



ACS-1803
**Introduction to Information
Systems**

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Networked Computing &
The Internet
Lecture Outline 9-2



Computer Networking

- Networks have existed from the early stages of human civilization
Ancient Rome: Water supply system serving multiple communities covering large territories
- Network: “a group or system of interconnected people or things.”
- A computer Network is a group of two or more computing devices that are linked through some medium
- Computer networks use computing and telecommunication technologies
- Its evolution is at the interface of these two technologies

Computer Networking

- Uses telecommunications technology
- Why learn about telecommunications and networks?
 - Need to access data that may be located in different places
 - Need to communicate, share information, upload/download data and software
 - Very important for supply chain management
 - Cooperation and communications among workers in inbound logistics, warehouse and storage, production, outbound logistics, and customers, suppliers and shippers
 - Different areas of the organization communicate with people internal and external to the organization

Components of a Simple Network*

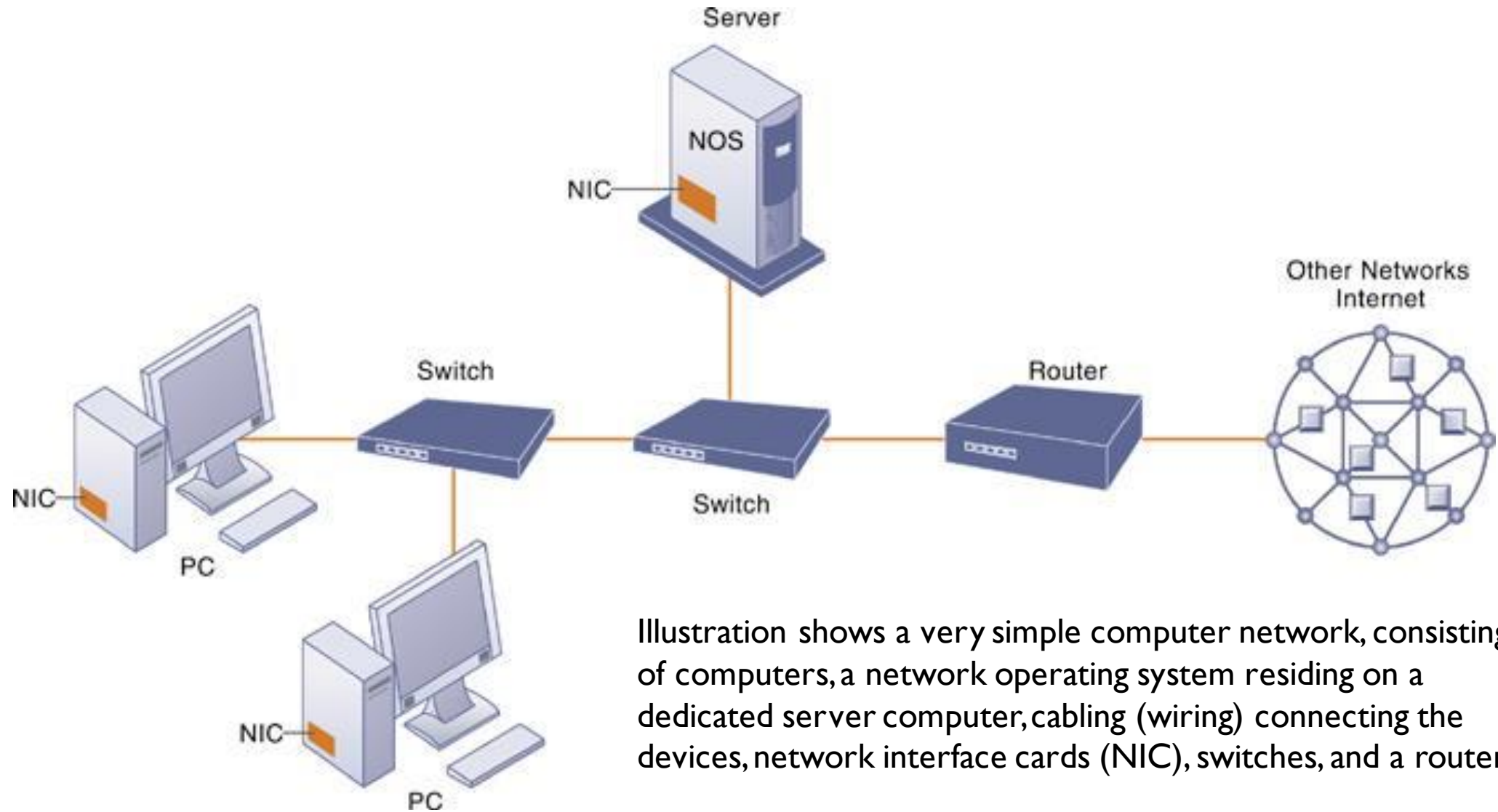


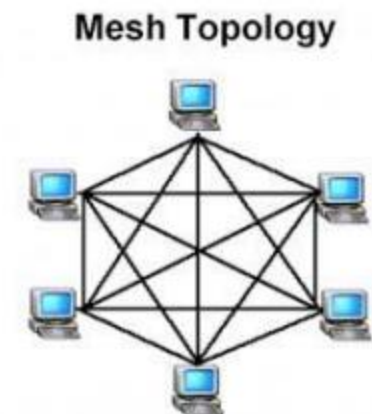
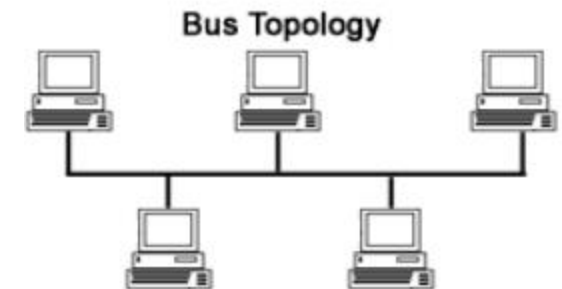
Illustration shows a very simple computer network, consisting of computers, a network operating system residing on a dedicated server computer, cabling (wiring) connecting the devices, network interface cards (NIC), switches, and a router.

Computer Network

- A computer network consists of two or more computing devices connected by a medium allowing the exchange of electronic information ©
- Consists of communications media, devices, and software needed to connect two or more computer systems or devices
- Can transmit and receive information to improve organizational effectiveness and efficiency
- Network nodes: the computers and devices on the networks
- Organizations can use networks to share hardware, programs, and databases

