

Managing Network Resources

Presented by
Eldon Y. Li

*** All right reserved. Video or audio recording and distributing are prohibited without the author's consent. Reference to this document should be made as follows: Li, E.Y. "Managing Network Resources," unpublished lecture, National Chung Cheng University, 2020.

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.1

Sharing Moment

1. In the case study I-4 mobile clinics, what are most critical issue that leads to the problem in the minicase;
2. What are the choices available to make a decision?



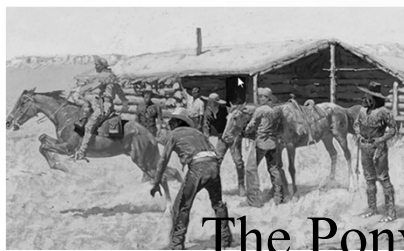
Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.2

The Past

Source: https://en.wikipedia.org/wiki/Main_Page

Communications before 1861



The Pony Express

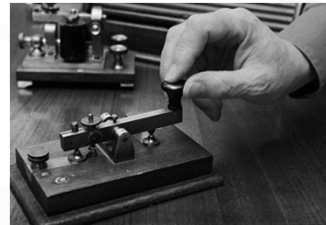


Telegraph before 1861

- **1835** - Samuel Morse devised a **recording telegraph** and the **Morse code**.
- **1838** - **electronic commence (EC)** was born when William Fothergill Cooke and Charles Wheatstone deployed the first **electrical telegraph system** on the Great Western Railway.
- **09/1845** - John L. Ricardo and William Fothergill Cooke formed **the Electric Telegraph Company**, the first public telegraphy company in the world.
- **10/24/1861** - a telegraph network connected East and West Coasts of the U.S. using Morse-Vail Telegraph Key (invented by Samuel Morse and Alfred Vail), bringing an **end to the Pony Express**.



Copyright © 2020 E.Y. Li



WMU GIMBA BUS 6180 Ch.4: IT MNR. 5

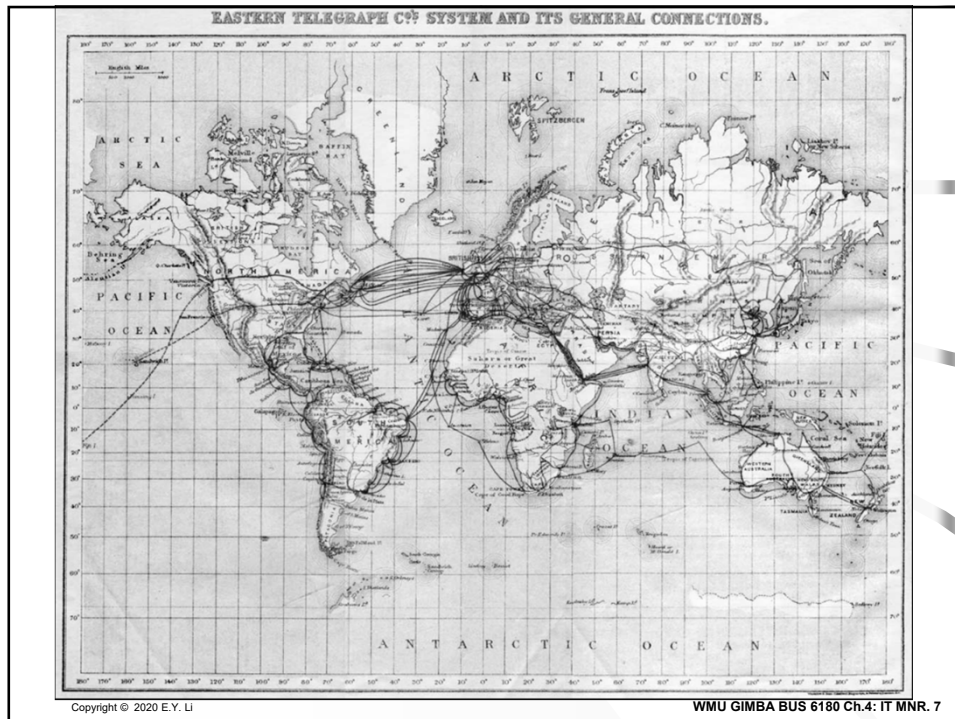
The Connected World of 1902

- **1841** - Alexander Bain devised a **printing telegraph**.
- **1846** - Royal Earl House patented a printing telegraph.
- **1849** - **landline teleprinter** operations began when a circuit was put in service between Philadelphia and New York City.
- **1850** - the first **undersea telegraph cable** was laid, connecting France and England and then to Ireland and the Low Countries.
- **1870** - the **transatlantic submarine telegraph** lines from Britain London to India Bombay were connected.
- **1872** - four British telegraph companies were combined to form the **Eastern Telegraph Company**.
- **10/1872** - **Australia** was first **linked to the rest of the world** by a submarine telegraph cable at Darwin.
- **1892** - **British companies** owned and operated **2/3** of the world's submarine telegraph cables and by 1923 their share was down to **42.7%**.
- **1902** - the telegraph line **across the Pacific** was completed, finally encircling the world (the first **Internet?**).

Copyright E.Y. Li

6

2020/10/26
WMU GIMBA BUS 6180 Ch.4: IT MNR. 6



Telefax before 1970

- **1865** - Italian physicist Giovanni Caselli introduced the first commercial **telefax** service between Paris and Lyon.
- **1880** - English inventor Shelford Bidwell constructed a scanning **phototelegraph** that was the first telefax machine to scan and print any two-dimensional original.
- **11/1924** - American designer of RCA Richard H. Ranger invented the **transoceanic radiofax**, the forerunner of today's "fax" machines. He sent a photograph of President Calvin Coolidge from New York to London.
- **1924** - Herbert E. Ives of AT&T transmitted and reconstructed the first **color facsimile** using RGB color separations.
- **Late 1920s** - a **globally wired teleprinter network**, called the "**Telex network**", was developed and used through most of the 20th century for business communications.
- **1960s** - the U.S. Army transmitted the first photograph via **satellite facsimile** to Puerto Rico via Courier 1B satellite built by Philco.
- **1966** - Xerox released the **Magnafax Telecopiers**, a 46-pound facsimile machine that was easy to operate and could be connected to any **standard telephone line**. This unit set the standard for fax machines for many years.

Xerox Telecopiers in 1966



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR. 9

Telephone before Internet

- **1876** - Alexander Graham **Bell** invented the **telephone** with a **liquid** transmitter.
- **1876** - Hungarian engineer Tivadar Puskás later invented the **telephone switch**, which allowed for the formation of telephone exchanges and eventually telephone networks.
- **1877** - Thomas Edison improve the **phone** with a **carbon** (graphite) transmitter which kept the Bell monopoly viable into the 20th century.
- **1878** - before telephone exchange was exploited, subscribers needed to lease **the phone in pairs**. Those who wanted the ability to speak to several different locations would need to obtain and set up several pairs of telephones, one for each location.
- **1878** - George W. Coy designed and built the first commercial US **telephone exchange** central office in New Haven, Connecticut.
- **1878** - Charles Glidden also established a **telephone exchange** in Lowell, MA. with 50 subscribers.
- **09/25/1956** - the **trans-Atlantic telephone cable system** was inaugurated.

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR. 10

Telephone Exchange Systems



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR. 11

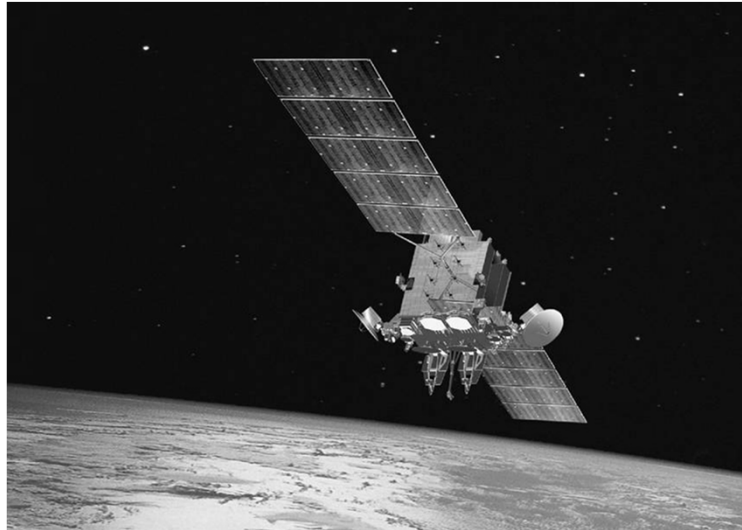
Radio and Satellite Communications

- **1900** - Reginald Fessenden wirelessly transmitted a human voice via radio.
- **12/1901** - wireless **telegraph system using radio** waves was built.
- **1958** - **Project SCORE** was the first U.S. satellite to relay voice communications.
- **10/04/1960** - Philco launched the world's first active repeater satellite, **Courier 1B**.
- **1960** - NASA launched a passive reflector for radio communications, **Echo** satellite.
- **07/10/1962** - the first active, AT&T launched a direct relay commercial communications satellite, **Telstar**.
- **12/13/1962** - NASA launched the first satellite to broadcast across the Pacific, **Relay 1**.
- **Late 20th century** - satellite communications declined because the improvements in submarine communications cables through the use of fiber-optics, but they still exclusively service remote areas where landline telecommunications are rare to nonexistent.

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR. 12

Radio and Satellite Communications



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR. 13

Mobile Communications

- **1979** - Nippon Telegraph and Telephone (NTT) launched the first 1G network in Tokyo, using time-division multiple access (TDMA) **analog** radio signals .
- **1979** - the Inmarsat satellite system started to use a series of satellites in **geostationary orbits** (35,786 km or 22,236 mi) to cover the majority of the globe for safety of life at sea.
- **1991** - Radiolinja in Finland launched commercially **2G cellular GSM** networks.
- **Since 2000** - Iridium and Globalstar satellite phone services use a series of **low Earth orbit satellites** with an altitude of about 2,000 km (1,200 mi) and orbital period of about 84 - 127 minutes.
- **10/01/2001** - NTT DoCoMo in Japan launched the first commercial **3G cellular W-CDMA** network .
- **06/2009** - as **IPv4** addresses were (nearly) exhausted, Verizon in the U.S. required all 4G devices on its network to support **IPv6** which removes **network address translation (NAT)**, a method of sharing a limited number of addresses among a larger group of devices.
- **12/14/2009** - Swedish-Finnish TeliaSonera and Norwegian NetCom operators deployed the first commercial **4G LTE networks** in Stockholm and Oslo.
- **05/2018** - Qatar network operator Ooredoo launched the first commercial **5G EHF network**. Worldwide commercial launch is expected in 2020.

