COIS 1010H

Chapters 7 and 8

Networks and the Internet

What Is a Network?

- **Network**: A connected system of objects or people
- **Computer network**: A collection of computers and other hardware devices connected together so users can share hardware, software, and data, and electronically communicate
- Computer networks converging with telephone and other communications networks

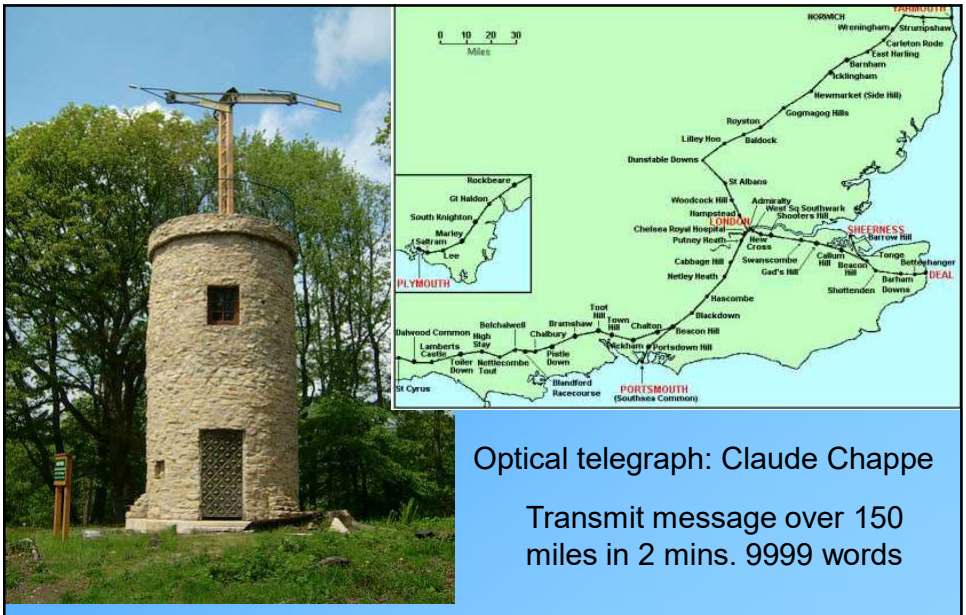
FIGURE 7-1
Common uses for computer networks.

USES FOR COMPUTER NETWORKS
Sharing an Internet connection among several users.
Sharing application software, printers, and other resources.
Facilitating Voice over IP (VoIP), e-mail, video-conferencing, IM, and other communications applications.
Working collaboratively, such as sharing a company database or using collaboration tools to create or review documents.
Exchanging files among network users and over the Internet.
Connecting the computers and the entertainment devices (such as TVs, gaming consoles, and stereo systems) located within a home.

2

Evolution of Networks

1960's	How can we transmit bits across a communication medium efficiently and reliably?	terminals to mainframes
1970's	How can we transmit packets across a communication medium efficiently and reliably?	Arpanet Bulletin Boards
1980's	How can we provide communication services across a series of interconnected networks?	email, telnet, file services
1990's	How can we provide multimedia services across a series of globally interconnected networks?	www, IP telephony, Java
2000's	How can we provide seamless access to voice, video and text-based information, distributed resources?	e-commerce
Today…	IoT – Smart Homes, embedded medial sensors. Telemedecine.	



Optical telegraph: Claude Chappe

Transmit message over 150 miles in 2 mins. 9999 words

http://www.telemuseum.org/semaphore.html

Example Networking Applications

- The Internet
- Telephone service
  - POTS network (Landlines, Party Lines)
  - Mobile phones (wireless phones)
    - Cellular (cell) phones - must be within range of cell tower to function
    - Satellite phones - used where cell service isn't available
    - Dual-mode phones - allow users to make telephone calls on more than one network
      - Cellular / Wi-Fi dual-mode phones are most popular (Vonage)

5

Example Networking Applications

"One-Way" Networks:

- Television and Radio Broadcasting
- Global Positioning Systems
- Monitoring Systems (Tsunami Warning)