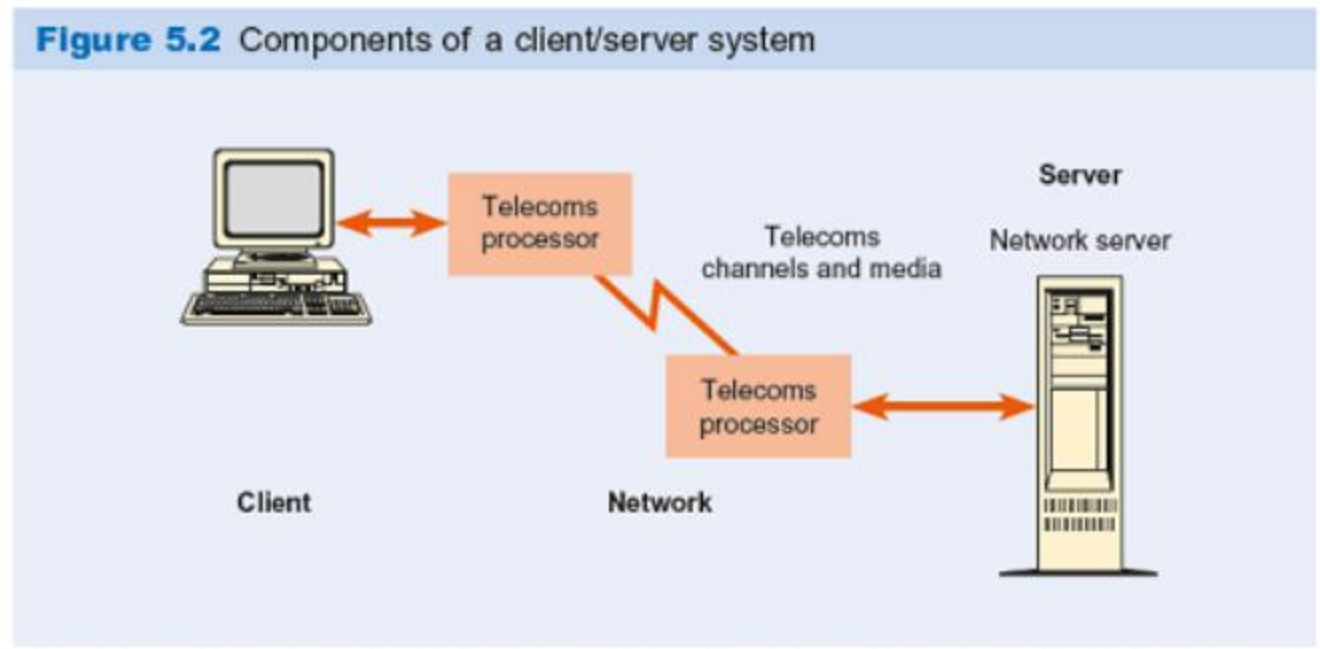
Network Topology

- Refers to how the communication links and the hardware devices are arranged on a network
- Star Network
 - Connected through a hub node
- Bus Network:
 - There is a common backbone
- Mesh Network:
 - All devices are access points and connected to one another



Client/Server Systems

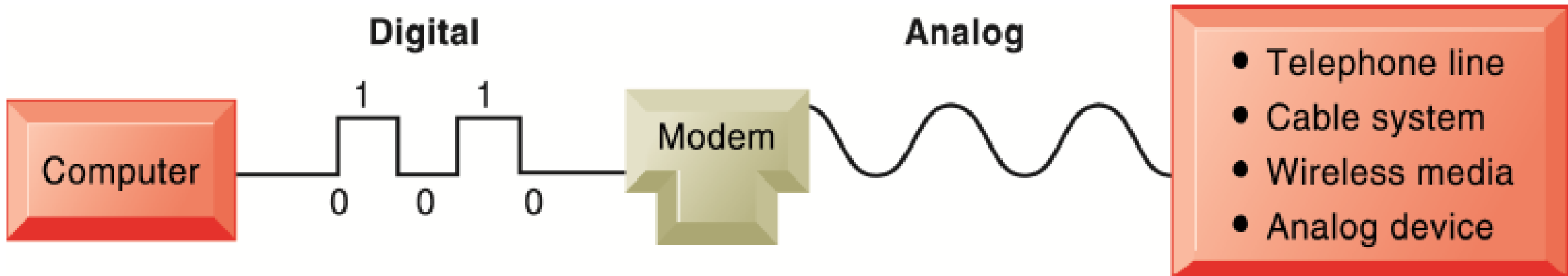
- Client/server architecture features multiple computer platforms dedicated to special functions, e.g., database management, printing, or communications
- A client is any computer that sends messages requesting services from the servers on the network
- A database server sends only the data that meets a specific query—not the entire file



Network Hardware

Modem (Modulator/Demodulator)

Enables computers to **connect and transmit data over phone lines** by converting the sending computer's **digital signals to analog** and back again for the receiving computer



Speed of Transmission

- **Channel bandwidth:** the rate at which data is exchanged, measured in bits/sec
- **Broadband communications:** a relative term; a telecommunications system that can transmit data very quickly > 25 Mbps
- **Measures in bits per second (bps)**
 - Thousands of bits per second - Kbps
 - Millions - Mbps
 - Billions - Gbps

Transmission Media

- Physical pathways between network members
- Computers send bits to each other (+ / -)
- Different media chosen to make up pathways
- Cables: twisted pair, coaxial, fiber optic
- Wireless: infrared line of sight, high frequency radio, microwave
 - Wi-Fi
- Two broad categories
 - Wired (guided) transmission media: signals are guided along a solid medium
 - Wireless: the signal is broadcast over airwaves as a form of electromagnetic radiation

Transmission Media

- WiFi Network



Transmission Media – Guided

Transmission

- Twisted-pair wire (MTS)
 - Shielded or unshielded twisted pairs of copper wire
 - Used for telephone service
 - There are transmission and distance limitations
- Coaxial Cable (Shaw)
 - Inner conductor wire surrounded by insulation
 - Cleaner and faster data transmission than twisted-pair wire
 - More expensive too
- Fiber Optic (Both)
 - Thin strands of glass bound together in a shell, uses light beams to transmit signals
 - Smaller diameter than coaxial, less signal distortion, capable of high transmission rates
 - Even more expensive to purchase and install

Wireless Technologies

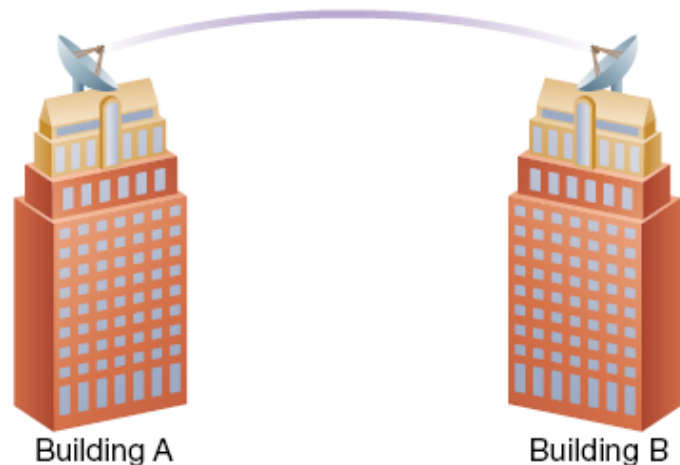
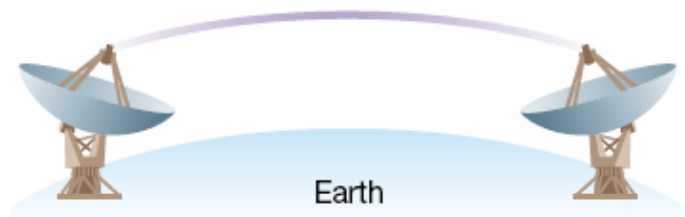
- Wireless transmission involves the broadcast of communications in one of three frequency ranges
 - Radio, microwave, or infrared frequencies
- In some cases, use of wireless communications is regulated
 - The signal must be broadcast within a specific frequency range to avoid interference with other wireless transmissions

TABLE 4.2 Frequency ranges used for wireless communications

Technology	Description	Advantages	Disadvantages
Radio frequency range	Operates in the 3 KHz–300 MHz range	Supports mobile users; costs are dropping	Signal is highly susceptible to interception
Microwave—terrestrial and satellite frequency range	High-frequency radio signal (300 MHz–300 GHz) sent through the atmosphere and space (often involves communications satellites)	Avoids cost and effort to lay cable or wires; capable of high-speed transmission	Must have unobstructed line of sight between sender and receiver; signal is highly susceptible to interception
Infrared frequency range	Signals in the 300 GHz–400 THz frequency range	Lets you move, remove, and install devices without expensive wiring	Must have unobstructed line of sight between sender and receiver; transmission is effective only for short distances

