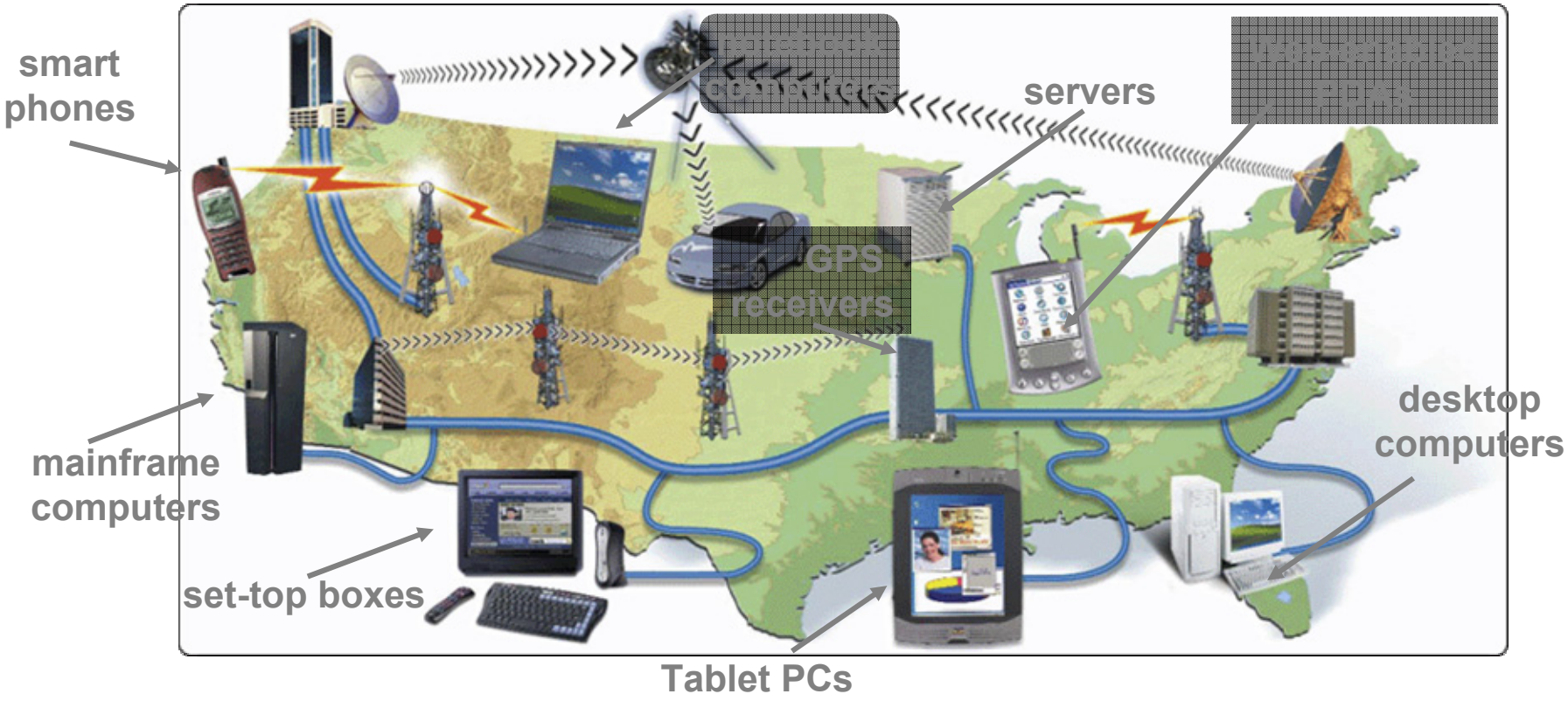
Communication and Network

Communication

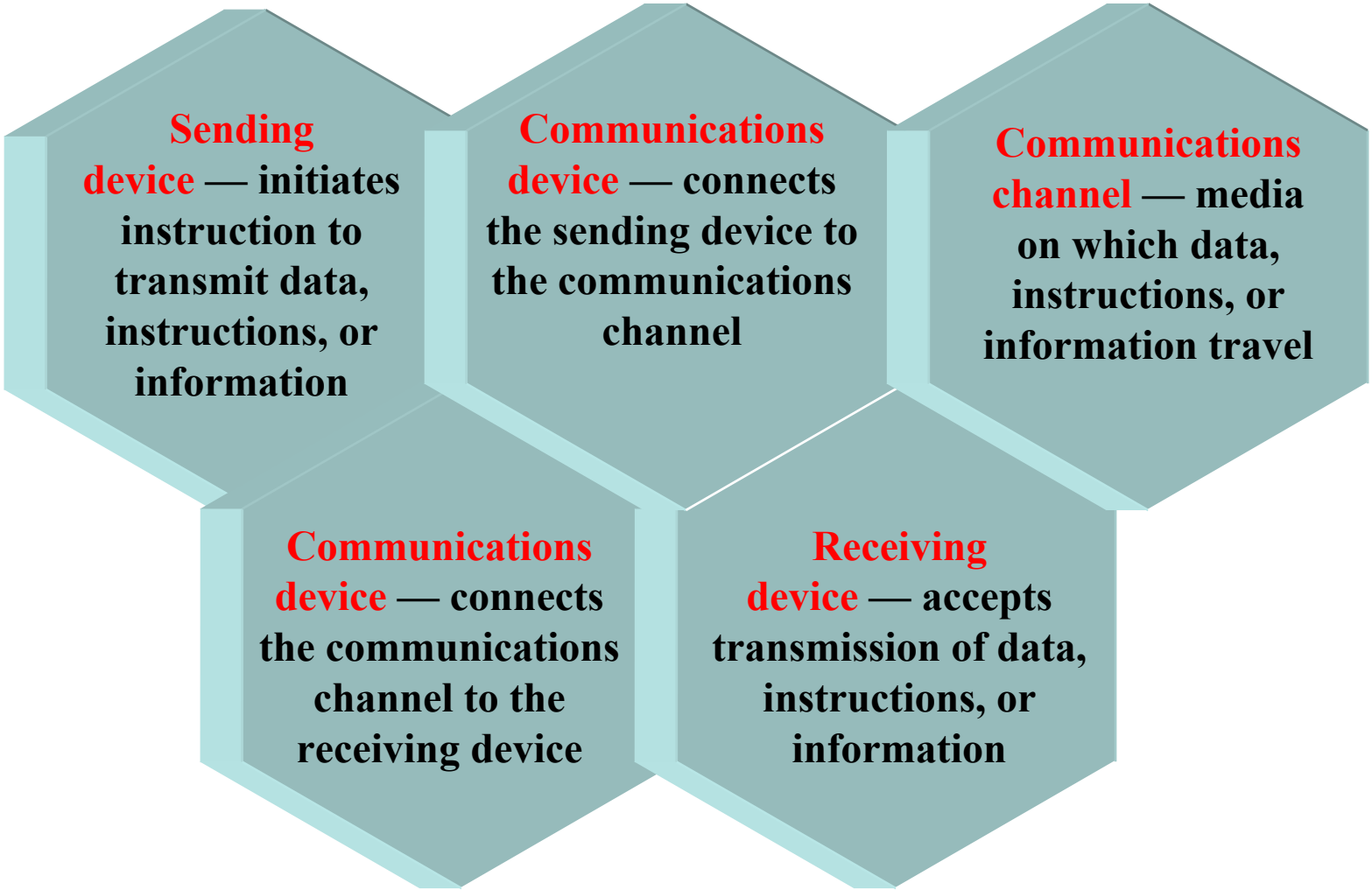
computer communication

- **Process in which two or more computers or devices transfer data, instructions, and information via cables and wires or wirelessly mainframe computers**



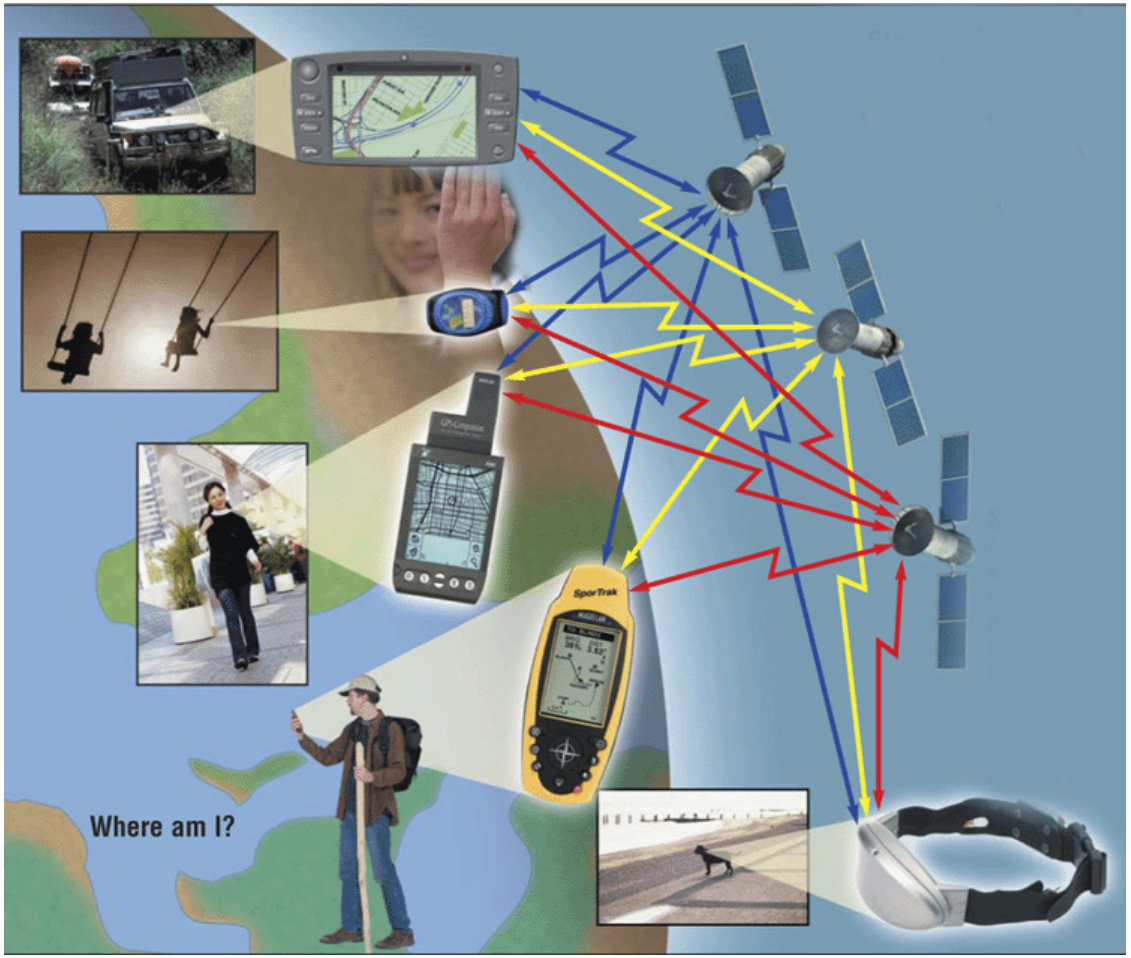
Communications

- What is needed for successful communications?