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR. 14

Mobile Communications



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR. 15

Timeline of Computing

- **2400 BC - Abacus:** the first known calculator, the abacus, was invented in Babylonia.
- **1623 - Calculating Clock:** is invented by Wilhelm Schickard.
- **1834 - Analytical Engine:** The Analytical Engine was invented by Charles Babbage.
- **1853 - Tabulating Machine:** is invented by Per Georg Scheutz and his son Edvard.
- **1896 - Tabulating Machine Company:** is formed by Herman Hollerith which later becomes IBM.
- **1911 - IBM:** IBM is formed on June 15, 1911.
- **1937 - Alan Turing:** develops the concept of a theoretical computing machine.
- **1939 - George Stibitz:** develops the Complex Number Calculator - a foundation for digital computers
- **1939 - Hewlett Packard:** William Hewlett and David Packard start their computer company.
- **1939 - John Vincent Atanasoff and Clifford Berry:** develop the ABC (Atanasoff-Berry Computer) prototype

Source: http://anddum.com/timeline/history_short.htm

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR. 16

Timeline of Computing

- **1943 - Colossus:** Alan Turing develops the code-breaking machine Colossus
- **1944 - Howard Aiken & Grace Hopper:** design the MARK series of computers at Harvard University
- **1945 - ENIAC:** John Presper Eckert & John W. Mauchly develop the ENIAC (Electronic Numerical Integrator and Computer)
- **1946 - F.C. Williams:** develops his cathode-ray tube (CRT) storing device, the forerunner to random-access memory (RAM)
- **1947 - Pilot ACE:** Donald Watts Davies joins Alan Turing to build the fastest digital computer in England at the time, the Pilot ACE
- **1947 - William Shockley:** invents the transistor at Bell Labs
- **1949 - Claude Shannon:** builds the first machine that plays chess
- **1949 - Howard Aiken:** develops the Harvard-MARK III
- **1950 - Hideo Yamachito:** creates the first electronic computer in Japan
- **1950 - Alan Turing:** publishes his paper - Computing Machinery and Intelligence which helps create the Turing Test

Source: http://anddum.com/timeline/history_short.htm

Timeline of Computing

- **1951 - LEO:** T. Raymond Thompson and John Simmons develop the first business computer, the Lyons Electronic Office (LEO) at Lyons Co.
- **1951 - UNIVAC:** UNIVAC I (UNIVersal Automatic Computer I) is introduced - the first commercial computer made in the United States and designed principally by John Presper Eckert & John W. Mauchly
- **1951 - EDVAC:** The EDVAC (Electronic Discrete Variable Automatic Computer) begins performing basic tasks. Unlike the ENIAC, it was binary rather than decimal
- **1953 - The IBM 701** becomes available and a total of 19 are sold to the scientific community
- **1955 - Bell Labs:** introduces its first transistor computer
- **1971 - E-mail:** is invented by Ray Tomlinson
- **1971 - Liquid Crystal Display (LCD):** is developed by James Fergason
- **1971 - Pocket calculator:** is invented by Sharp Corporation
- **1971 - Floppy Disk:** is created by David Noble with IBM - Nicknamed the "Floppy" for its flexibility.

Source: http://anddum.com/timeline/history_short.htm

Timeline of Computing

- **1973 - Robert Metcalfe and David Boggs:** creates the Ethernet, a local-area network (LAN) protocol
- **1973 - Personal computer:** The minicomputer Xerox Alto (1973) was a landmark step in the development of personal computers
- **1973 - Gateways:** Vint Cerf and Bob Kahn develop gateway routing computers to negotiate between the various national networks
- **1975 - Portable computers:** The Altair 8800 is developed by Micro Instrumentation and Telemetry Systems (MITS) and the first personal home computer is released on 23 Jan, 1975
- **1975 - Microsoft Corporation:** is founded April 4, 1975 by Bill Gates and Paul Allen to develop and sell BASIC interpreters for the Altair 8800
- **1976 - Apple:** Apple Computers is founded by Steve Wozniak and Steve Jobs on 1 Apr 1976 (April Fools Day)
- **1977 - Apple II,** the first personal computer with colour graphics is demonstrated
- **1977 - MODEM:** Ward Christensen writes the programme "MODEM" allowing two microcomputers to exchange files with each other over a phone line

Source: http://anddum.com/timeline/history_short.htm

Timeline of Computing

- **1980 - Paul Allen and Bill Gates:** IBM hires Paul Allen and Bill Gates to create an operating system for a new PC. They buy the rights to a simple operating system manufactured by Seattle Computer Products and use it as a template to develop DOS
- **1981 - IBM** releases its PC model 5150 on Aug. 12 and **Microsoft MS-DOS** Computer Operating System increases its success
- **1983 - Microsoft Windows:** is introduced eliminating the need for a user to have to type each command, like MS-DOS, by using a mouse to navigate through drop-down menus, tabs and icons
- **01/24/1984 - Apple** introduces the **Macintosh** with mouse and window interface
- **1984 - Dell Computer** is founded in Austin Texas on 3 May, 1984
- **1985 - Microsoft** releases **Windows 1.01**
- **1990 - The Internet, World Wide Web:** Tim Berners-Lee and Robert Cailliau propose a 'hypertext' WWW system starting the modern Internet
- **1990 - Microsoft and IBM** stop working together to develop operating systems
- **1990 - Microsoft** releases **Windows 3.0** and the first commercial Internet dial-up access provider comes online on 20 Sep, 1990
- **1991 - The World Wide Web** is launched to the public on August 6, 1991
- **1991 - The U.S. Congress** passed the **Gore Bill** (*High Performance Computing Act of 1991*) in 12/09/1991

Timeline of Computing

- **1994 - YAHOO** is created in April, 1994.
- **1995 - Amazon:** Amazon.com is founded by Jeff Bezos on 09/20/1995
- **1995 - eBay** is founded by Pierre Omidyar on 09/20/1995
- **1995 - Hotmail** is started by Jack Smith and Sabeer Bhatia on 09/20/1995
- **1995 - James Gosling** and his co-workers introduced 'Java' language
- **1997 - Microsoft** acquires Hotmail
- **1998 - Google:** Google is founded by Sergey Brin and Larry Page on September 7
- **1998 - PayPal** is founded by Peter Thiel and Max Levchin
- **1999 - Alibaba** is founded by Jack Ma
- **2002 - PayPal** is acquired by eBay
- **2003 - Skype** is launched on 20 Aug, 2003
- **2004 - Facebook** is first launched on 20 Sep, 2004
- **2005 - YouTube** begins on 14 Feb, 2005
- **2005 - eBay** acquires Skype on September 12, 2005
- **2006 - iPhone:** the first iPhone is released on 29 Jun, 2006
- **2008 - First Android OS and Android Smartphone** is released on 21 Oct, 2008
- **2014 - Microsoft acquires Nokia** on April 25 and starts **Microsoft Mobile**

Source: http://anddum.com/timeline/history_short.htm

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR. 21

Speed of Media

<i>TRANSMISSION MEDIUM</i>	<i>TYPICAL SPEED</i>
Twisted pair, voice telephone	300–28,800 bps
Twisted pair, conditioned	64 Kbps–1 Mbps
Twisted pair in LAN	4 Mbps–16 Mbps
Coaxial cable, baseband	10 Mbps–264 Mbps
Coaxial cable, broadband	10 Mbps–550 Mbps
Optical fibers in LAN	500 Kbps–30 Gbps
Microwave (terrestrial)	12 Mbps–50 Mbps
Microwave (satellite)	56 Mbps–274 Gbps

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.22

Contrast of 3G, 4G, 5G

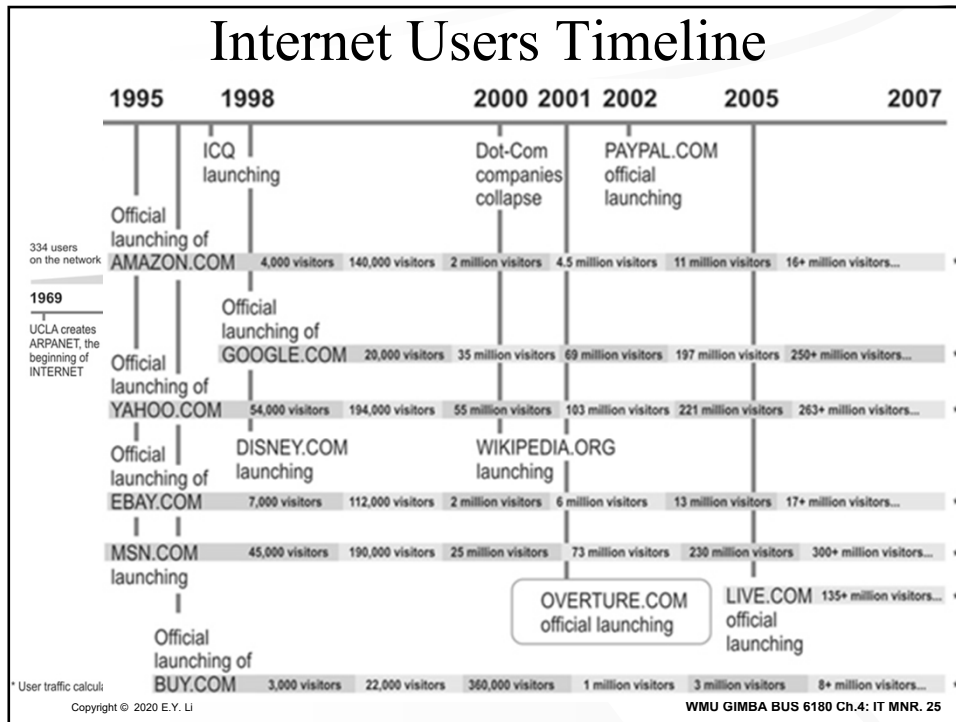
Mobile Generation	Usage ID	The range of Frequencies; (Examples)	User Data Bandwidth (Practical examples)	Coverage per Antenna & usage
3G	Mobile	850MHz, 2100MHz	2-10 Mbps	50 – 150km Suburban, City, Rural area
4G	Mobile	750MHz, 850MHz, 2.1 GHz, 2.3GHz and 2.6GHz	10-30 Mbps Long-Term Evolution (LTE) version	50 – 150km Suburban, City, Rural area
	Fixed Wireless	(Centimeter wave)	50-60 Mbps Long-Term Evolution (LTE) version	1 – 2km Home, office and high density area
5G	Mobile	3.6 GHz, 6 GHz	80-100 Mbps	50 – 80km Suburban, City, Rural area
	Fixed Wireless	24-86 GHz (Millimetre wave)	1-3Gbps	250 – 300 m Home, office and high density area