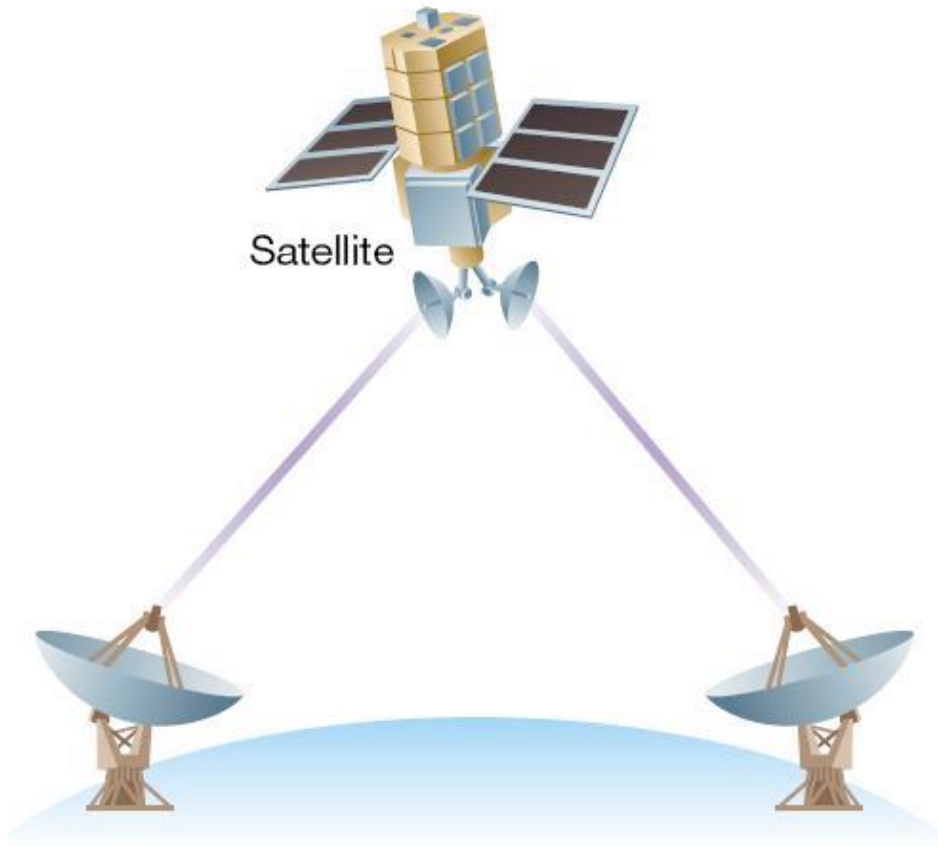
Networking Fundamentals – Media (Microwave)

- **Microwave** A high frequency radio signal that is sent through the air using either terrestrial (earth-based) or satellite systems



Terrestrial Microwave A line-of-site technology (unobstructed) used to cross **inaccessible terrain** or to connect buildings where cable installation would be expensive. **Attenuation is low** over **short distance** but **higher** over **longer distances**, and **high winds, heavy rain, EMI** and **eavesdropping** are also problems

Networking Fundamentals – Media (Satellite)



Satellite Microwave A **line-of-site** technology that uses **relay stations** to **transfer signals** between **antennae** located on **earth** and a **satellite orbiting the earth**. It can be used to **access very remote locations** and, like a terrestrial microwave, **attenuation, EMI** and **eavesdropping** are also **problems**

Networking Fundamentals – Media (Wireless)

Cellular Phone A two-way wireless communication that assigns unique frequencies to calls and can transmit in analog or digital

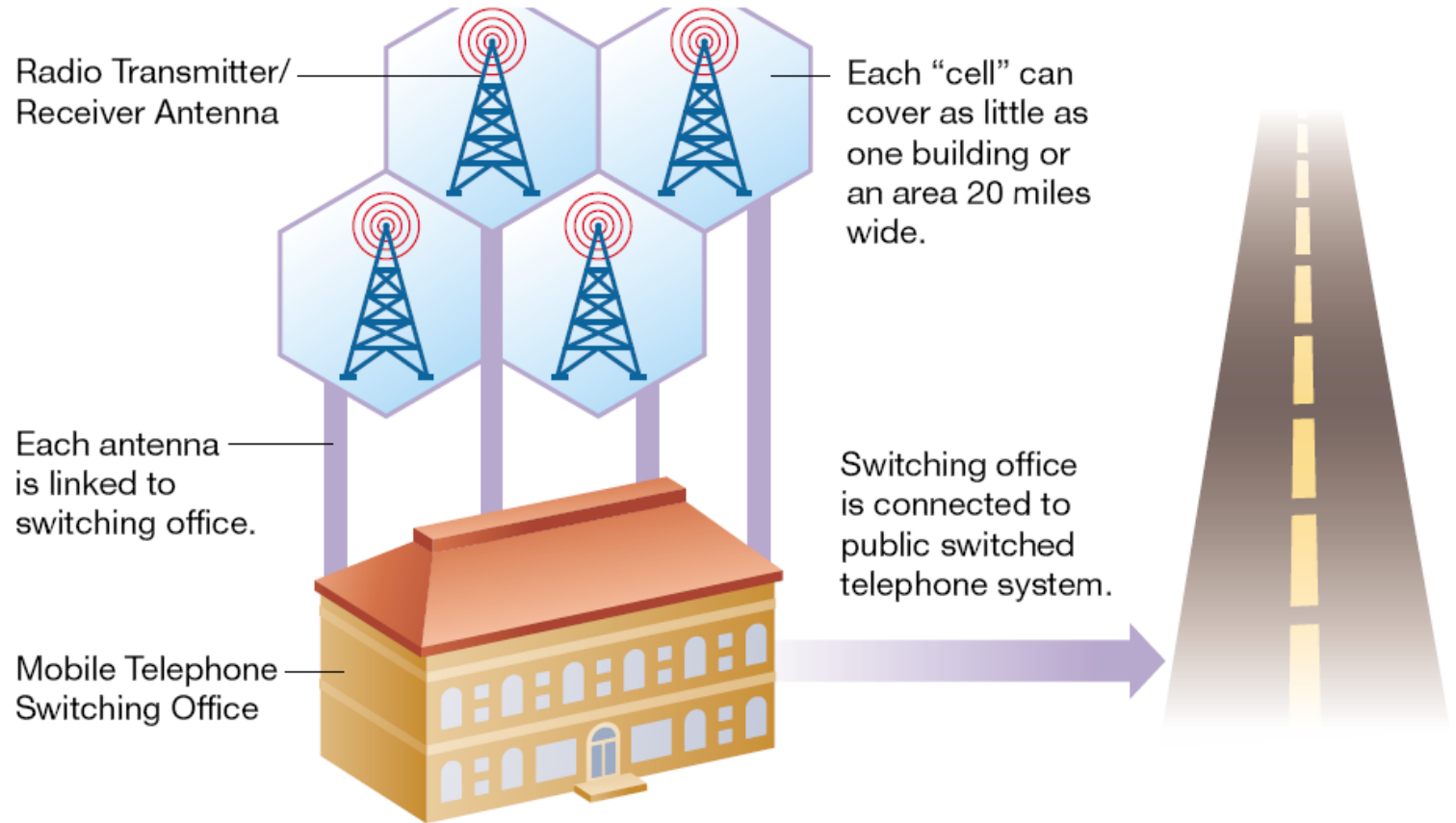


Figure C.17 → A cellular network divides a geographic region into cells.

