

Lecture 8

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Basic Network Concepts

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1. Major Network Categories
2. Elements of a Network
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4. Packet Switched Networks
5. Quality of Service (QoS)
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7. Internets, the Internet
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9. Standards and OSI Model

Major Network Categories

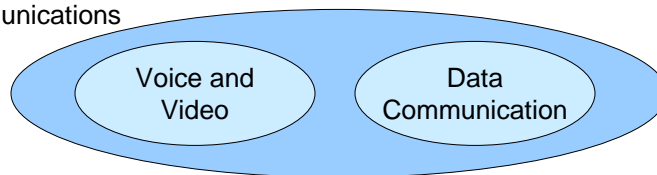
- Major Network Types
 - The Global Internet
 - Internal Corporate Networks
 - The Worldwide Telephone System

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Major Network Categories

- Telecommunications Spans Two Concerns
 - Voice and Video Communication vs
 - Data Communication
 - At least one party is a computer
 - The two are converging

Telecommunications



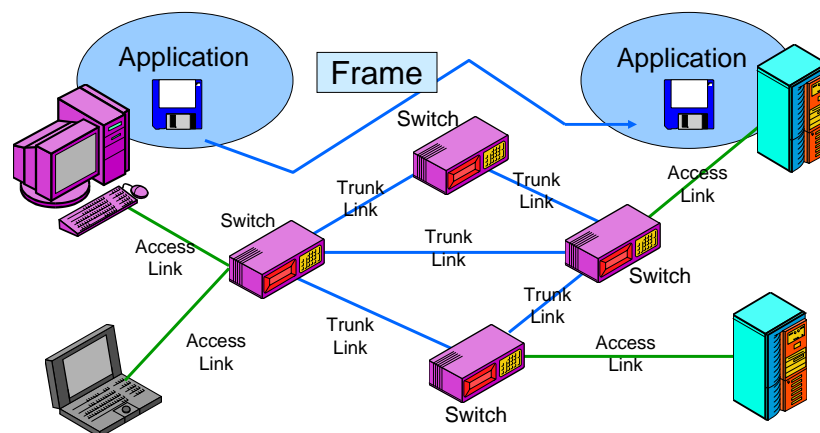
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Network

- A network is a system of hardware, software and transmission components that collectively allow two application programs on two different stations connected to the network to communicate well.

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Elements of a Network



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Elements of a Network

- Networks connect applications on different station.
- Stations are computers and other devices such as cell phones (mobile Phones) and Personal Digital Assistants (PDAs).
- Stations communicate by sending messages called *Frames*.
- Frames may pass through multiple switches.
- Access links connect stations to the first switch.
 - Usually copper wire,
 - Increasingly radio (Wireless) links.
- Trunk links connect switches
 - Higher capacity than access links
 - Often optical fiber

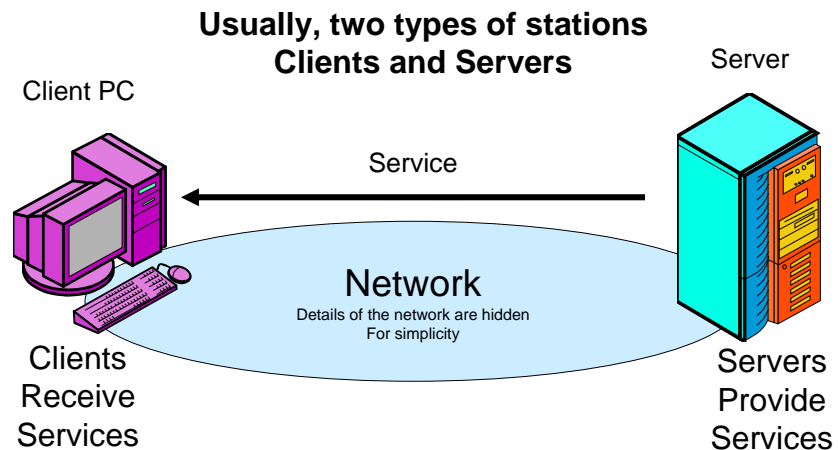
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Network Elements: Recap

- Applications
- Stations
- Frames
- Switches
- Access Links
- Trunk Links

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Client/Server Architecture



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Key Point

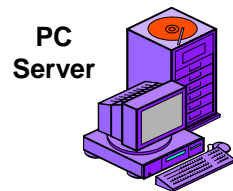
- Most desktop clients are **Wintel** computers, which run client versions of the *Microsoft Windows* operating system and use a standard *Intel Pentium* microprocessor or a compatible microprocessor from one of Intel's competitors such as AMD.