- global positioning system (GPS)

Step 1.
GPS satellites orbit Earth. Every thousandth of a second, each satellite sends a signal that indicates its current position to the GPS server.



Step 2.
A GPS receiver (such as in a car, a PDA, a watch, a handheld device, or a collar) determines its location on Earth by analyzing at least 3 separate satellite signals from the 24 satellites in orbit.

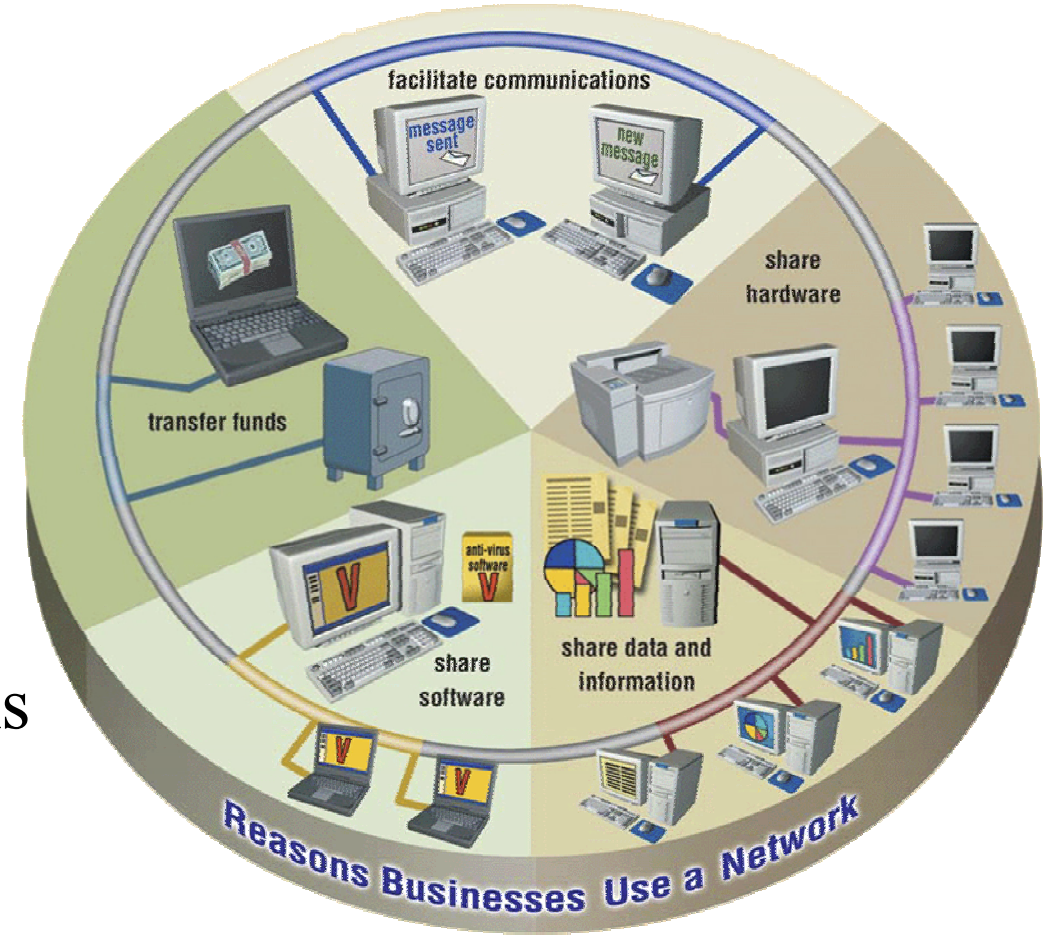
An Old Way of PC-PC Communication

- PC A to floppy disk
- Then floppy disk to PC B

- Someone needs to carry the floppy disk from the location of PC A to PC B

Networks

- Collection of computers and devices connected via communications devices and transmission media



Internet

- First experimental Internet
  - 1969, ARPANET (Advanced Research Project Agency Network), UCLA
  - TELNET (Telecommunication Network Protocol)
  - FTP (File Transfer Protocol)
  - E-mail (Electronic mail)
- Late 70's, US Defense Dept. released the technology
- 1981, National Science Foundation (NSF) supported Computer Science Network (CSnet),
  - CSnet and ARPANET were connected => Internet

• Protocols: The rules that govern the communication between different components within a computer system.

(通訊) 協定

Internet

- In the beginning, only for government units, academia, research institutes, military units, companies…
- Internet Service Provider (ISP)
  - Everyone can use internet
  - http://map.twnic.net.tw/

Connecting to the Internet

- The principle
  - Transmission
  - Media and transmitter
- Network structure
  - LAN and WAN
  - Ethernet and IP routing

Person-Person Communication

- Polly writes a letter
- The letter reaches Tiffany

- The postal system carries the letter from Taipei to LA

Why that trouble?

Polly calls Tiffany!

Also person-person communication

Telephone Network

- Telephones connected by cables

- Conversations are transmitted through cables
- Use the cables and then no person needs to carry letters around

Computer Network

- Computers connected by cables

- Data are transmitted through cables
- Use the cables and then no person needs to carry data around

But…

How does voice or data go from one end of a cable to another end?

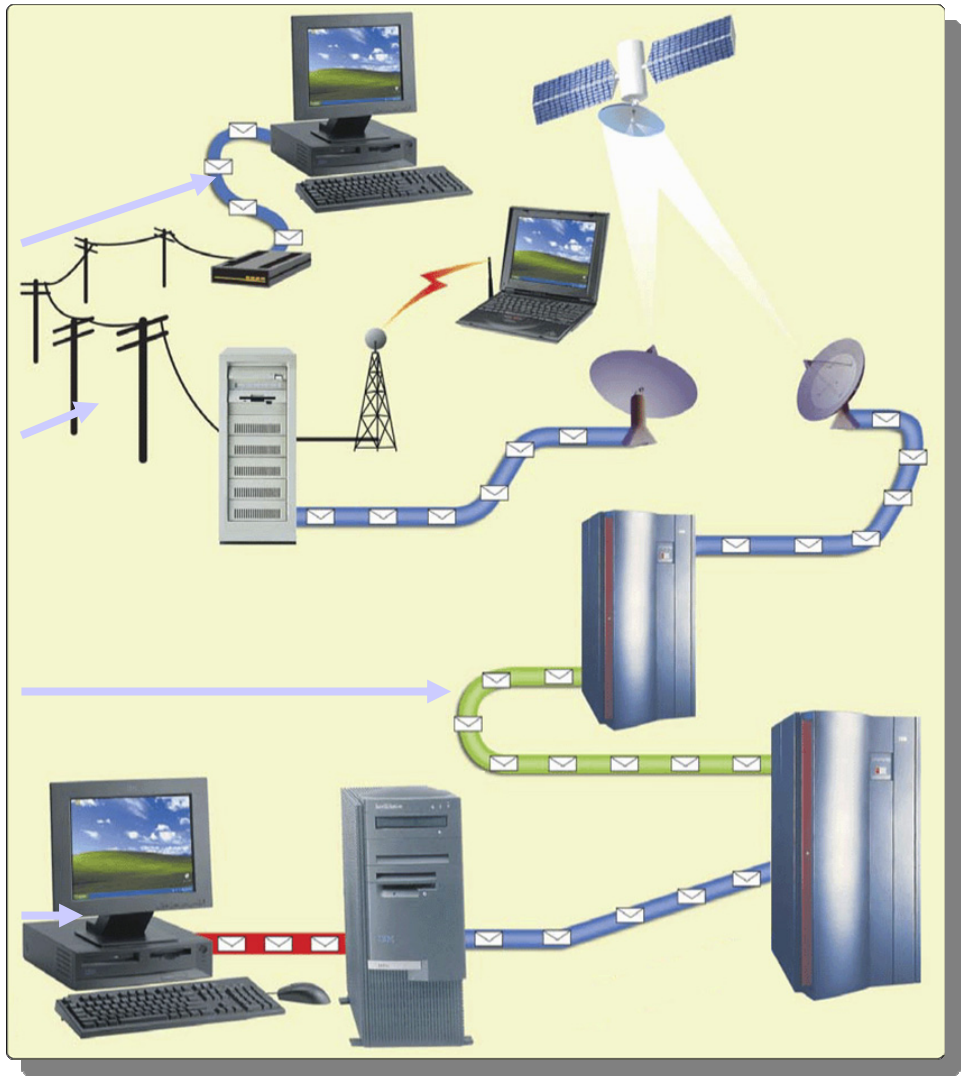
How is a request sent over the Internet using a communications channel?

Step 1. The sending device requests information using either a physical transmission media or a wireless transmission media.