Communications Media

- 3G wireless communications:
 - Supports wireless voice and broadband speed data communications in a mobile environment
- 4G wireless communications:
 - 4G will also provide increased data transmission rates in the 20–40 Mbps range
 - LTE – Long Term Evolution
- 5G – “Super” 4G
 - 100x faster than 4G
 - Low latency
 - Support Internet of things

Telecommunications Hardware

- Smartphones:
 - Combine the functionality of a mobile phone, camera, Web browser, e-mail tool, MP3 player, and other devices
 - Have their own software operating systems
 - Applications are developed by:
 - The manufacturers of the handheld device
 - The operators of the communications network on which they operate
 - Third-party software developers

Wireless Technologies

- Near Field Communication (NFC)
 - Short-range wireless connectivity
 - Used on cellphones and credit cards
- Bluetooth
 - Distances of 10-30 feet
 - Speed: 2Mbps
 - Devices must be paired to communicate
- Wi-Fi
 - Communication through a wireless adapter on the device (cellphone, laptop, etc)
 - The wireless adapter translates data into radio signals
 - Wireless access point connected to the computer
 - Transmitter, antenna, receives signal and decodes it

Network Types

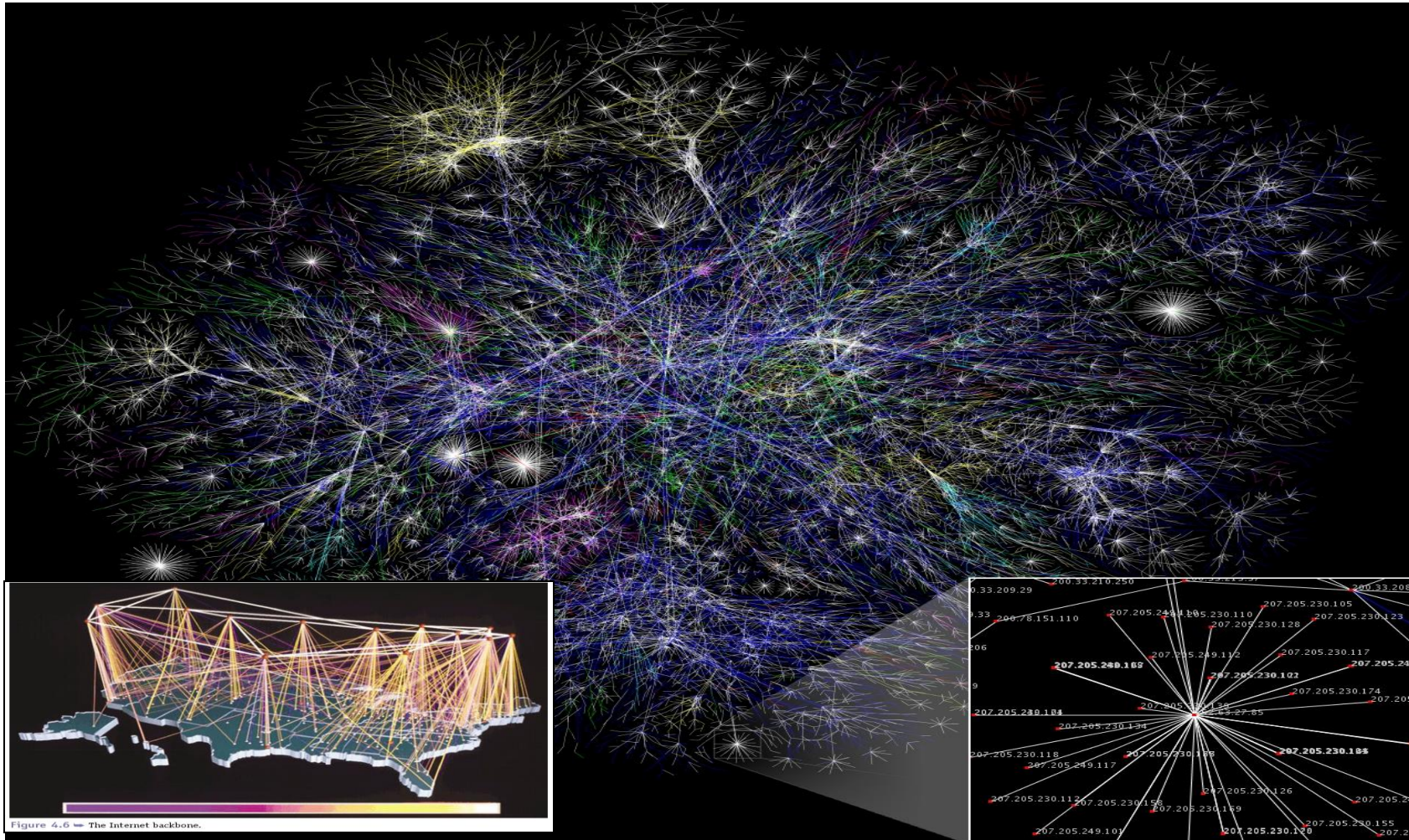
- Personal area networks:
 - Support interconnection of information technology within a range of about 33 feet
- Local area networks:
 - Connect computer systems and devices within a small area (e.g., office or home)
- Wide area networks:
 - Connect large geographic regions



The Internet

The Internet “Network of Networks”

- Large, worldwide collection of networks that use a common protocol to communicate with each other



JAN
2016

GLOBAL DIGITAL SNAPSHOT

A SNAPSHOT OF THE WORLD'S KEY DIGITAL STATISTICAL INDICATORS



TOTAL
POPULATION



7.395
BILLION

URBANISATION: 54%

FIGURE REPRESENTS TOTAL GLOBAL
POPULATION, INCLUDING CHILDREN

INTERNET
USERS



3.419
BILLION

PENETRATION: 46%

FIGURE INCLUDES ACCESS VIA
FIXED AND MOBILE CONNECTIONS

ACTIVE SOCIAL
MEDIA USERS



2.307
BILLION

PENETRATION: 31%

FIGURE BASED ON ACTIVE USER
ACCOUNTS, NOT UNIQUE INDIVIDUALS

UNIQUE
MOBILE USERS



3.790
BILLION

PENETRATION: 51%

FIGURE REPRESENTS
UNIQUE MOBILE PHONE USERS

ACTIVE MOBILE
SOCIAL USERS



1.968
BILLION

PENETRATION: 27%

FIGURE BASED ON ACTIVE USER
ACCOUNTS, NOT UNIQUE INDIVIDUALS

History of the Internet

- **ARPANET** (Advanced Research Project Agency Network)
 - Created in the 1960s by **DARPA** (Defense Advance Research Projects Agency)
 - Used by **government** and **universities** as a means to communicate for **research purposes**
- **NSFNET** (National Science Foundation Network)
 - Created in 1986 by the National Science Foundation for connecting research institutions
 - Connected to **ARPANET** and **many others** (BITNET, CSNET, etc) to become a major component of the Internet
- **Internet Support**
 - Ongoing **support** comes from many **universities**, federal and state **governments**, and national international **research institutions** and **industry**

How the Internet Works – Connecting to the Internet

- **Modem (stands for Modulate/Demodulate)**
 - A **modem** converts signals back and forth from **digital to analog** for transmission and receipt between computers
 - A computer requires a modem to get access to the Internet
- **Internet Service Provider (ISP)**
 - These companies provides access to the **Internet** for a fee (*i.e. MTS, Shaw*)
 - A computer is connected to an **ISP** through a **modem** to allow **Internet** access
- **Network Access Points (NAPs)**
 - NAP's connect ISPs together
 - They serve as Internet **access points** for the ISPs and serve as **exchange points** for Internet traffic
- **Internet Backbone**
 - Collection of main **network connections** and **telecommunications lines** that make up the Internet

Internet Backbone

- Network hardware that makes internet connections possible.
- Special technology for the construction of transmission lines. These networks do not serve end users, they connect equipment of each of the networks that participate.
- Internet service providing companies own this network hardware and they interconnect it to make worldwide communications possible.
- Cables, routers, switches, antenna towers, satellites, etc...



or duplicated, or posted to a publicly accessible website, in whole or in part.

Network Protocols

- **In general**
 - **Protocol – a set of rules on HOW to do something**
- **Here**
 - **Agree upon format for transmitting data between connected computers**
- **How to arrange data packets, how to signal end of message, how to specify destination address etc.**

TCP/IP & Routers

- **TCP – Transmission Control Protocol**
 - Breaks information into small chunks called data packets
 - Manages the transfer of the packets from computer to computer
 - Reassembles data packets into a message at the destination
- **IP – Internet Protocol**
 - Controls how data packets are formed
 - Addresses each packet with the source and destination address
 - A data packet conforming to the IP spec is called an **IP datagram**
- **Routers Connect one network to another**
 - Identify each device on a network as unique using IP protocol
 - Serve as the “Traffic Cop” directing packets to their destination

Packet Switching

I want to communicate with you.

