

Part 1: Introduction to the module Networks and Protocols CE00997-6

Mohammad S. Hasan
Staffordshire University

Teaching staff

◆ Mohammad Hasan

- Lectures
- Room: K216
- Email: m.s.hasan@staffs.ac.uk

◆ Tomasz Bosakowski

- Tutorials
- Room: K216
- Email: t.bosakowski@staffs.ac.uk

Teaching schedule

Week	Lecture 1		Lecture 2
1	Introduction to module and networks		OSI 7 layer model Vs TCP/IP
2	Network Hardware (routers, hubs, Switches)		LAN's CSMA/CD, Bus, Star, Ring etc...
3	ARP, HTTP etc...		ARP, HTTP etc... cont
4	Classful addressing		Classless Addressing
5	WAN overview ISDN		Frame Relay, ATM
6	Wireless, Cellular		Routing - general, flow control...
7	Distance vector routing		link state routing
8	Project brief		Project surgery
9	Network Management		SNMP
10	Security, firewalls		VPN, Remote access
11	network design		Network design
12	Surgery		In class test

Assessment

◆ One in-class test – 30%

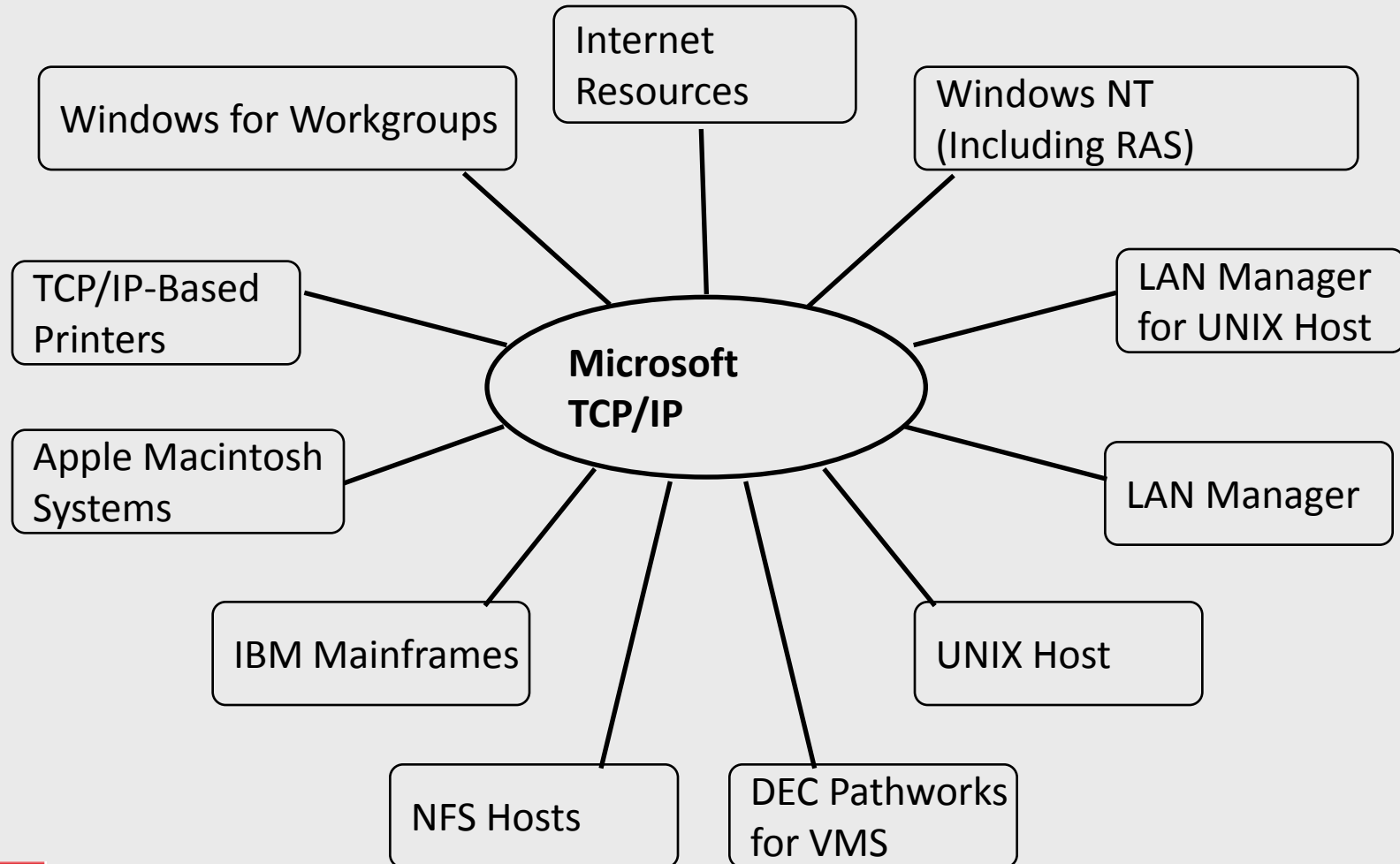
- This will be in week 12 in the last lecture

◆ One individual project – 70%

- To be submitted in week 12
- If the work is submitted late it will attract a score of zero unless extenuating circumstances are upheld

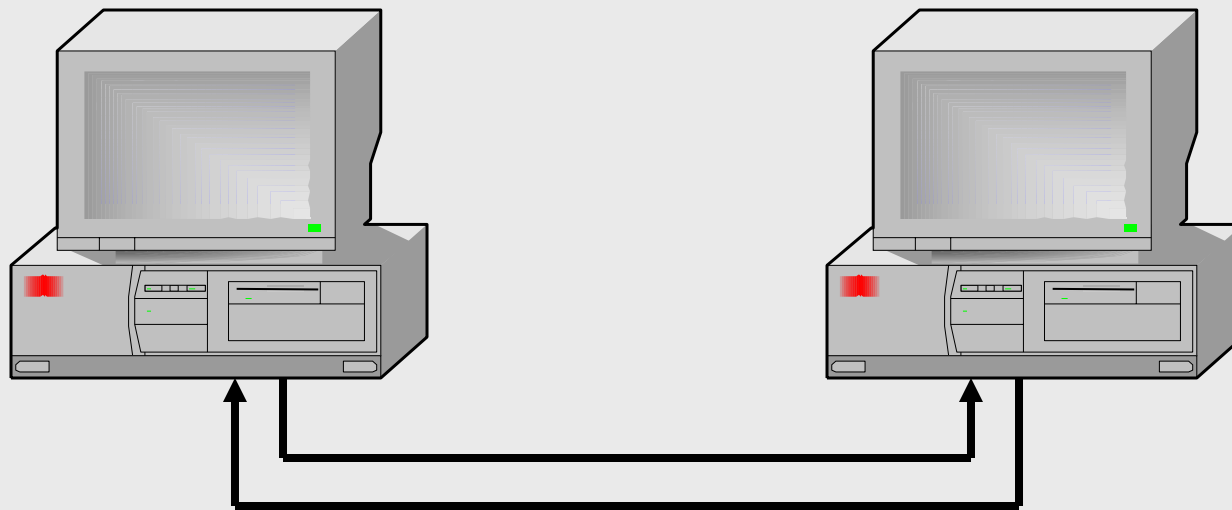
Part 2: Inter & Intra Network Systems

Heterogeneous environments

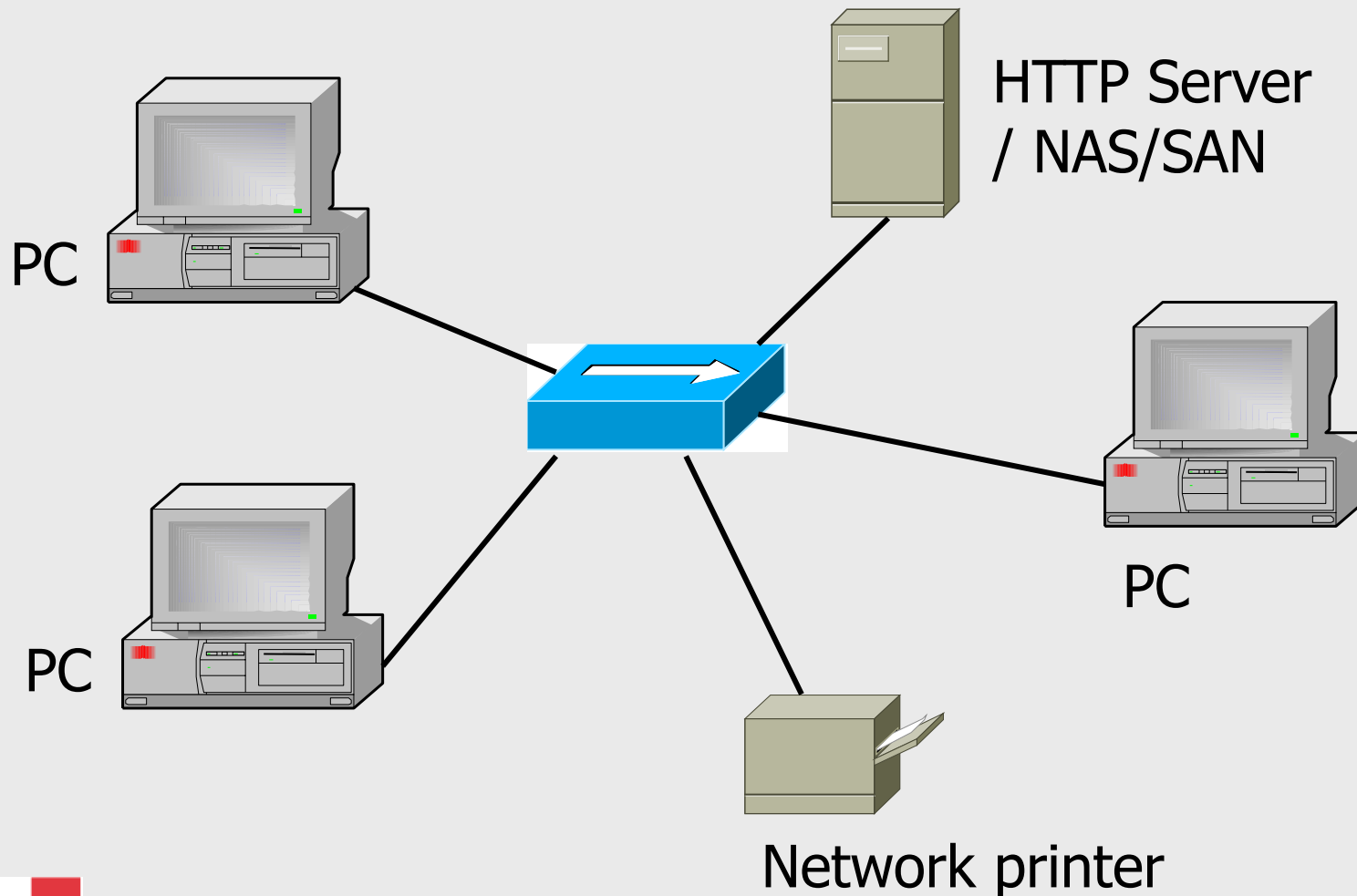


Definition of a Network

- ◆ **Two or more devices e.g. computers utilising data communications (peer to peer)**