The summary of Frequency and data bandwidth: 3G to 5G cellular mobile generation
- 5G network real-world test: examples by Qualcomm's simulated 5G tests on Feb/2018

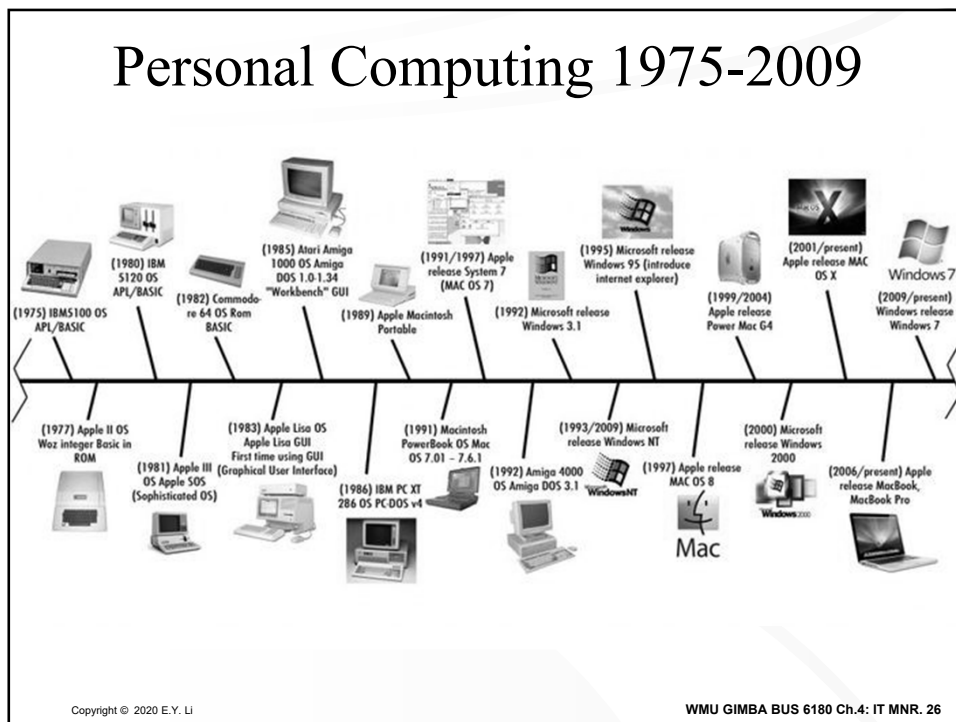
4G vs. 5G

Capability	Description	4G	5G Target
Data speed (uplink downlink)	Achievable data rate across coverage area	50 Mbps 100 Mbps	500 Mbps 1 Gbps
Peak data rate	Maximum achievable data rate	1 Gbps	20 Gbps
Mobility	Maximum speed for handoff and QoS requirements	350 km/hr	500 km/hr
Latency	Radio network contribution to packet travel time	10 ms	1 ms
Connection density	Total number of devices per unit area	10 ³ /Km ²	10 ⁶ /Km ²
Area traffic capacity	Total traffic across coverage area	0.1 Mbps/m ²	10 Mbps/m ²
Modulation	Quadrature Amplitude Modulation (QAM)	64-QAM, 256-QAM	512-QAM, 1024-QAM
Frequency	The rate of oscillatory and vibratory phenomena	700MHz, 900MHz, 1800Mhz, 2600Mhz	28GHz, 60GHz (Extremely High Frequency, EHF)

Internet Users Timeline



Personal Computing 1975-2009



Techno

We bu We ge
1 cor wh We feelir

Techno
It is
The ben
on c
cust
Cor
glo
cust
geo
W
Tech
anc
Gre
rev
cor
as
less
Tech
start
Cust
conc
pract
satis
have
make
and t
Tech
great
conn
e-Co
custo
infor
Com
them
haver
custo
Techno
comm
Growt
"expl
the pl
Social
articul
compa
on the
on pri
react a

Welcome to adulthood!

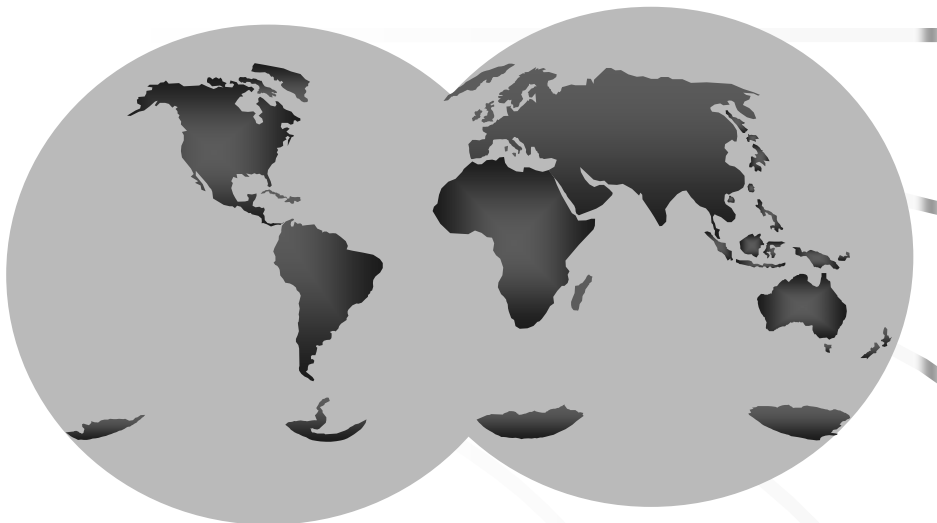
2010s

Technology becomes fully intergrated into our daily lives. We live more fully in a digital world.

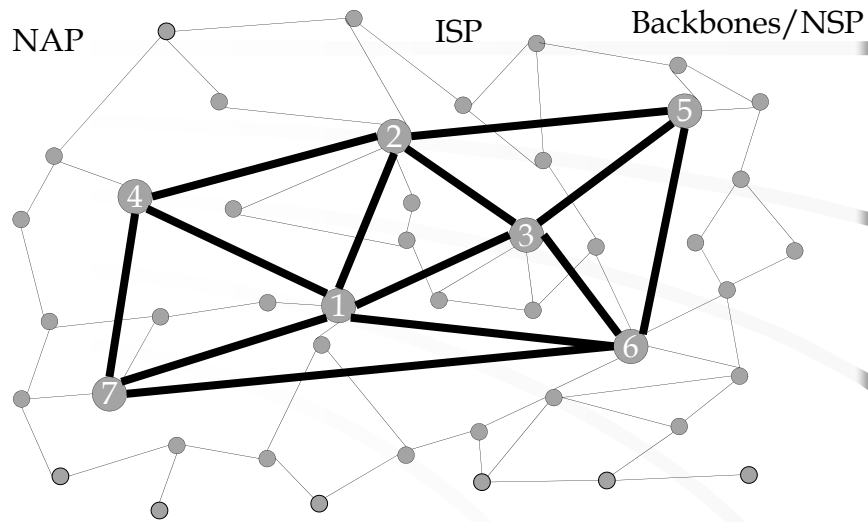
Social Businesses are the evolution of companies now keenly aware that how they act and how they engage with customers can be more important than price, that the relationship is part of the value.

Companies allow greater transparency into all aspects of the company and use social media channels to effectively engage with customers, but with a focus on WHAT the customer wants and HOW best to deliver it to the customer.

Our World



Epitome of Internet



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.29

Information Superhighway

- National
- Worldwide
- Digital telecommunications
- High speed
- Accessible by general public
- Reliable message delivery
- Common transmission standard: TCP / IP

