 1984

OSI Model

In order for data packets to travel from a source to a destination on a network

all devices on the network must speak the same language or protocol

ISO/OSI Reference Model

- Developed by International Standards Organization (ISO)
  - *Facilitates the international standardization of communications protocols*
- Basic Reference Model for Open Systems Interconnection
  - *Not a Network Architecture*
  - *Doesn't specify any protocols or services*

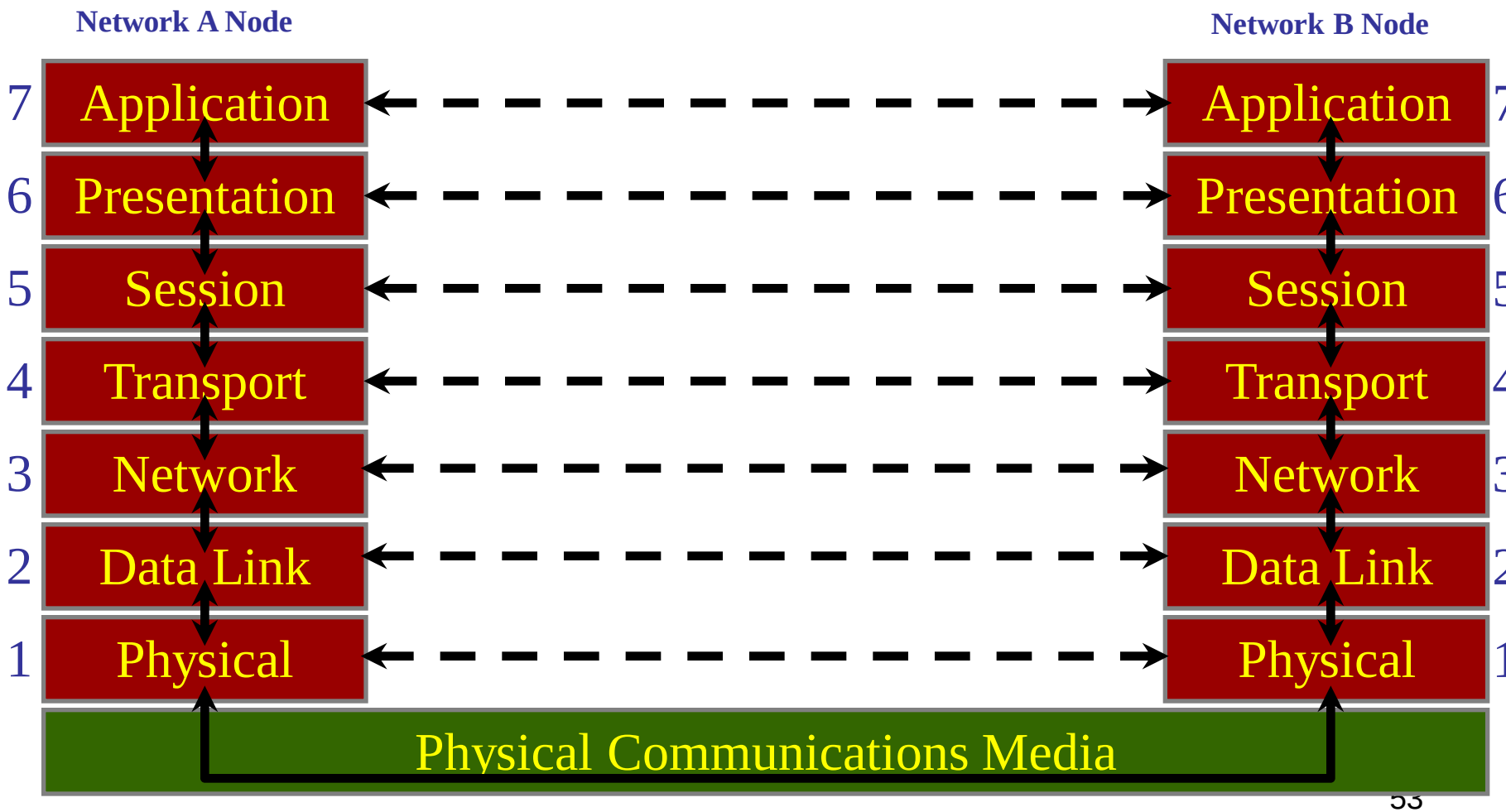
- Protocol
  - Set of rules
  - Makes communication on a network more efficient
  - Governing the ways in which two entities cooperate to exchange information
- Network Architecture
  - Set of layers and protocols