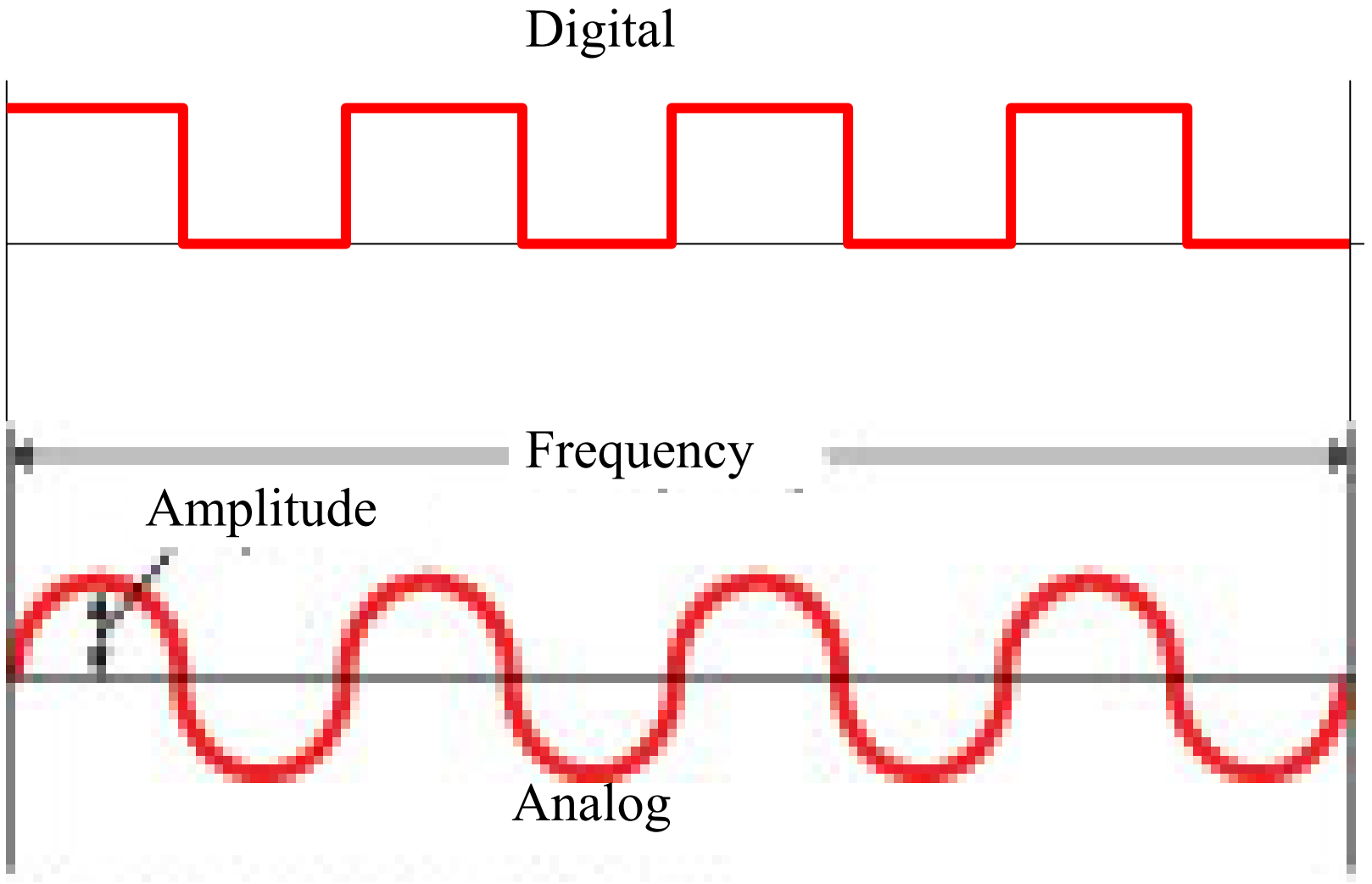
Step 2. When the request leaves the ISP, it travels over T1 lines, microwave stations, earth-based stations, and communications satellites until it reaches the Internet backbone.

Step 3. The request travels over T3 lines along the Internet backbone.

Step 4. The Request travels over T1 lines until it reaches the destination network server.



Believe it or not!



Pulses or Waves

- Going through the cables
- Carrying the 0/1 information

- Called **carrier pulses** **or** **carrier waves**

Going Through the Cables

- Electrical signal
- Optical signal

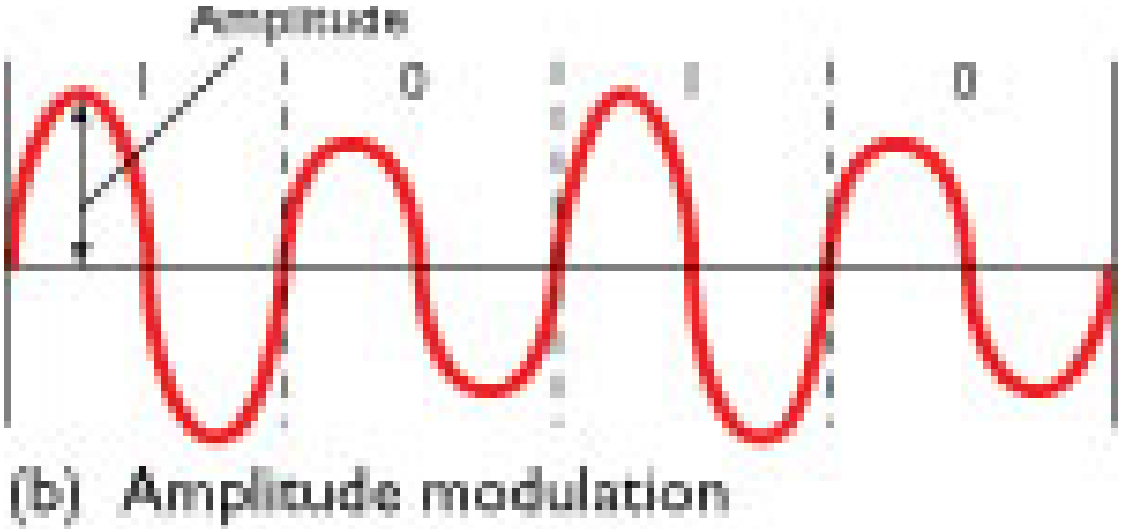
- EE's
  - Electronics engineering
  - Electro-optical engineering

Carrying 0 and 1

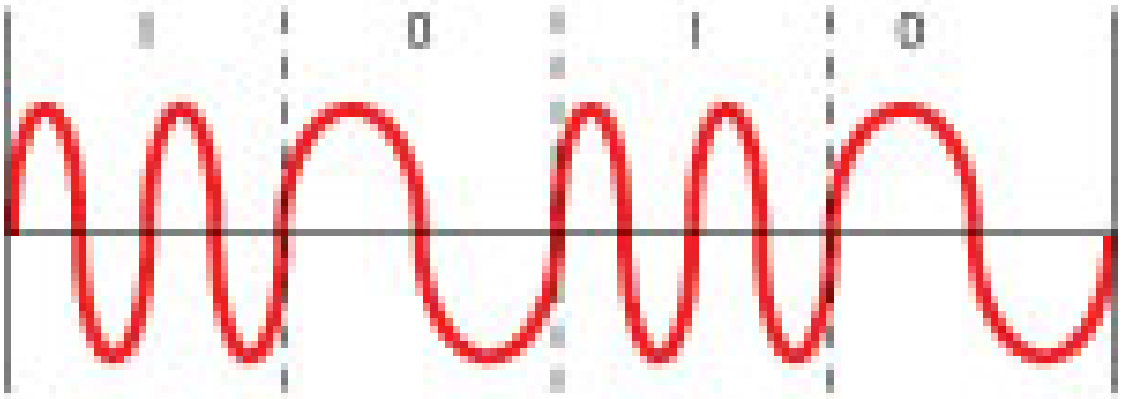
- Embody information in the waves
- The more, the merrier

- EE's
  - Communication engineering

For Example



(b) Amplitude modulation



(c) Frequency modulation

Transmission Media

- Physical
  - Twisted pair
  - Coaxial
  - Fiber optic
- Wireless

Physical Transmission Media

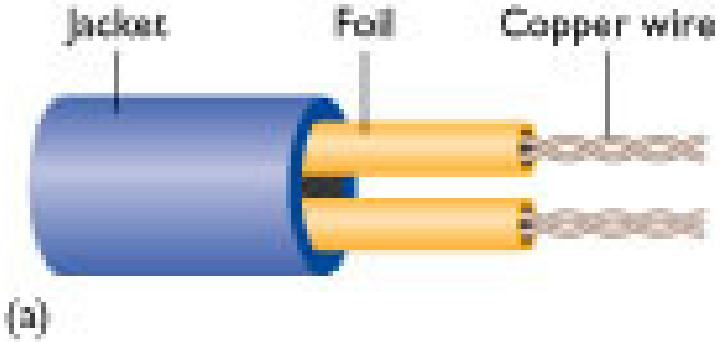
- **Wire, cable, and other tangible materials used to send communications signals**

Transfer Rates for Various Types of LANs Using Physical Transmission Media

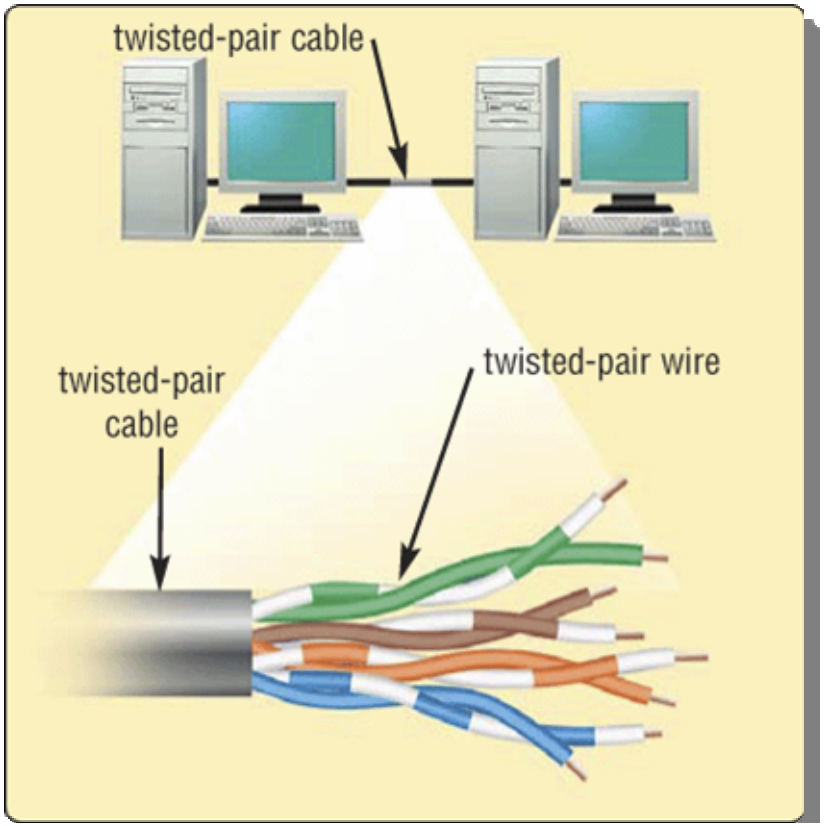
Type of Cable and LAN	Maximum Transfer Rate
Twisted-Pair Cable	
• 10Base-T (Ethernet)	10 Mbps
• 100Base-T (Fast Ethernet)	100 Mbps
• 1000Base-T (Gigabit Ethernet)	1 Gbps
• Token ring	4 Mbps to 16 Mbps
Coaxial Cable	
• 10Base2 (ThinWire Ethernet)	10 Mbps
• 10Base5 (ThickWire Ethernet)	10 Mbps
Fiber-Optic Cable	
• 10Base-F (Ethernet)	10 Mbps
• 100Base-FX (Fast Ethernet)	100 Mbps
• FDDI (Fiber Distributed Data Interface) token ring	100 Mbps
• Gigabit Ethernet	1 Gbps
• 10-Gigabit Ethernet	10 Gbps