Copyright © 2020 E.Y. Li

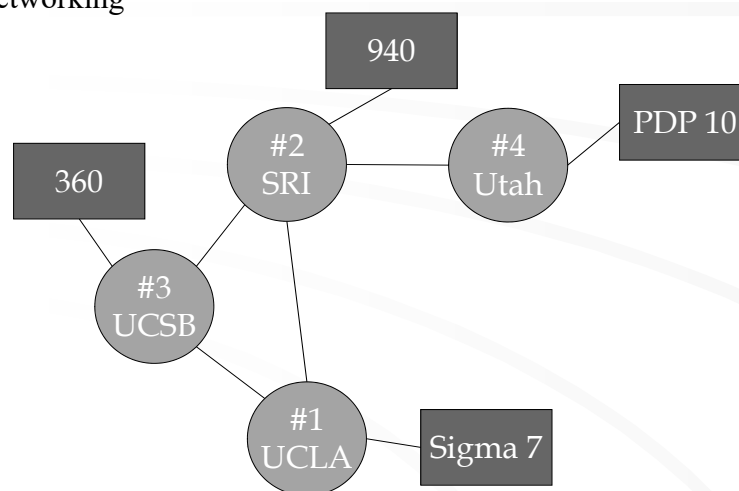
WMU GIMBA BUS 6180 Ch.4: IT MNR p.30

Internet Benefits

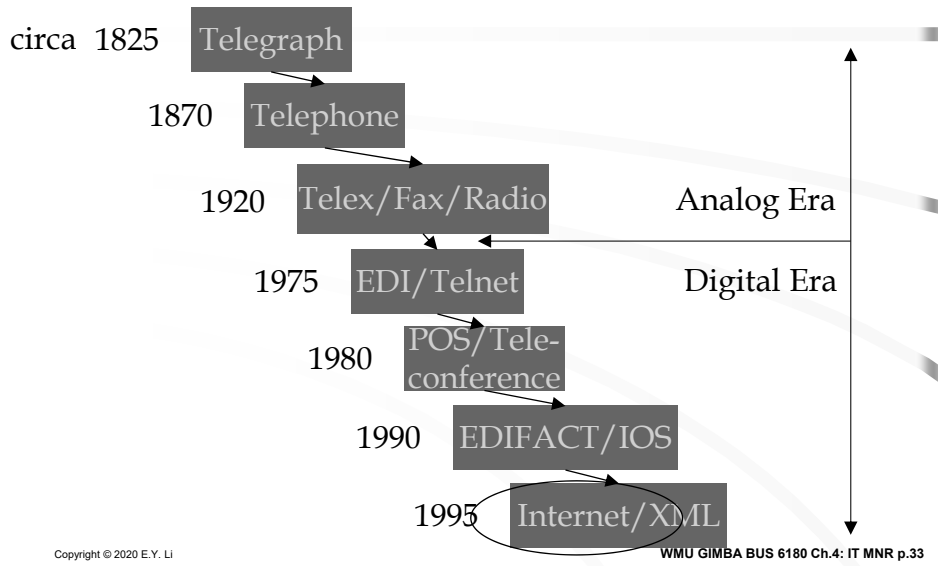
- Global connectivity
- Reduced communications cost
- Lower transaction costs
- Reduced agency costs
- Increased coordination/managerial span
- Interactivity, flexibility, customization
- Accelerated knowledge

The Dawn of Internet

- **1969**: ARPANET commissioned by DoD for research into networking



Evolution of Telecom Media



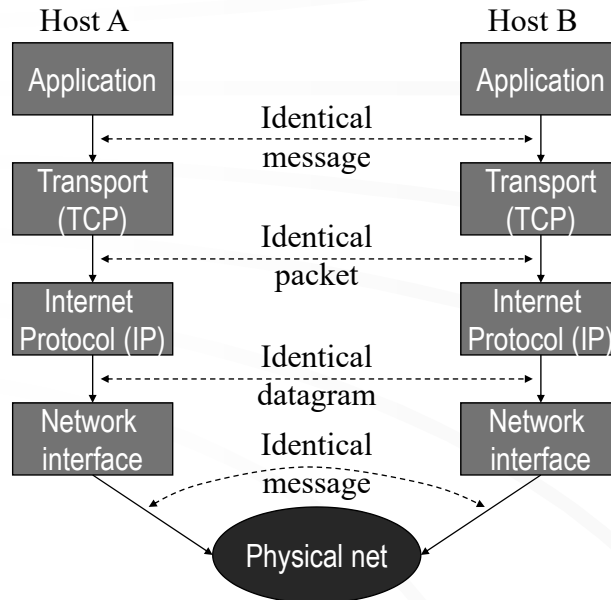
TCP / IP Standard

(Transmission Control Protocol/Internet Protocol,)

Reference model developed by DOD in 1972.

- **APPLICATION**: Provides screen presentations.
- **TRANSMISSION CONTROL PROTOCOL (TCP)**: Breaks data into datagrams.
- **INTERNET PROTOCOL (IP)**: Breaks, sends datagrams as smaller IP packets; can repeat transmission to increase reliability.
- **NETWORK INTERFACE**: Handles addressing and interface between computers and networks.
- **PHYSICAL NET**: Defines electrical transmission characteristics for sending signal along networks to destination.

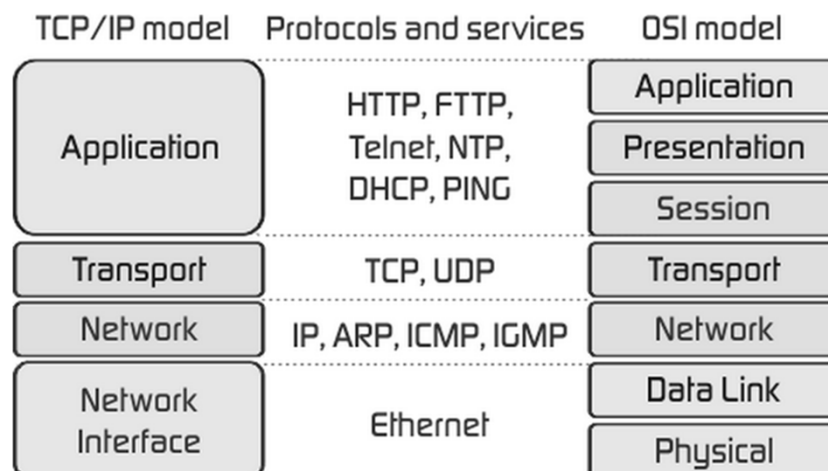
TCP/IP Reference Model



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.35

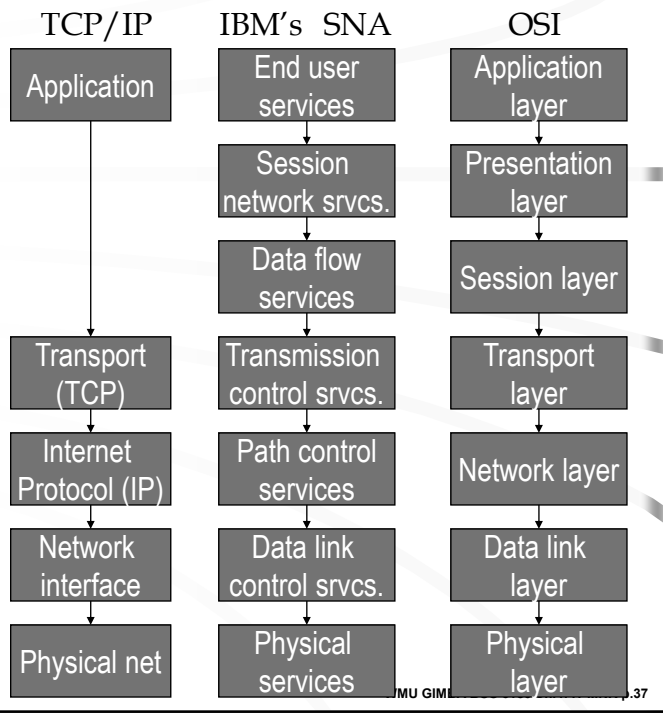
TCP/IP Model vs. OSI Mod31



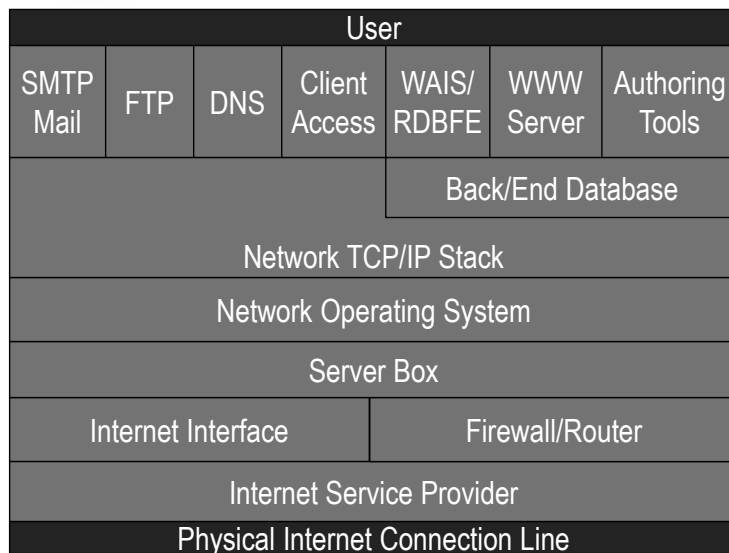
Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.36

Network Standards



Components of Internet Server



Components of Internet Server

- SMTP Mail: (Small Mail Transfer Protocol) translates between local and Internet mail formats, allowing clients to send/receive Internet e-mail.
- FTP: (File Transfer Protocol) enables file transfers to and from the server.
- DNS: (Domain Name Serving) maps numerical Internet machine addresses (160...) to alphabetic names (misnt.calpoly.edu).

Components of Internet Server

- Client Access: allows local clients to use the Internet (Web, FTP, etc.) over the existing network.
- WAIS/RDBFE: (Wide Area Information Service and Relational Database Front End) allows Web site guests to access document databases without requiring HTML encoding beforehand.
- WWW Server: serves Web pages to guests and helps to administrate the Web site.

Components of Internet Server

- **Authoring Tools:** create the pages that appear on the Web site.
- **Back/End Database:** is an Oracle, Sybase, or Back Office database that contains content served to the Web via the RDBFE and WWW Server.
- **Network TCP/IP Stack:** allows the NOS to communicate via the Internet protocol in addition to its native protocol.

Components of Internet Server

- **Network Operating System:** is UNIX, Netware, or NT.
- **Server Box:** houses the CPU, disks, and Ethernet I/O hardware.
- **Internet Interface:** is a WAN card that connects the server to the leased line provided by the ISP. These cards can be installed in a separate firewall/router box or on the server itself.

Components of Internet Server

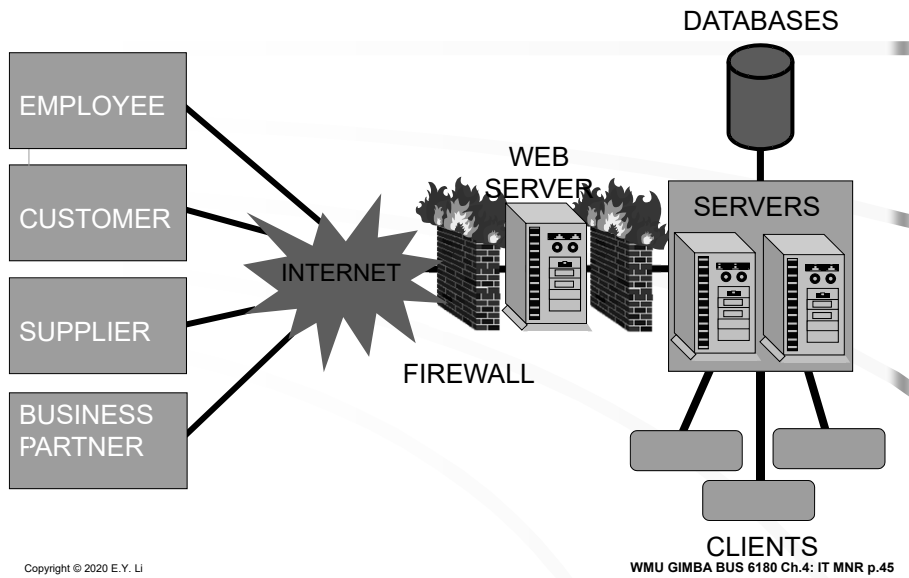
- Firewall/Router: sorts and filters data passing to and from the Internet. This functionality is performed by software either installed on the server itself or on a separate box.
- Internet Service Provider: provides an IP address, works through the local telephone company to arrange for a leased line and provides installation and administration consulting services.