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Servers

Servers are typically three types:

- PC Server
- Workstation Server
- Mainframe Server



**PC
Server**

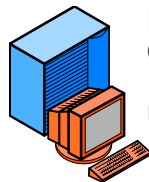
Standard PC
Microprocessor

Network Operating Systems (NOS):

- Microsoft Windows Server
- Novell Network
- LINUX

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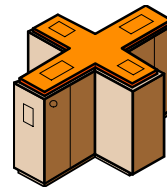
Servers (Cont'd)



**Workstation
Server**

Fast (and Expensive)
Custom-Built Microprocessor

UNIX Operating System



**Mainframe
Server**

Fastest Servers
Ultra-Reliable
Specialized Operating
System

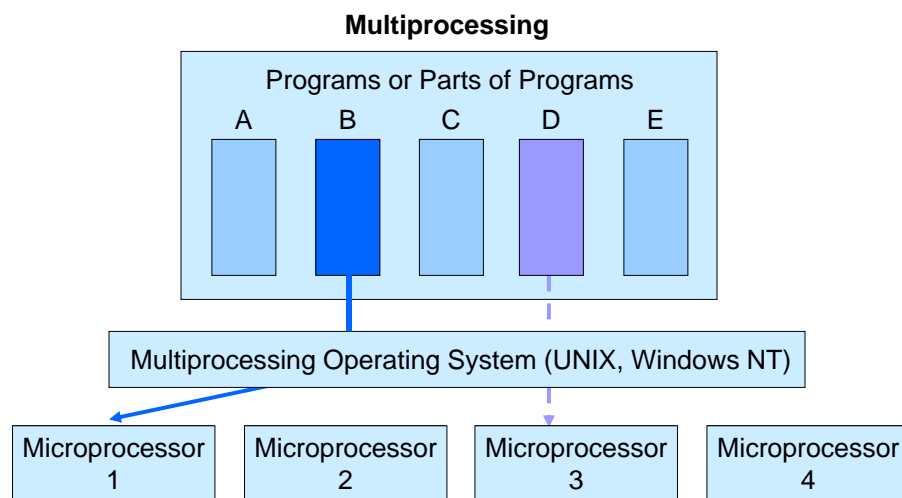
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Increasing Server Scalability

- Scalability refers to the ability to grow as demands grow.
- Three approaches for server scalability
 - Multiprocessing.
 - Server Clusters.
 - Load Balancing Routers.

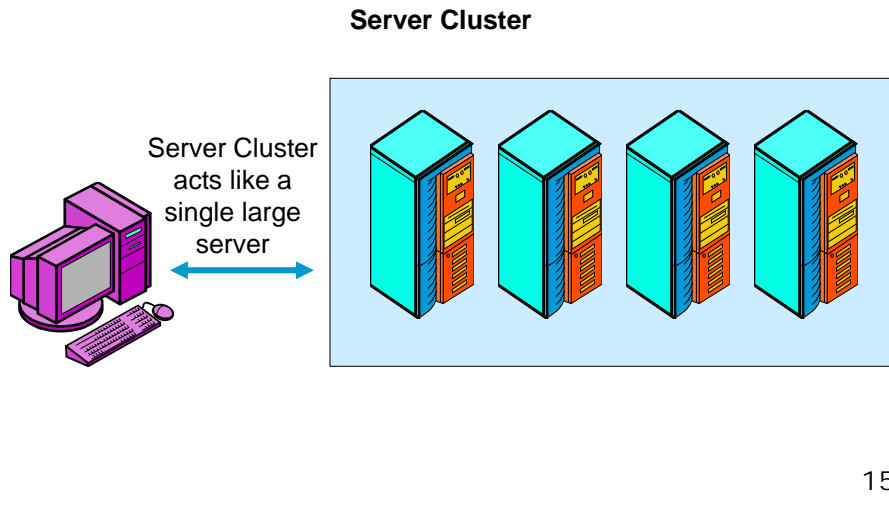
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Increasing Server Scalability (and Sometimes Reliability)