Network Characteristics

- Wired vs. wireless networks
  - **Wired**: A network in which computers and other devices are connected to the network via physical cables
    - Found in homes, schools, businesses, and government facilities
  - **Wireless:** A network in which computers and other devices are connected to the network without physical cables; data is typically sent via radio waves
    - Found in homes, schools, and businesses
    - Wi-Fi hotspots found in coffeehouses, businesses, airports, hotels, and libraries

7

Network Topologies

- Topology: How the devices in the network (called nodes) are arranged
  - **Star** networks: A network that uses a host device connected directly to several other devices
  - **Bus** networks: A network consisting of a central cable to which all network devices are attached
  - **Mesh networks:** A network in which there are multiple connections between the devices on the network so that messages can take any one of several paths
  - Some networks use a combination of topologies

8

Network Architectures

- **Architecture**: The way networks are designed to communicate
- **Client-server** networks
  - **Client**: Computer or other device on the network that requests and utilizes network resources
  - **Server**: Computer dedicated to processing client requests

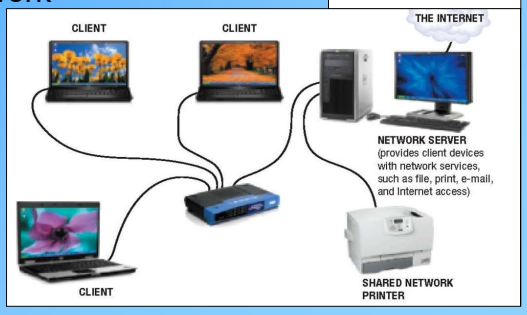


FIGURE 7-10
Client-server networks. With this type of network, client computers communicate through one or more servers.

9

Network Size and Coverage Area

Personal Area Network (PAN): Connects an individual's personal devices that are located close together.

Local Area Network (LAN): Connects devices located in a small geographic area

Metropolitan Area Network (MAN): Serves a metropolitan area

Wide Area Network (WAN)
- Large geographic area

Hybrid:

Virtual Private Networks (VPN)

FIGURE 7-12
WPANs. Wireless PANs connect and synchronize an individual's devices wirelessly.

FIGURE 7-13
Municipal Wi-Fi. This MAN covers downtown Riverside, California.

10

Data Transmission Characteristics

Bandwidth: The amount of data that can be transferred in a given period of time

- Measured in bits per second (bps)

Analog vs. digital signals (waves vs. discrete)

Serial vs. parallel transmission

- Serial = 1 bit
- Parallel = at least 1 byte at a time

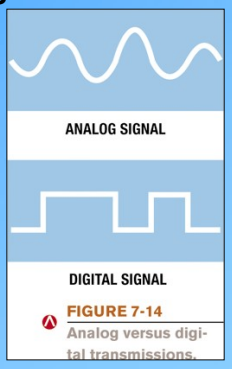


FIGURE 7-14
Analog versus digital transmissions.

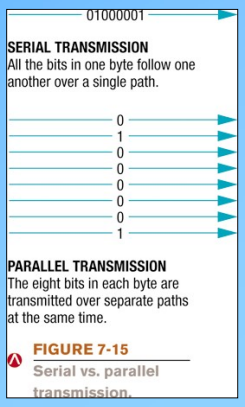


FIGURE 7-15
Serial vs. parallel transmission.