OSI Reference Model

- Describes computer communications protocols in a general sense
- No assumptions are made regarding
  - *Programming language bindings*
  - *Operating system bindings*
  - *Applications programming interfaces (API)*

Layers of the OSI Model

Layers in OSI Reference Model



Benefits of OSI Model

- Reduces Complexity
- Standardizes interfaces
- Facilitates modular engineering
- Ensures interoperable technology
- Accelerates evolution
- Simplifies teaching and learning

Advantages of Dividing the network into 7 Layers

- Break network communication into smaller manageable parts
- Standardizes components to allow multiple vendor development and support
- Allows different types of network hardware and software to communicate with each other
- Prevents changes in one layer from affecting other layers
- Divides network communication into smaller parts to make learning it easier to understand.

Layer 1 –Physical Layer

- Defines the Electrical, Mechanical, Procedural and Specifications for activating, maintaining and deactivating the physical link between the network and communication system
- Characteristics such as
  - Voltage, timing, transmission distances, physical connectors, Wires
  - Binary Transmission

Layer 2 – Data Link Layer

- Connection to the Media
  - Reliable transfer of data
    - Error notification
    - Flow control
- **Physical Addressing**
  - MAC (Media Access Control)
- **Network topology**
  - Star, Bus, Ring, Mesh…

Data Link Layer
LAN & WAN Specifications

- LAN Specifications
  - Ethernet, Fast Ethernet, Token Ring, FDDI
- WAN Specifications
  - Frame Relay, X-25, PPP
- Devices found in Data Link Layer
  - NIC, Switch, Bridge

Sub Layers in Data Link Layer

- LCC – Logical Link Layer Sub layer
  - Allow several higher protocols to share a single link
- MAC Sub layer
  - Manages access to physical medium
  - Determine the hardware address

Layer 3 - Network Layer

- Defines the Logical Addressing of nodes (IP)
- Determines the best path
- Enables internetworking
  - Passing data from one network to another (*Routers*)
- Protocols can be
  - **Routed** -used to encapsulate data into packets
  - **Routing** - creates routing tables to determine best path
    - OSPF, RIP, BGP…
    - **OSPF** (Open Shortest Path First)
    - The Routing Information Protocol (RIP)
    - Border Gateway Protocol (BGP)

Layer 4 - Transport Layer

- End-To-End Communication
- Purpose is the delivery of data that is
  - Error free
    - Error Detection and Error Recovery
  - In the correct sequence
    - Flow Control
    - Windowing
- E.g., of transport Layer Protocols
  - TCP – Transmission Control Protocol
  - UDP – User Datagram Protocol

Layer 5 - Session Layer

- Inter Host Communication
- Establishes, manages, maintains and terminates a communication channel between software program and host node
- Error reporting for *Application* and *Presentation* layers
- Protocols – which query a database remotely
  - SQL, RPC…(SQL: Structured Query Language, RPC: Remote Procedure Call)

Layer 6 - Presentation Layer

- Data Representation – Coding and Conversion
  - Data formats
  - Character representation
  - Data compression
  - Data encryption
- Protocols
  - MPEG, JPEG, Quick Time, ASCII, EBCDI, GIFF…
- Ensures information sent from the application layer on 1 system can be read by the application layer on another system