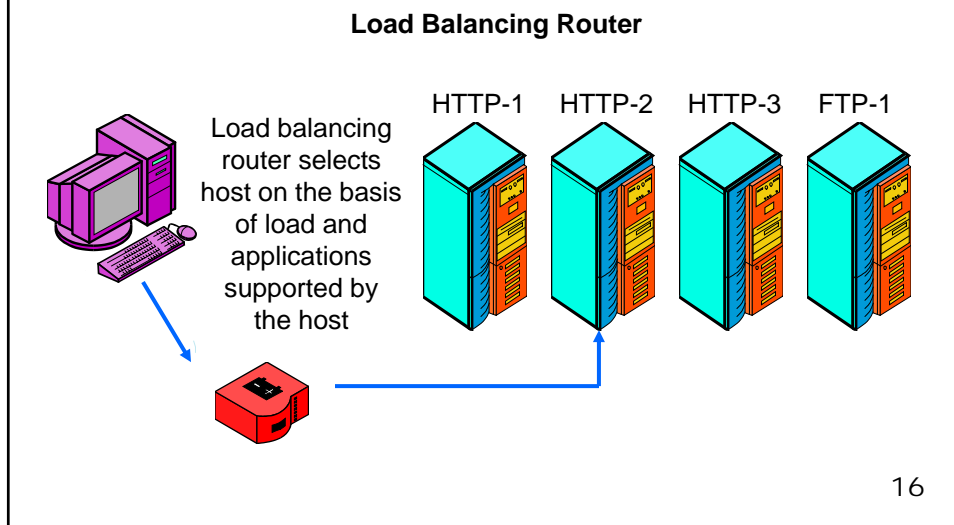


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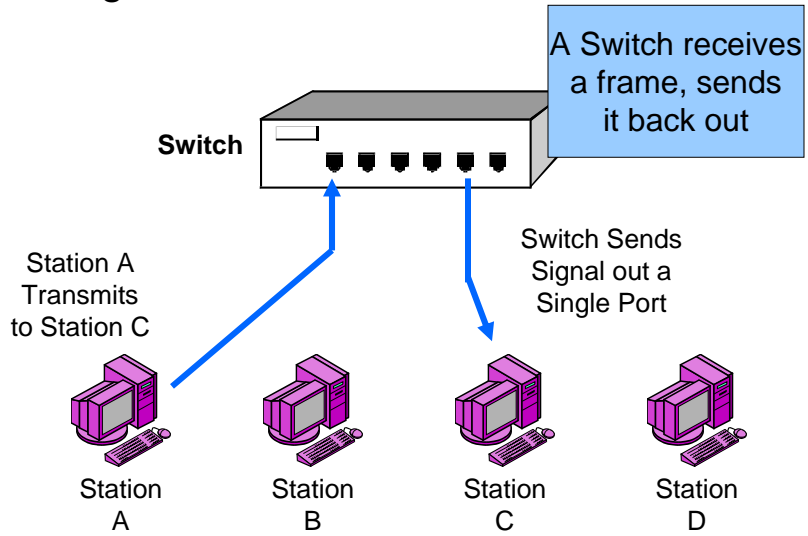
Increasing Server Scalability (and Sometimes Reliability)



Increasing Server Scalability (and Sometimes Reliability)