Original text message

0010110110001001101110001101

Text message digitized into bits

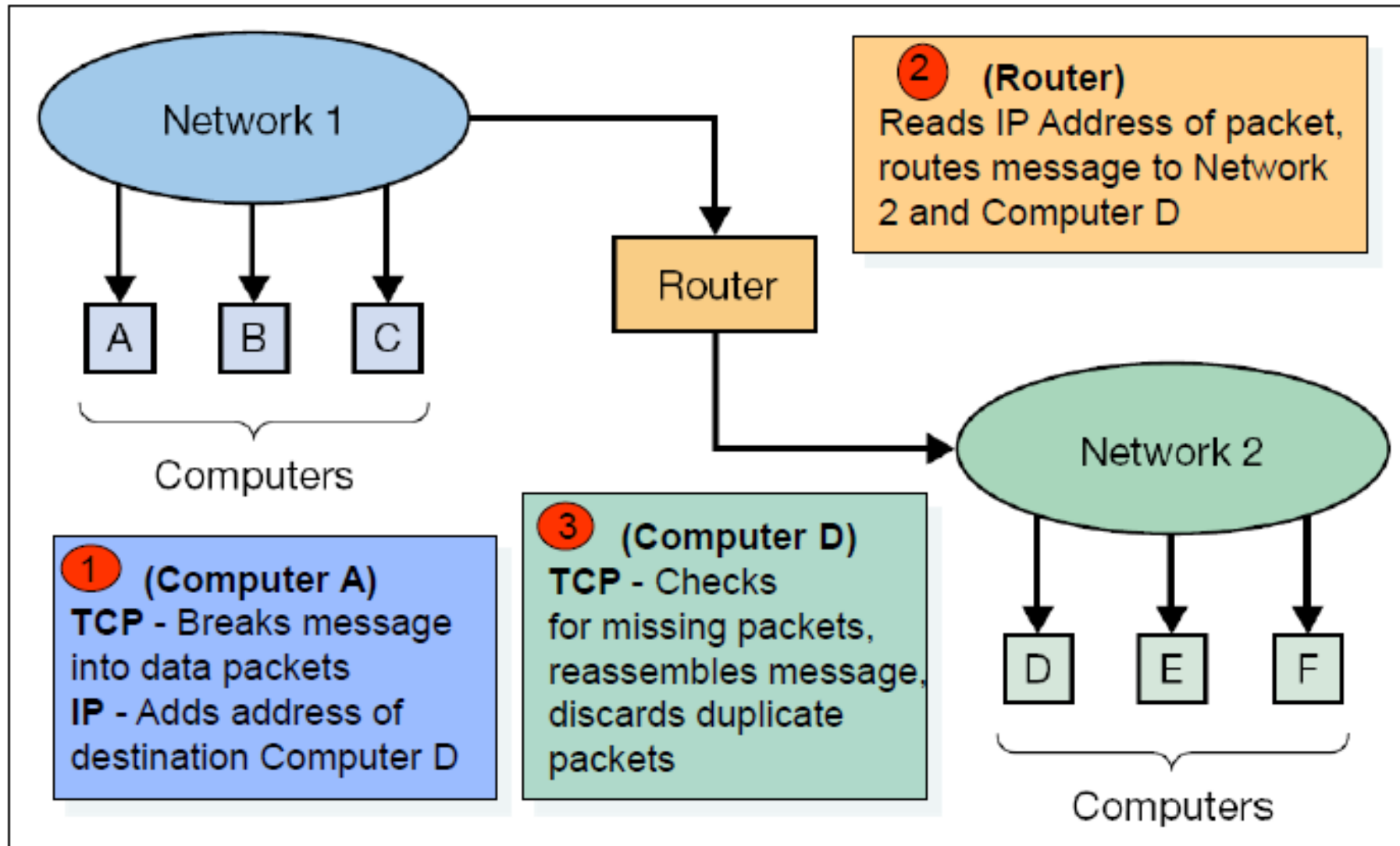
01100010 10101100 11000011

Digital bits broken into packets

0011001 10101100 11000011

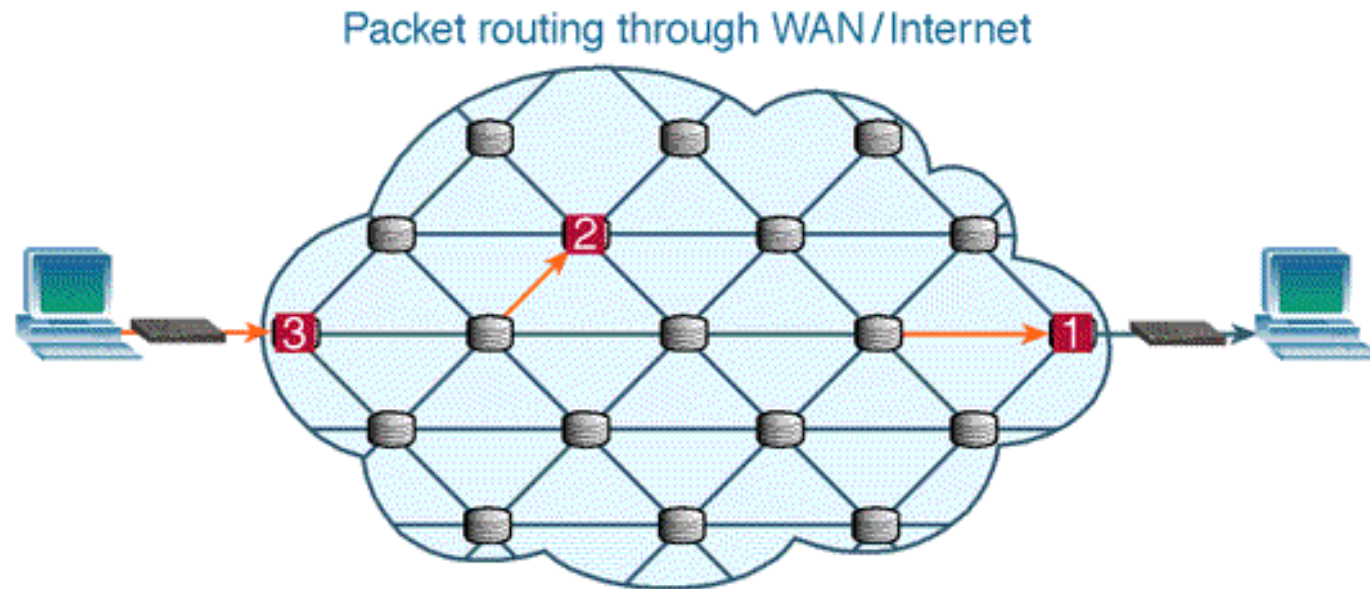
Header information added to each packet indicating destination, and other control information, such as how many bits are in the total message and how many packets

How the Internet Works – Sending a Message from Computer A to D



Packet Switching

- Internet uses packet switching to enable users to transmit across it concurrently
- What is to be sent down the network is 'sliced up' into packets
- Each packet has header with source and destination address
- *Each computer attached to a network has a unique network address*



Popular Uses of the Internet

- Telnet – use a remote computer/cpu
- FTP – file transfer protocol, downloading and uploading files
- Internet telephone calls (VoIP)
- Email
- Texting/messaging services
- Access to the World Wide Web