Local Area Network (LAN)



Local Area Network (LAN)

- ◆ **Interconnects various devices e.g. servers, workstations etc.**
 - **Normally more than 3 machines going through a connection point e.g. Hub**
 - **Broadcasts data at high data rate**
 - **Very low error rate**
- ◆ **Small geographic area e.g. a building**
- ◆ **Normally owned by an organisation**
- ◆ **LAN's use has become widespread in commercial and academic environments**

Primary Function of a LAN

- ◆ **To provide access to hardware and software resources**
- ◆ **File serving / sharing**
 - **large storage disk drive acts as a central storage repository**
- ◆ **Print serving**
 - **Access a particular printer, queue print jobs, administrative duties etc.**

Other LAN Functions

◆ Video transfers

- High speed LANs can support live video

◆ Manufacturing support

- Manufacturing and industrial environments

◆ Academic support

- In classrooms, labs, and wireless

◆ E-mail support

◆ Interconnection between multiple systems

Advantage of LAN

- ◆ **Sharing hardware and software resources**
- ◆ **Fault tolerance**
- ◆ **Heterogeneous hardware and software**
- ◆ **Access to other LANs and WANs**
- ◆ **Private ownership**
- ◆ **Secure transfers at high speeds with low error rates**

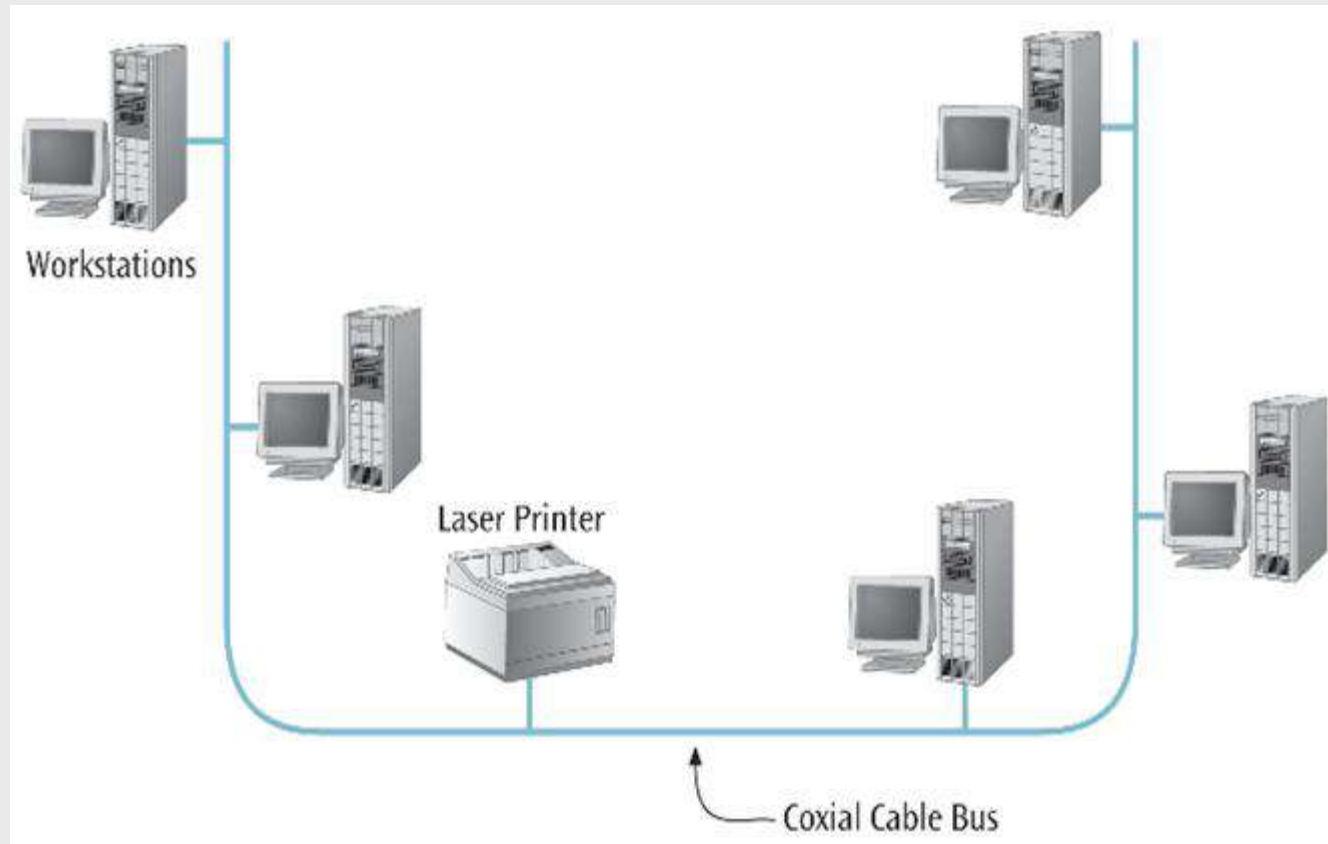
Disadvantages of LAN

- ◆ **Equipment and support can be costly**
- ◆ **Level of maintenance continues to grow**
- ◆ **Hardware incompatibility**
- ◆ **Just because a LAN can support two Software package/application, protocol incompatibility**
- ◆ **Troubleshooting complexity**

