# CSC 170 - Introduction to Computers and Their Applications

Lecture 7 – The Internet

# Background

- The history of the Internet begins in 1957.

- In a response to the Soviet Union launching Sputnik, the first man-made satellite, the U.S. government resolved to improve its scientific and technical infrastructure.

- One of the resulting initiatives was the Advanced Research Projects Agency (ARPA).

# Background

- ARPA designed a project to help scientists communicate and share valuable computer resources, and called The ARPANET.

- The ARPANET, created in 1969, connected computers at UCLA, the Stanford Research Institute, the University of Utah, and UC California at Santa Barbara.

The original diagram of the ARPANET included four nodes, depicted as circles.
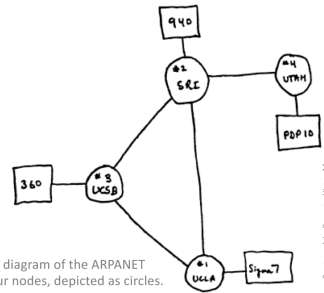
# Background

- Early Internet pioneers used primitive command-line user interfaces to send email, transfer files, and run scientific calculations on Internet supercomputers.

- In the 1990s, software developers created new user-friendly Internet access tools, and Internet accounts became available to anyone willing to pay a monthly subscription fee.

# Background

- Today's Internet, with an estimated 500 million nodes and more than 3 billion users, is huge.
- It is estimated that the Internet handles more than two exabytes of data every day; an exabyte is 1.074 billion gigabytes – a nearly unimaginable amount of data!
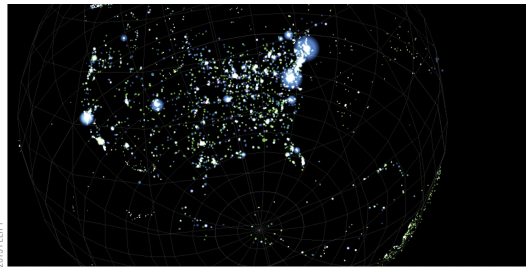


# Background

- In theory, no single person, organization, company, or government runs the Internet.
- *Internet governance* is simply a set of shared protocols, procedures, and technologies that evolve through common agreement among network providers.
- The organization that supervises internet addressing is *ICANN*, the Internet Corporation for Assigned Names and Numbers.

# Internet Infrastructure

- The way networks fit together is referred to as the **Internet Infrastructure.**
- Tier 1 networks represent the top of the Internet hierarchy and form the **Internet backbone**, a system of high-capacity routers and fiber-optic communication links providing the main routes for data speeding across the Internet.
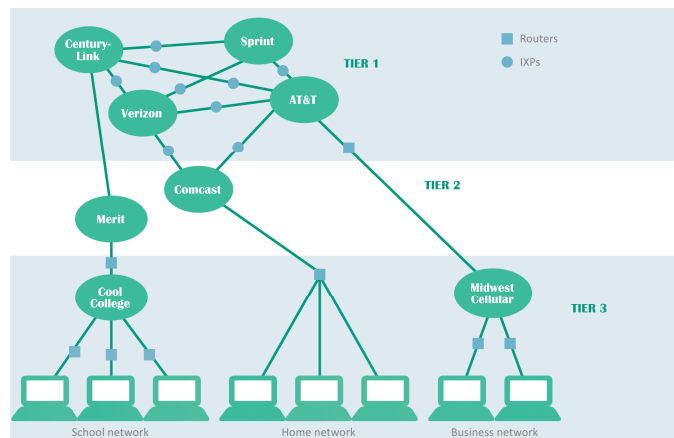
# Internet Infrastructure

- Tier 1 networks include:
  - AT&T
  - CenturyLink
  - Verizon
  - NTT Communications

# Internet Infrastructure

- Networks that form the Internet are maintained by **Internet service providers** (ISPs).
- ISPs exchange data at **Internet exchange points** (IXPs)

# Internet Infrastructure

# Internet Infrastructure

- The internet is not free; ISPs make a substantial investment in equipment and infrastructure to connect consumers.
- Tier 1 ISPs own and maintain millions of dollars of data communication equipment.

Century-Link  FREE  FREE  AT&T

Merit  FREE  Swiss-com

Campus Net

Local ISP
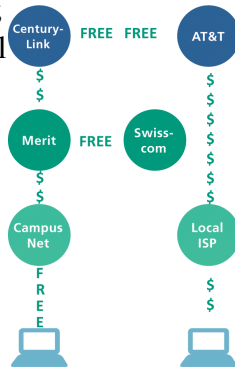
Tier 1 service providers exchange data with other Tier 1 providers on a no-cost basis.