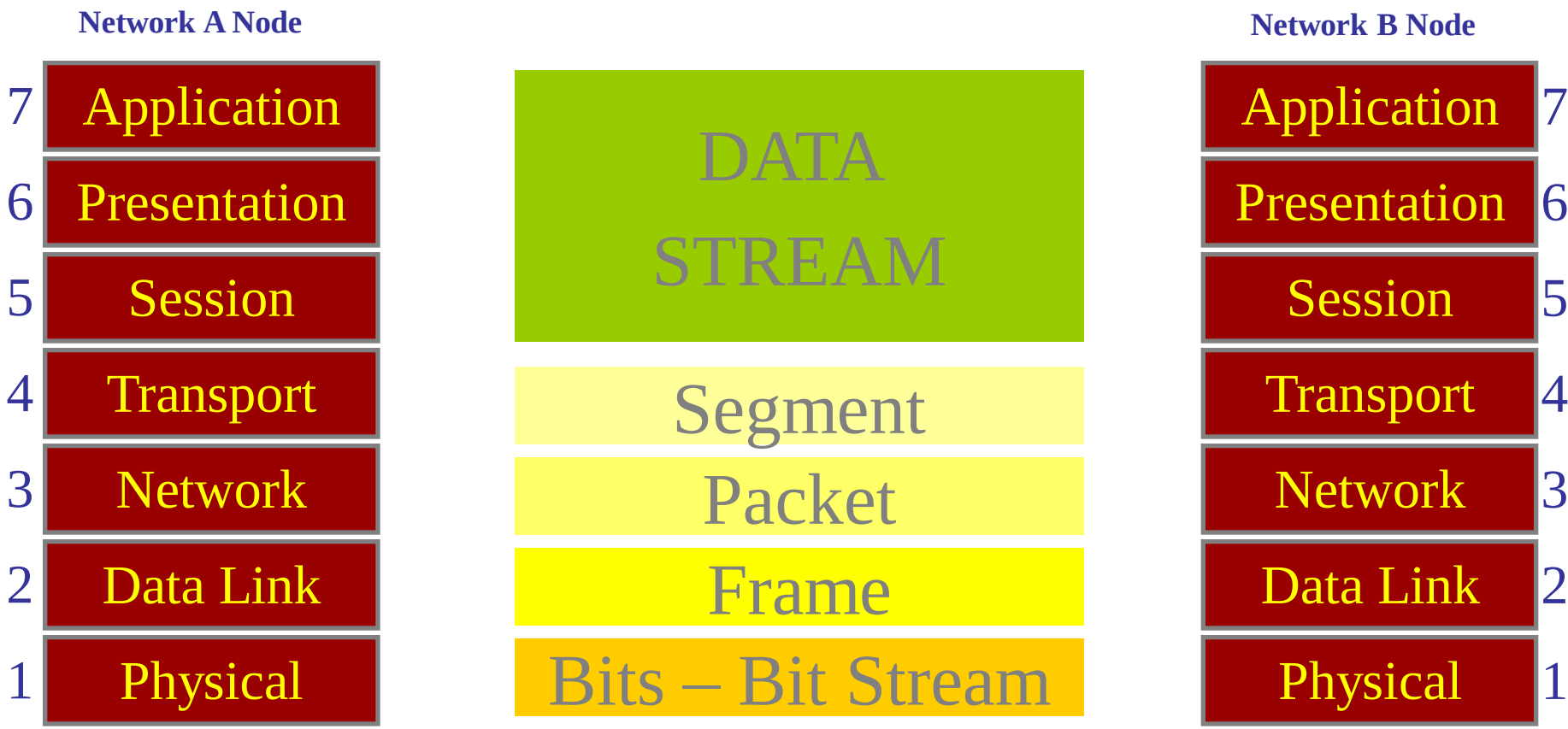
Layer 7 - Application Layer

- Provides network services to application
- Determines
  - Identify the availability of communication partners
  - Sufficient resources available for program-to-program communications
- Application Layer Protocols
  - Telnet – log into another machine
  - FTP, SMTP…