Basic LAN Topologies or Configuration

- ◆ **Bus / Tree**
- ◆ **Star-wired Bus**
- ◆ **Wireless**

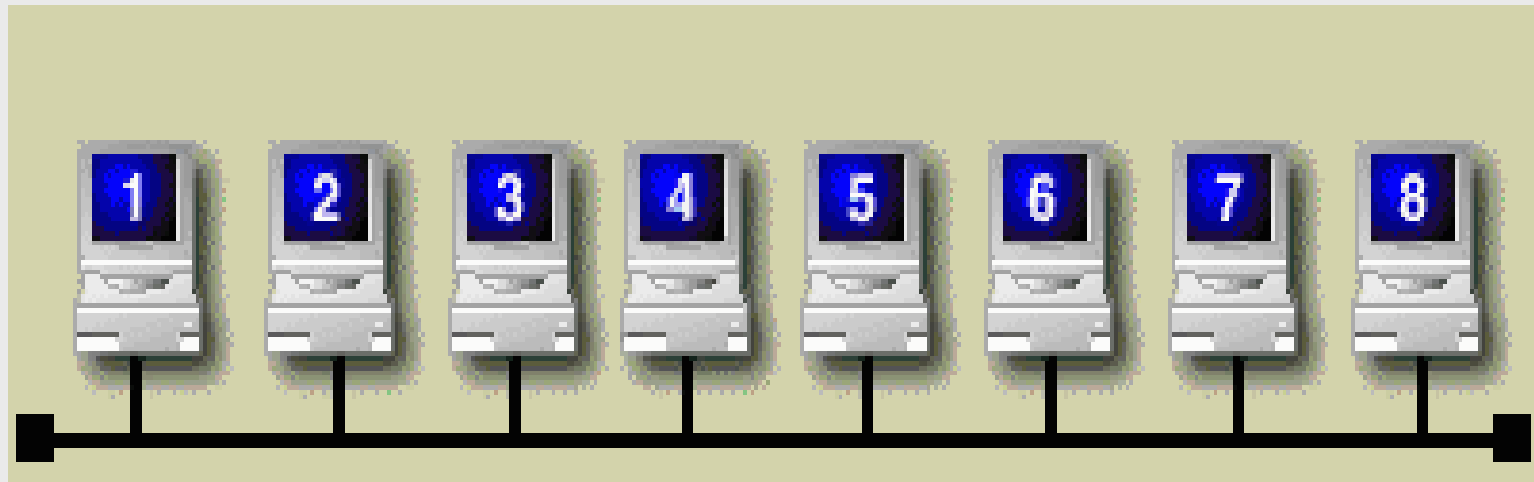
Bus / Tree Topology



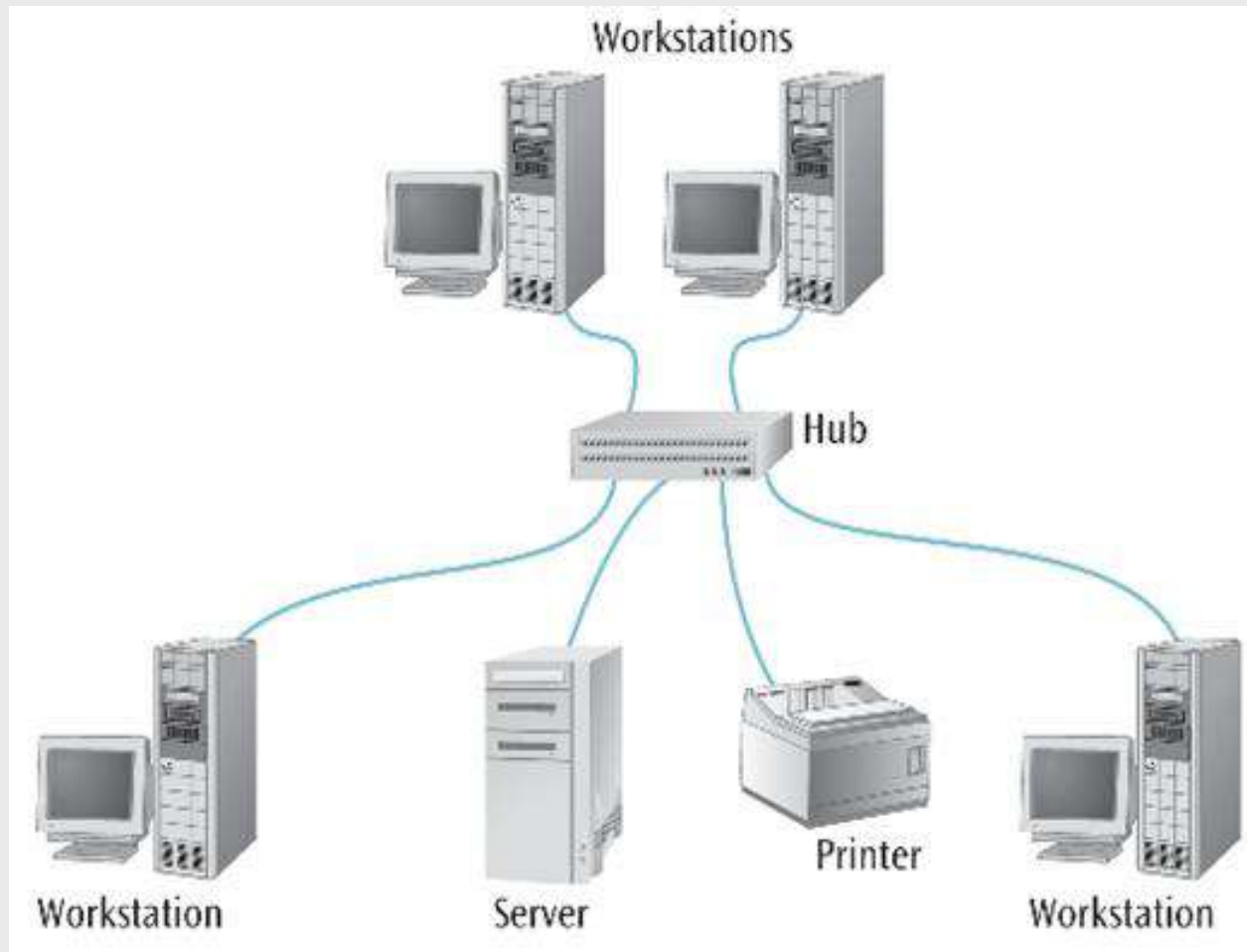
Bus / Tree Topology (cont.)

- ◆ **The original topology**
- ◆ **A Tap connects PC's network interface card (NIC) to the bus (a coaxial cable)**
- ◆ **Data can be transferred using either:**
 - **Baseband digital signals**
 - **Bidirectional, outward transmitting from the workstation in both directions**
 - **Broadband analog signals**
 - **Usually uni-directional, special wiring considerations needed**

Bus / Tree Topology Operation



Star-wired Bus Topology



Star-wired Bus Topology

- ◆ **Physically looks like a star but logically operates as a bus**
- ◆ **Star design based on hub**
- ◆ **All workstations attach to hub**
- ◆ **Usually Unshielded twisted connects workstations to hub**
- ◆ **Hub is a broadcasting device**
- ◆ **Hubs can be interconnected to extend network size**

Pros and Cons of Star-wired Bus Topology

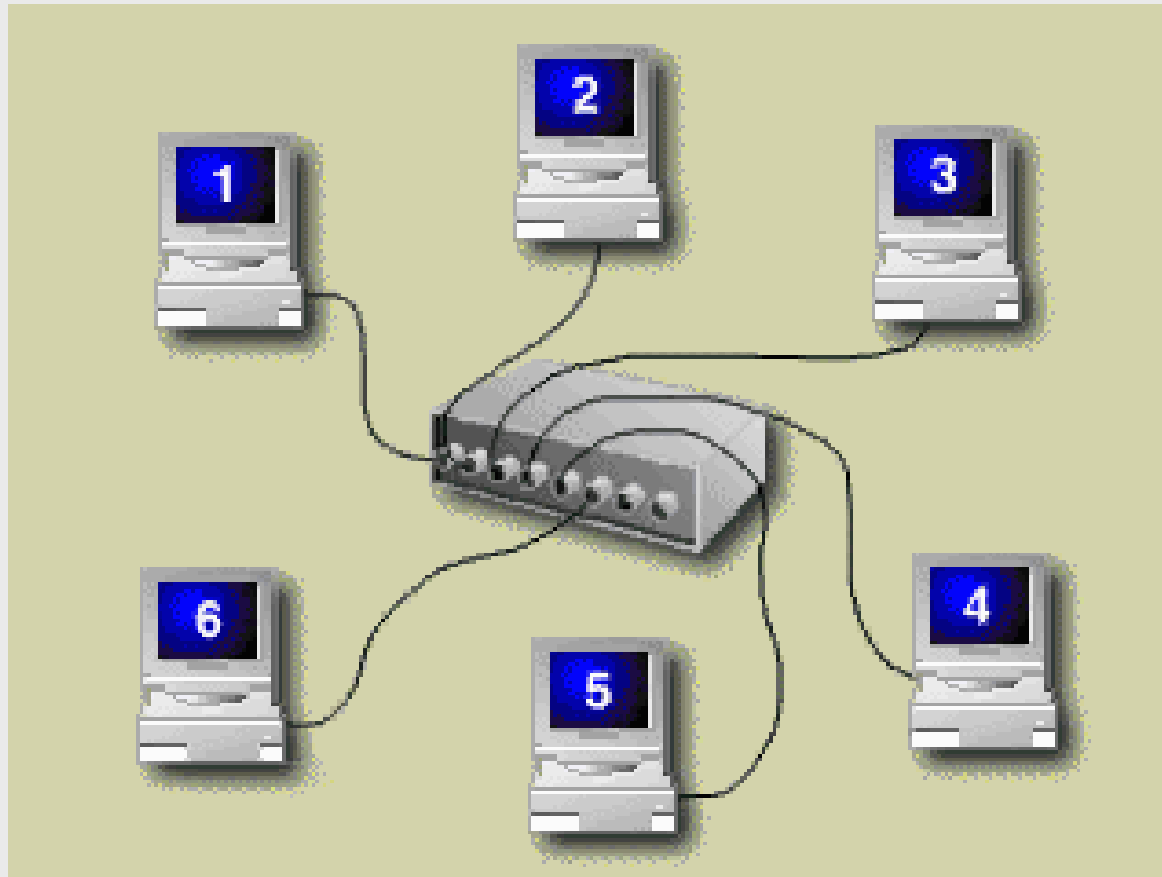
◆ Pros

- Easier installation and maintenance because of modular connectors and twisted pair
- Hubs can be interconnected with twisted pair, coaxial cable, or fiber optic cable