Push vs. Pull Technologies

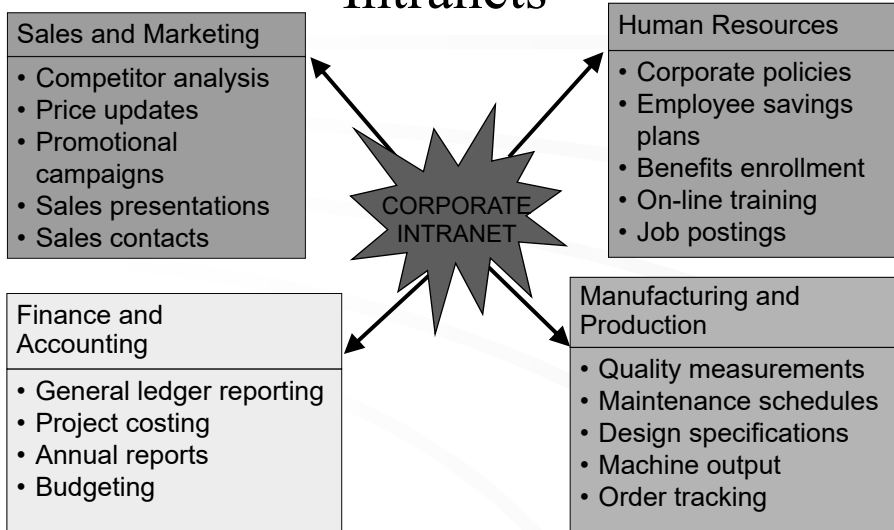
- Pull Technology
 - Google Chrome
 - Microsoft Internet Explorer
- Push Technology
 - PointCast.com



Intranet and Extranet



Functional Applications of Intranets



Intranet Benefits

- Connectivity
- Can be tied to legacy system and transaction processing
- Interactive applications with text, audio, video
- Scalable to larger or smaller systems as required
- Easy to use browser interface
- Low start-up costs
- Rich, responsive information environment
- Reduced information distribution costs

Extranet Benefits

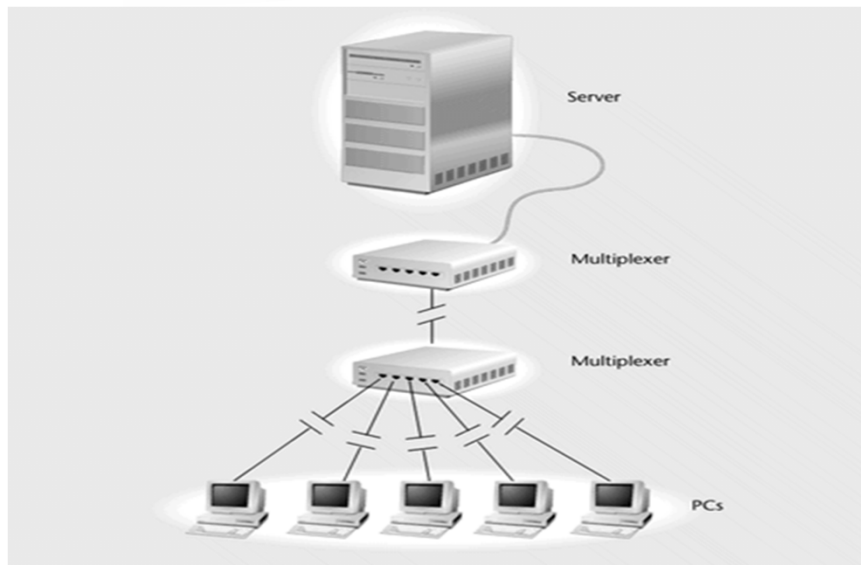
- **Exchange large volumes of data using XML, replacing EDI network.**
- **Share product catalogs exclusively with wholesalers or those "in the trade."**
- **Collaborate with other companies on joint development efforts.**
- **Jointly develop and use training programs with other companies.**
- **Provide or access services provided by one company to a group of other companies, such as an online banking application managed by one company on behalf of affiliated banks.**
- **Share news of common interest exclusively with partner companies.**

Network Topology

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.49

Multiplexing

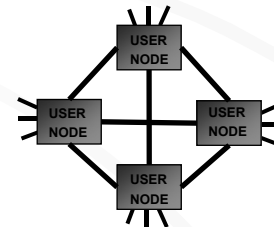
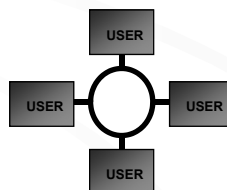
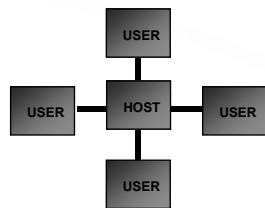
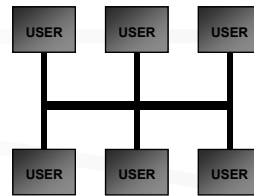
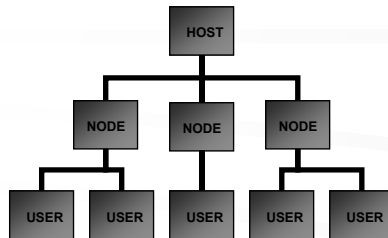


Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.50

Network Topology

- Star
- Bus
- Ring
- Tree
- Peer-to-peer
- Mesh



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.51



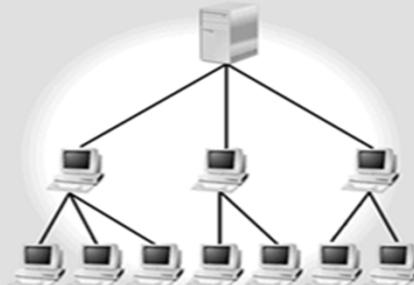
Star



Ring



Bus

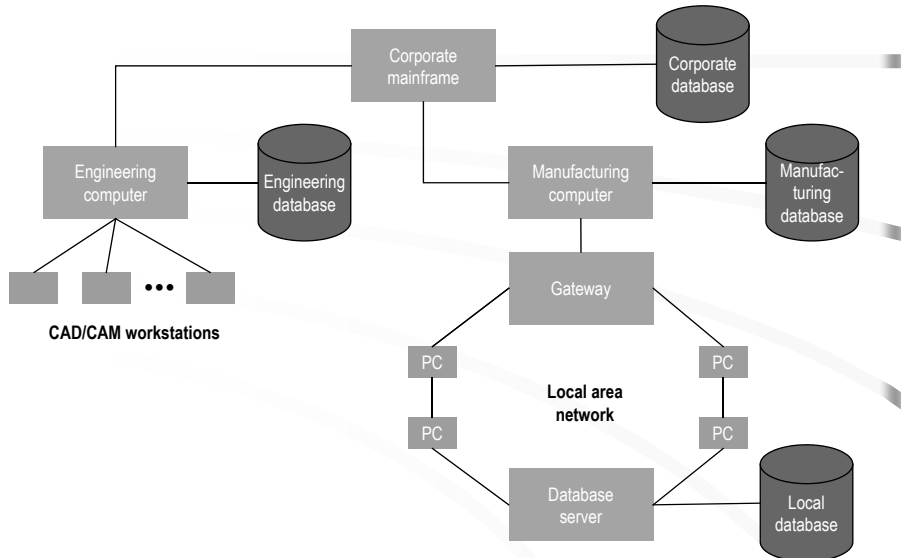


Tree

Copyright © 2021 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.52

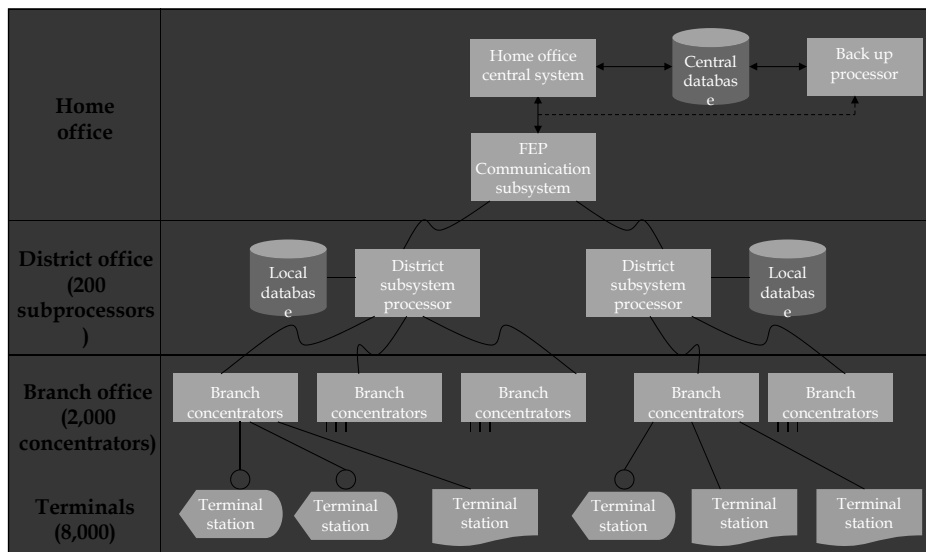
Example of Networks



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.53

Example of Networks



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.54

Database Architectures

- **Centralized Database:** A single logical database in one location.
- **Decentralized Database:** A collection of independent databases on non-networked computers.
- **Distributed Database:** A single logical database that is spread physically across computers in multiple locations that are connected by a data communications link.