11

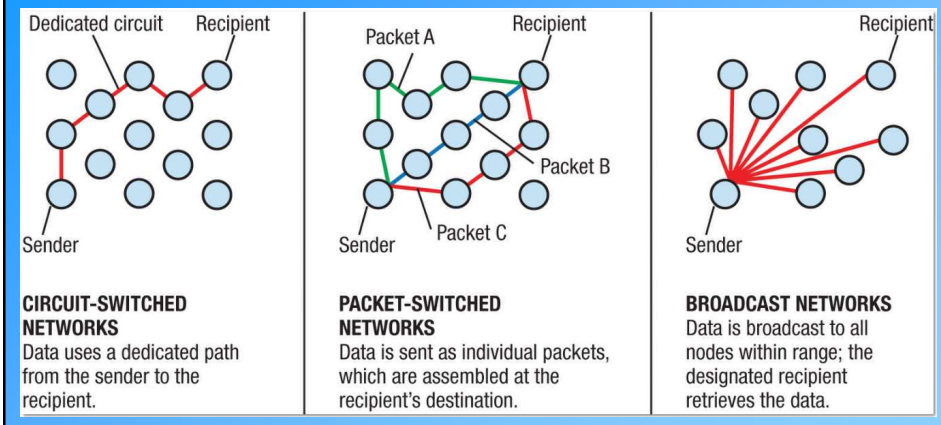
Data Transmission Characteristics

Transmission directions:

- **Simplex** transmission
  - Data travels in a single direction only
- **Half-duplex** transmission
  - Data travels in either direction but only one way at a time
- **Full-duplex** transmission
  - Data travels in both directions, both ways at the same time

12

Delivery Methods for network data



Old phone systems | **The internet** | **GPS WiFi/Wireless**

Networking Media

Wired connections: The computer is physically cabled to the network

- **Twisted-pair** cable
  - Pairs of wires twisted together
  - Used for telephone and network connections
- **Coaxial** cable
  - Thick center wire
  - Used for computer networks, short-run telephone transmissions, cable television delivery
- **Fiber-optic** cable
  - Glass or fiber strands through which light can pass
  - Used for high-speed communications
  - Multi-Mode (Colour)

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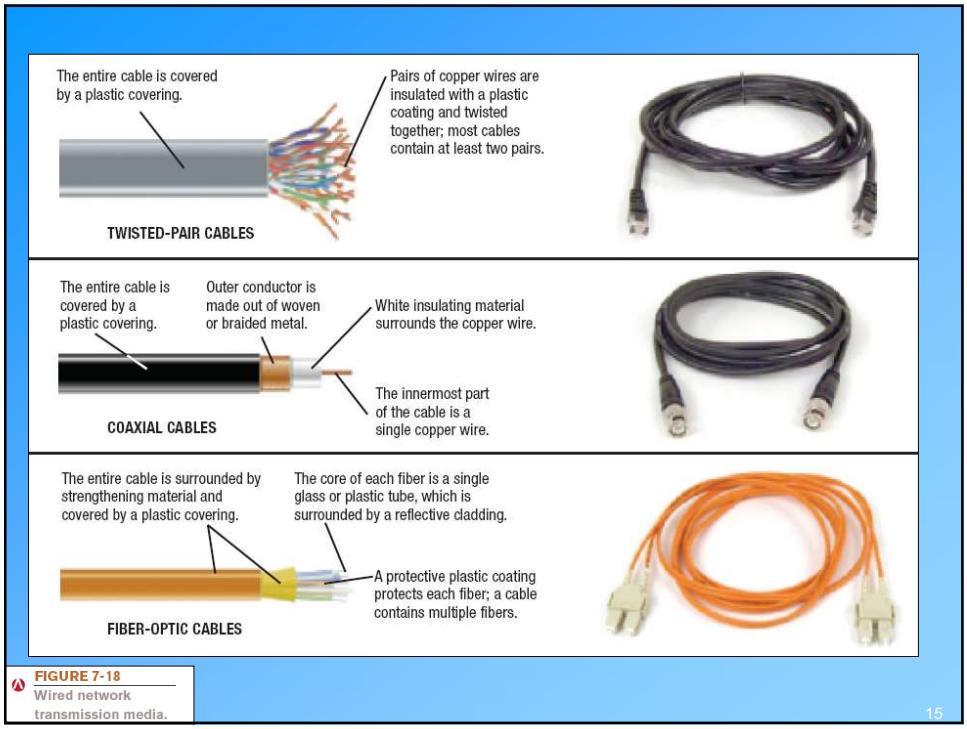

FIGURE 7-18
Wired network transmission media.