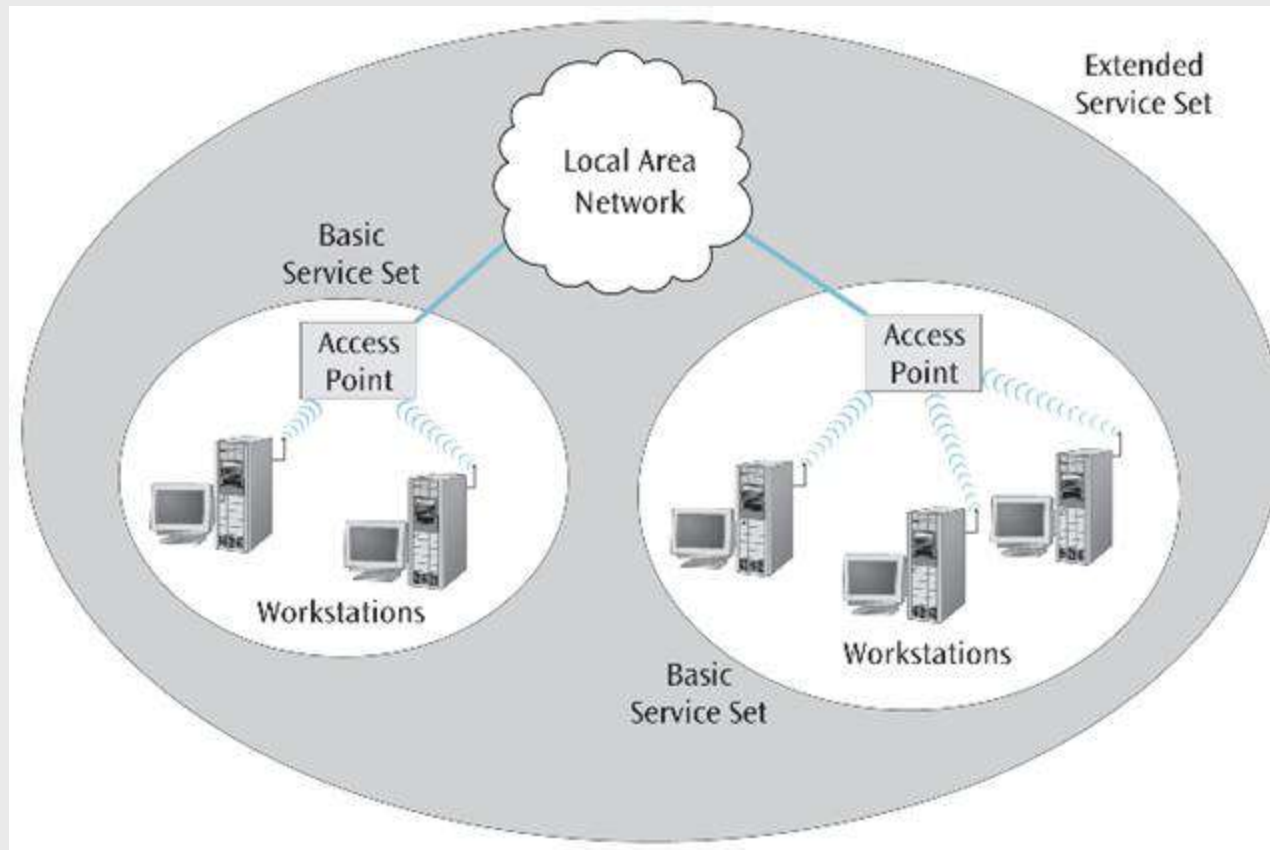
◆ Cons – network sharing

- Only one station can transmit at a time
- when one station talks, everyone hears it
 - shared or broadcast network

Star-wired Bus Topology operation



Wireless LAN (WLAN)



WLAN (cont.)

- ◆ **Not really a specific topology**
- ◆ **Workstation in WLAN can be anywhere as long as within transmitting distance to access point**
- ◆ **Several versions of IEEE 802.11 standard defines various forms of wireless LAN connections**
- ◆ **Workstations reside within a basic service set**
- ◆ **Multiple basic service sets create an extended service set**

WLAN (cont.)

◆ Two basic components

- Client Radio - usually PC card with integrated antenna installed in a laptop or workstation
- Access Point (AP) - Ethernet port plus transceiver

◆ Access Point

- Acts as bridge between wired and wireless networks
- Can perform basic routing functions

◆ Workstations with client radio cards reside within a basic service set

◆ Multiple basic service sets create extended service set

WLAN Standards

- **802.11b**
 - 11Mbps, 100-150ft, 2.4Ghz (crowded)
- **802.11a**
 - 54Mbps, 25-75ft, 5Ghz (uncrowded)
- **802.11g**
 - 54Mbps, 100-150ft, 2.4GHz (crowded)
 - Compatible with 802.11b
- **802.11n – new standard**
 - Up to 260Mbps, 230ft, 2.4 and 5GHz



WLAN Security Standards

◆ Wired Equivalent Privacy (WEP)

- The first security protocol
- Claimed that WEP would offer the same level of privacy over a WLAN as could be expected with a wired network
- Unfortunately, WEP used 40-bit static encryption keys that were too easy to break

◆ Wi-Fi Protected Access (WPA)

- WEP was replaced by WPA
- Uses a different key for every packet of data that is transmitted
- Offers integrity and authentication of clients



WLAN Security Standards (cont.)

◆ WPA2 (second version of WPA version 2)

- Uses Advanced Encryption Standard (AES) encryption
- Part of IEEE 802.11i (the official WLAN security standard, which was agreed after WPA2)
- 802.11i uses the Extensible Authentication Protocol (EAP), which offers several different types of authentication

Comparison of Bus, Star-Wired Bus, Star-Wired Ring, and Wireless Topologies

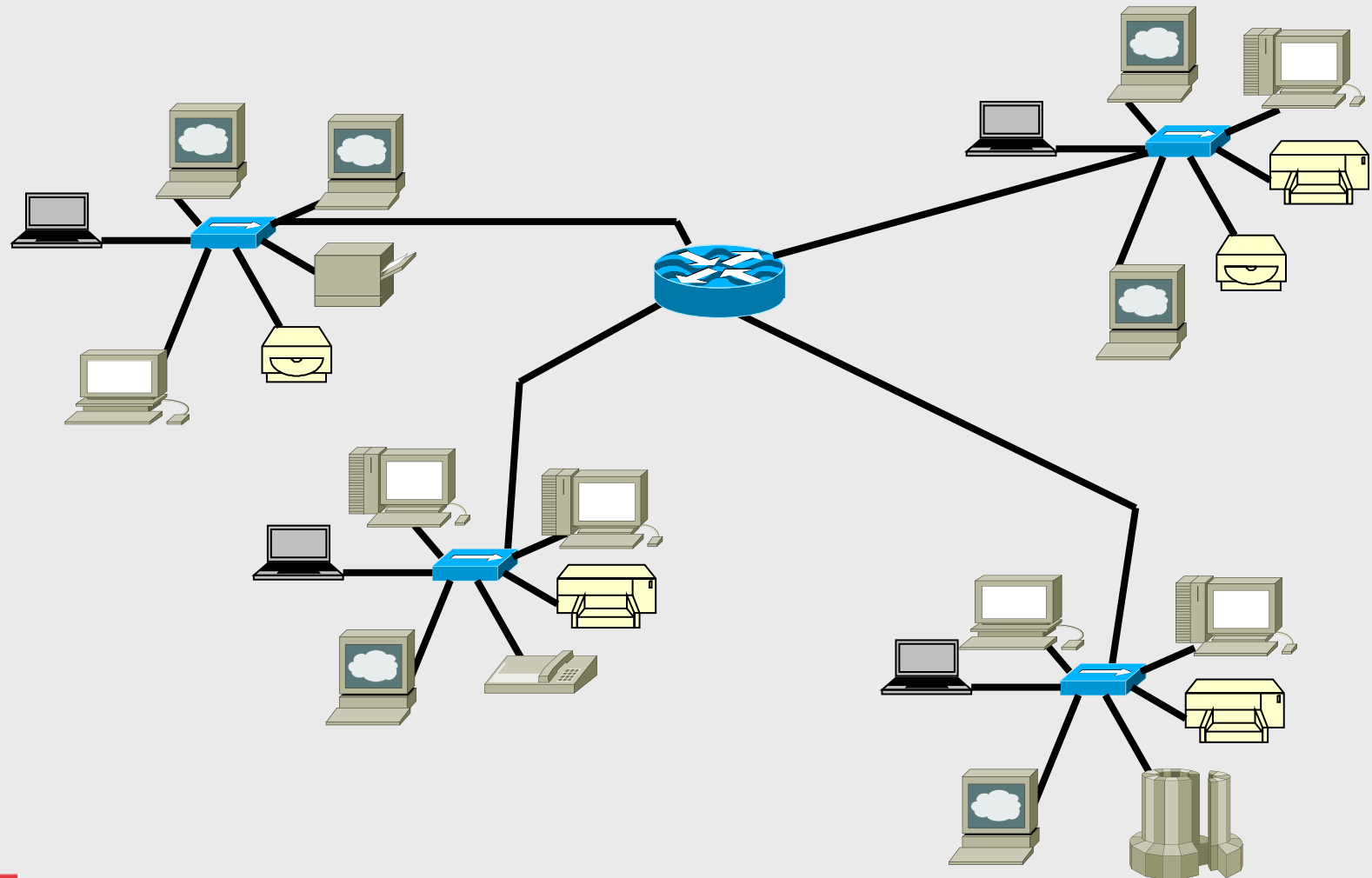
Table 7-1

Comparison of the bus, star-wired bus, star-wired ring, and wireless topologies

	Baseband Bus	Broadband Bus/Tree	Star-Wired Bus	Star-Wired Ring	Wireless
Signaling technique	Digital	Analog	Digital	Digital	Analog
Physical layout	Linear	Linear	Central	Central	None
Usual media type	Coaxial cable	Coaxial cable	Twisted pair	Twisted pair	None
Installation ease	Moderate	Moderate	Easy	Easy	Easy
New workstation installation	Hard (if no tap available)	Hard (if no tap available)	Easy (if port available)	Easy (if port available)	Very easy
Concurrent channels	No	Yes	No	No	No (per access point)
New LAN installations	No	No	Yes	No	Yes