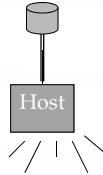
Options for Distributed Database

P#	PNAME	COLOR	WEIGHT	CITY
P1	Nut	Red	12	London
P2	Bolt	Green	17	Paris
P3	Screw	Blue	17	Rome
P4	Screw	Red	14	London

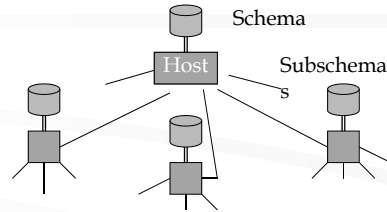
- Data replication.
- Horizontal partitioning.
- Vertical partitioning.
- Combinations of the above.

Distribution of Networked Databases

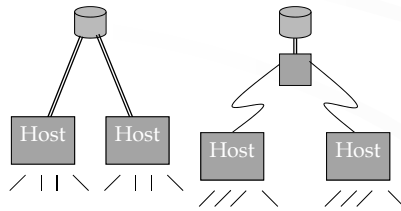
Central data, single host



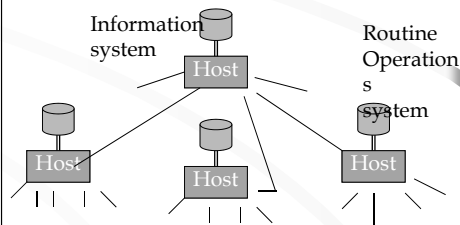
Dependent hierarchical data



Central data, multiple host



Independent hierarchical data



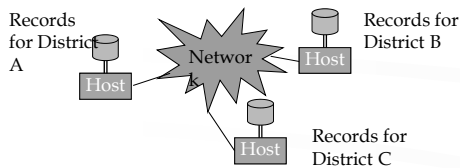
Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.57

Distribution of Networked Databases

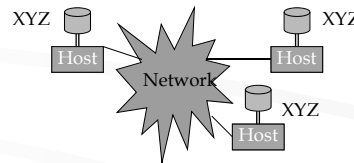
Split data

The same data structure in different locations.



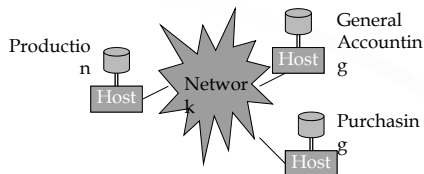
Replicated data

Multiple copies of the same data are stored at different locations because this is cheaper than transmission.



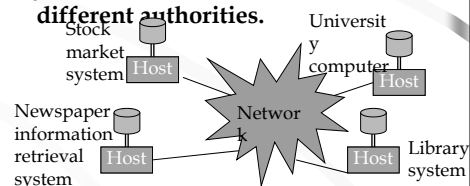
Separate data

Different data structures in different locations forming an integrated system.



Heterogeneous data systems

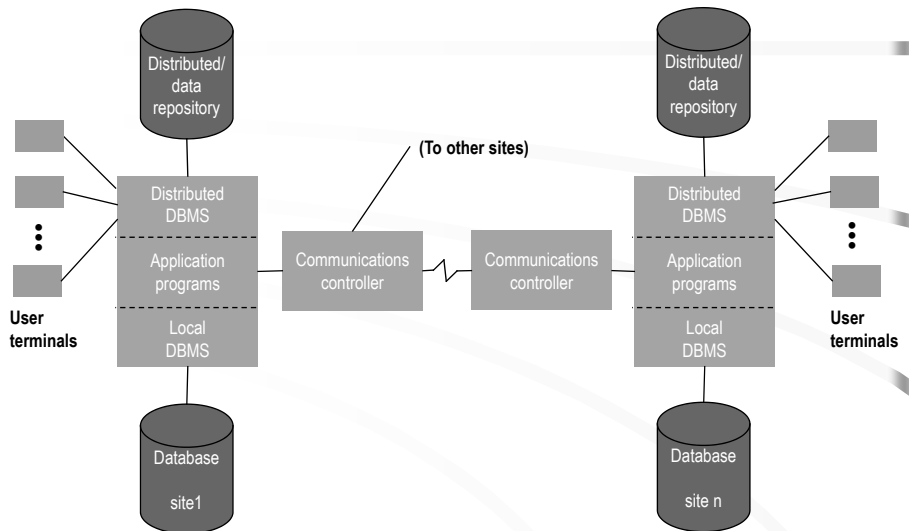
Independent computer systems set up by different authorities.



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.58

Distributed DBMS Architecture



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.59

Speed & Cost of Media

Medium	Speed	Cost
Wire Pair (Narrow-band)	45 bps - 150 bps (Bandwidth < 3 KHz)	Low ↑ High
Twisted Pair (Voice-grade)	300 bps - 10 Mbps (Bandwidth = 3 KHz)	
Microwave (Radio wave)	256 Kbps - 100 Mbps (Bandwidth < 1+ GHz; 18,000 v-g channels)	
Satellite (Radio wave or laser)	256 Kbps - 100 Mbps (Bandwidth = 4 to 30 GHz; 12,000 v-g + 2 TV channels)	
Coaxial Cable (Broad-band)	56 Kbps - 200 Mbps (Bandwidth < 60+ MHz)	
Fiber Optics (Laser or LED)	56 Kbps - 10 Gbps (Bandwidth = 500M to 1G Hz; ~ 30,000 v-g channels)	

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.60

Types of Network Services

Service	Description	Bandwidth
X.25 (Packet switching)	Packet switching standard that parcels data into packets of 128 bytes and performs error-correction routines	9.6 Kbps to 256 Kbps
Frame Relay (Fast packet switching)	Packages data into frames for high-speed transmission over reliable lines but does not use error-correction routines	Up to 1.024 Mbps
ATM (Asynchronous transfer mode)	Parcels data into uniform cells to allow high-capacity transmission of voice, data, images and video between different types of computers	25 Mbps to 2.5 Gbps
ISDN (Integrated services digital network)	Digital dial-up network access standard that can integrate voice, data, and video services over copper wires.	Basic rate ISDN: 128 Kbps Primary rate ISDN: 1.5 Mbps

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.61

Types of Network Services

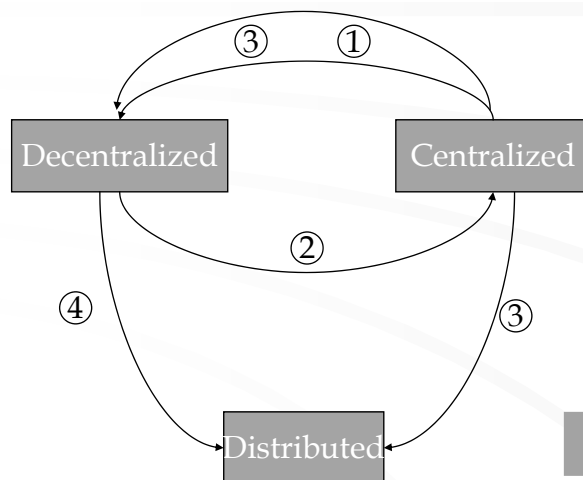
Service	Description	Bandwidth
FDDI (Fiber Distributed Data Interface)	A reliable, high-speed backbone for mission critical and high traffic networks that can support up to 500 stations on a single network and up to 60 kilometers apart.	Single ring: 100 Mbps, Dual ring: 200 Mbps
DSL (Digital subscriber line)	Series of technologies for high-capacity transmission over copper wires	ADSL: receiving up to 9 Mbps, sending up to 640 Kbps SDSL: sending and receiving up to 3 Mbps
Cable modem	Service for high-speed transmission of data over cable TV lines	Up to 10 Mbps
T1 (T3)	Dedicated telephone connection with 24 (672) channels for high capacity transmission	1.544 (44.736) Mbps, 64 Kbps/channel