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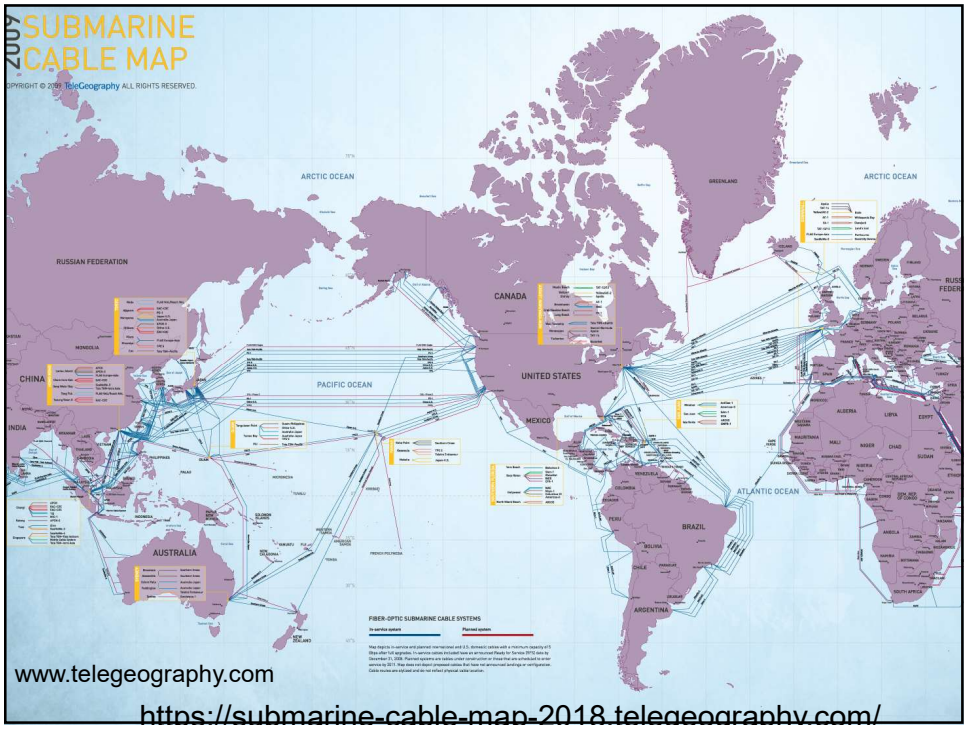
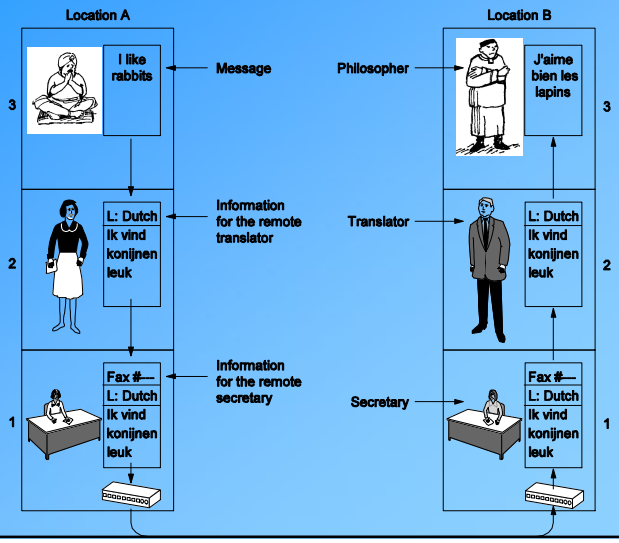


www.telegeography.com

https://submarine-cable-map-2018.telegeography.com/

How to make everything work together? Protocol Hierarchies



TCP/IP

TCP/IP: The most widely used communications protocol

- Used with the Internet
- TCP responsible for delivery of data
- IP provides addresses and routing information
- Uses packet switching