Tier 2 service providers exchange data on a no-cost basis with other Tier 2 providers, but they pay fees to connect to the backbone through Tier 1 providers.

Tier 3 service providers connect to Tier 2 or Tier 1 providers and pay transit fees for the data exchanged.

Consumers either pay fees directly or their access is subsidized by an organization or government.
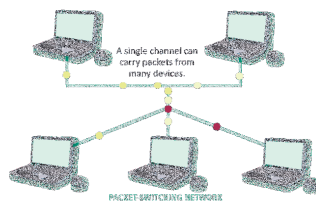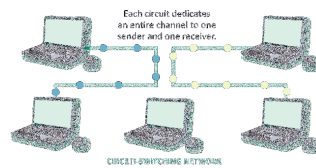
# Packets

- A packet is a parcel of data that is sent across a computer network; when packets reach their destination, they are reassembled into the original message according to their sequence numbers.

# Packets



- Messages divided into equal-size packets are easier to handle than an assortment of small, medium, large, and extra large files.

# Packets



Packet-switching networks (bottom) provide a more efficient communication system than circuit-switching networks (top).

# Packets

- One of the core Internet protocols, *TCP* (*T*ransmission *C*ontrol *P*rotocol) is responsible for dividing files into chunks, adding headers containing information for reassembling packets in their original order, and verifying that the data was not corrupted while in transit (a process called error checking).

# Packets

- *UDP* (*U*ser *D*atagram *P*rotocol) is an alternative transport protocol which is faster than a TCP but does not perform error checking and cannot reorder packets

# Internet Addresses

- Internet Addresses are controlled by **IP** (Internet Protocol), which is part of the Internet protocol suite.
- Many devices on the Internet have permanently assigned IP addresses called *static addresses*.

# Internet Addresses

- IP defines two sets of addresses: IPv4 and IPv6
  - **IPv4** – (Internet Protocol version 4); is the Internet address standard; uses 32-bit addresses to identify Internet connected devices.
  - **IPv6** – (Internet Protocol version 6); uses 128 bits for each address; produces billions and billions of unique Internet addresses.
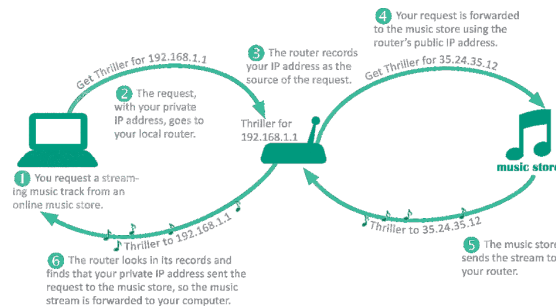
# Internet Addresses

- Internet addresses that are temporarily assigned to a device are called *dynamic addresses*.
- IP addresses can be assigned by a network administrator, but more commonly they are automatically assigned by *DHCP* (*D*ynamic *H*ost *C*onfiguration *P*rotocol)

# Internet Addresses

- A **private IP address** can be allocated by any network without supervision from ICANN – but it cannot be used to send data over the Internet; it's not routable.

# Internet Addresses

- Because a private IP address cannot be routed over the Internet, a local router connects instead.
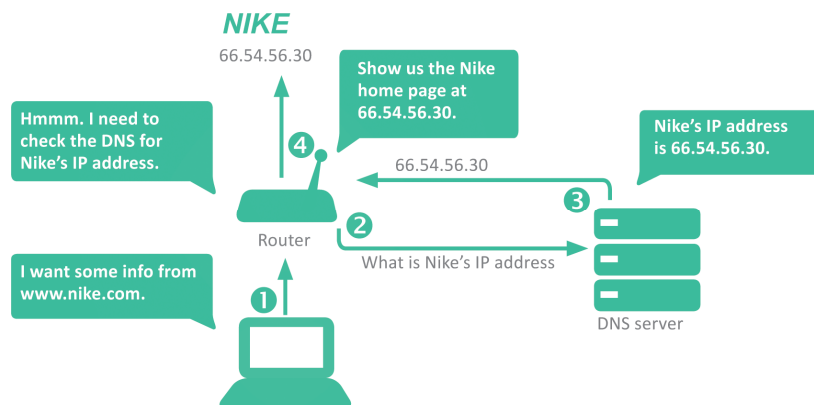- The local router has a public IP address that is routable over the Internet.