Wide Area Network (WAN) connectivity



Types of Communications Networks

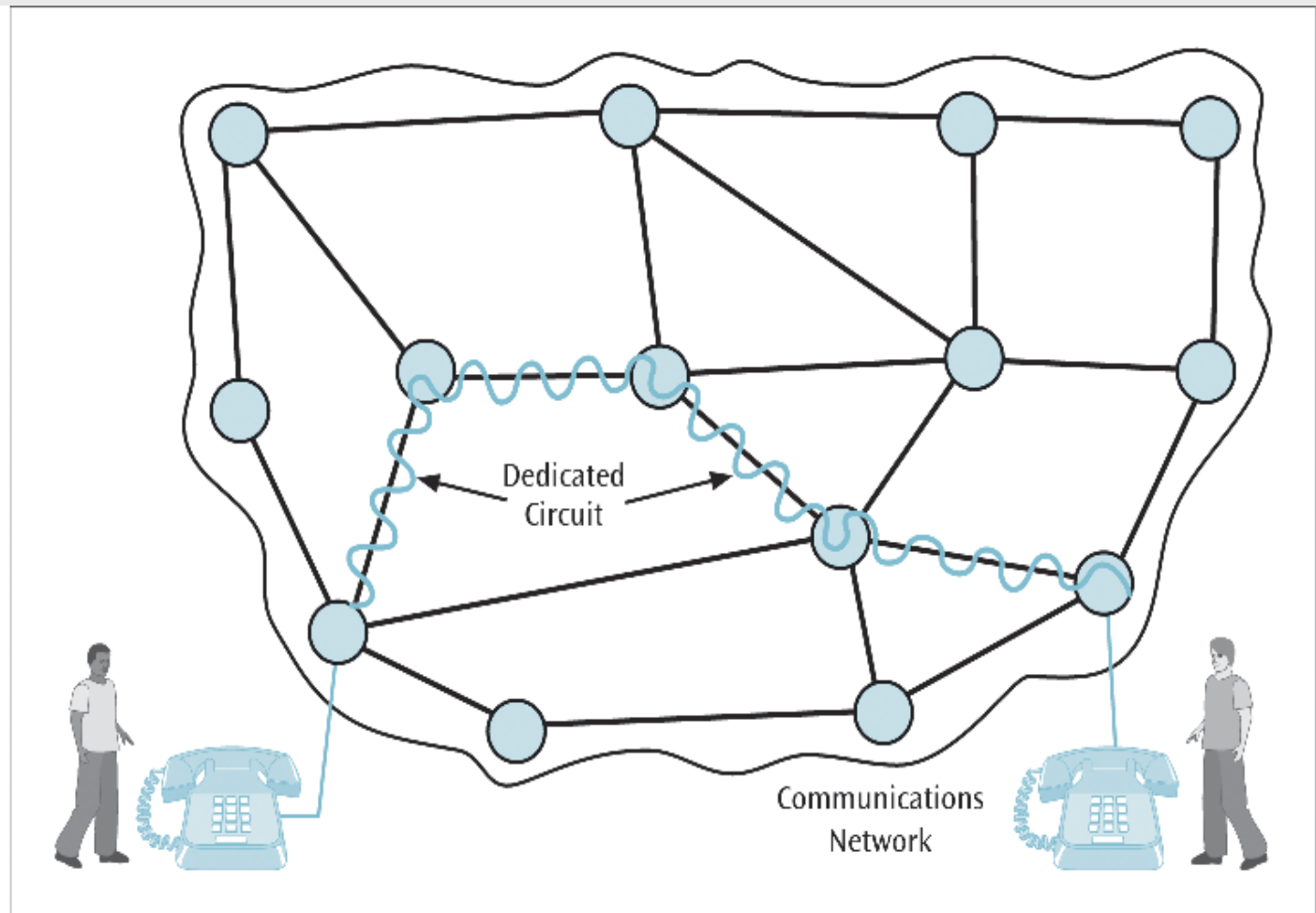
◀ Circuit switched network

- A dedicated circuit is established between sender and receiver
- All data passes over this circuit
- The Plain Old Telephone System (POTS) is a common example
- Connection is dedicated until one party or another terminates the connection

Circuit-Switched Network

Figure 10-6

Two people carrying on a telephone conversation using a circuit-switched network



Packet-Switched Network

- All data messages are transmitted using fixed-sized packages, called packets
- More efficient as packets from multiple sources can share the medium.
- One form of packet switched network is the datagram
- With a datagram, each packet is on its own and may follow its own path
- Virtual circuit creates a logical path through the subnet
 - All packets from one connection follow this path

Broadcast Network

- ◆ Typically found in LANs but occasionally found in WANs
- ◆ A workstation transmits its data and all other workstations “connected” to the network hear the data

Summary of Network Structures

Table 10-1

Summary of communications network characteristics

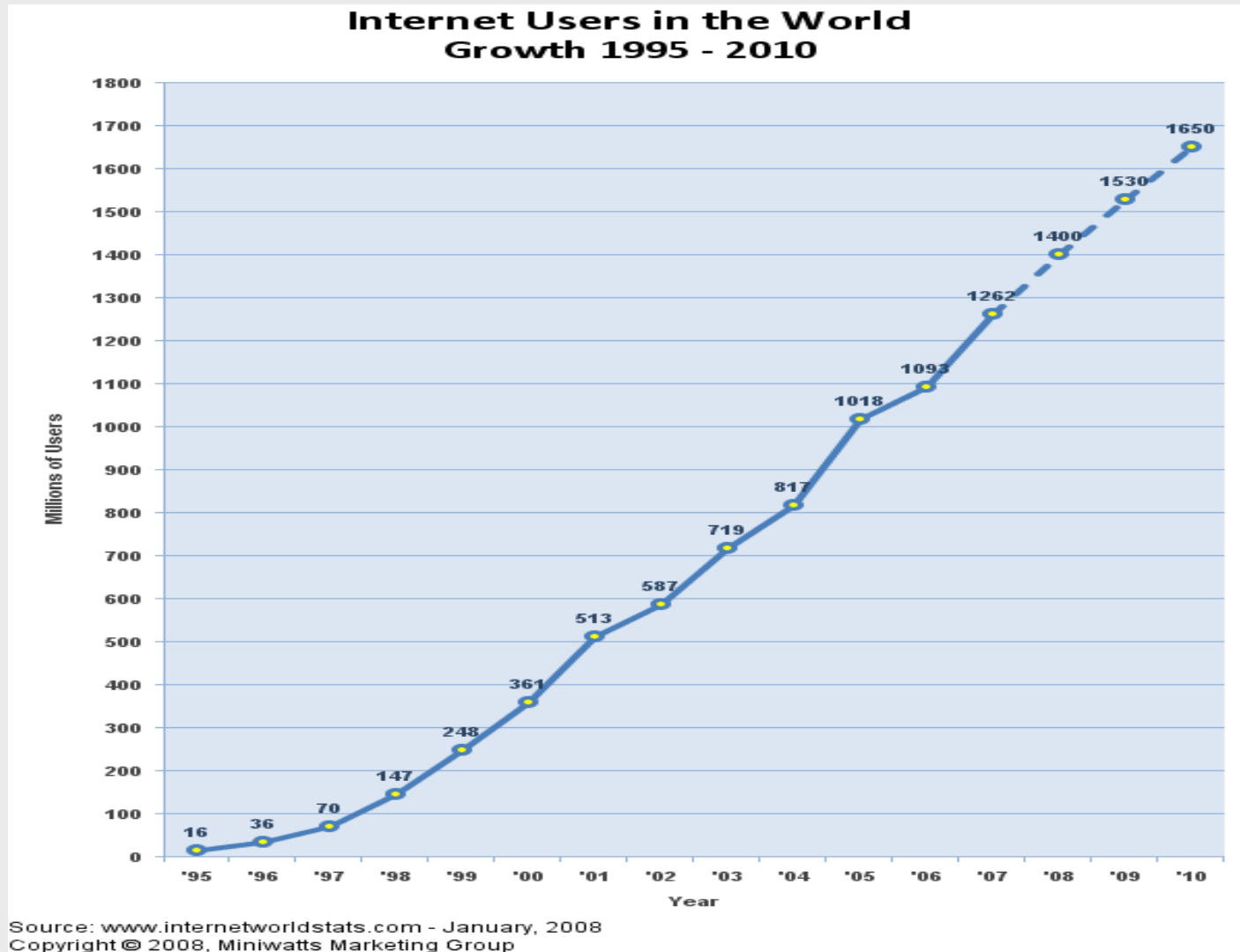
Characteristic	Circuit-Switched	Datagram Packet-Switched	Virtual Circuit Packet-Switched	Broadcast
Path setup time?	Yes	No	Yes	No
Routing decision for each packet?	No	Yes	No	Typically no routing
Dedicated path?	Yes	No	No	No
Can dynamically reroute if problems occur?	No	Yes	No	Typically no routing
Designed for data or voice?	Voice	Data	Data	Both
Connection dedicated to your transfer only?	Yes	No	No	No