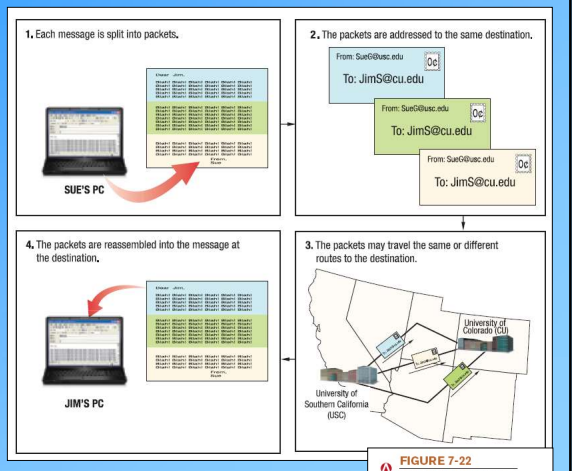
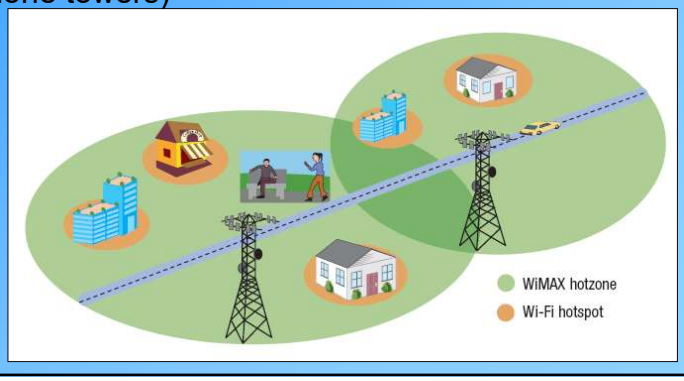


FIGURE 7-22
How TCP/IP works.
TCP/IP networks (like the Internet) use packet switching.

WiMAX and Mobile WiMAX

WiMAX (802.16): Fairly new wireless standard for longer range wireless networking connections

- Designed to deliver broadband to homes, businesses, other fixed locations
- Hotzones close to 2 miles (similar in concept to cell phone towers)



19

Short-Range Wireless Standards

- **Bluetooth**: Very short range (less than 10 feet)
  - For communication between computers or mobile devices and peripheral devices
  - Bluetooth devices are automatically networked with each other when they are in range (piconets)

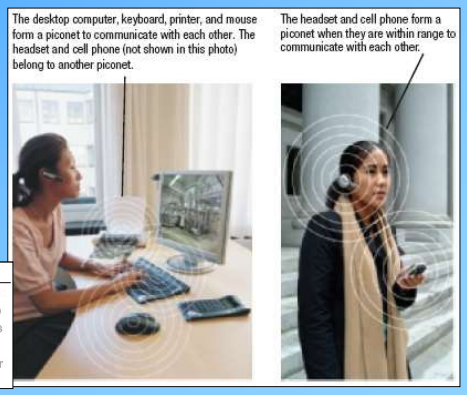


FIGURE 7-30
Bluetooth. Bluetooth is designed for short-range wireless communications between computers or mobile devices and other hardware.

20

Range of Wireless Standards

CATEGORY	WIRELESS STANDARD	APPLICATION	APPROXIMATE RANGE
Short range	Bluetooth WiGig	To connect peripheral devices to a computer or mobile device or to connect devices together.	33 feet
	WiGig WirelessHD (WiHD)	To connect and transfer multimedia content between home consumer electronic devices (computers, TVs, DVD players, printers, etc.).	33 feet
	ZigBee Z-Wave Low Power Wi-Fi (802.11ah)	To connect a variety of home, personal, and automation devices.	33 feet–164 feet
Medium range	Wi-Fi (802.11)	To connect computers and other devices to a local area network.	100–300 feet indoors; 300–900 feet outdoors
	Wi-Fi Direct	To connect computers and other devices directly together.	600 feet
Long range	WiMAX Mobile WiMAX	To provide Internet access to a large geographic area for fixed and/or mobile users.	6 miles non-line of sight; 30 miles line of sight
	Cellular standards (3G, 4G, 5G)	To connect mobile phones and other devices to a cellular network for telephone and Internet service.	10 miles

Networking Hardware for Connecting Devices and Networks

- **Hub:** Central device that connects all of the devices on the network
- **Switch:** Connects devices in a network like a hub but only sends data to the device for which the data is intended
- **Bridge:** Used to connect two LANs together
- **Router:** Responsible for moving packets around in Internet