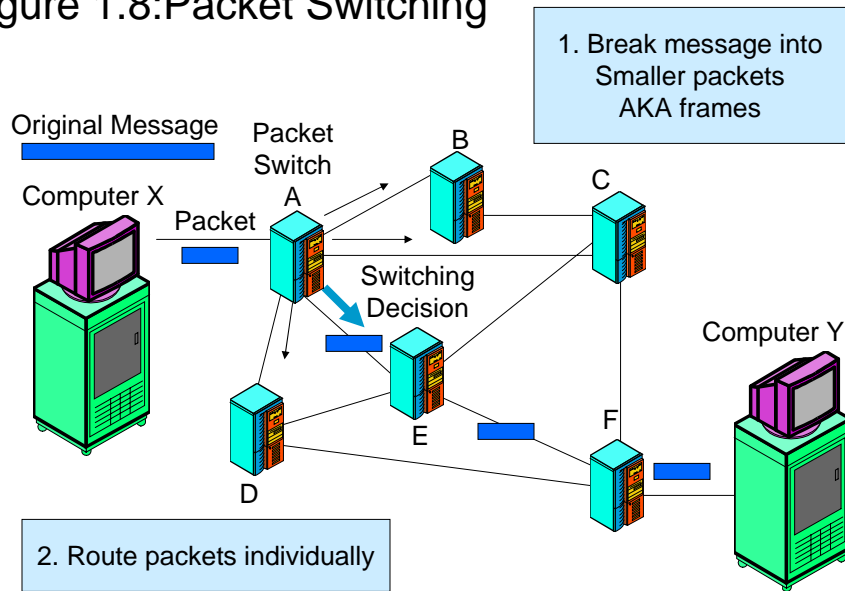


Switching Decision



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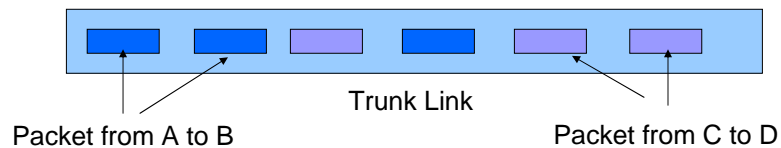
Figure 1.8: Packet Switching



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Packet Switching

- Packet Switching Reduces Trunk Line Costs
 - Packets from several conversations are *multiplexed* on trunk lines
 - Each conversation only pays for the capacity it uses



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Quality of Service

- It is not enough that networks work
 - They must work *well*
- Quality of Service (QoS) defines quantitative measures of service quality
 - Speed and Delay (Latency)
 - Reliability
- Security (not a QoS measure but crucial)

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Quality of Service (QoS)

- Speed

- Bits per second (bps)
- Multiples of 1,000 (not 1,024)
- Kilobits per second (kbps) — Note the Lower-case “k”
- Megabits per second (Mbps)
- Gigabits per second (Gbps)
- Terabits per second (Tbps)
- Petabits per second (Pbps)

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Quality of Service (QoS)

- Congestion and Latency

- Congestion because traffic chronically or momentarily exceeds capacity
- Latency (delay measured in milliseconds)
- Especially bad for some services such as voice communication or highly interactive applications

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Quality of Service (QoS)

- Reliability
 - Availability
 - Percentage of time the network is available to users for transmission and reception
 - Want 24 x 7 x 365 availability
 - Telephone network: Five 9s (99.999%)
 - Error Rate
 - % Lost or damaged messages or bits

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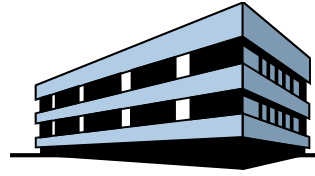
Quality of Service (QoS)

- Service Level Agreements (SLAs)
 - Guarantees for various service parameters
 - Network provider pays performance penalties if guarantees are not met

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Geographic Scope

- Local Area Network (LAN)

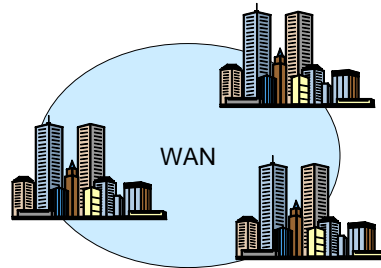


- Limited geographical distance: home, office, building, campus, industrial part
- Customer premises operation
 - User firm chooses technology
 - User firm needs to manage on ongoing basis
- Low cost per bit transmitted
 - Companies can afford high speed
 - 100 Mbps to the desktop is typical

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Geographic Scope

- Wide Area Network (WAN)



- To link sites
 - Long distances
- Requires the use of carriers to provide service
 - Limited and complex choices but carrier manages
- High cost per bit transmitted
 - Companies cannot afford high speeds
 - Usually low speed (56 kbps to a few megabits per second)

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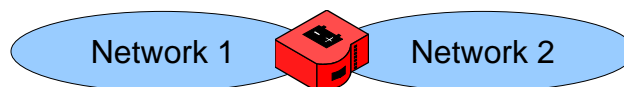
Geographic Scope

- Other Distinctions
 - Metropolitan Area Network (MAN)
 - Single urban area (city and its suburbs)
 - Faster than long-distance WANs
 - Personal Area Network (PAN)
 - A person's body or desk area
 - Storage Area Network (SAN)
 - To link servers to storage devices

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Internet

- An internet is a *group of networks* linked together with *routers* in a way that allows an application program on any station on any network in the internet to be able to communicate with an application program on another station on any other network.