Twisted Pair

- Used for telephone systems and network cabling



- Electrical signals
- Copper
- Noise



- Voice analog
- Cheap

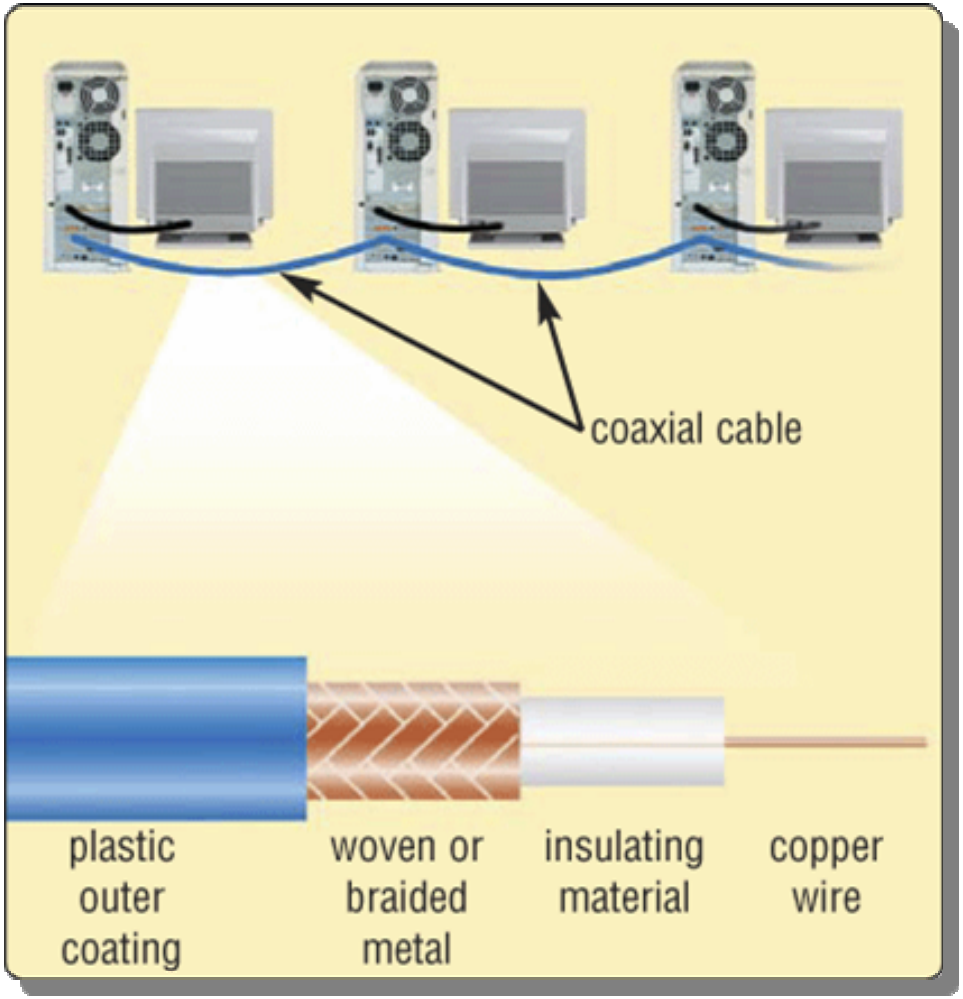
Note: Phone and network cables are different!

Coaxial Cable

- Often used for cable TV and Ethernet cable in bus topology

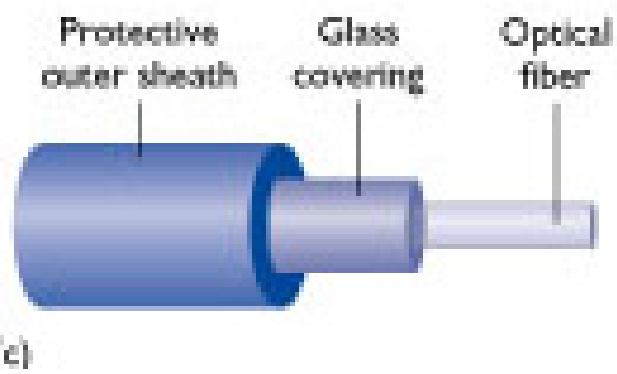
- Electrical signals
- Copper
- Little noise

- Data digital/analog
- Inexpensive



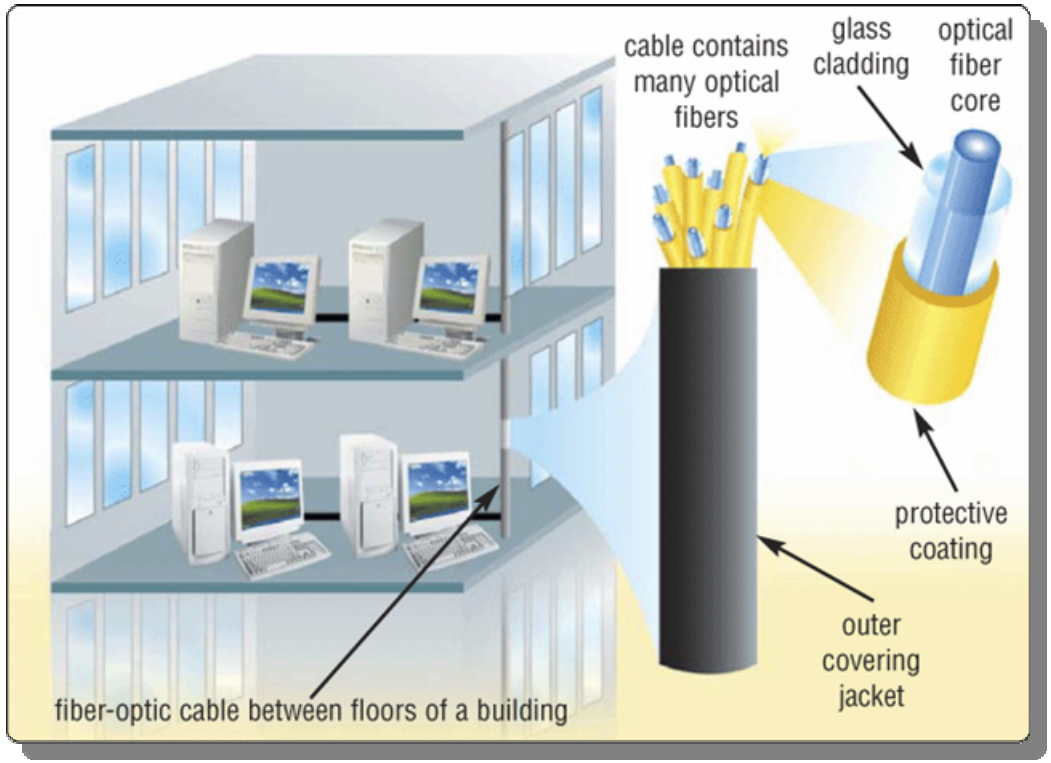
Fiber-Optic Cable

- Used in backbone cable, Fiber to the Home/Building (FTTH / FTTB)



- Light signals
- Fibers (glass)
- Less susceptible to interference (noise) and, therefore, more secure
- Ultra-high bandwidth

- Data digital
- Expensive



Backbone: major transmission Channels, on the ground and in the sea (http://map.twnic.net.tw/ and see map)

Wireless Transmission Media

- **Used when inconvenient, impractical, or impossible to install cables**
- **Includes Bluetooth and IrDA**

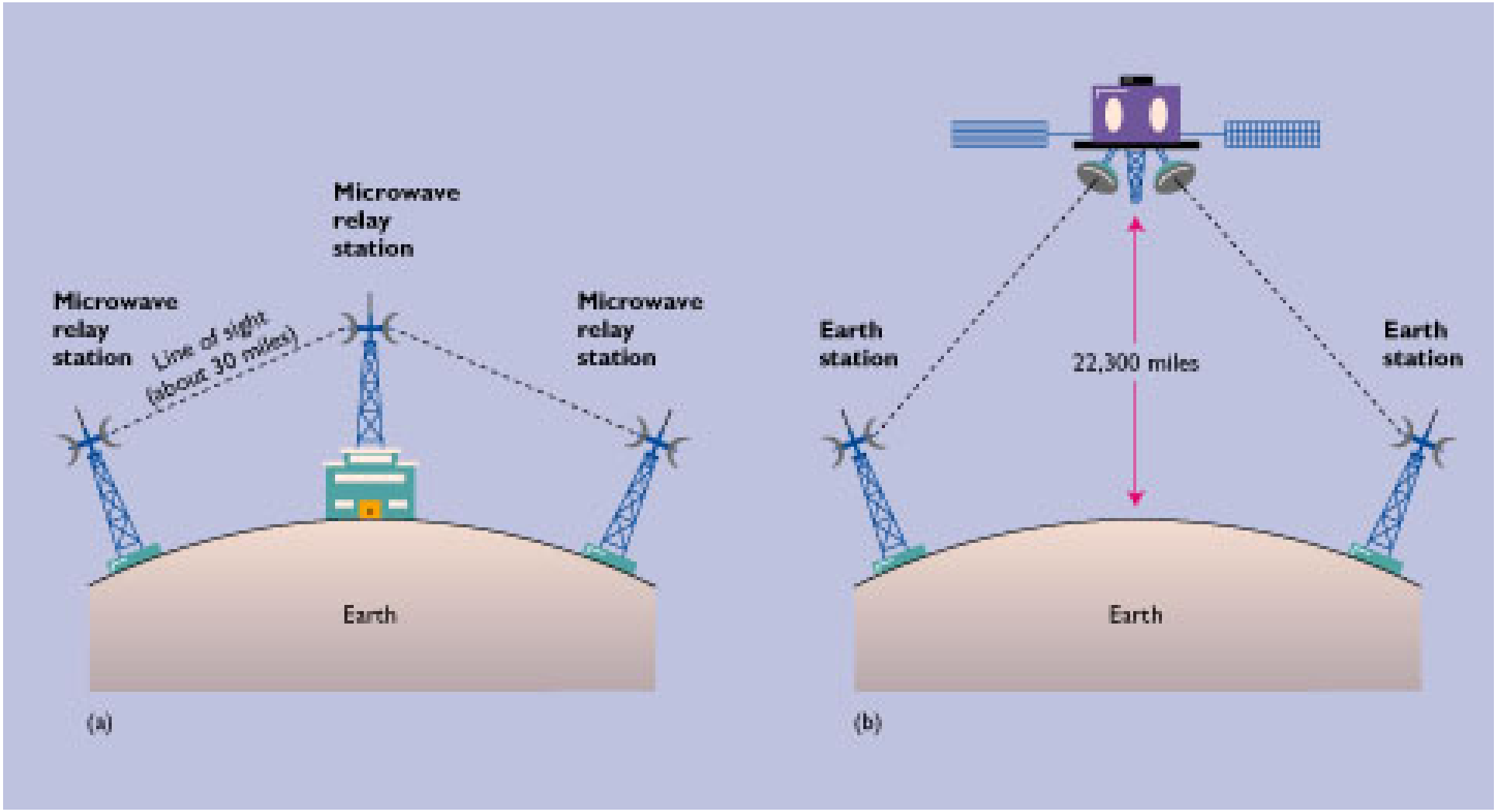
Transmission Media	Maximum Transfer Rate
Infrared	115 Kbps to 4 Mbps
Broadcast radio	
• Bluetooth	1 to 2 Mbps
• HomeRF	1.6 Mbps to 10 Mbps
• 802.11b	11 Mbps
• 802.11a	54 Mbps
Cellular radio	
• 2G	9.6 Kbps to 19.2 Kbps
• 3G	144 Kbps to 2 Mbps
Microwave radio	150 Mbps
Communications satellite	1 Gbps