22

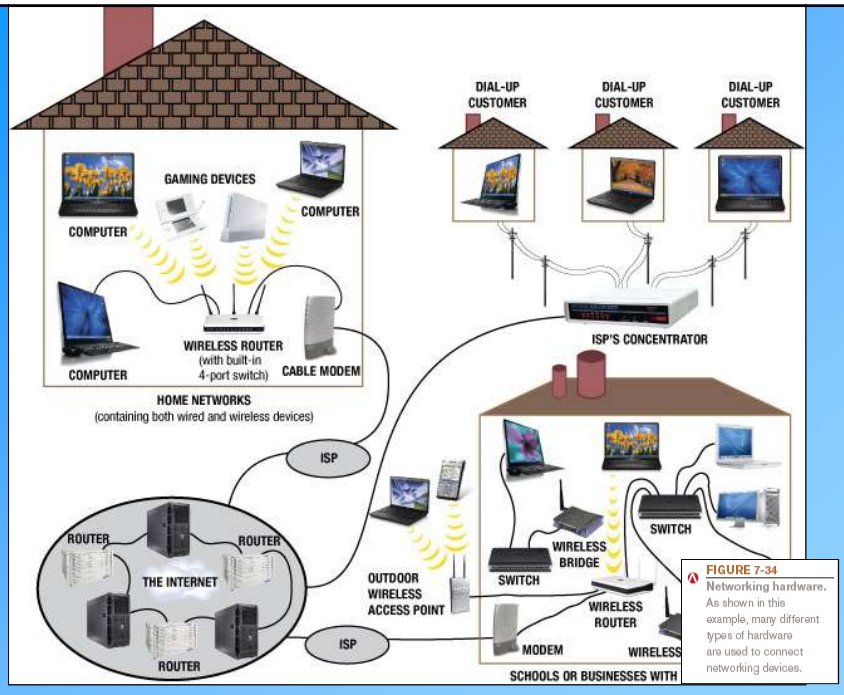


FIGURE 7-34
Networking hardware.
As shown in this example, many different types of hardware are used to connect networking devices.

23

Chapter 8

The Internet

The Internet Community Today

- **Application service providers (ASPs):** Companies that manage and distribute software-based services over the Internet
  - Web-based software, Software as a Service (SaaS), cloudware
  - Often fee-based business software
- **Web service**: Added to a Web page to provide specific services for end users
- **Infrastructure companies**: Own or operating the physical structure of the Internet
  - Conventional and mobile phone companies, cable companies, and satellite Internet providers

25

The Internet Community Today

- **Hardware and software companies**
  - Provide the hardware and software used in conjunction with the Internet and Web

  (Firewalls, Intrusion Detection Systems, SPAM filers)
- **Government and other organizations**
  - Some countries limit information and access
  - FCC influences communications
  - Internet Society (ISOC): Addresses issues impacting the future of the internet
  - Internet Corporation for Assigned Names and Numbers (ICANN): Domain and IP management
  - World Wide Web Consortium (W3C): Protocols and standards, ensures interoperability

26

Myths About the Internet

- **Myth 1: The Internet is free**
  - Most people and businesses pay for Internet access
  - Businesses, schools, and libraries lease communications lines from phone companies
  - Fee-based content is growing at a rapid pace
    - Music/movie downloads
    - Donation based sites

FIGURE 8-4
Fee-based Web content. The use of fee-based Web content, such as downloadable movies and music, is growing.