Copyright © 2020 E.Y. Li

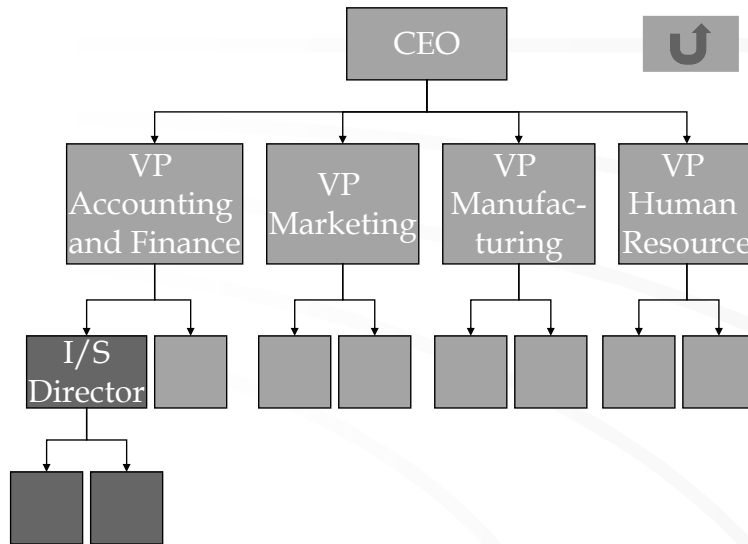
WMU GIMBA BUS 6180 Ch.4: IT MNR p.62

Enterprise Network Design

Evolution of IT Organizations



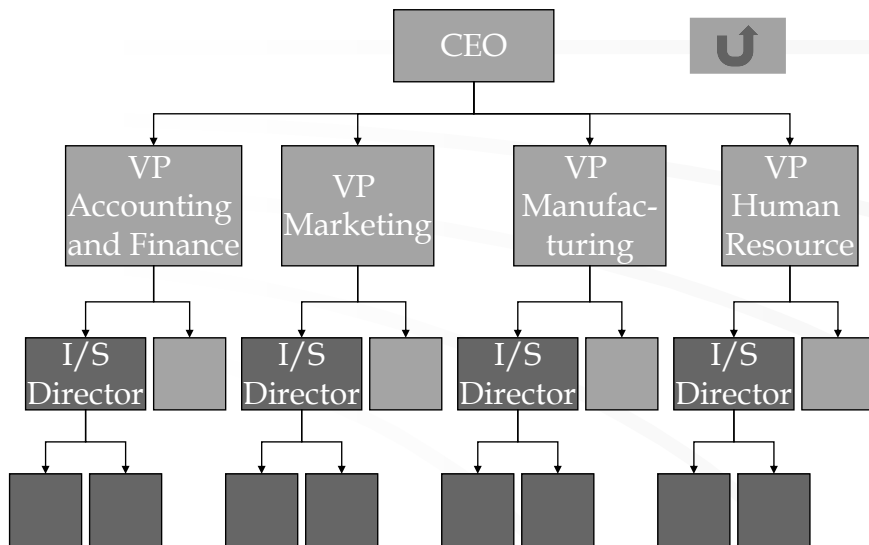
Centralized IT Organizations



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.65

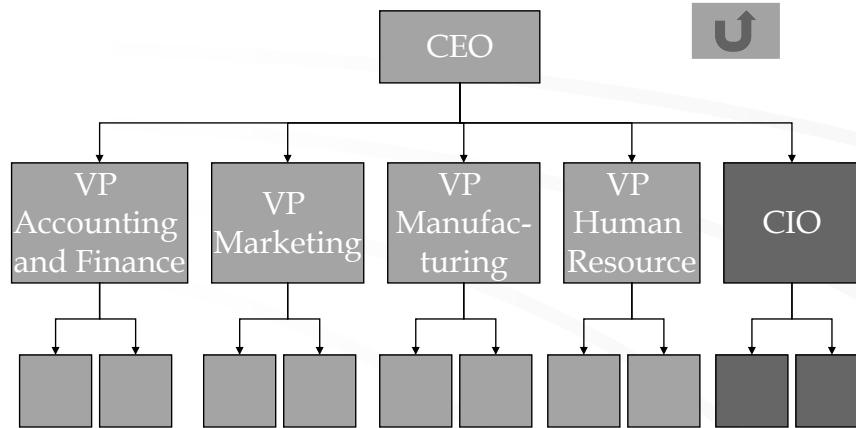
Decentralized IT Organizations



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.66

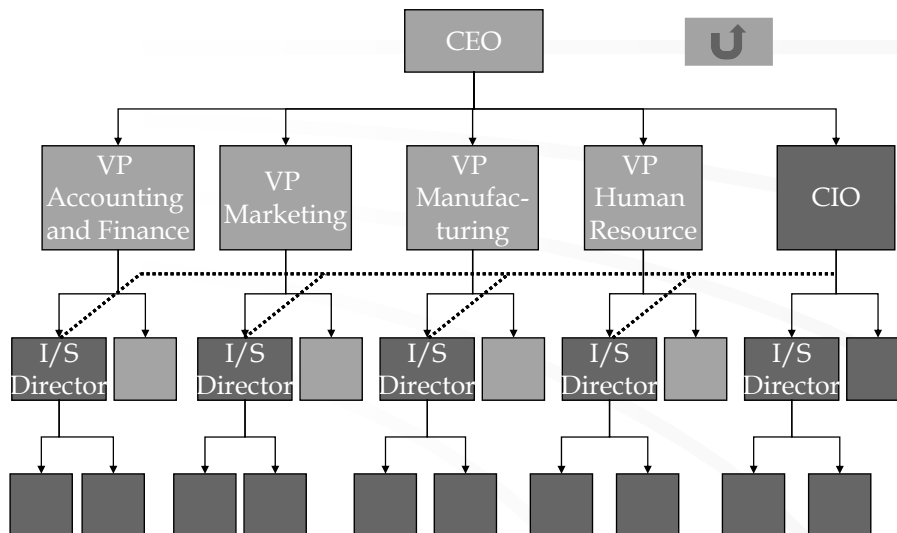
Centralized IT Organizations



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.67

Distributed IT Organizations



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.68

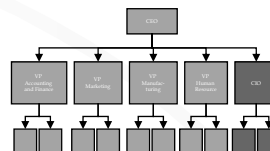
The CIO Attitude



- The business is what counts
- Build partnerships/ties with the rest of the firm
- Improve basic business processes
- Communicate in business terms, not IS jargons
- Provide reliable IS services
- Be positive, not defensive

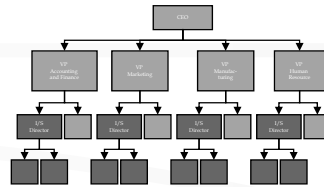
Advantages of Centralized Structure

- Standardized equipment and procedures.
- Economy of scale.
- Resource sharing.
- Ability to handle temporary increase in work load.
- Reduced duplication of files, processing, and reporting.
- CBIS centrally owned, managed, and operated.
- Easier security control.
- Central control over data.



Advantages of Decentralized Structure

- Low teleprocessing (TP) costs.
- Down time is not disastrous.
- Fast response time.
- Easy to expand and optimize.
- Responsive to user's needs
- Low complexity in development and management of small systems.
- Easy to assess user needs, costs, and effectiveness.
- Easy to determine the priorities for computer use.
- Reduced risk of telecommunication failure

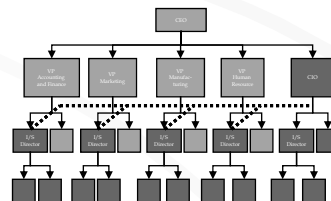


Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.71

Advantages of Distributed Structure

- Availability of equipment
- reduced teleprocessing costs
- Ability to handle temporary increase in workload
- Easy incremental expansion
- Fast response time
- Resource sharing
- etc.

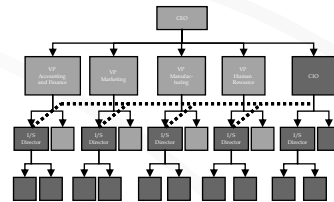


Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.72

Weaknesses of Distributed Structure

- More expensive
- More demand for information resources
- More demand for management
- More demand for coordination
- More processing overhead
- More complexity
- Data integrity risk



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.73

Selection Factors

- Costs
 - Hardware
 - Software
 - Personnel
 - Teleprocessing (TP)
- Data processing demand
 - Computing/I-O
 - Communications
 - Response time



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.74

Costs

<i>Incur cost Structure</i>	Hardware	Software	Personnel	Teleprocessing
Centralized	L	L	L	H
Decentralized	M	H	M	L
DDP	H	M	H	M



Data Processing Demand

<i>Meet Structure</i>	Computing/I-O	Communications	Response
Centralized	M	H	L
Decentralized	L	L	M
DDP	H	M	H



Selection Factors (Cont.)

- Nature of company
 - products vs. services
 - profit-centered vs. cost-centered
 - interdependency of functions
 - interdependency of branches
 - international vs. multinational
 - Size of company
 - large
 - medium
 - small
- Cent vs. Dec
 - Dec vs. Cent
 - Cent
 - Cent
 - Cent vs. Dec
 - DDP
 - ?
 - Cent

Selection Factors (Cont.)

- Organizational structure
 - functional
 - product
 - matrix
 - Management style
 - X
 - Y
 - Z
- Cent
 - Dec
 - DDP
 - Cent
 - Dec
 - DDP

Selection Factors (Cont.)

- Growth rate
 - high
 - medium
 - low
 - Management control
 - Man, Machine, Material, Money, Method, Data
 - information resources
 - standards
 - security
 - power/clout
- Dec
 - ?
 - Cent
 - Cent

Selection Factors (Cont.)

- Organizational complexity
(No. of products, SBU's, locations, etc.)
 - High
 - Medium
 - Low
 - End-user computing
 - user's software
 - user's data
 - security
- Dec
 - ?
 - Cent
 - Dec

Selection Factors (Cont.)

- Need for reliable service
 - High
 - Medium
 - Low
 - DDP
 - Dec
 - Cent
- Business environment
 - competition pressure
 - stability of operations
 - industry norm
 - experience of neighboring companies
 - D for High
 - C for High
 - ?
 - ?

Recommendations

- All factors should be duly considered.
- TELOS (technical, economic, legal, operational, schedule) feasibility study should be performed.
- Do not force a wrong network structure on an organizational structure.
- Distributed structure is the best topology.

Client/Server Computing (1990-)

Client/Server Components

- Personal computers.
- Local or wide area network (LAN / WAN).
- Share common devices.
 - Server.
 - Data storage.
 - Printer.
- Share software (e.g. a common DBMS).

Components of Application Logic

- **Input/Output or Presentation Logic**
 - Manage user input from the keyboard.
 - Format and present data on the screen.
- **Processing Component**
 - Data validation.
 - Identifies the data necessary for the transaction.
 - Business rules (coded at application level.)
 - Stored procedures (coded at DBMS level.)
- **Storage Component**
 - Data storage and retrieval processing.

Client/Server Architectures

- File server architecture
- Database server architecture
- Three-tier architecture

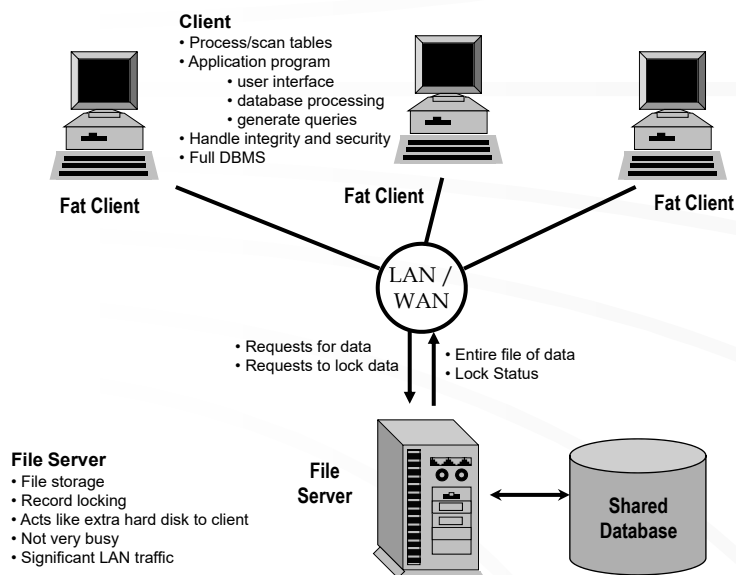
File Server Architecture

- All processing is done at the PC that requested the data (“fat client”).
- Entire files are transferred from the server to the client for processing.
- All applications including DBMS reside on client machines.
- Problems
 - Requires “fat” clients.
 - Huge amount of data transfer on the network.
 - Risk of data integrity.