Microwave

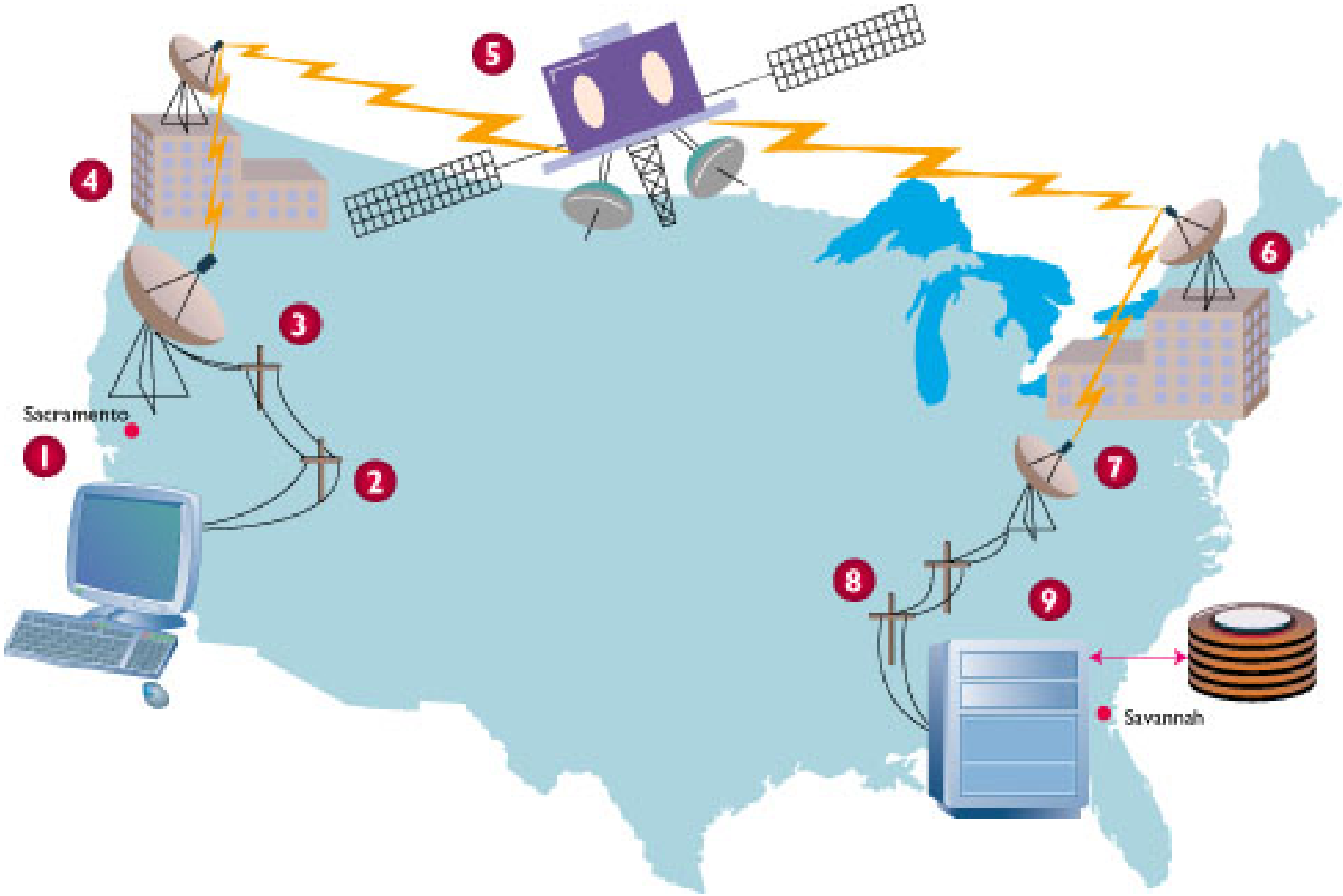
- Microwaves
- Line of sight
- Lots of noise

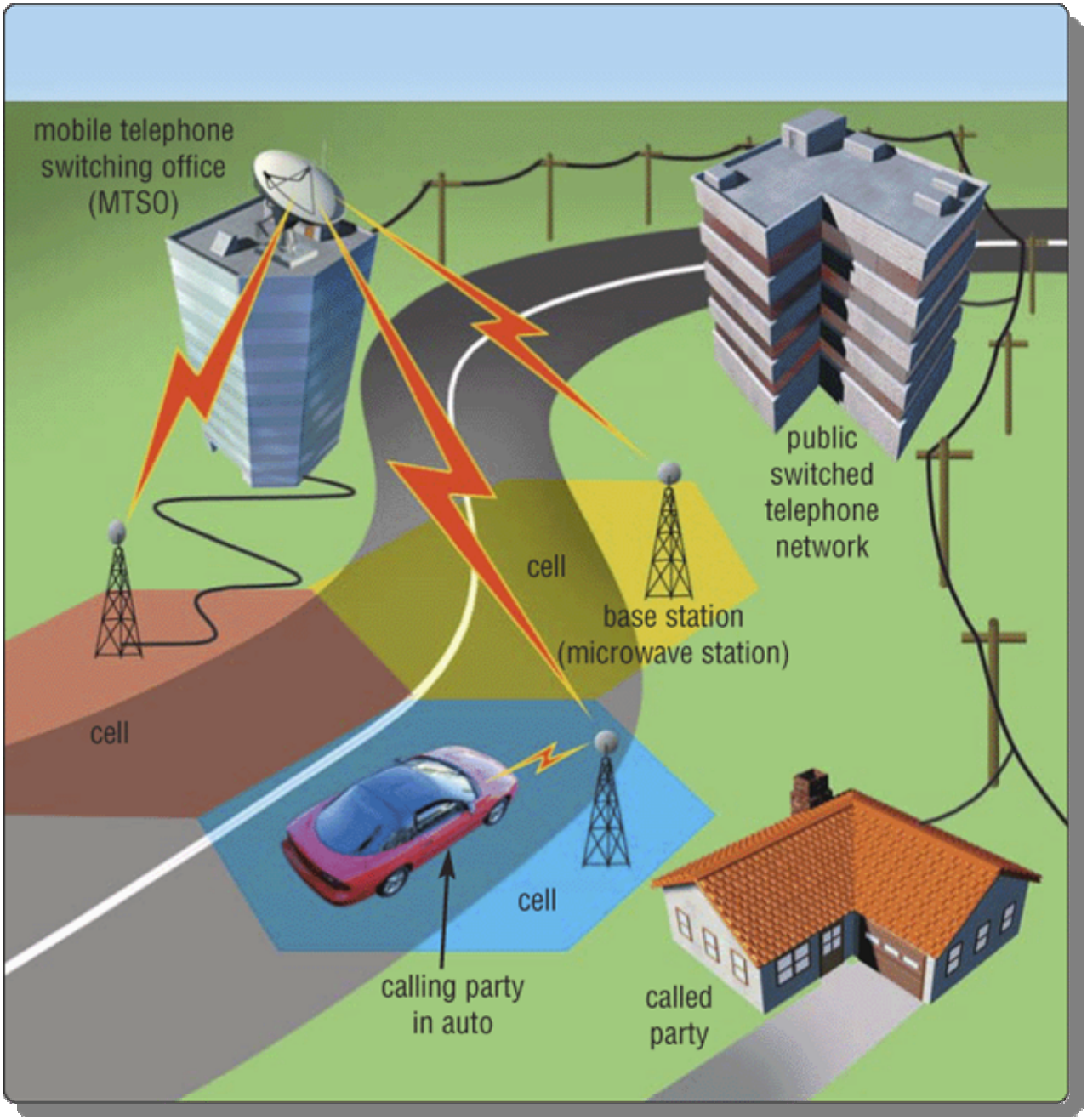
- Data digital/analogy
- Expensive
- Example
  - Cellular phone, Satellite