Data Encapsulation

Wrap the Data with the necessary protocols before transmission

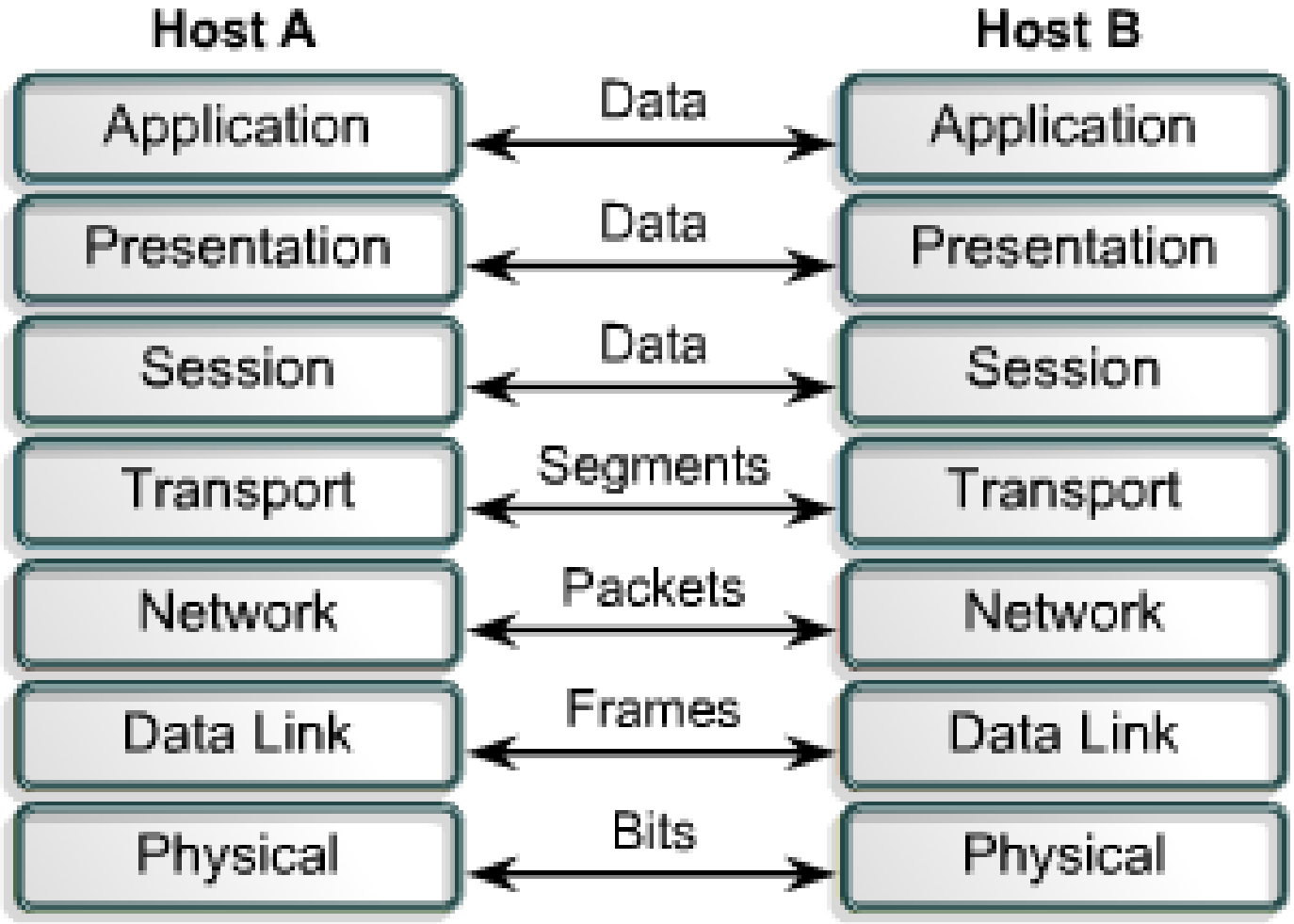
Data Encapsulation

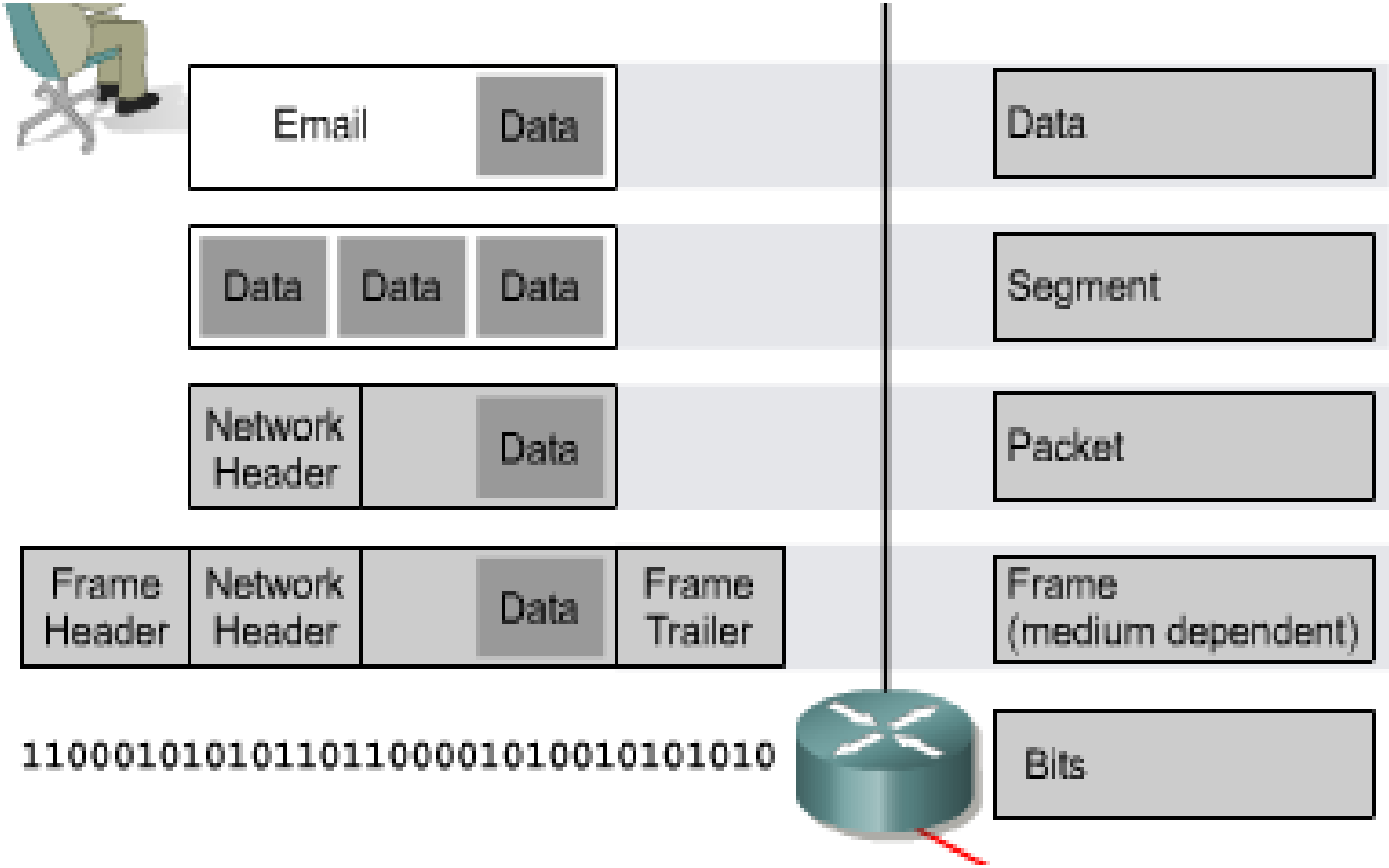


Peer-To-Peer Communication

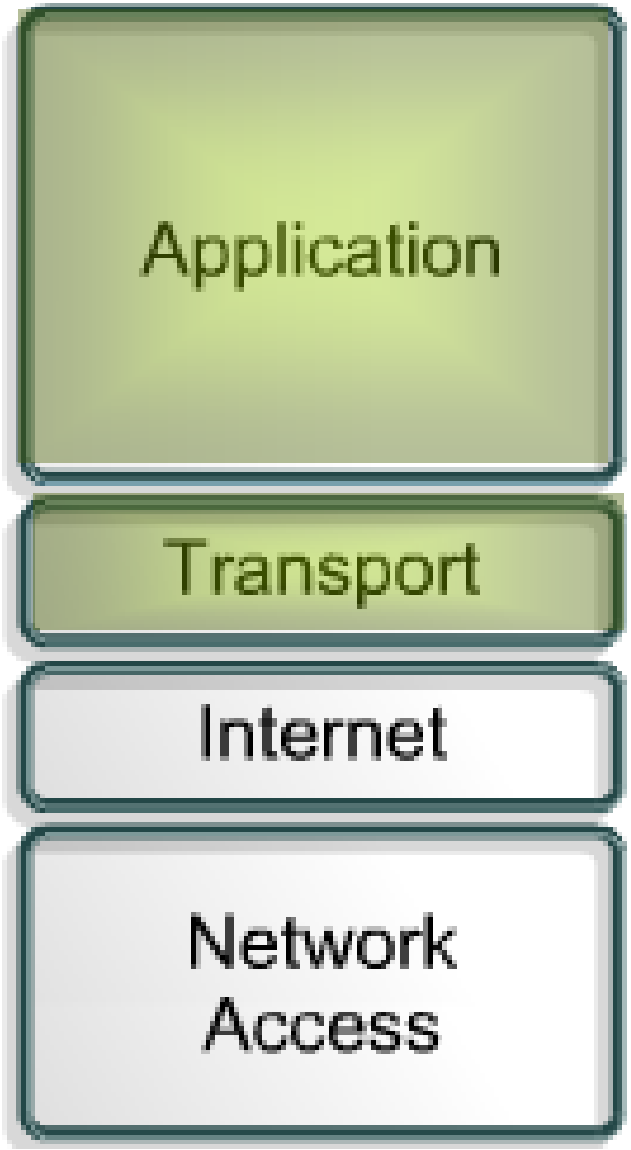
