Introduction to Networks

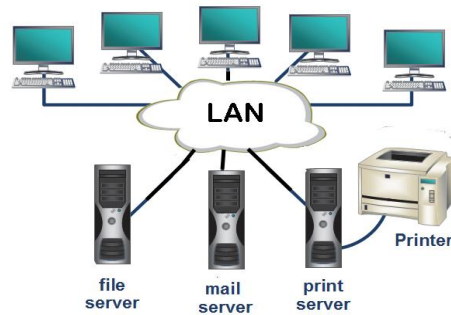# What's a Network?

What's a Network?

A **network** is two or more computer systems linked together by some form of the transmission medium that enables them to share information

Local Area Network (LAN)

Local Area Network (LAN)

A LAN is a **local** network

- Could be as small as two computers or large, with thousands of devices connected
- Usually restricted to spanning a particular geographic location

Wide Area Network (WAN)

Wide Area Network (WAN)

A **WAN** is a collection of computers and devices connected by a communications network over a wide geographic area

WANs are commonly connected either through the Internet or special arrangements made with phone companies or other service providers

The **Internet** is considered the **largest WAN** in the world

Common Network Components

Common Network Components

- **Node** ⟶ - A point or joint where a connection takes place
  - Can be a computer or device

  - PC   - Printer
  - Laptop   - Router
  - Server   - Switch
  - Smartphone   - etc.
  Some examples of Node

Common Network Components

- **Host** ⟶ - **Hosts** are any device which sends or receive traffic.
  - Requires IP Address
  - Can be a client or server

Common Network Components

- **Server** ⟶ A powerful computer used to store files and run programs centrally

- **Client** ⟶ A device that makes request from a server

- Web Server   - Application Server
- Proxy Server   - DNS Server
- Mail Server   - File Server
- Print Server   - Telephony Server

Common types of servers

Common Network Connectivity Devices

**Network Interface Controller (NIC)**

- A hardware that connects computers to a network
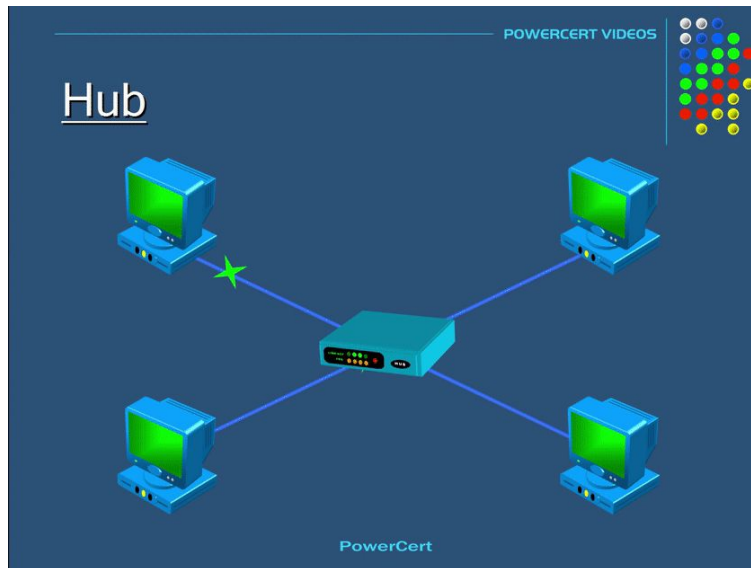
- Every NIC has a unique MAC address

MAC Address

- A media access control address (MAC address) is a unique identifier assigned to a network interface controller (NIC) for use as a network address in communications within a network segment.
- MAC Addresses are unique **48-bits** hardware number of a computer.
- Represented as:
  - 68-7F-74-12-34-56