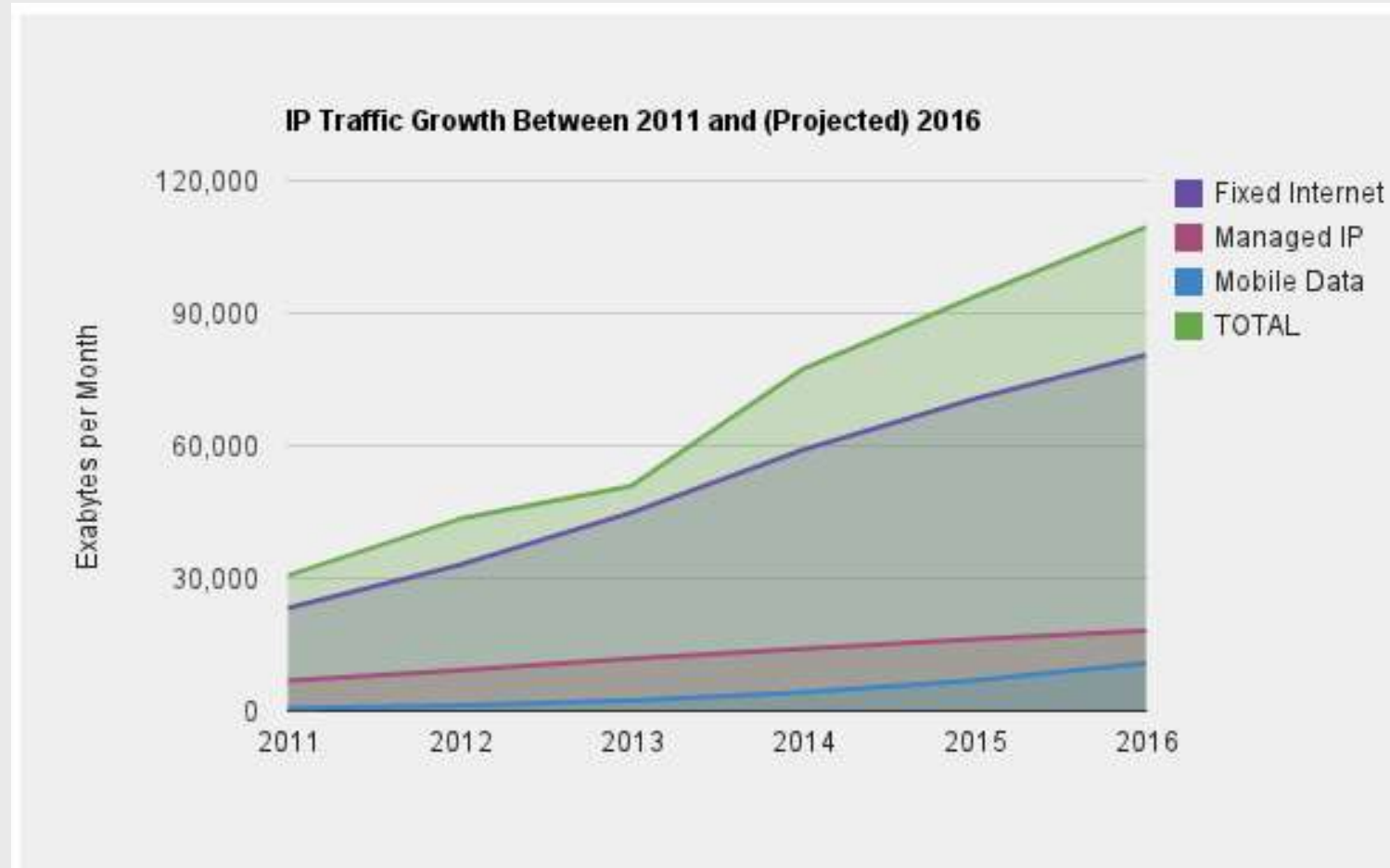
The Internet

- ◆ **US Department of Defence**
 - **Advanced Research Projects Agency (ARPA).**
- ◆ **1990's commercial success**
- ◆ **The ultimate WAN.**
 - **Thousands of LANS connected to form a WAN**
- ◆ **Main point to consider, there is no regulatory body, except for addressing**
- ◆ **Some people use the cloud analogy**

Growth of the Internet



IP traffic growth



<http://www.theatlantic.com/technology/archive/2012/05/the-future-growth-of-the-internet-in-one-chart-and-one-graph/257811/>

IP Traffic 2011 - 2016

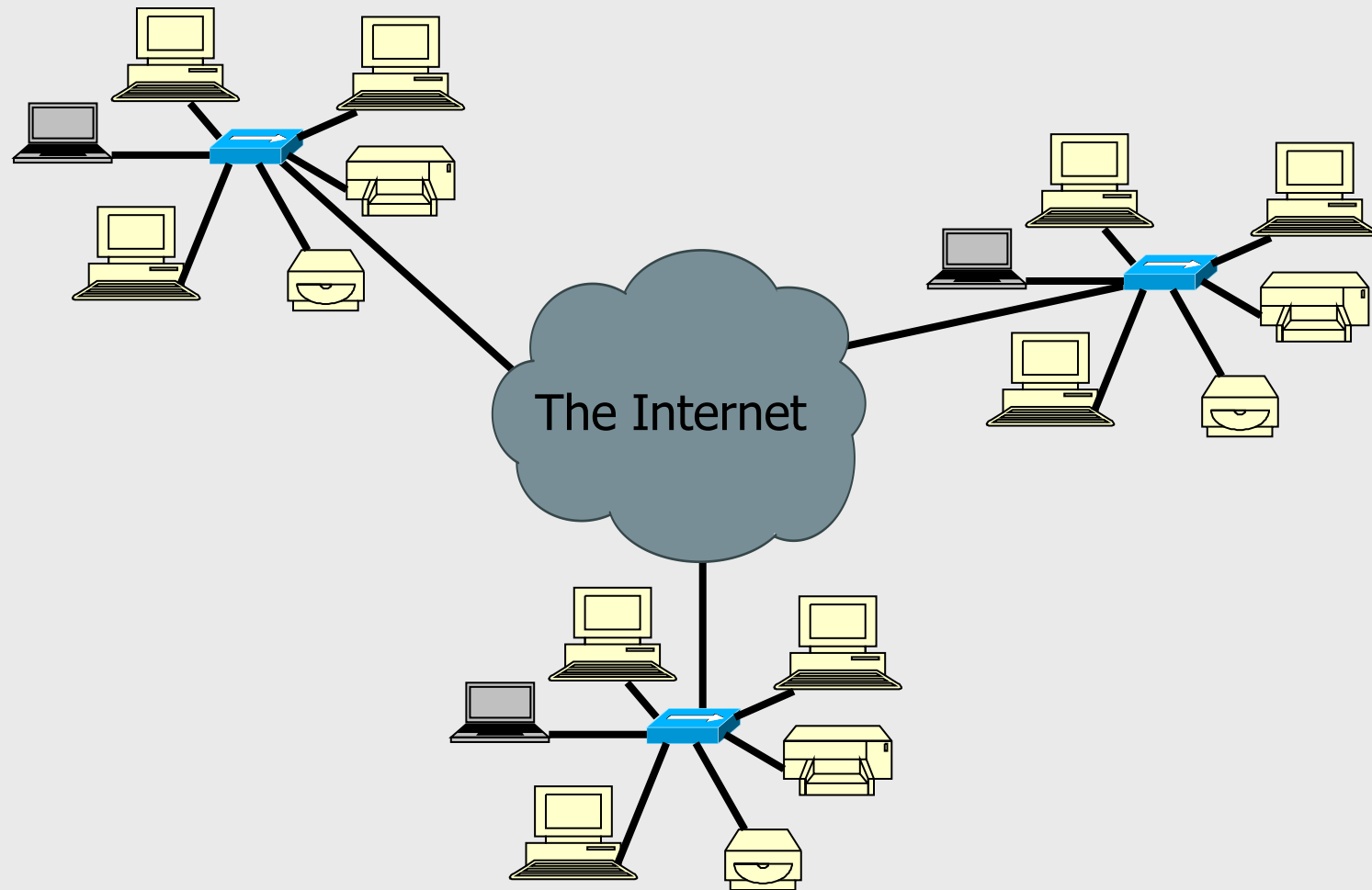
IP Traffic, 2011–2016							
	2011	2012	2013	2014	2015	2016	CAGR 2011–2016
By Type (PB per Month)							
Fixed Internet	23,288	33,049	44,883	59,096	70,622	80,562	28%
Managed IP	6,849	9,199	11,830	14,063	16,231	18,131	21%
Mobile data	597	1,252	2,379	4,215	6,896	10,804	78%
By Segment (PB per Month)							
Consumer	25,792	37,304	51,332	67,637	82,189	96,367	30%
Business	4,942	6,198	7,760	9,737	11,561	13,130	22%
By Geography (PB per Month)							
North America	10,343	14,580	18,866	22,810	25,464	27,486	22%
Western Europe	7,287	10,285	14,116	18,536	21,791	24,259	27%
Asia Pacific	10,513	14,792	20,463	27,567	34,220	40,488	31%
Latin America	1,045	1,570	2,355	3,619	5,349	7,564	49%
Central and Eastern Europe	1,162	1,673	2,377	3,382	4,578	5,987	39%
Middle East and Africa	384	601	914	1,460	2,349	3,714	57%
Total (PB per Month)							
Total IP traffic	30,734	43,501	59,092	77,374	93,750	109,498	29%

Source: Cisco VNI, 2012

<http://www.theatlantic.com/technology/archive/2012/05/the-future-growth-of-the-internet-in-one-chart-and-one-graph/257811/>



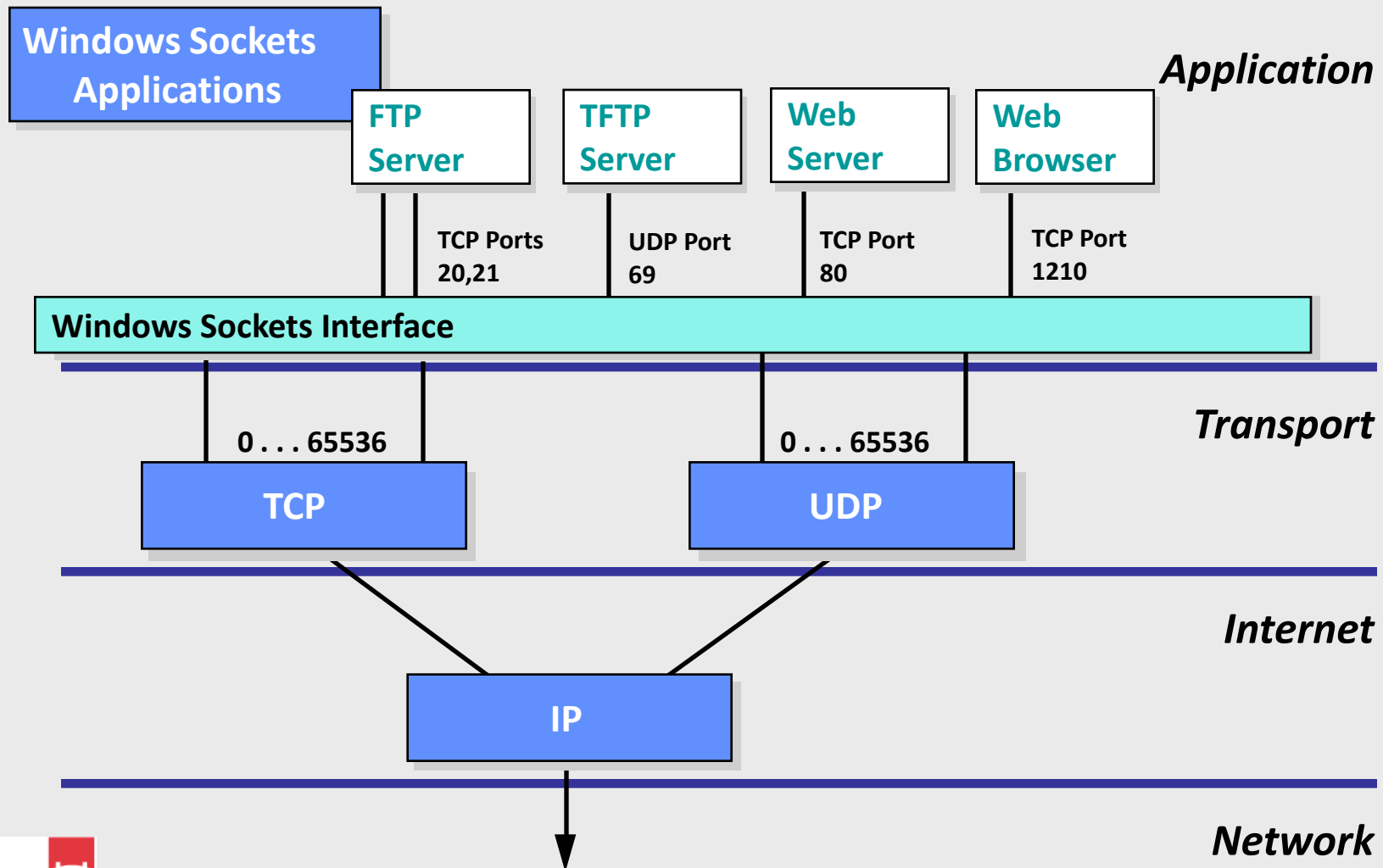
The Concept of “Cloud”