- Each layer at the source communicates to its equivalent layer (*peer)* at the destination
- Information exchanged between source and destination peers is called PDU's
  - Protocol Datagram Units

Peer-To-Peer Communication




Email
Data
Data
Data
Data
Data
Segment
Network Header
Data
Packet
Frame Header
Network Header
Data
Frame Trailer
Frame (medium dependent)
11000101010110110000101001010101 0
Bits

TCP/IP Model



Application layer handles
- Representation
- Encoding
- Dialog control

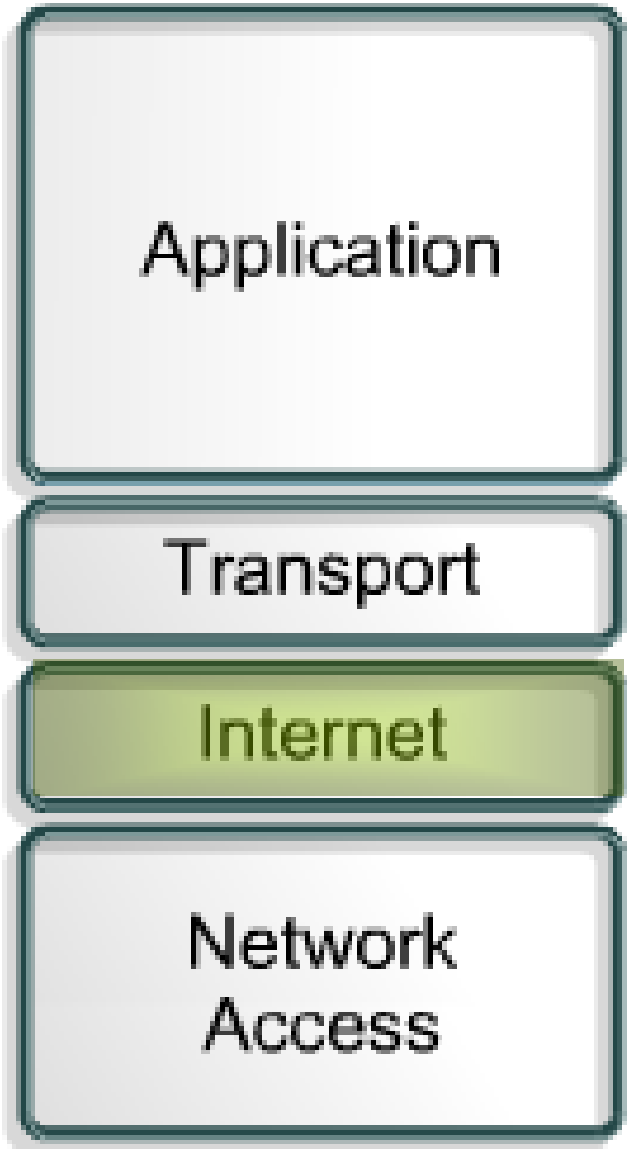
Transport layer deals with
- Quality of service
- Reliability
- Flow control
- Error correction