Hub
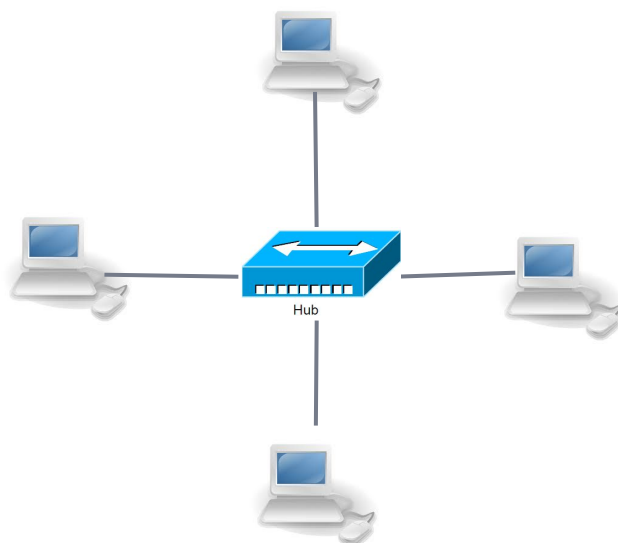
Hub

Switch

Switch

Router

network-A   network-B
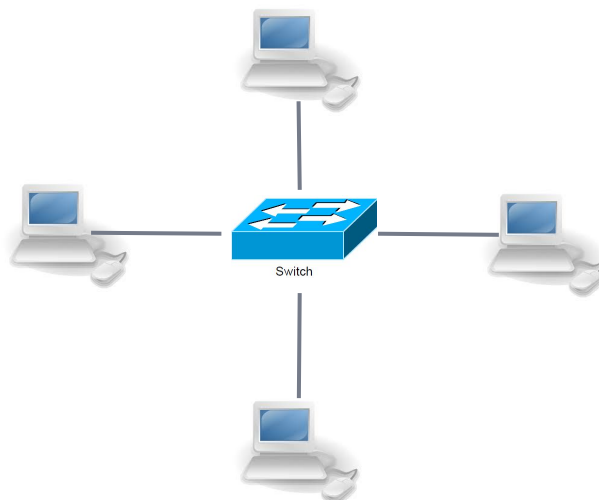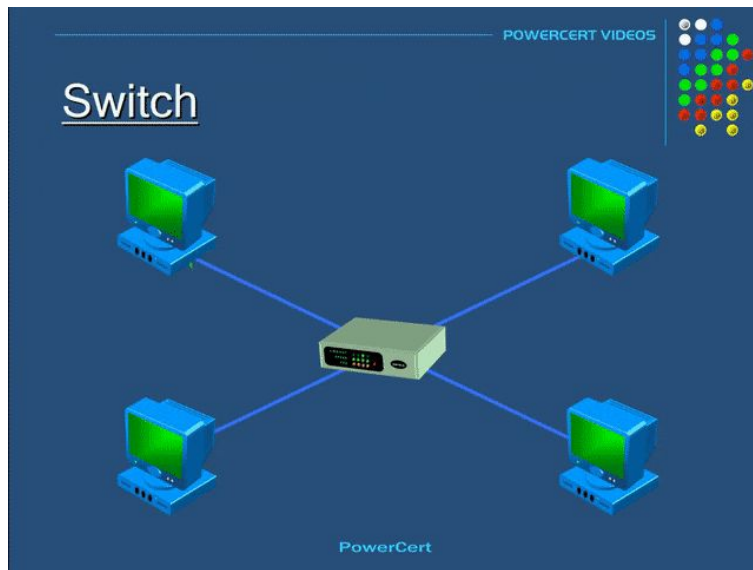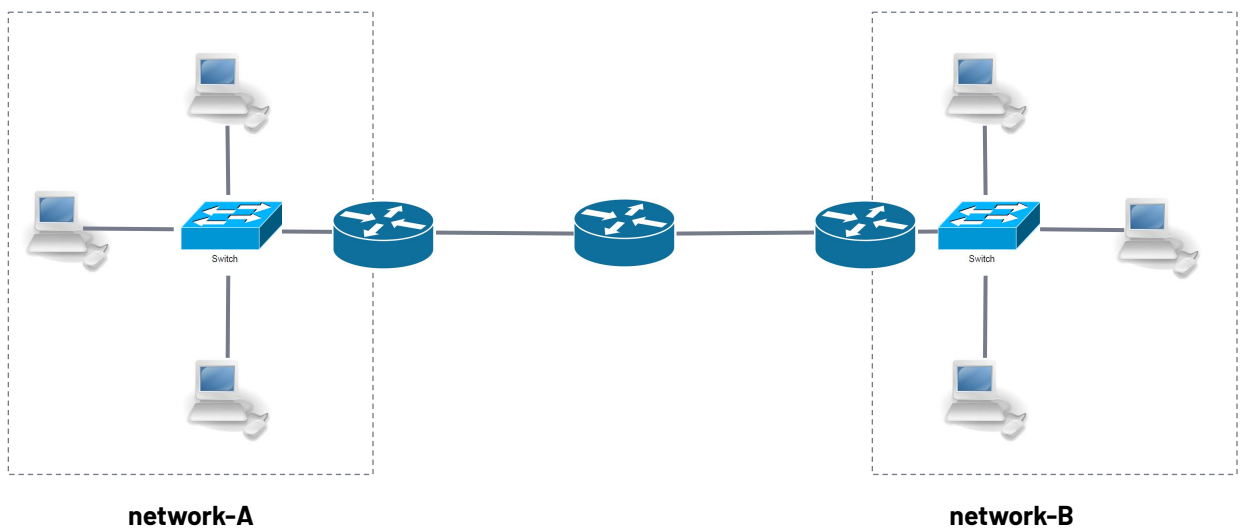
Router
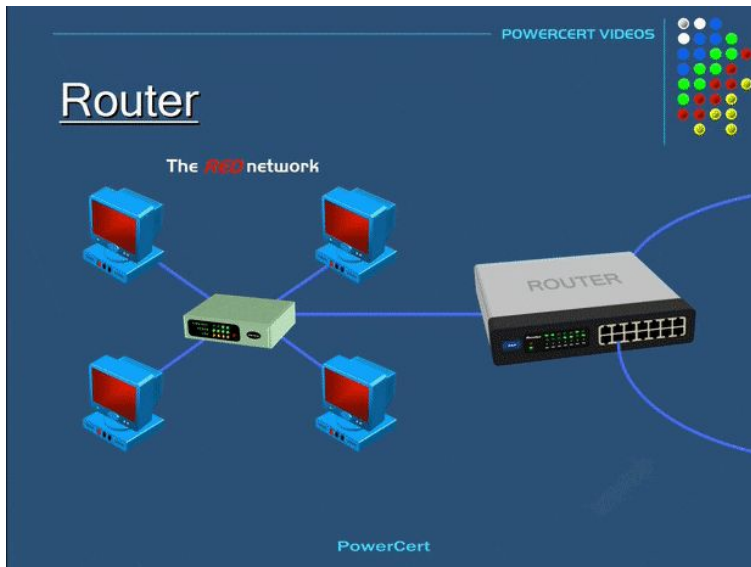
What is OSI Reference Model?

The **OSI** provides a standard for different computer systems to be able to communicate with each other

Developed by ISO in 1984

OSI Model

- Nodes must follow rules to communicate
    - Example: any language - English, Spanish, etc

- Rules for networking are divided into 7 layers (OSI Model)

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	Physical
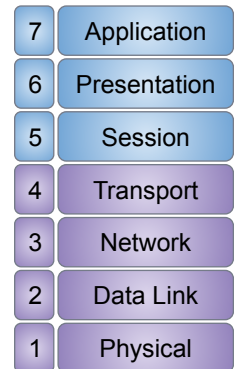
Data Encapsulation

Data Encapsulation

- For two nodes communicate they must use the same protocol

- Each layer communicates with its equivalent layer on the other node via the lower layers of the model

- Each layer provides services for the layer above and uses the services of the layer below