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.87

Fig 8-2: File server architecture



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.88

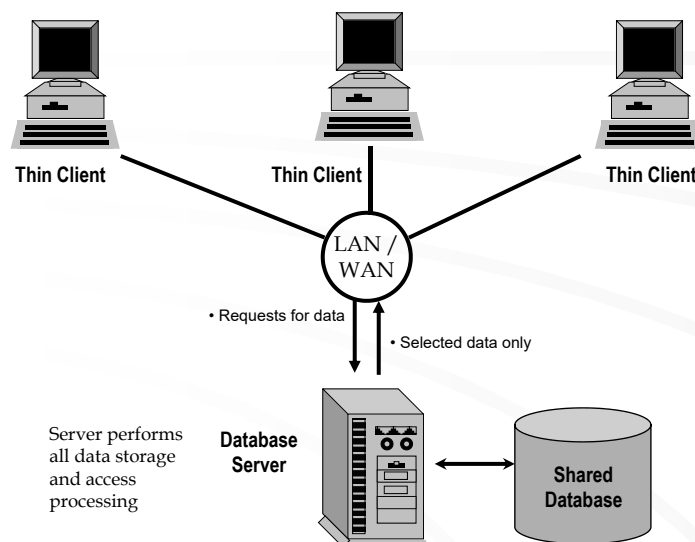
Database Server Architecture

- Client is responsible for processing I/O logic and business rules logic.
- Server keeps DBMS and stored procedures
- Server performs all data storage and access processing.
- Advantages
 - Clients do not have to be as powerful.
 - Server optimizes DB processing performance
 - Greatly reduced data traffic on the network.
 - Improved data integrity.

Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.89

Fig 8-3: Database server architecture



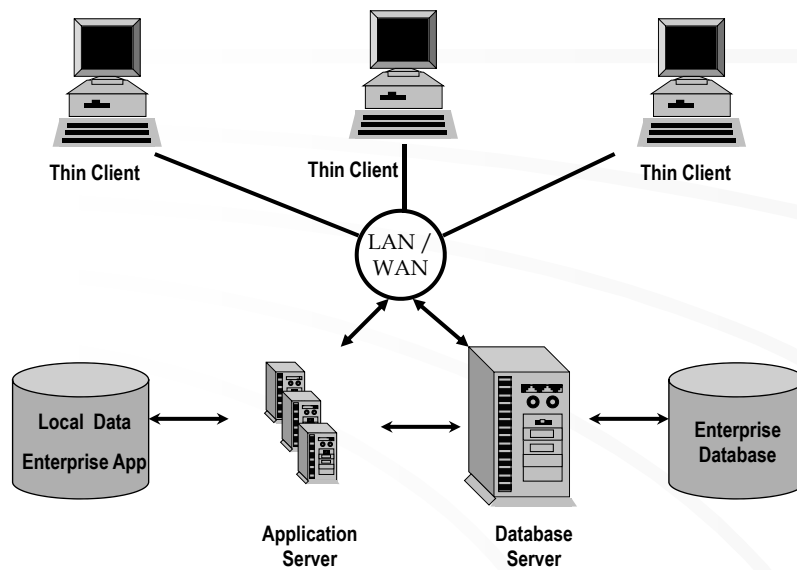
Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.90

Three-Tier Architecture

- Client
- Application server
- Database server

Fig 8-4: Three-tier architecture



Three-Tier Architecture

- Client can responsible for only I/O interface (thin client).
- Application server(s) can keep and run all processing logic in application programs and stored procedures.
- Database server performs all data storage and access processing.

Three-Tier Architecture

- Advantages
 - Scalability and flexibility - easier to add more application servers, to change middle-tier platform or add more middle tiers, and to change DBMS.
 - Improved customer service - provide different clients with different user/system interfaces.
 - better match of systems to business needs - modules can be added or changed quickly to react to business changes; this reduces risk, decreases costs, and creates competitive advantage.
 - Clients need only minimum power.
 - Very little data traffic on the network.
 - Suitable for large enterprise network.
 - Improved data integrity.

2020 Top 12 Database Servers

- Oracle
- IBM DB2
- Microsoft SQL
- SQLite
- Redis Enterprise
- InterSystems IRIS
- SAP HANA
- MariaDB Platform
- Cloud SQL Google
- Amazon Aurora
- Couchbase Mobile
- Postgres EDB

Your Turn

- What are the 7 types of IT network topology?
- What are the 3 types of IT organizational structure?
- What 12 factors do you consider in network design as a manager?

Q & A

Copyright © 2020 E.Y. Li

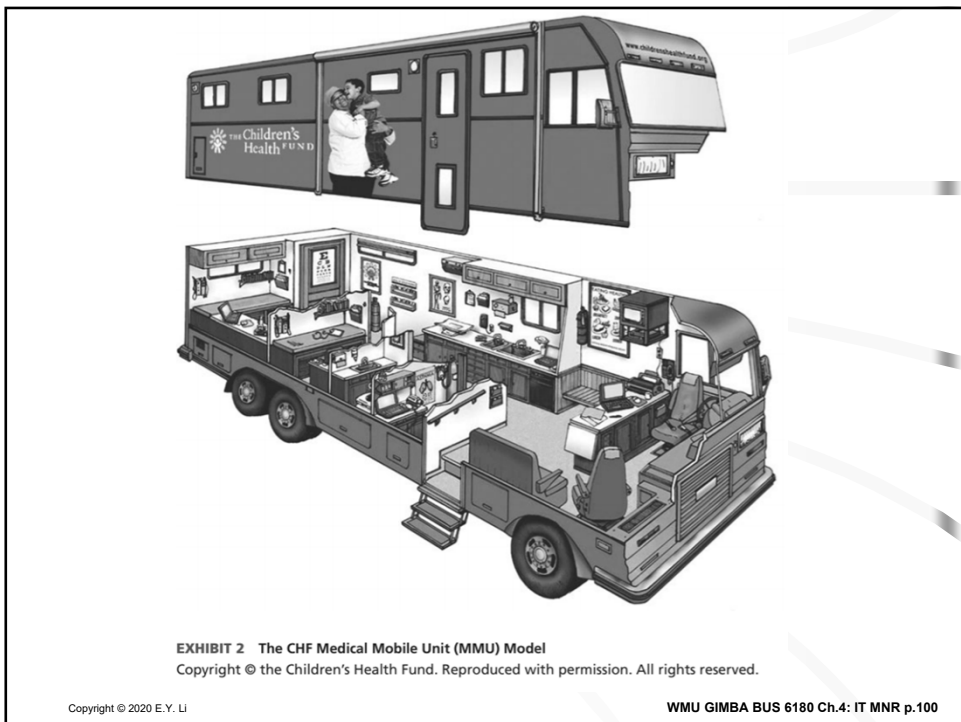
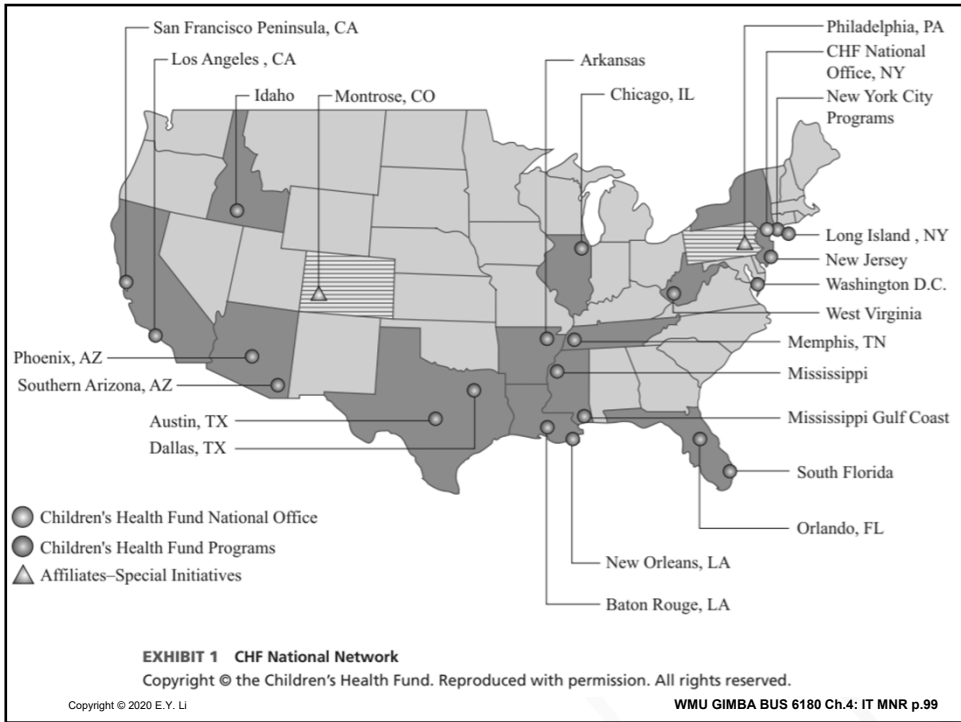
WMU GIMBA BUS 6180 Ch.4: IT MNR p.97

Case Study I-4 Supporting Mobile Health Clinics: The Children's Health Fund of New York City



Copyright © 2020 E.Y. Li

WMU GIMBA BUS 6180 Ch.4: IT MNR p.98



MMC Connectivity Needs

1. Network availability and reliability;
2. Data security meets HIPPA requirements;
3. Easy to use with zero on-site support;
4. Inexpensive to deploy and operate;
5. Network throughput (data rate) and latency.

Case Analysis Tasks

1. Identify the most important or the most critical issue that leads to the problem in the minicase;
2. Analyze this most important or most critical issue; then, provide your suggestions about what should be done;
3. Identify any additional issues;
4. Analyze these additional issues; then, provide your suggestions about what should be done and set the priority for each of them.