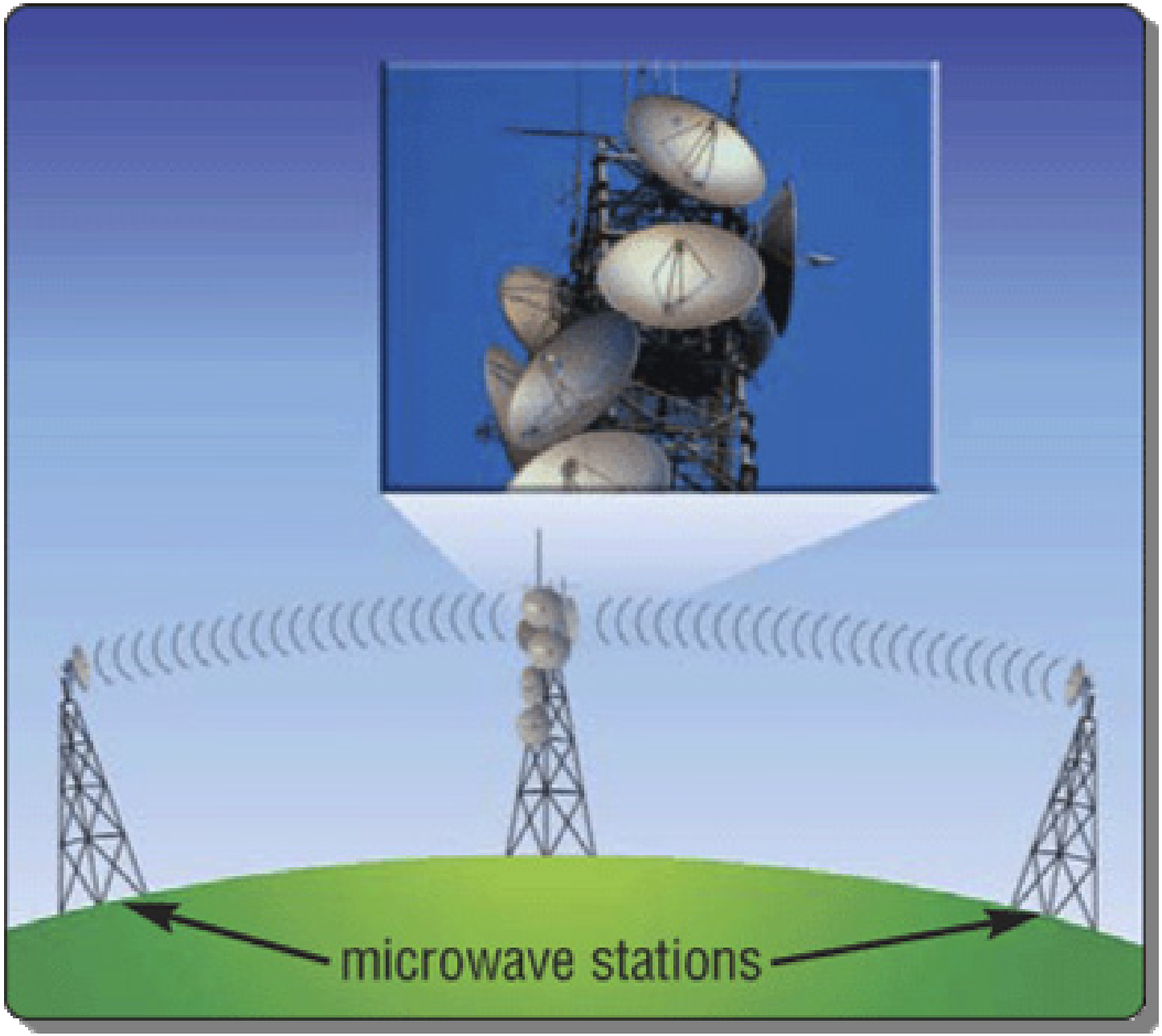
Satellite

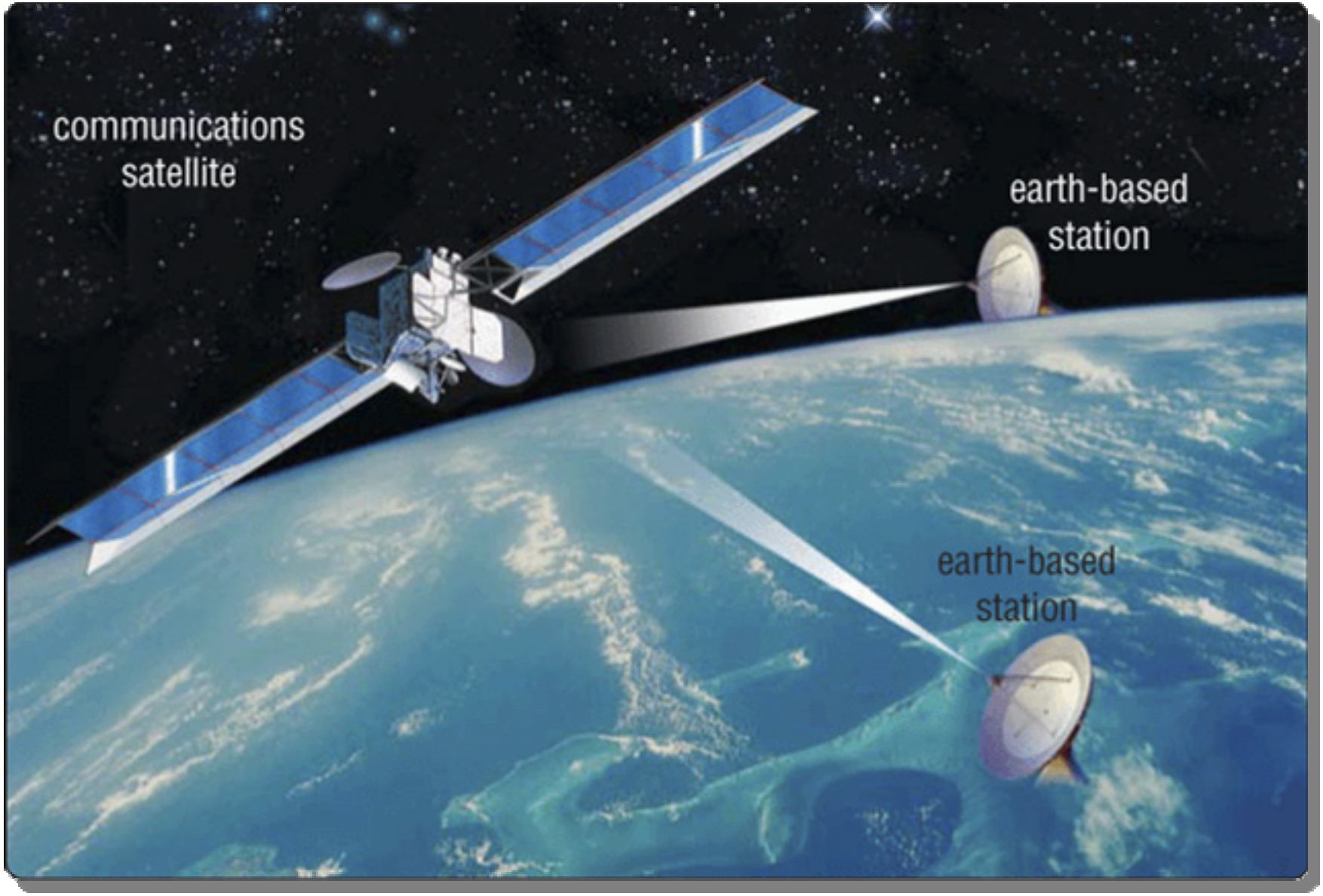

Microwave relay station
Microwave relay station
Microwave relay station
Line of sight (about 30 miles)
Earth
(a)
Earth station
22,300 miles
Earth station
Earth
(b)

Traversing the Media




mobile telephone
switching office
(MTSO)
public
switched
telephone
network
cell
base station
(microwave station)
cell
cell
calling party
in auto
called
party


microwave stations


communications satellite
earth-based station
earth-based station

Bandwidth

- Capacity
  - Max amount of data to be transmitted over a given time interval
- Depends on
  - Media type (microwave, twisted pair, coaxial, optical)
  - Coding of 0/1 information

PC to Medium Interface

- Twisted pair
  - Modem, ISDN, DSL
- Coaxial
  - Cable modem
- Optical (potential application)
  - Fiber to the Home (FTTH), Fiber to the Building (FTTB)
- Microwave
  - Wireless LAN, Cellular modem

What is a dial-up line?

- Temporary connection using telephone line for communications
  - Costs no more than making regular call
  - Computers at any two locations can establish a connection using modems and telephone network

What is a dedicated line?

- Always-on connection between two communications devices
  - Four types are ISDN line, DSL, T-carrier line, and ATM

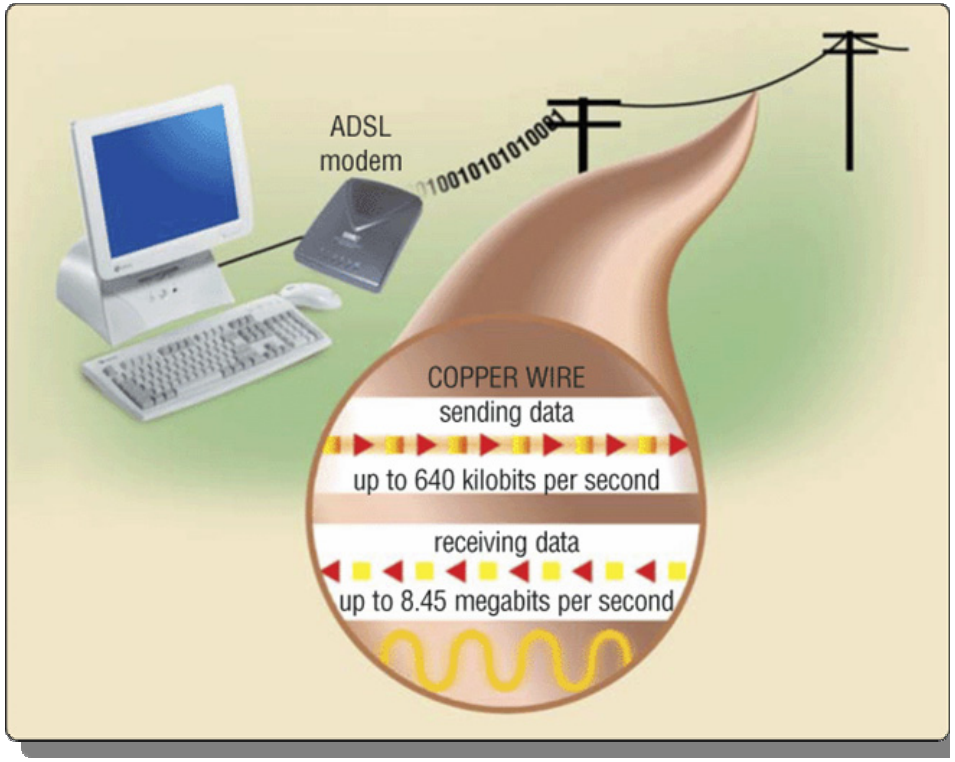
Type of Line	Approximate Monthly Cost	Transfer Rates
Dial-up	Local or long-distance rates	Up to 56 Kbps
ISDN	$10 to $40	Up to 128 Kbps
DSL	$40 to $80	128 Kbps to 8.45 Mbps
Cable TV (CATV)	$30 to $50	128 Kbps to 10 Mbps
Fractional T1	$150 to $350	128 Kbps to 768 Kbps
T1	$1,000 or more	1.544 Mbps
T3	$10,000 or more	44.736 Mbps
ATM	$8,000 or more	155 Mbps to 622 Mbps, can reach 10 Gbps

Dialup (Modem)

- For transmission over the telephone network
- Convert digital data to analog signal
- Sender side
  - Digital to analog
  - **Mo**dulation
- Receiver side
  - Analog to digital
  - **Dem**odulation
- 56Kbps (28K bps ..)