Encapsulation

#	Layer					Unit
7	Application					
6	Presentation	Data				
5	Session					
4	Transport	TCP	Data			Segment
3	Network	IP	TCP	Data		Packet
2	Data Link	MAC	IP	TCP	Data	Frame
1	Physical	1011101101110111011011101110110111011011101				Bits

Data Encapsulation

Encapsulation & De-encapsulation in OSI Model

Data Encapsulation

Layer 1 - Physical

- **Purpose: Transporting Bits**
  - Transmits bits (1's, 0's) between nodes

- **Technologies**
  - Cables, WiFi, Repeaters, Hubs

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Layer 1 - Transporting Bits

10111011011
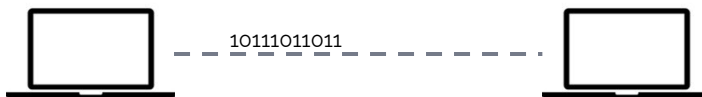
7	Application
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Layer 2 - Data Link

- **Purpose: Hop-to-Hop**
  - Addressing scheme: MAC Address
    - 48-bits / 12 hex digits (e.g. 74:56:D9:84:AB:6F)
  - Often traffic is sent over multiple "hops"

- **Technologies**
  - Network Interface Card (NIC)
  - Switch

7	Application
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Layer 2 - Hop to Hop

a1:a1 b2:b2 (router) b3:b3 d5:d5 (router) d6:d6 e7:e7
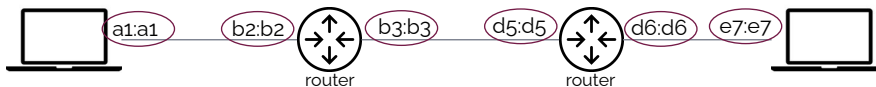
7	Application
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Layer 3 - Network Layer

- **Purpose: End-to-End**
  - Addressing scheme: IP Address
    - 32-bits / 4 Octets each 0-255
    - 192.168.1.20

- **Technologies**
  - Routers, Hosts
  - Anything with an IP

7	Application
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Layer 3 - End-to-End

10.1.1.11   a1:a1   b2:b2 (router) b3:b3   d5:d5 (router) d6:d6   e7:e7   10.3.3.33

7	Application
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1	Physical
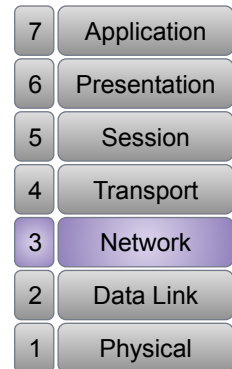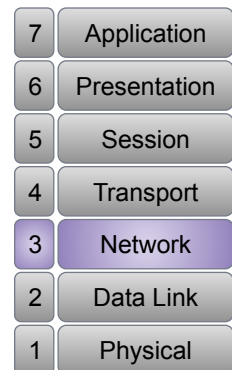
Layer 4 - Transport Layer

- **Purpose: Service-to-Service**
  - Deliver to the right service (aka software)
    - Distinguish data streams
  - Addressing scheme: Port / Protocol
  - Ports - 0 to 65535
  - Protocols - TCP, UDP

7	Application
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5	Session
4	Transport
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Layer 4 - Transport Layer

TCP / 80

UDP / 3230

TCP / 25
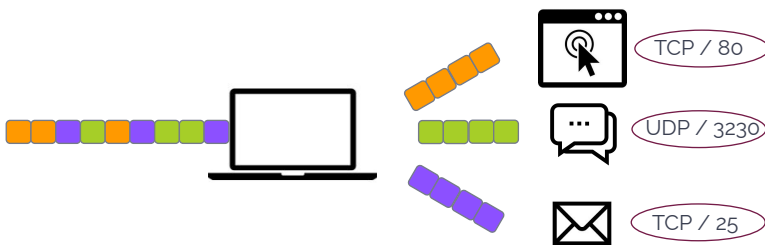
7	Application
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Contribution of Each Layer