27

Myths About the Internet

- **Myth 2: Someone controls the Internet**
  - No single group or organization controls the Internet
  - Governments can regulate Internet use within its country, but difficult to enforce
- **Myth 3: The Internet and World Wide Web are identical**
  - Internet = physical network
  - WWW = one resource (Web pages) available via the Internet
  - Other resources are available via the Internet
    - e.g. FTP

28

Type of Connection and Internet Access

- Computer must be connected to access the Internet
  - Most connections today are broadband
- Connections can be:
  - **Dial-up**
    - Uses standard phone lines
    - Uses modem to dial-up ISP
      - Inconvenient
      - Slower, but cheaper
      - Ties up phone lines
      - Relatively secure from hackers

29

Type of Connection and Internet Access

  - **Direct (**always on)
    - Device is continually connected to the Internet
    - Direct connections are typically broadband; fast speeds needed for many Web activities today
    - Because you are always connected, it is important to protect your computer from hackers

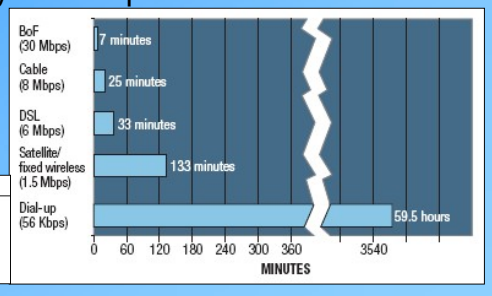


FIGURE 8-6
Length of time to download a 1.5 GB movie using different home Internet options.

30

Direct Connections

- **Cable:** Most widely used home broadband connection
  - Fast, between 5 and 20 Mbps
  - Requires a cable modem
- **DSL:** Broadband delivered over telephone lines
  - Must be less than 3 miles from a switching station
  - Transmits over telephone lines but does not tie up the line
  - Typically 1-7 Mbps
- **Satellite:** Broadband option for rural areas
  - Slower and more expensive that cable or DSL
  - Available in many areas other broadband options are not
  - Requires satellite modem, and transceiver dish

31

Direct Connections

- **Fixed wireless:** Uses radio transmission towers rather than satellites
  - Not available in all areas
  - Uses Wi-Fi or WiMAX
- **Broadband over Fiber (BoF):** Delivers over fiber-optic cabling all the way to the building
  - Also called Fiber-to-the-premises (FTTP)
  - Fast, available in limited areas
  - Requires special networking equipment
- **Mobile wireless:** Access via mobile phone or device
- **Hotspot:** Public wireless networks (Wi-Fi)
  - Both free and fee-based are available

32

TYPE OF INTERNET CONNECTION	AVAILABILITY	APPROXIMATE MAXIMUM SPEED*	APPROXIMATE MONTHLY PRICE
Conventional dial-up	Anywhere there is telephone service	56 Kbps	Free–$30
Cable	Virtually anywhere cable TV service is available	6–200 Mbps	$30–110
DSL	Within 3 miles of a switching station that supports DSL	3–15 Mbps	$30–40
Satellite	Anywhere there is a clear view of the southern sky and where a satellite dish can be mounted and receive a signal; most often in rural or mountainous areas	5–15 Mbps	$40–80
Fixed wireless	Selected areas where service is available; most often in rural areas	2–12 Mbps	$60–250
Broadband over fiber (BoF)	Anywhere fiber has been installed to the building; most often in urban areas	5 Mbps–1 Gbps	$30–70
Mobile wireless (4G)	Virtually anywhere cellular phone service is available	3–100 Mbps	Varies greatly depending on data plan

* Download speed; most connections have slower upload speeds.

Trends

Internet of Things (IoT)

- Everyday objects interconnected via the Internet
- Sensors in shoes and other objects, smart fitness devices, home automation systems, smart freeways and traffic lights, for example
- Devices will communicate with each other and provide feedback to users as needed

A home automation system.

"In 2005, the broadband internet had a maximum speed of 2 Megabits per second. Today, 100Mbps download speeds are available in many parts of the country. But experts warn that science has reached its limit and fiber optics can take no more data." https://fossbytes.com/10-interesting-facts-internet-really-need-know/

Trends

- Video calls – e.g. Skype
- Texting
- Twitter
- Social Networking
- E-Commerce
- Online Banking/Financial Services
- MMORPG - Massively multiplayer online role-playing games
- Voice over IP (Power, 911 considerations)

Censorship - Privacy

- Censorship
  - Government mandated
  - Employer Mandated
  - Site based self-censorship
  - ISP based
- Privacy:
  - Cookies (tracking)
  - Spyware/ADware
  - E-mail Standards
  - VPNs ?