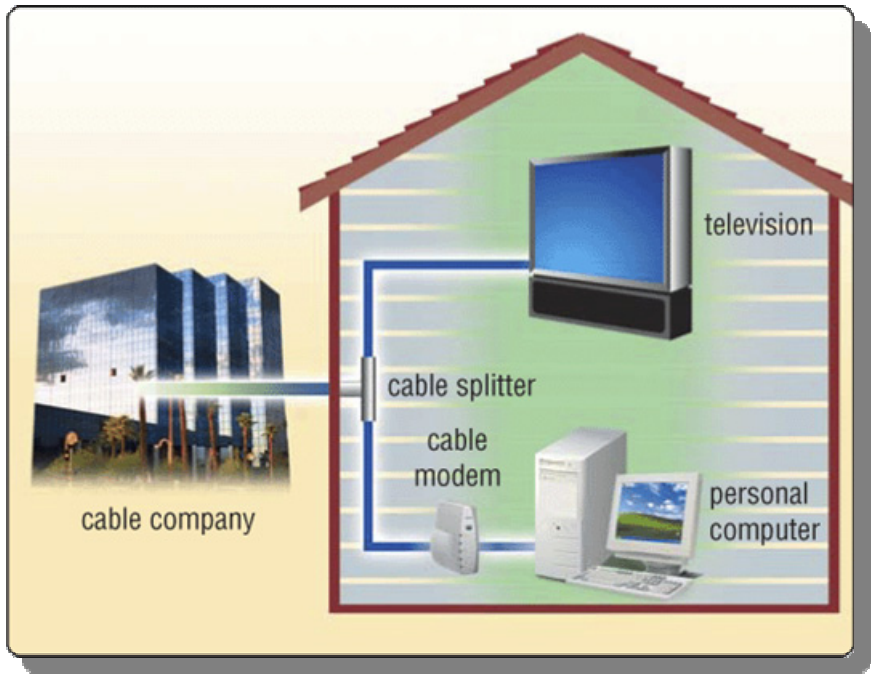
DSL

- **D**igital **S**ubscriber **L**ine
- For transmission over the telephone network
- Digital-analog conversion
- Sending data over multiple frequencies
- Several times faster than 56Kbps
  - provider dependant
- No one standard
  - ADSL, SDSL, etc



Cable Modem

- For transmission over cable TV network
- Digital-analog conversion
- Always on
- 10Mbps
- Users sharing cables also share bandwidth



ISDN

- **I**ntegrated **S**ervices **D**igital **N**etwork
- For transmission over the telephone network
- No conversion
- 128Kbps

Cellular Modem

- For transmission over wireless cellular network
- Analog-digital conversion
- Slower than modem

Access Network

- Ways for users to connect to the Internet
- Depending on
  - Where you are
  - What bandwidth required
  - How much they cost
- Select from below
  - Modem, ISDN, DSL
  - Cable modem
  - Cellular modem

Questions?

Network Structure

- LAN
- WAN

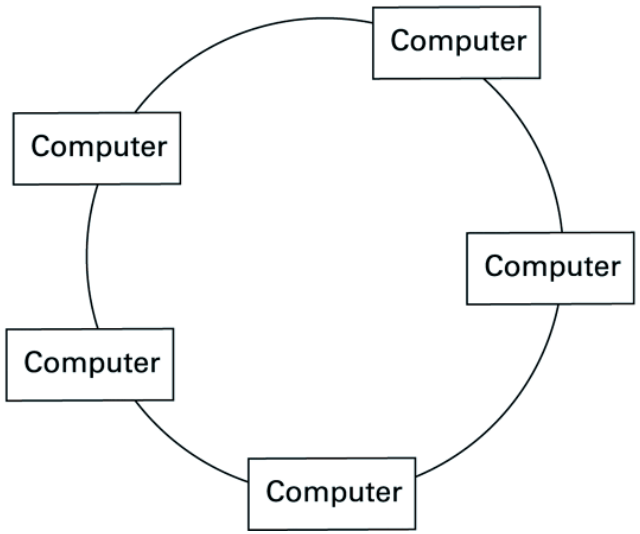
LAN

- **L**ocal **A**rea **N**etwork
- A small number of connected computers within close proximity
- Usu. < 2 KM

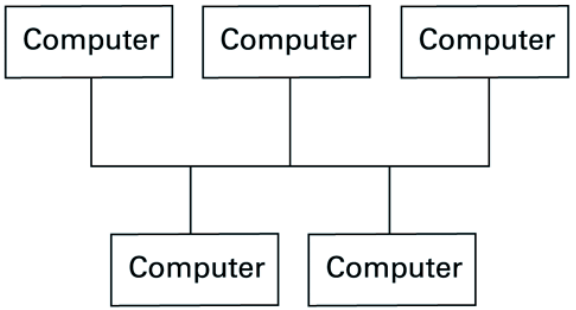
Constructing a LAN

- Ring
- Bus
- Star
- Irregular

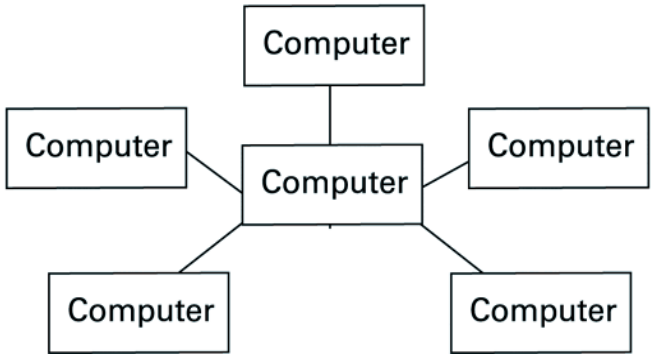
a. Ring



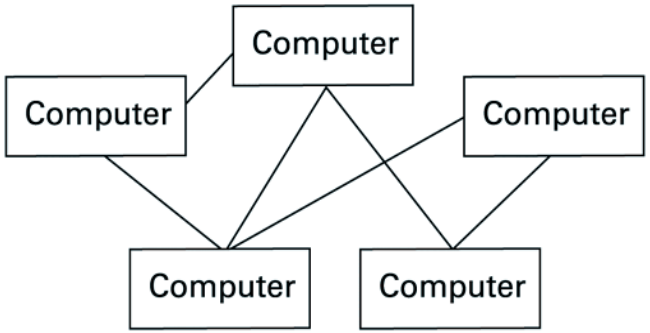
b. Bus



c. Star

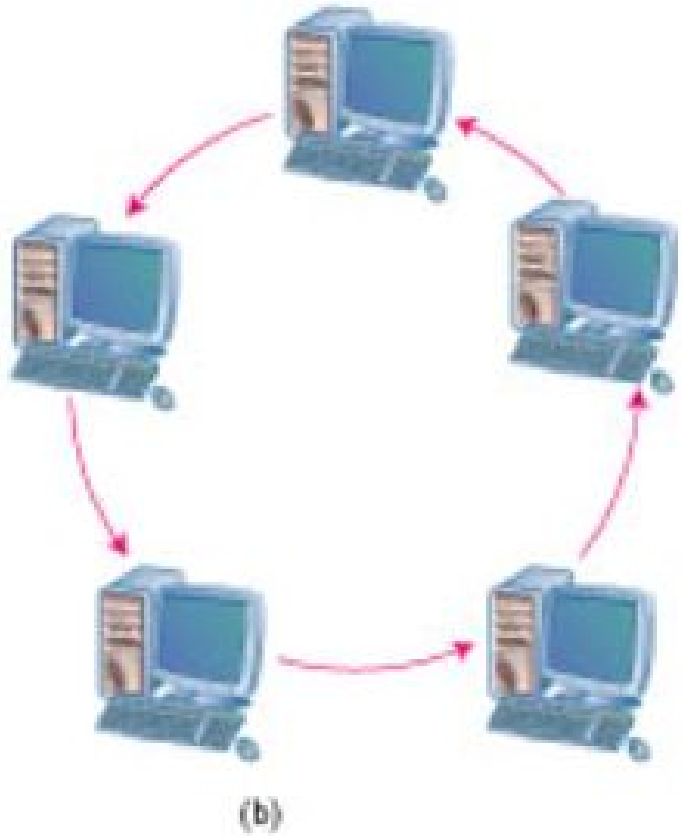


d. Irregular



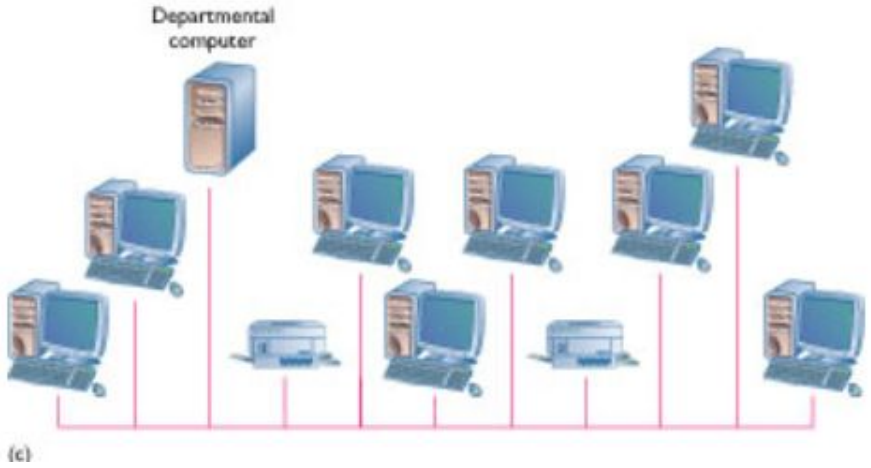
Ring

- Each computer keeps passing transmitted data in order (using Token)
- No signal collision, more efficient
- Any computer down, network down (can be solved double rings)



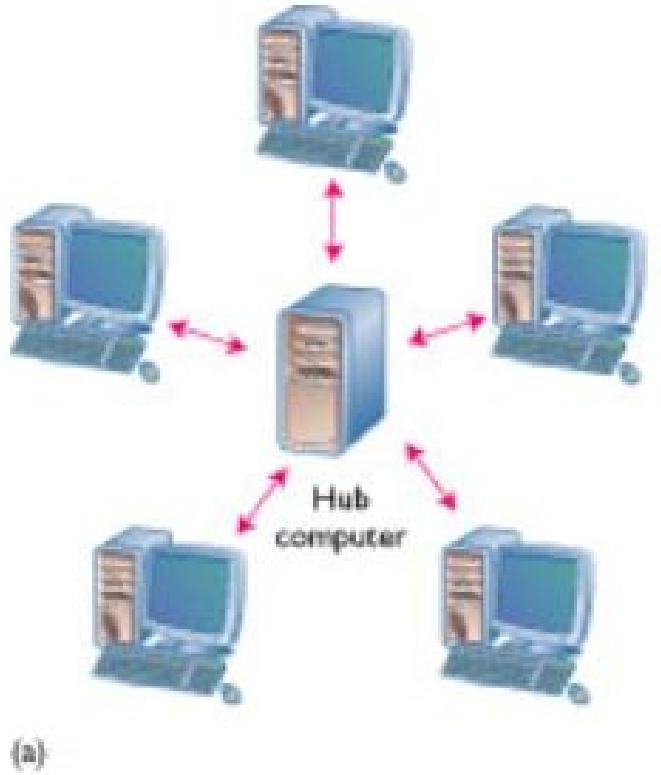
Bus

- Shared medium
- Just throw the data on the network
- Lower cost
- Bus down, network down
- Collision
- Dumb star network