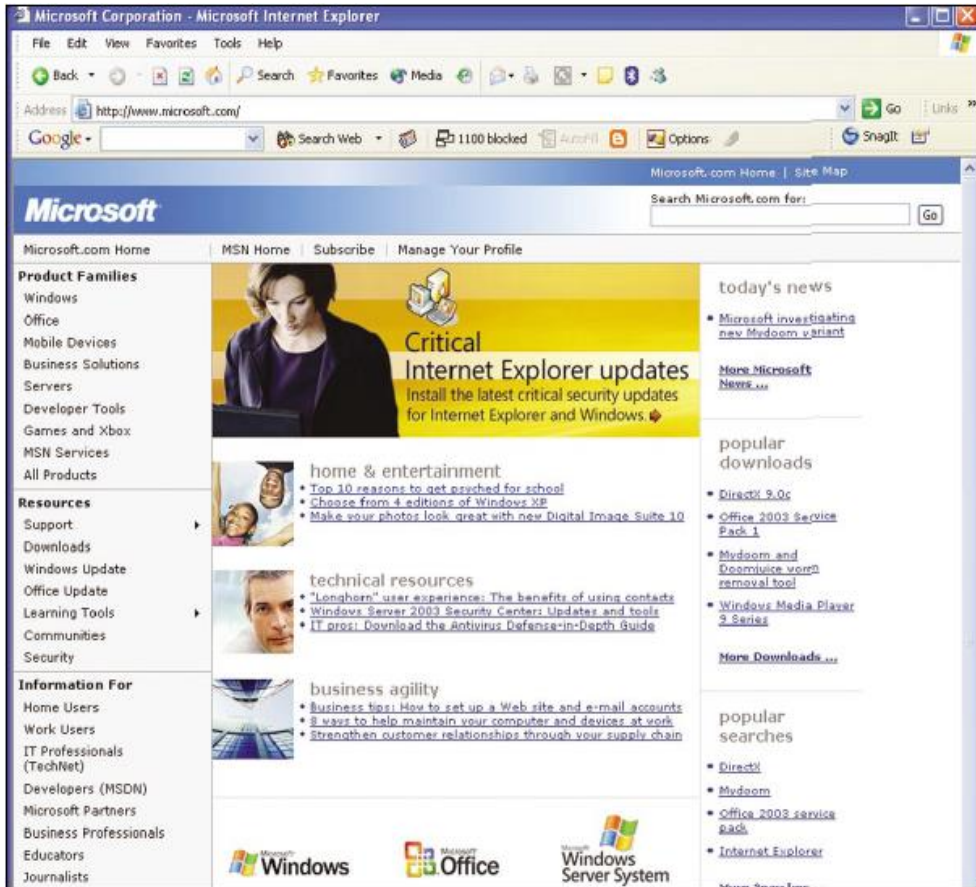


The World Wide Web

The World Wide Web

- Developed by Tim Berners-Lee at CERN (c. 1980)
- Originally conceived of as an internal document-management system
- The Web has grown to become:
 - A primary source of news and information
 - An indispensable conduit for commerce
 - A popular hub for social interaction, entertainment, and communication

The World Wide Web



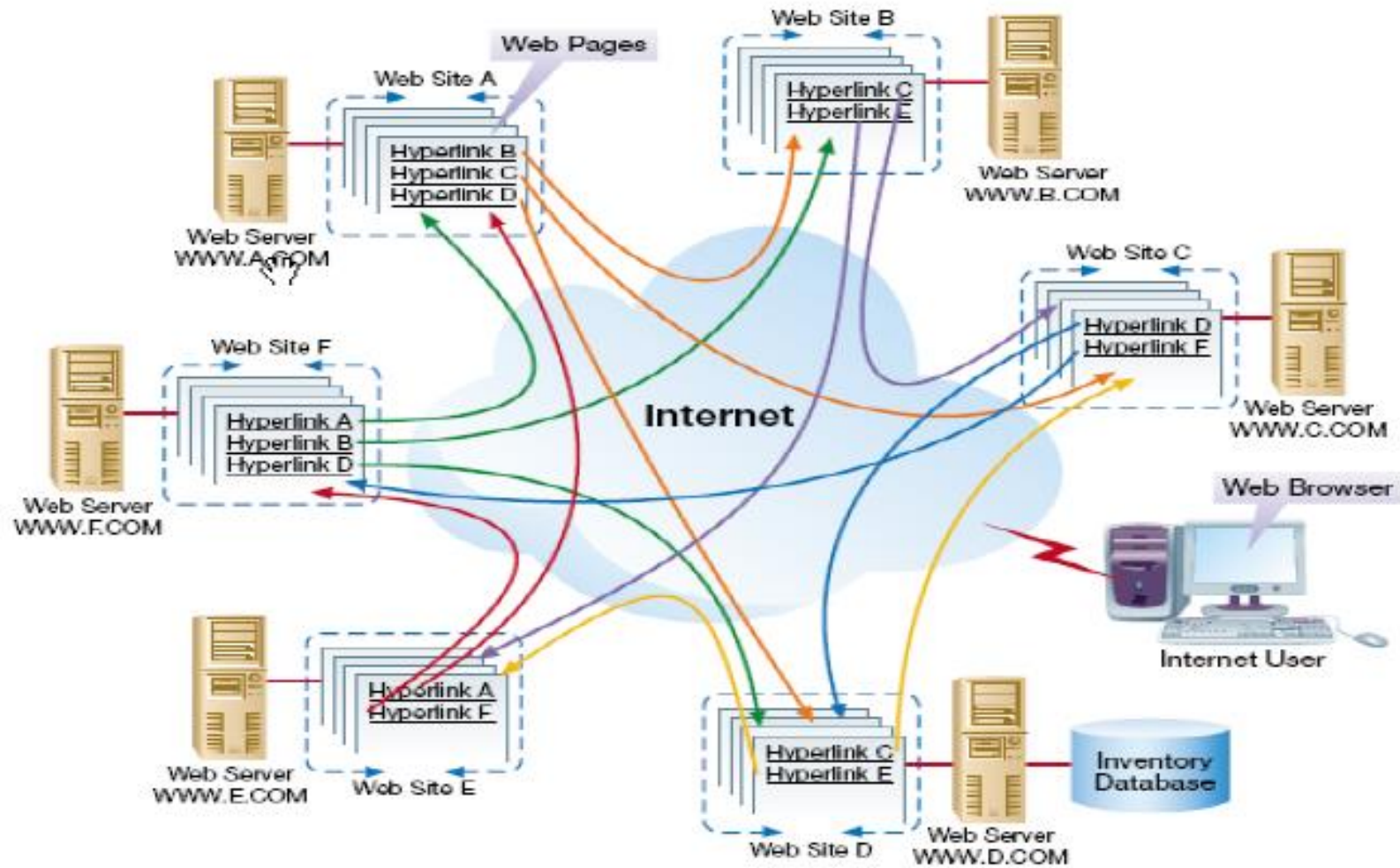
- **Hypertext**
- A Web page stored on a Web server
- Contains **information** and **links** to other related information (hyperlinks)
- **HTML (Hypertext Markup Language)**
- A standard method used to **specify the format** of Web pages
- Uses **codes/tags** which stipulate how the content should appear to the user
- **Web Browser**
- A software program used to **locate and display** Web pages
- Includes **text, graphics, and multimedia** content

Web Browsers

- A software program used to locate and display Web pages
- Includes text, graphics, and multimedia content



World Wide Web - Architecture



A Website

- Collection of interlinked web pages created by the same author(s) for common purpose
- Respond to requests over the Internet from browsers according to the hypertext transfer protocol (http)
- URL (Uniform Resource Locator)
 - Each site has a URL address
 - <http://www.uwinnipeg.ca>

How the Internet Works – Web Addresses & Domains



Domain

- Identifies the Website (host)
- Comes in many **suffixes** such as:
 - .edu (educational institutions)
 - .org (organizations; non-profit)
 - .mil (military)
 - .net (network organizations)

Example: microsoft.com
uwinnipeg.ca

IP Address

- Each domain is associated with one or more **IP addresses**
- Format: a 32-bit address written as 4 numbers (from 0-255) separated by periods

Example: 1.160.10.240

(URL) Uniform Resource Locator

- Identifies particular Web pages within a domain
- Example: http://www.microsoft.com/security/default.mspx**