The World Wide Web (WWW)

- ◆ WWW can be thought of as an application
- ◆ Large scale, online repository of information
- ◆ Can search using an application – browser
- ◆ Distributed Hypermedia system
- ◆ LANS's, WAN'S, the internet and WWW all have commonalities
- ◆ All are designed to share data/information
- ◆ All must follow some sort of standard, Protocols

Ports & Sockets (TCP/IP model)



Port numbers

- ◆ **Between 0 and 65,536**
- ◆ **Client side port numbers are dynamically assigned**
- ◆ **Well known server side apps have port numbers**
 - **assigned by IANA (Internet Assigned Numbers Authority)**
- ◆ **Numbers below 255**
 - **for public applications**
- ◆ **Numbers from 255-1023**
 - **assigned to companies for marketable applications**
- ◆ **Numbers above 1023**
 - **unregulated**

Browser operation

- When a browser is launched the default home page is opened
- The browser loads files into clients memory & disconnects from web server
- When a new URL is entered the connection is established to the new web server
- The web server then transfers the files to clients browser, then stored in clients memory, web server disconnects
- If next page on same website, client must re-establish connection

Locating a Document on the Internet

- ◆ Every document on the Internet has a unique uniform resource locator (URL)

- <http://cs.depaul.edu/public/example.htm>

- <ftp://gatekeeper.dec.com/pub/games/starwars.exe>

- ◆ URL components

- Service type

- Host or domain name

- Directory or subdirectory information

- Filename



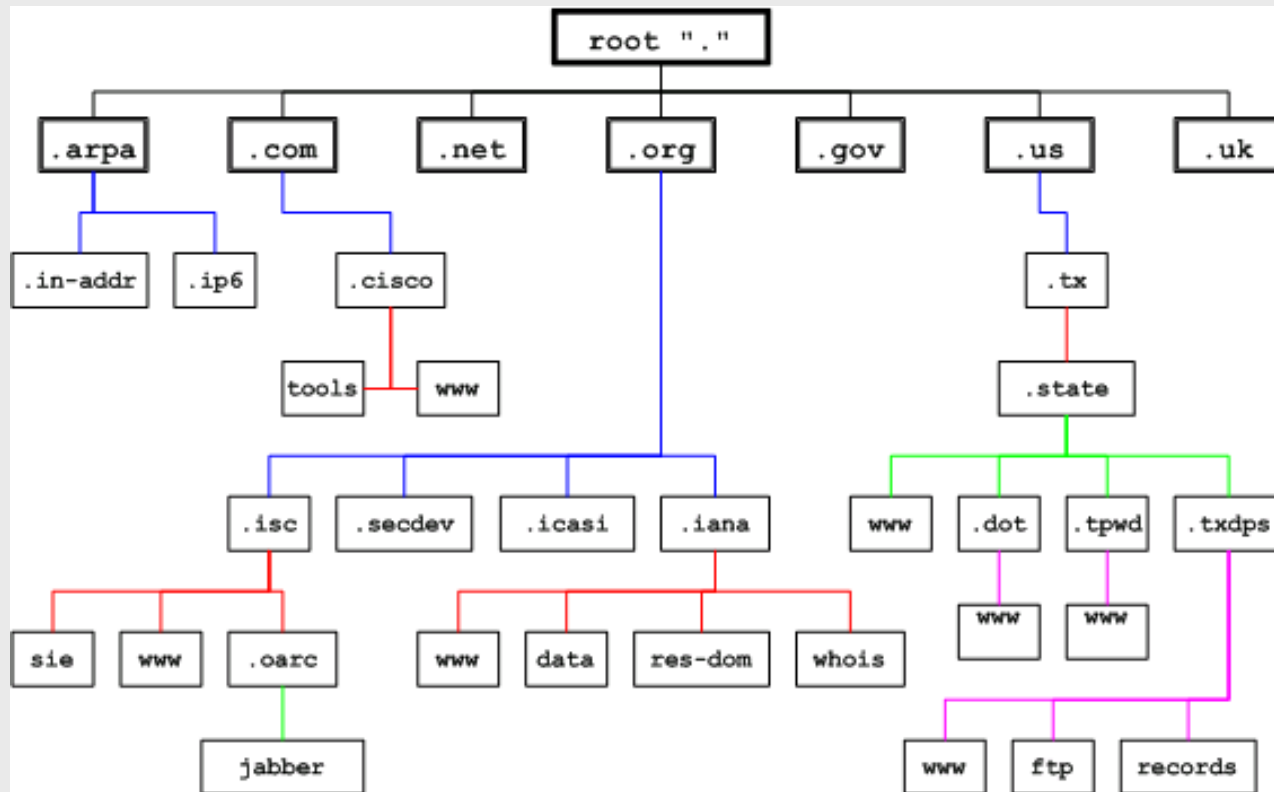
Domain Name Service (DNS)

- ◆ **The DNS is a large, distributed database of URLs and IP addresses**
- ◆ **The first operation performed by DNS is to query a local database for URL/IP address information**
- ◆ **If the local server does not recognize the address, the server at the next level will be queried**
- ◆ **Eventually the root server for URL/IP addresses will be queried**

Domain Name Service (DNS)

- ◆ If root server has the answer, results are returned
- ◆ If root server recognizes domain name but not the extension in front of the domain name, the root server will query the server at the domain name's location
- ◆ When the domain's server returns results, they are passed back through the chain of servers (and their caches)

Domain Name Hierarchy



.arpa: primarily used for address to host mappings

.com, .net, .org, .org: are generic TLDs (gTLD)

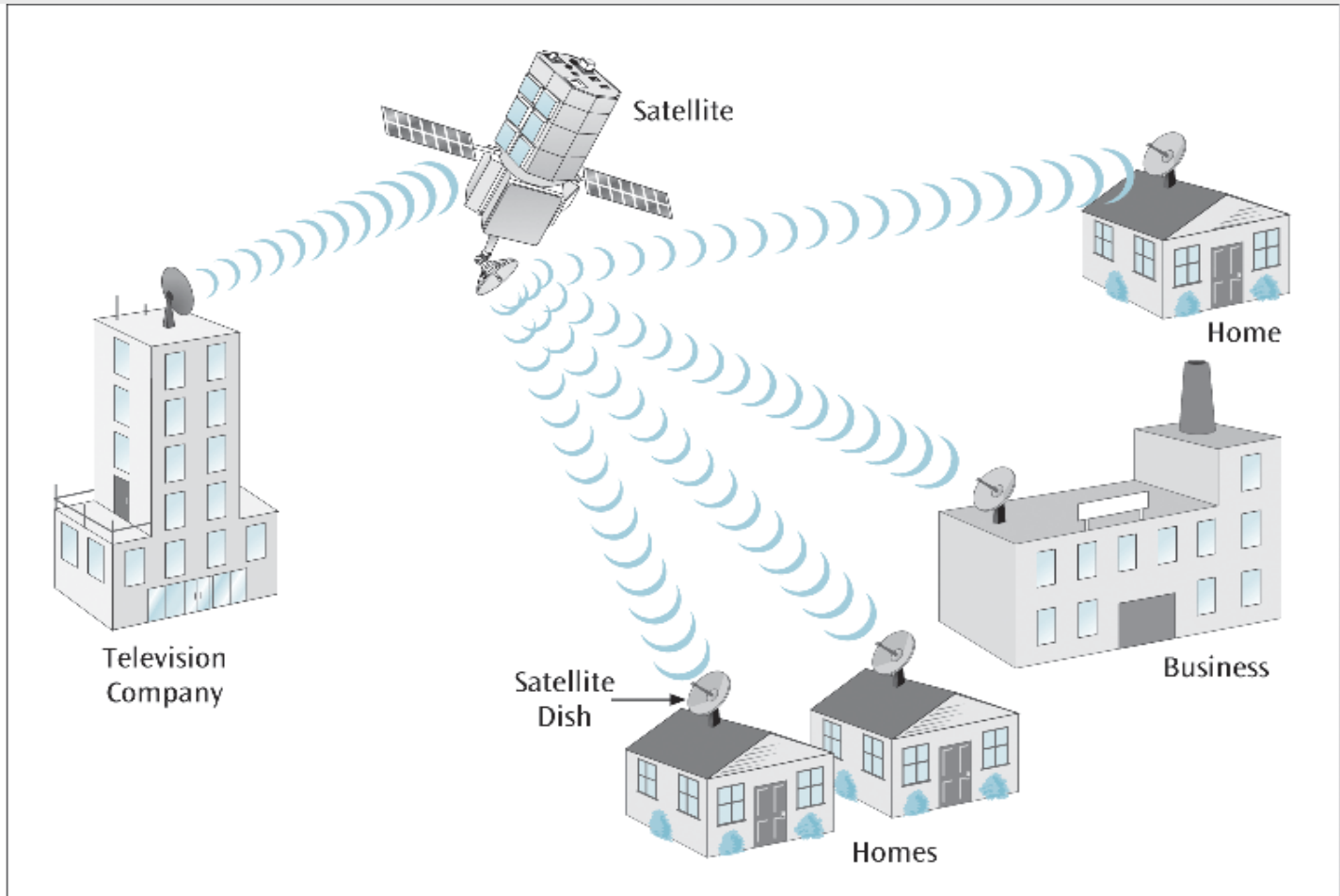
.us, .uk: are country code TLDs (ccTLD)



Satellite and Microwave Configurations

Figure 1-10

Example of a television company using a satellite system to broadcast television services into homes and businesses



Satellite and Microwave Configurations (cont.)