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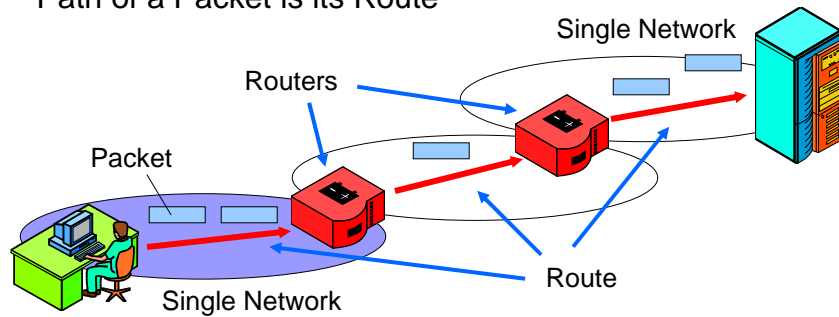
Packets and Frames

- Messages in Single Networks are Called Frames
- Messages in Internets are Called Packets

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An Internet

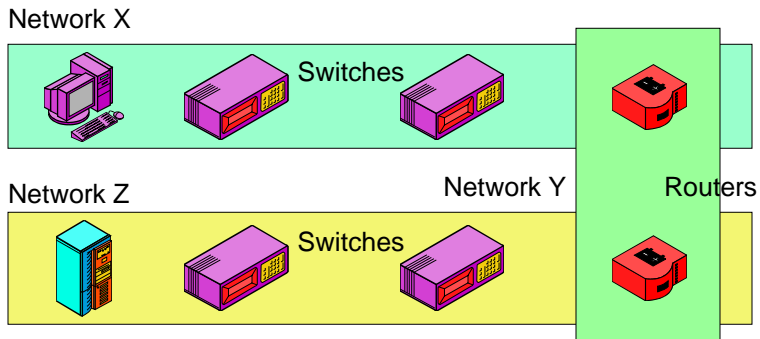
Multiple Networks
Connected by Routers
Path of a Packet is its Route



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An Internet

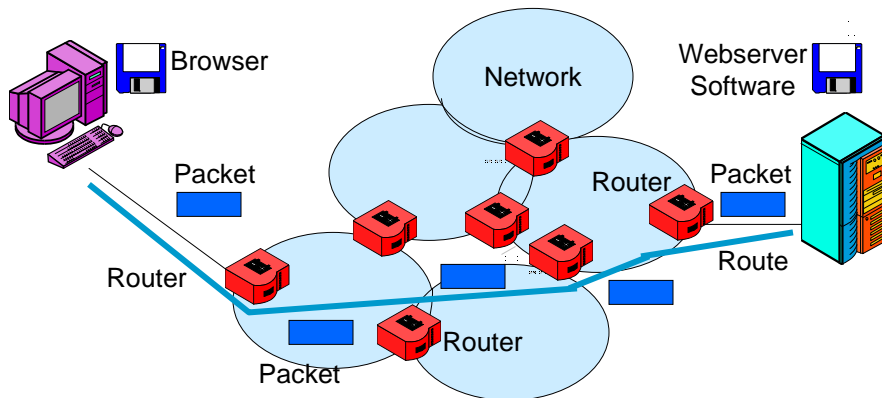
Single Networks Have Switches
Switches Connect Station-to-Router or Router-to-Router