TCP / 80

UDP / 3230

TCP / 25

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

L2 — a1:a1 → d5:d5
L3 — 10.1.1.11 → 10.3.3.33
L4 — TCP 1020 → 80
L5,6,7 — Data

Summary

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

Data

Function	Addressing	Devices (example)
Service-to-Service	Port/Protocol	-
End-to-End	IP Address	Routers, Hosts
Hop-to-Hop	MAC Address	NIC, Switch
Bits		Cable, Connector

TCP/IP Model

TCP/IP and the OSI Model

- The TCP/IP model is a condensed version of the OSI model

Encapsulation

4	Application	App. header	Data
3	Transport	TCP header	Application data → TCP Segment
2	Internet	IP header / TCP header	Application data → IP datagram
1	Network Interface	Ethernet header / IP header / TCP header	application data → Ethernet Frame

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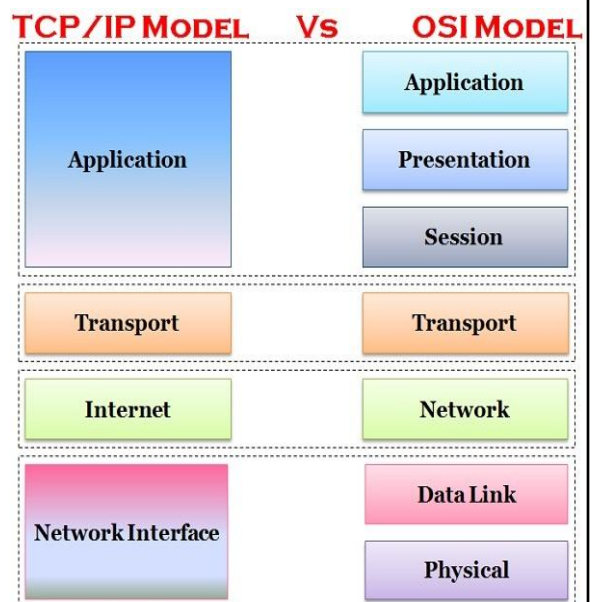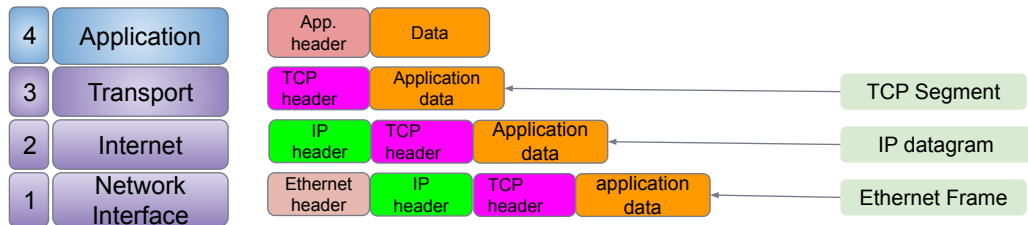
TCP/IP (DoD) and the OSI Model