- ◆ Long distance wireless connections
- ◆ Many types of applications
 - long distance telephone, television, radio, long-haul data transfers, and wireless data services
- ◆ Typically expensive services but many companies offer competitive services and rates

Connection-Oriented vs. Connectionless Network Applications

◆ A connection-oriented application

- requires both sender and receiver to create a connection before any data is transferred
- Applications (such as large file transfers) and sensitive transactions (such as banking and business) are typically connection-oriented

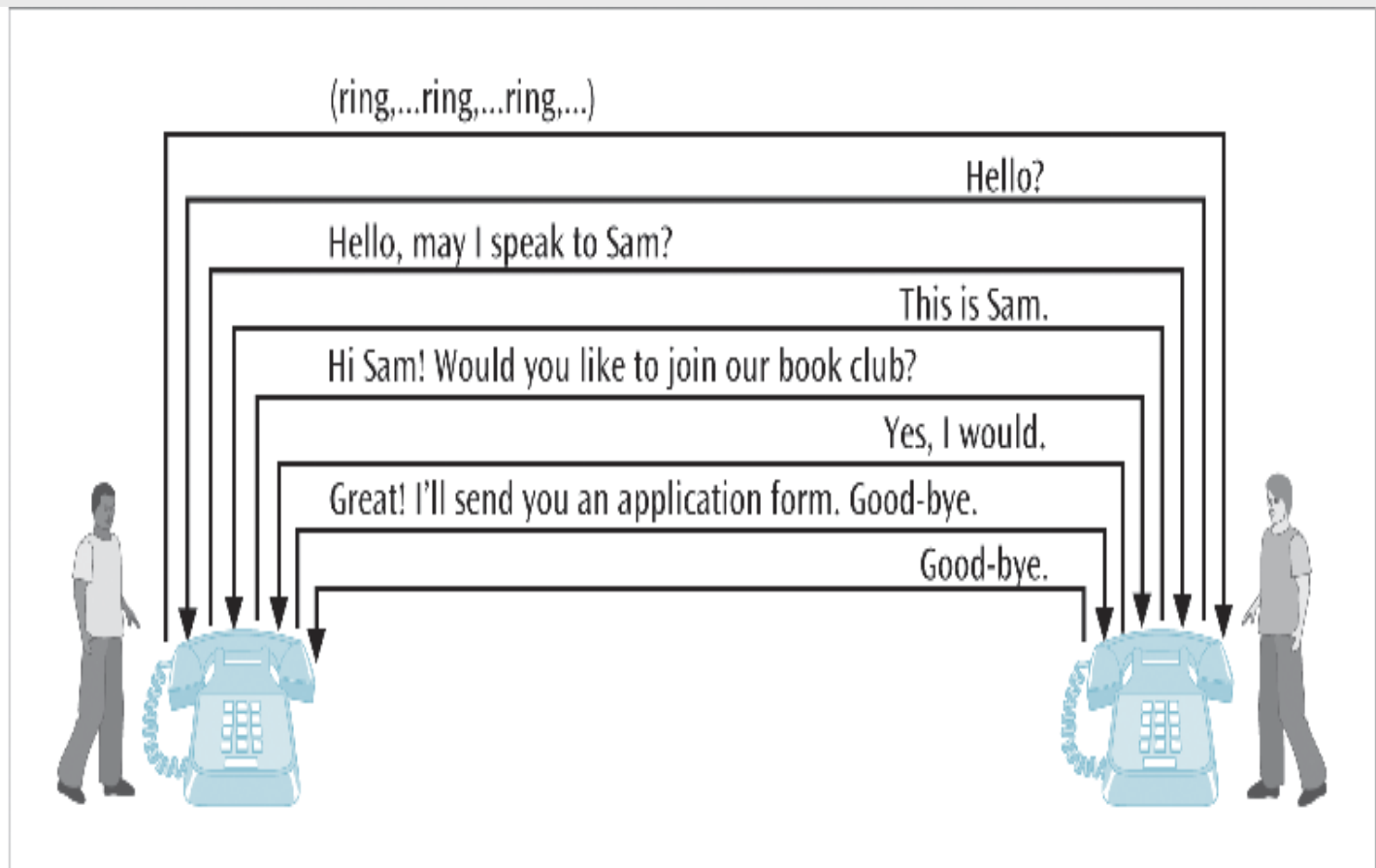
◆ A connectionless application does not create a connection first but simply sends the data

- Electronic mail is a common example

Connection-Oriented Network Applications

Figure 10-7

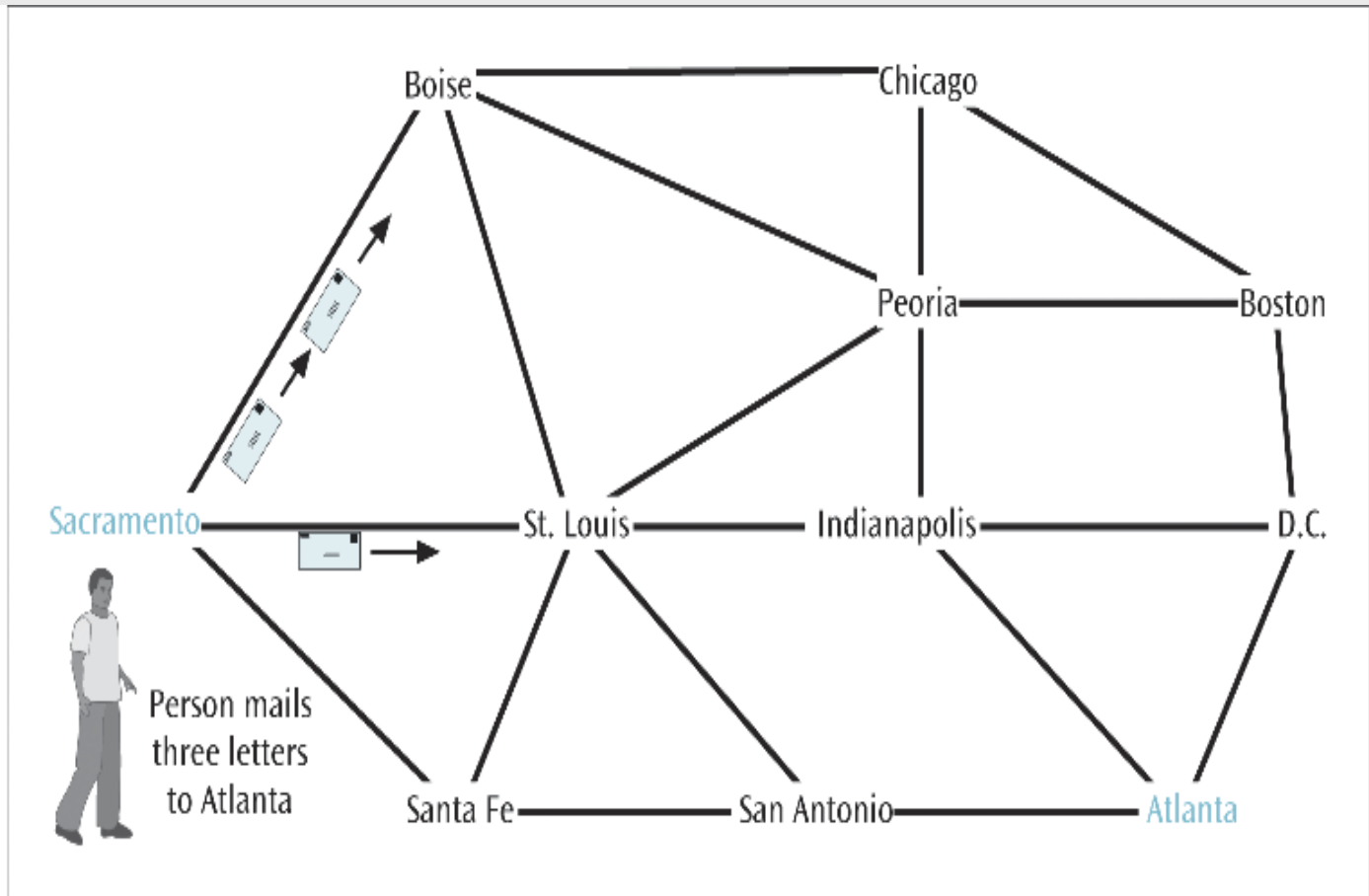
*Connection-oriented
telephone call*



Connectionless Network Application

Figure 10-8

Connectionless postal network



Connection-Oriented vs. Connectionless Network Applications

- ◆ **Both connection-oriented and connectionless applications**
 - **Circuit switched network**
 - **Packet switched network**
- ◆ **However, a packet switched network may be more efficient**