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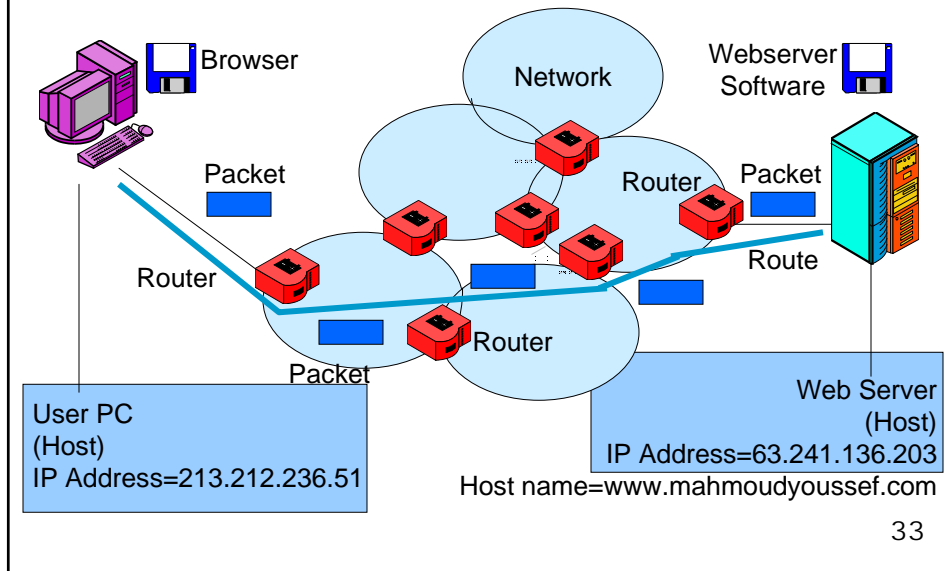
The Internet

The global Internet has thousands of networks



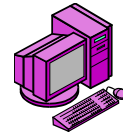
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The Internet



Hosts

- All computers connected to the Internet are hosts
 - Server hosts (webservers, FTP servers, etc.)
 - Also client PCs at home, at school, and at work
 - Also PDAs and Internet-enabled cellphones
 - The Internet treats all hosts of all sizes as equals
 - Only application software distinguishes between them (browsers for client PCs, webserver applications for server hosts, etc.)



Host Addresses and Host Names

- Host IP Address

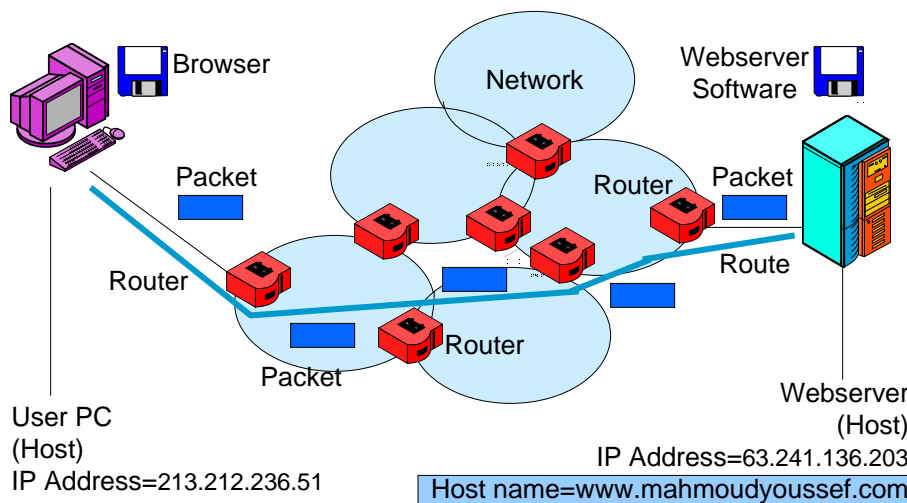
- Official address of host on the Internet
- Every host must have an IP address, including client PCs and PDAs
- 32 bits long
- Often expressed in dotted Decimal Notation for human reading (e.g., 213.212.236.51)
- Hosts and routers work with 32-bit binary form



IP Address: 213.212.236.51

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The Internet



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Host Addresses and Host Names

- Host Name
 - Several labels separated by dots
(www.mahmoudyoussef.com)
 - Like nickname; easy to remember
 - Not the official address of the host

Host Name
www.mahmoudyoussef.com



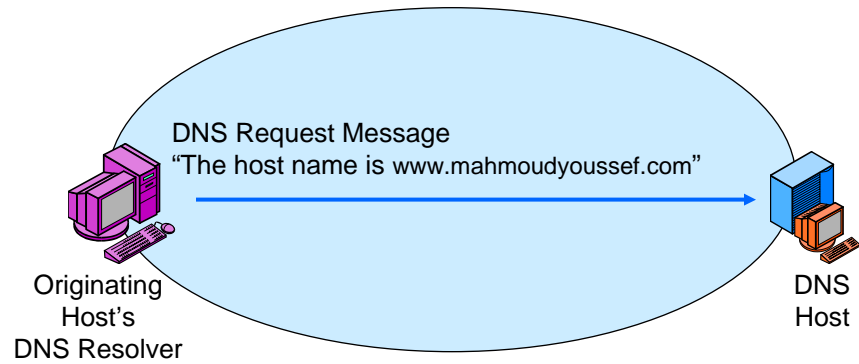
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Host Addresses and Host Names