TCP/IP and the OSI Model

TCP/IP model	Protocols and services	OSI model
Application	HTTP, FTTP, Telnet, NTP, DHCP, PING	Application
		Presentation
		Session
Transport	TCP, UDP	Transport
Internet	IP, ARP, ICMP, IGMP	Network
Network Interface	Ethernet	Data Link
		Physical
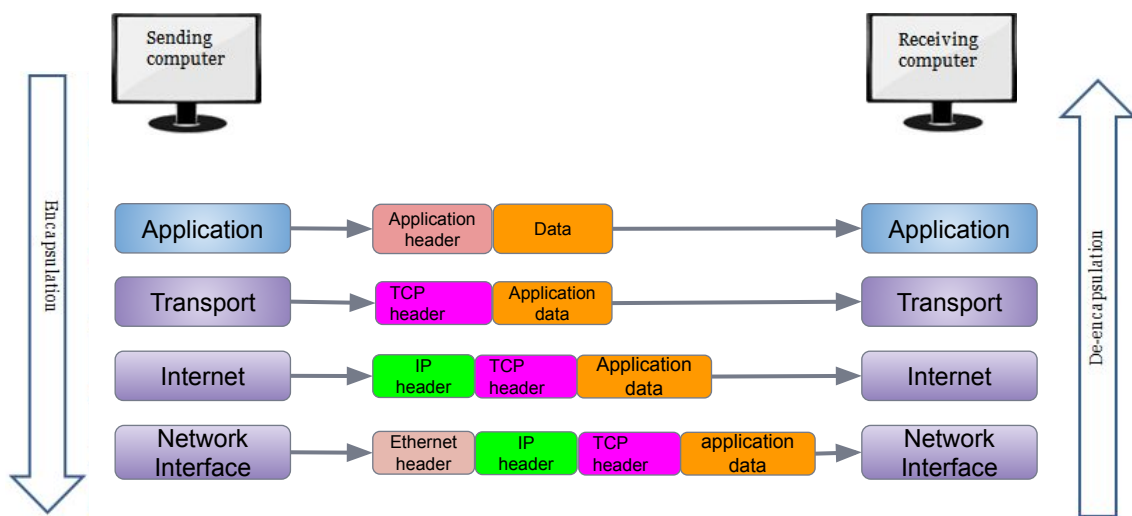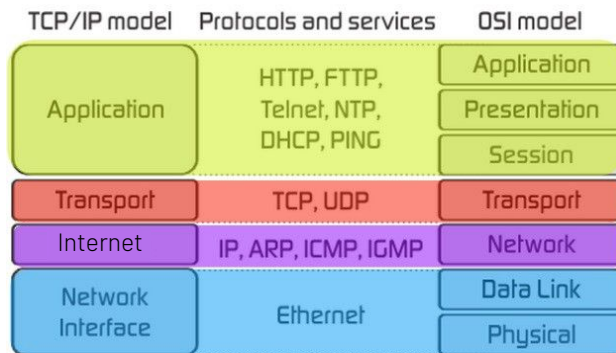
TCP/IP and the DoD Model

Network Access Layer

- Defines details of how data is physically sent through the network
- Main protocols are Ethernet, Token Ring, FDDI, X.25, and Frame Relay

FDDI: Fiber Distributed Data Interface

TCP/IP and the DoD Model

Internet Layer

- Packs data into data packets known as IP datagrams
- Responsible for routing of IP datagrams
- Main protocols are IP, ICMP, ARP, RARP, and IGMP

IP: Internet Protocol
ICMP: Internet Control Message Protocol
ARP: Address Resolution Protocol
RARP: Reverse Address Resolution Protocol
IGMP: Internet Group Message Protocol

TCP/IP and the DoD Model

Transport Layer

- Permits devices on the source and destination to carry on a conversation
- Defines the level of service and status of the connection used when transporting data
- Main protocols are TCP and UDP

TCP: Transmission Control Protocol
UDP: User Datagram Protocol

TCP/IP and the DoD Model

Process/Application layer

- Enables applications to communicate with each other.
- Provides access to the services that operate at the lower layers of the TCP/IP model.
- It contains a protocol that implements user-level functions such as mail delivery, file transfer, and remote login.
- Includes all higher-level protocols: DNS, HTTP, Telnet, SSH, FTP, SNMP, DHCP, etc.

DNS: Domain Name Service
HTTP: Hyper-text Transfer Protocol
SSH: Secure Shell
FTP: File Transfer Protocol
SNMP: Simple Network Management Protocol
DHCP: Dynamic Host Configuration Protocol

THANKS!

Any questions?

You can find me at:

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- ▸ david@clarusway.com

Encapsulation

4	Application	
3	Transport	
2	Internet	
1	Network Interface	

App. header	Data	

TCP header	Application data

→ TCP Segment / UDP Datagram

IP header	TCP header	Application data

→ IP datagram

Ethernet header	IP header	TCP header	application data

→ Ethernet Frame