Web addresses

- Website: `http://www.yyy.zz`
- Page on that site:
`http://www.yyy.zz/xx`
- Domain name: `yyy.zz`
- Prefix: *yyy* e.g. *uwinnipeg*
- Suffix: `zz`
- e.g.
- `.com` – business
- `.org` – nonprofit organization
- `.ca` - Canada

Internet Protocol (IP) Addresses

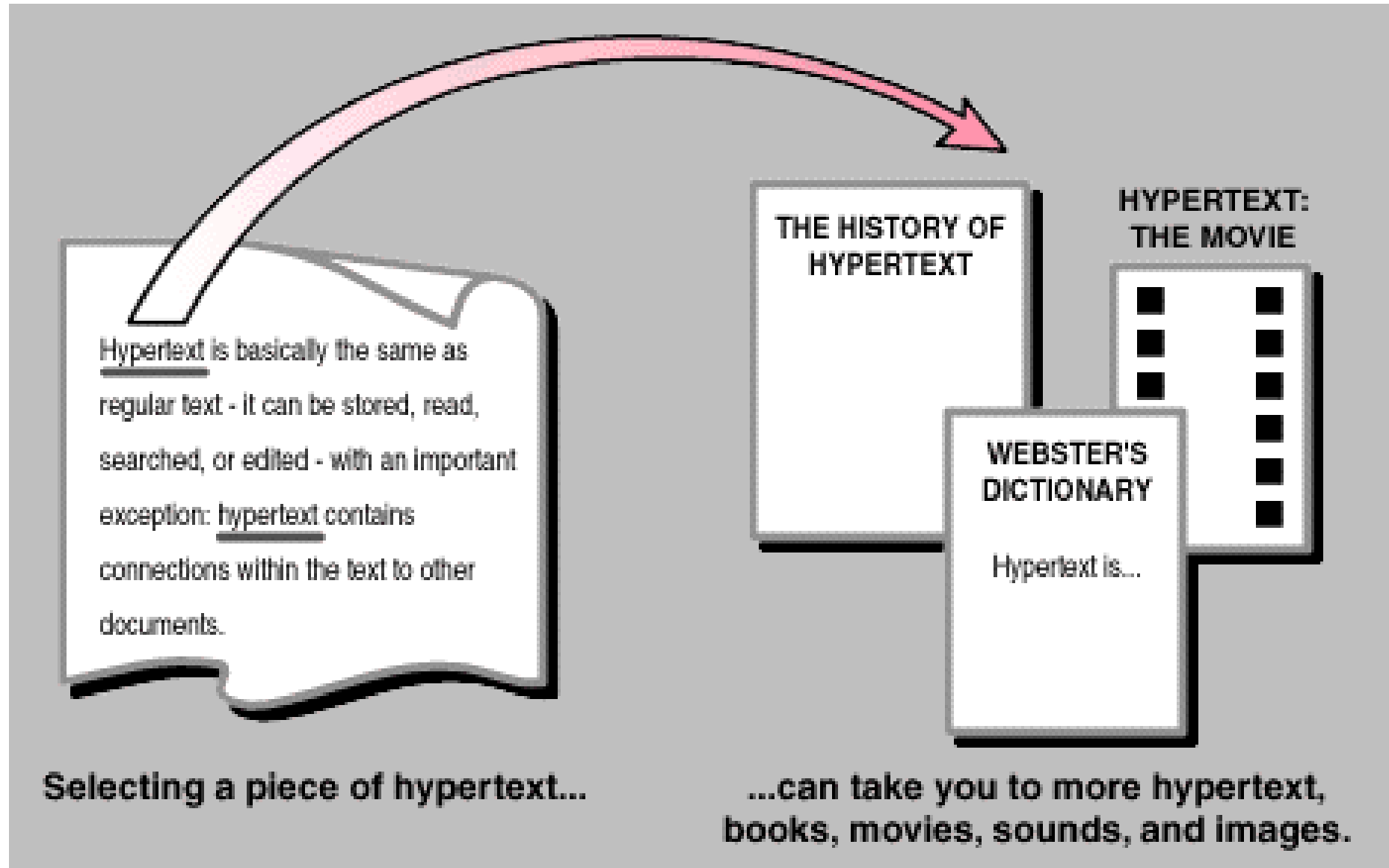
- Each domain name
 - uwinnipeg.ca
- is associated with an IP Address
 - Number assigned to each device (e.g., computer, printer) participating in a network that uses the internet protocol (IP)
 - 32-bit numeric address (4.29 Billion IP addresses)
 - written as 4 numbers separated by periods (IPv4)
 - Domain name is translated to IP Address by a special server on the Internet
 - e.g.. 1.160.10.240

IPv6

- June 6, 2012, Internet Society launched IPv6
- 128-bit addresses, able to handle up to 1 quadrillion addresses
- written as 6 sets of numbers marked by colons
- e.g.. 2001:db8:85a3::8a2e:370:7334



Web Browser and Hypertext



HTML (Hypertext)

```
<html>
<head>
<link rel=File-List href="Index_files/filelist.xml">
<title>ACS 1803 Introduction to Information Systems</title>
</head>
<body lang=EN-CA link=blue vlink=purple style='tab-
  interval:36.0pt'> <h1><Welcome to Section 053</h1>
...
</body>
</html>
```

Internet email address

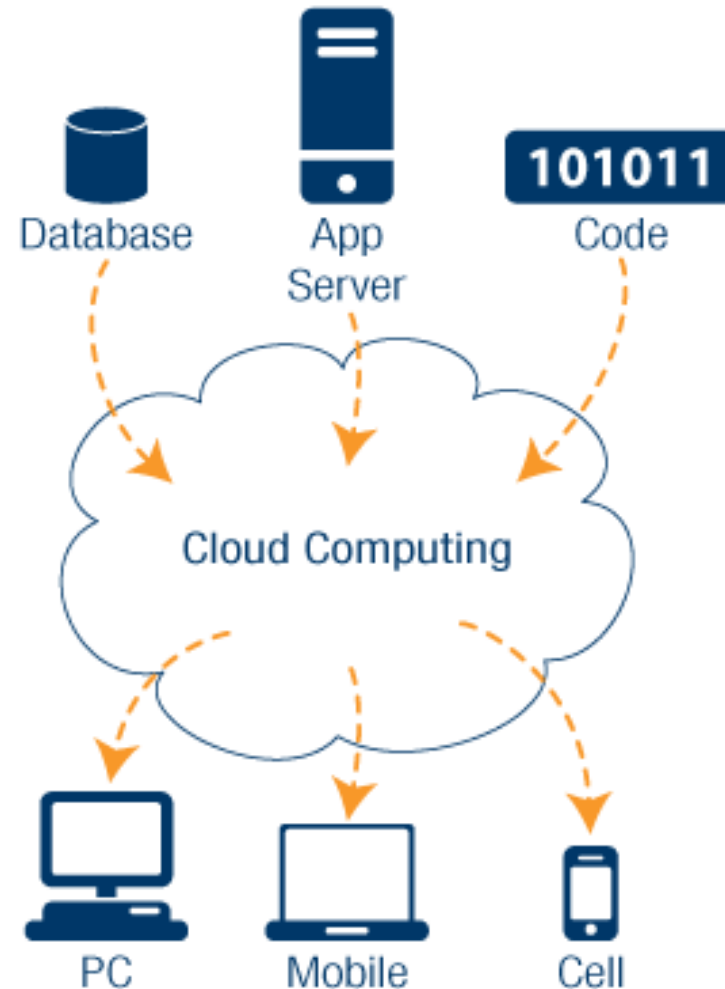
- john@uwinnipeg.ca
 - e-mail address has @ symbol
 - user name @ domain name
- Domain names (general areas):
 - .com commercial organization
 - .edu educational organization
 - .gov government organization
 - .ca Canada
 - .us U.S.
 - .hk Hong Kong