Protocol is TCP

Transmission Control Protocol

- Connection-oriented protocol
- Maintains a dialogue between source and destination
- Packages application layer information into segments

TCP/IP Model



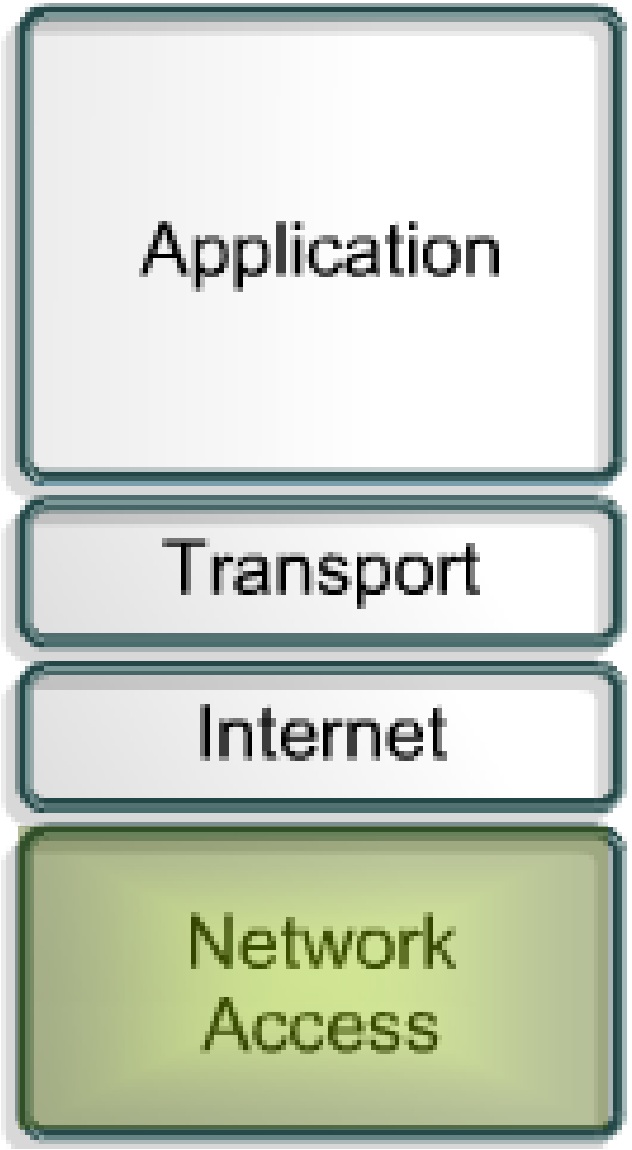
Internet layer

- Divide segments into packets
- Internet Protocol (IP)
- Path determination
- Packet switching