- Domain Name System (DNS)
 - You cannot send messages to a host if you only know its host name
 - Must know its official address (IP Address)
 - DNS provides a way of finding a host's IP address if only its host name is known

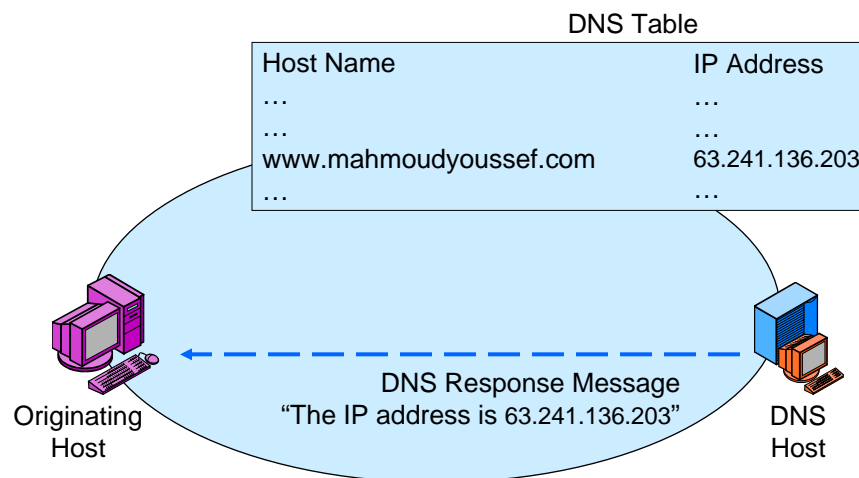
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Domain Name System (DNS) Host



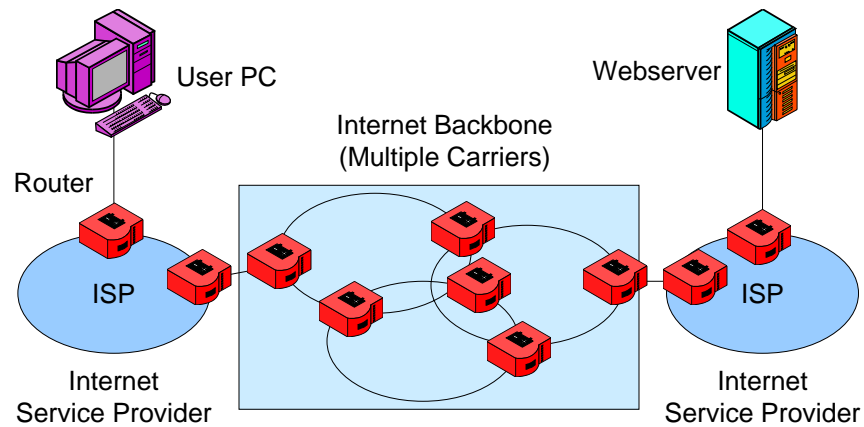
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Domain Name System (DNS) Host



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Internet Service Providers (ISPs) and Internet Backbone Carriers



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Internet Service Providers (ISPs)

- Connect you to the rest of the Internet
- Collect money from you to pay for their own operation and to pay backbone carriers to carry traffic
 - The Internet is almost entirely commercial

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The Internet, Intranets, and Extranets

Defined by Communities Served

- The Internet
 - Goal is universal community; include everyone
- Intranets
 - Community is a single (possibly multi-site) organization
 - Use Internet transmission standards and applications
 - Controlled communication with the outside world via firewalls
- Extranets
 - Community is a group of sellers and purchasers
 - Only some hosts within each company are included
 - Single seller with multiple buyers, or
 - Single buyer with multiple sellers, or
 - Marketplace with multiple buyers and seller

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Security

- A large and growing concern
- Attacks are roughly doubling each year
- Attacks are becoming more damaging when they occur (\$1 US billion per major virus outbreak)
- Companies and nations now face the prospect of far more destructive cyberwar and cyberterrorism

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