Types of Websites

1. Static: collection of static documents created in HTML and tied together with links
2. Static with forms: 90% is pure document delivery, but also has fill-in forms to collect information from the user
3. Dynamic Data Access: via a Web page, users can search a catalogue or perform queries on the contents of a database, e.g. University Course Registration
4. Web-based Software Applications: facilitate business processes beyond voiding information; have a business information system on a Web-site, e.g., inventory tracking, sales force automation

Cloud Computing

- Software and storage provided as an internet service and accessed within a web browser
- Example: Email, Data storage, skydrive, tax software, flicker, facebook.
- Soon most computing will take place on the internet



Cloud Computing – Advantages to Businesses

- Outsourcing Resources – Saves on system design, installation, and maintenance
- Provides an ability to access corporate systems from any Internet-connected device
- Increases the data storage capabilities of the firm
- Data safeguarding responsibility of service provider

Search Engines

- Search engines are programs that search documents for specified keywords and returns a list of the documents (web pages) where the keywords were found
- Biggest application on the web
- Web Search is such a profitable business (Google \$15.5 billion annual revenue) because it is an application that is of use to everybody
- Search engines are an important contributor to the development of the Web and the Internet
- Today businesses build their websites using *Search Engine Optimization (SEO)*

How Google Works



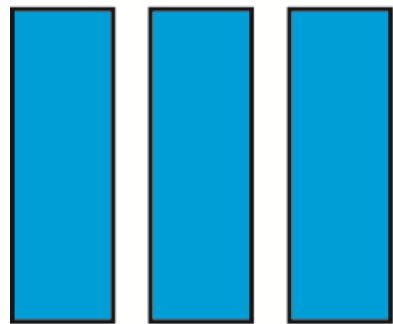
1. A user enters a search query.



2. Google's Web servers receive the search request. Google uses an estimated 1 to 2 million PCs linked together and connected to the Internet to handle incoming queries and produce search results.

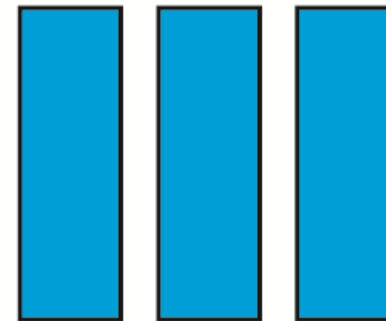
6. Results delivered to user, 10 to a page.

5. Small text summaries are prepared for each Web page.



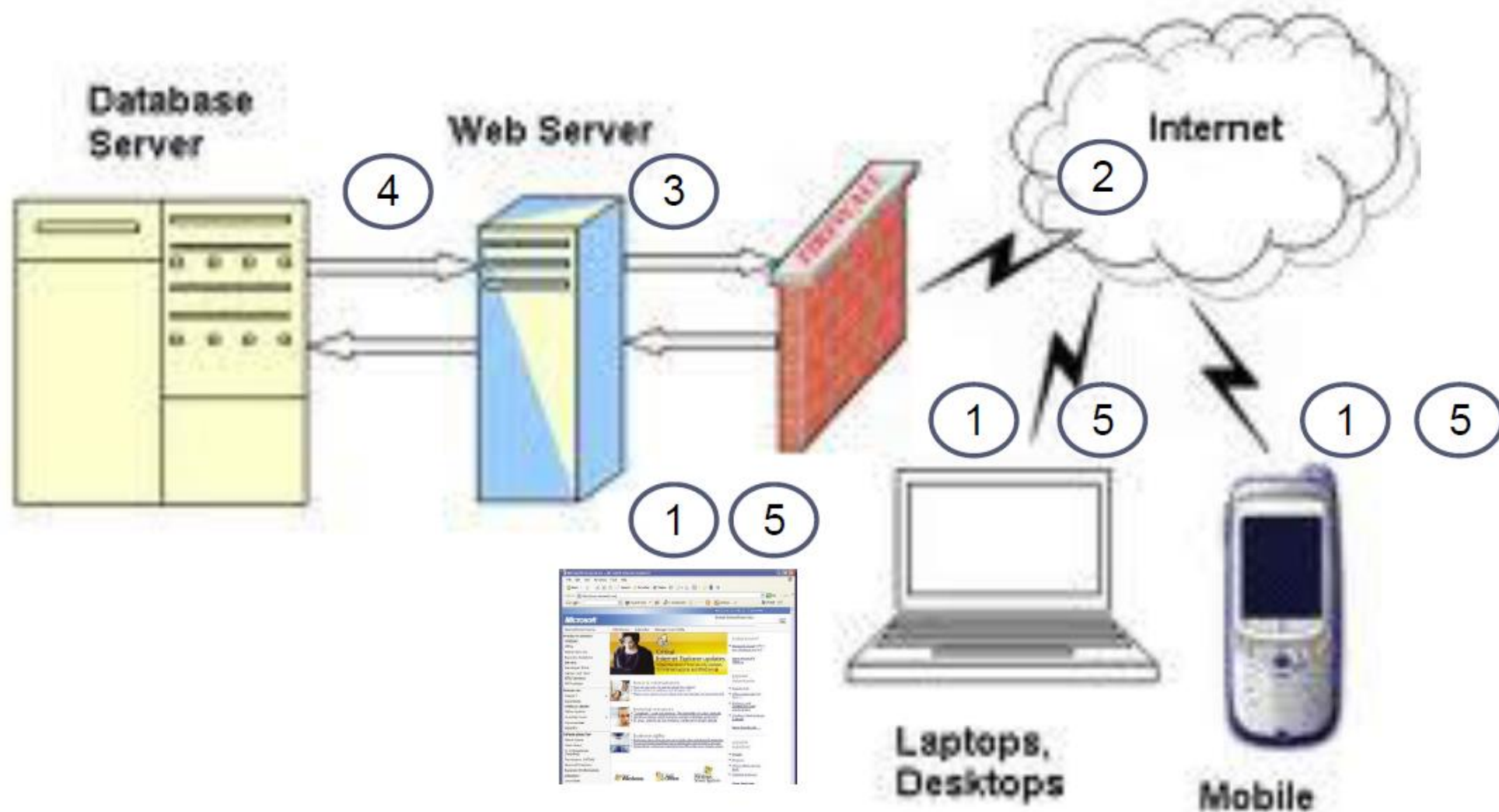
4. Using Google's PageRank software, the system measures the "importance" or popularity of

each page by solving an equation with millions of variables and terms. These are likely the "best" pages for the query.



3. The search request is sent to Google's index servers, which maintain data about the Web pages that contain the keywords matching the query, and the location of those pages.

Overview of a Web Session



Overview of a Web Session

1. User, with browser software, requests a document from a remote Web server on the Internet
 - enters desired address as Uniform Resource Locator (URL) e.g.,
`http://www.irwin.com`
2. Actual address is determined from a domain name server (computer) on the Internet
3. Once the machine has been located, a request can be sent to the server
 - discussion between the Web browser and the Web server is handled by HTTP (hypertext transfer protocol) - defines how a client must ask for data (pages) from the server and how the server responds when it returns what was asked for

{HTTP does not specify how the data is transferred, that is up to TCP/IP, at a lower level}

Overview of a web session (cont`d)

4. Server attempts to process request (is it valid?)
 - they send data from disk onto the network; it uses **Web Server software**, such as Apache

5. The browser, on the client, reads what has been sent to it, identifies it as an HTML document, and places the page in the browser window
 - information moves from the network or modem to the client system
 - once in the client computer, information goes along a bus to the hard disk or into main memory (browser might temporarily put info onto disk)
 - it is then processed by the browser software only)

The Future Internet

- The Internet2 Project

- Consortium of 350+ institutions collaborating to facilitate revolutionary Internet technologies
- Guaranteed service levels and lower error rates
 - Ability to purchase the right to move data through network at guaranteed speed in return for higher fee
- Declining costs

- The Internet of Things (IoT)

- Objects connected via sensors/RFID to the Internet

Networked Computing & The Internet

End of Lecture 9-2