IP points the way for the packets

TCP provides a reliable transport

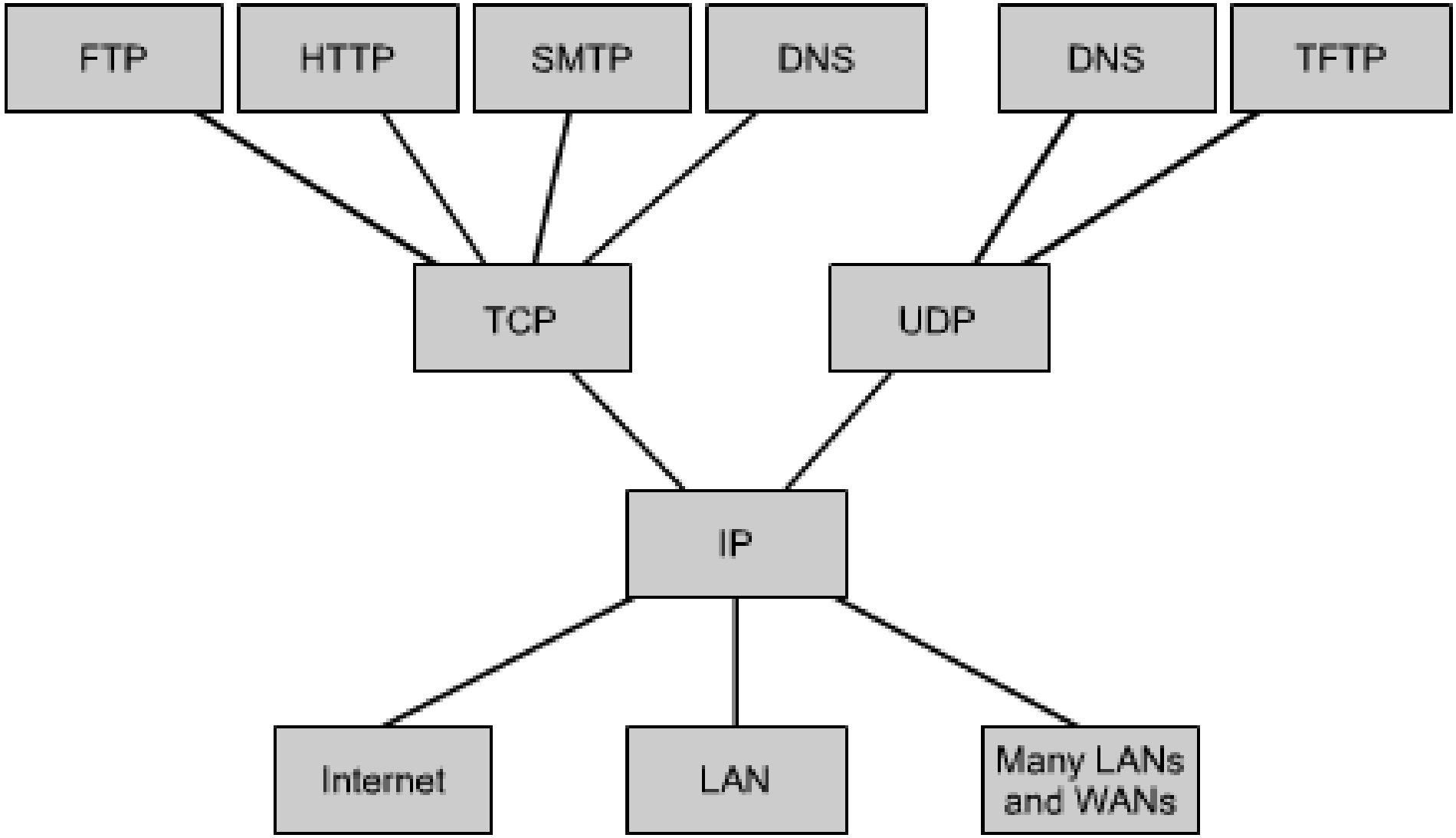
TCP/IP Model



Network Access Layer

Components required to make a physical link

Common TCP/IP Protocols



Comparison of OSI and TCP/IP Models