Star

- Central point routes all data transmissions
- Central point down, network down
- Cost higher than bus



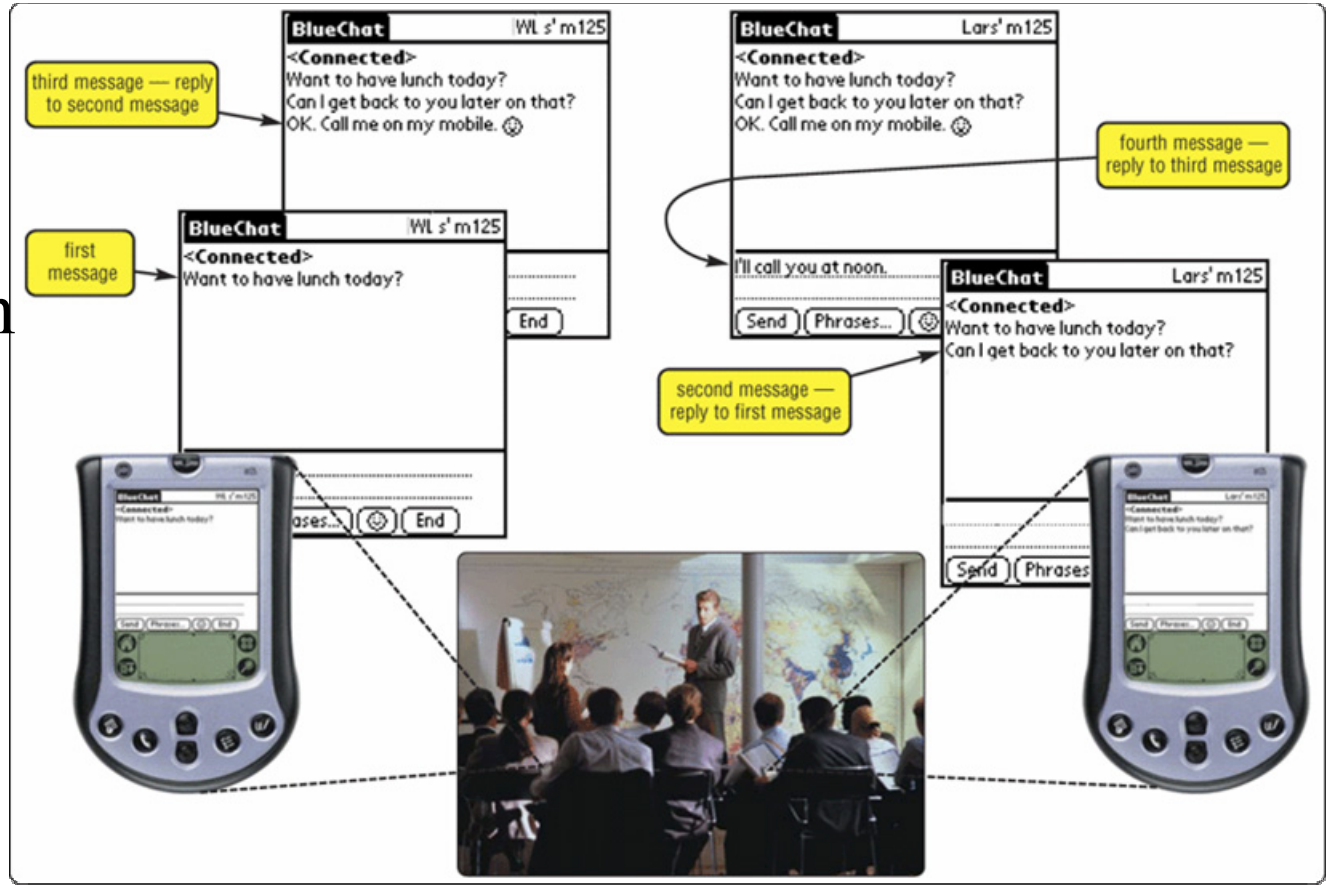
Networks

- **TCP/IP (Transmission Control Protocol/Internet Protocol) technology transmits data by breaking it up into small pieces, or packets**
  - **Commonly used for Internet transmissions**
- **802.11 is family of standards for wireless LANs**

Standard	Transfer Rates
802.11	1 or 2 Mbps
802.11a	Up to 54 Mbps
802.11b (Wi-Fi)	Up to 11 Mbps
802.11g	20 Mbps and higher

Bluetooth

– Short-range radio waves transmit data between Bluetooth devices



Intranet

Internal network that uses Internet technologies

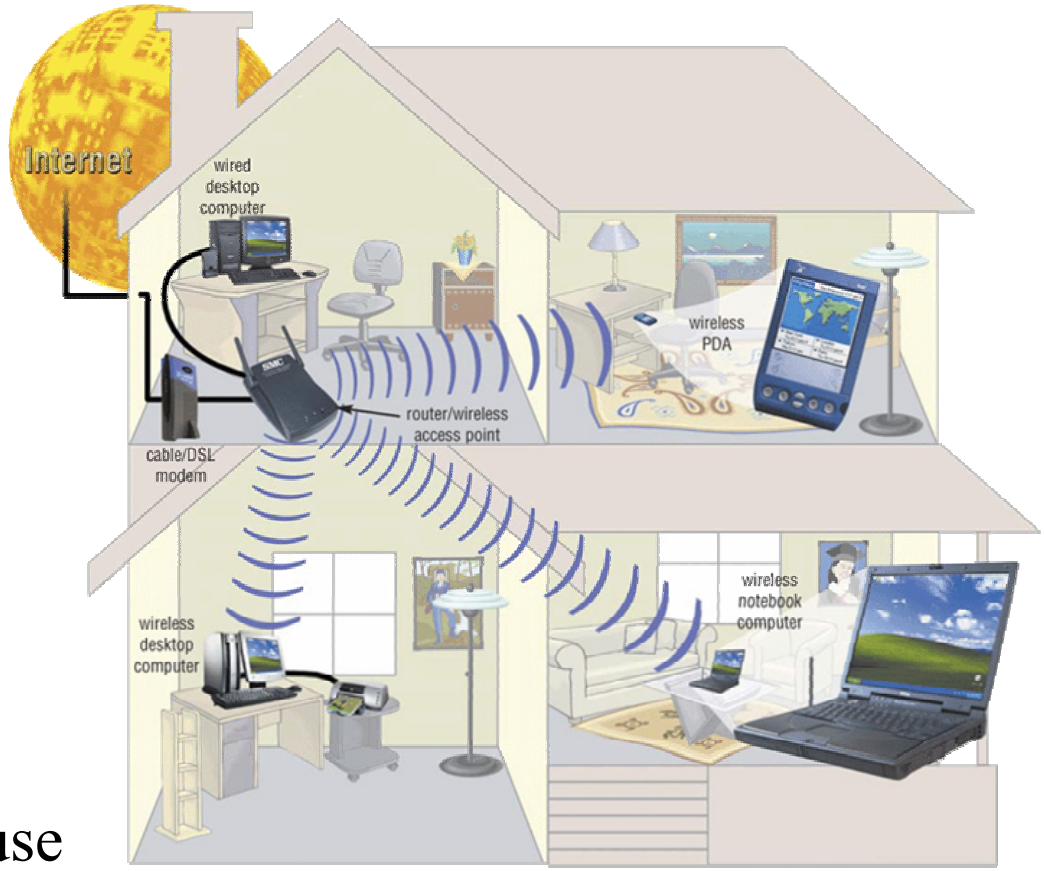
Makes information accessible to employees

Typically includes connection to Internet

Extranet allows customers or suppliers to access part of company's intranet

Home Networks

- Multiple computers connected in home
- Several types of home networks
  - **Ethernet** — connect computers via cable
  - **Powerline cable** — use electrical lines in house
  - **Phoneline** — use telephone lines
  - **HomeRF (radio frequency)** — wireless

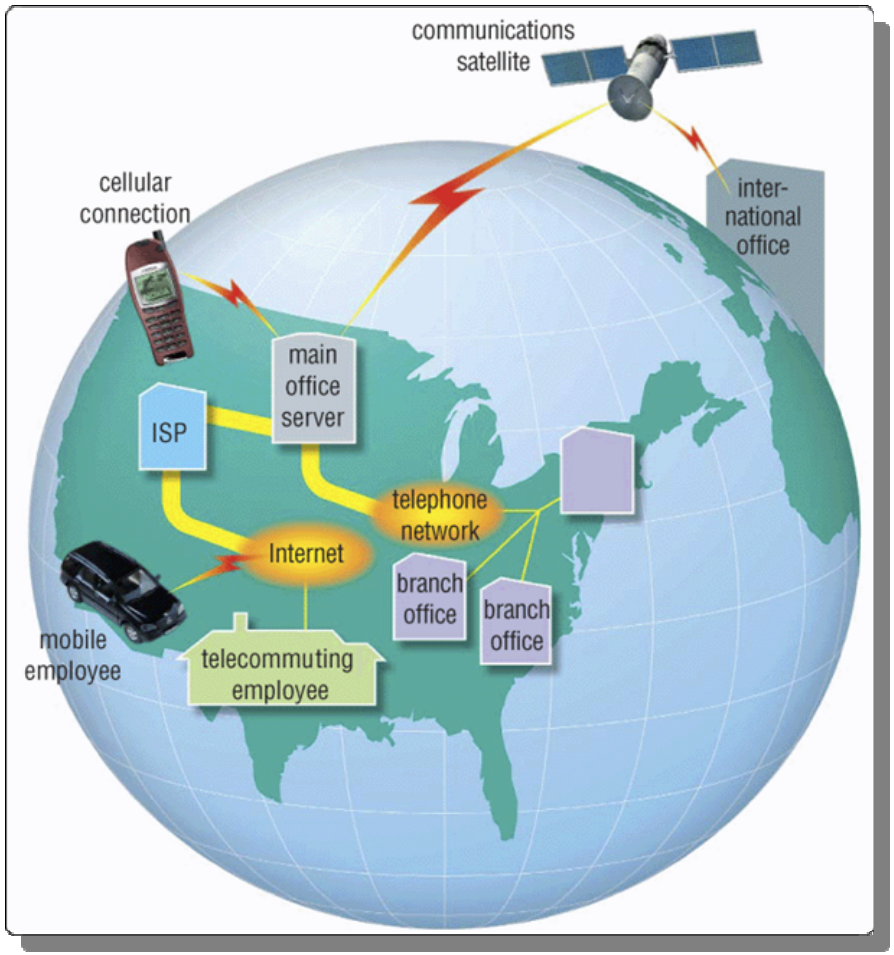


Metropolitan area network (MAN)

- connects LANs in city or town
- 2~ 10 KM

Wide area network (WAN)

- Network that covers large geographic area using many types of media
- Usu. > 10 KM



Internet – Structural View