# Domain Names

- It's hard to remember the string of numbers in an IP address; most Internet destinations also have an easy-to-remember *domain name*, such as nike.com.
- The mechanism for tracking domain names and their corresponding IP addresses is called the *domain name system* **(DNS).**

# Domain Names

- A domain name ends with an extension that indicates its *top-level domain*, such as .edu or .org.
- **Domain name servers** are scattered around the world and maintain lists of all domain names and their corresponding IP addresses.

# Domain Names

**NIKE**
66.54.56.30

Show us the Nike home page at 66.54.56.30.

Hmmm. I need to check the DNS for Nike's IP address.

Nike's IP address is 66.54.56.30.

❹

66.54.56.30

❸

Router

❷

What is Nike's IP address

I want some info from www.nike.com.

❶

DNS server

# Domain Names

- Altering DNS records can change the destination of email, browser connections, and download requests.
- Unauthorized changes to the DNS are called DNS spoofing.



# Connection Basics

- Data travels over the Internet at an incredible speed, but that speed varies; some Internet services are faster than others
- It is easy to check the speed of your Internet connection by running a few online tests

# Connection Basics

- The most common measurement of connection speed is the amount of data that can be transmitted in a specified time; technically, it is a measure of capacity

| SERVICE | Recommended Download | Recommended Upload |
|---|---|---|
| Skype video calling and screen sharing | 300 Kbps | 300 Kbps |
| Skype video calls (HD) | 1.5 Mbps | 1.5 Mbps |
| Skype three-person group calling | 2 Mbps | 512 Kbps |
| Netflix movie on a laptop computer | 1 Mbps | |
| Netflix SD movie on a TV | 2 Mbps | |
| Netflix 720p HD movie | 4 Mbps | |
| Netflix "best video and audio experience" | 5 Mbps | |
| YouTube basic videos | 500 Kbps | |
| YouTube movies, TV shows, and live events | 1 Mbps | |
| Amazon Prime Instant Video (SD) | 900 Kbps | |
| Amazon Prime Instant Video (HD) | 3.5 Mbps | |
| Netflix and Amazon 4K Streaming Video | 15-25 Mbps | |

# Connection Basics

- ISPs control connection speeds based on the service plan you've selected
- Your **bandwidth cap** is the top speed allowed by your plan.
- During peak times, ISPs can place further limits on speed, a process called **bandwidth throttling.**

# Connection Basics

- When Internet upload speed differs from download speed, you have an **asymmetric connection.**
- When upload and download speeds are the same, you have a **symmetric connection.**
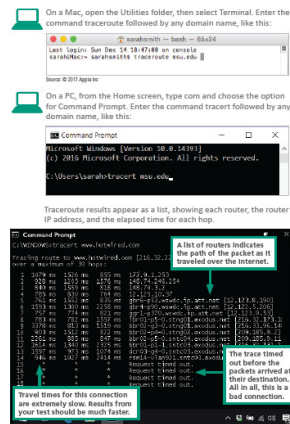
# Connection Basics

- ***Ping*** is utility software designed to measure responsiveness.
- ***Ping rate*** indicates how quickly data can reach a server and bounce back to you.
- ***Latency*** is the elapsed time for data to make a round-trip from point A to point B and back to point A.

# Connection Basics

- *__Jitter__* measures the variability of packet latency caused when network traffic and interference can delay packets and create erratic data flow.
- *__Packet loss__* refers to data that never reaches its destination or gets discarded because it arrives too late.

# Connection Basics

- To determine whether or not your slow Internet connection is caused by your ISP or your computer you can use a *__Traceroute__*, a network diagnostic tool that lists each router and server.

# Connection Basics

- Although public Internet access is available in many locations, such as coffee shops and libraries, most consumers like the convenience of having their own Internet connection.

**Fixed Internet Access**

Fixed Internet access links your computer to an ISP from a stationary point, such as a wall socket or roof-mounted antenna. This service is dependable and relatively cost effective. You can't take it with you, so when you're away from home, you must depend on public access points.

Cable, DSL, ISDN, Fixed WiMAX, Satellite, Fiber-to-the-home

**Portable Internet Access**

Portable Internet access allows you to easily move your access device, as in the case of vehicle-mounted satellite dishes that can be deployed when the vehicle is parked. This service is primarily used in situations where mobile and fixed access are not available.

Mobile satellite

**Mobile Internet Access**

Mobile Internet access allows you to use the Internet while you are on the go, such as using a cell phone to collect your email while you are traveling by train. Data plans for these services can be costly.

Mobile broadband          Mobile WiMAX

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# Cable Internet Service

- The gold standard of fixed Internet access is cable Internet service, which is offered by the same companies that supply cable television.
- CATV stands for community antenna television.
- With cables branching out from a central location, the topology of a CATV system works well as the infrastructure for a digital data network.
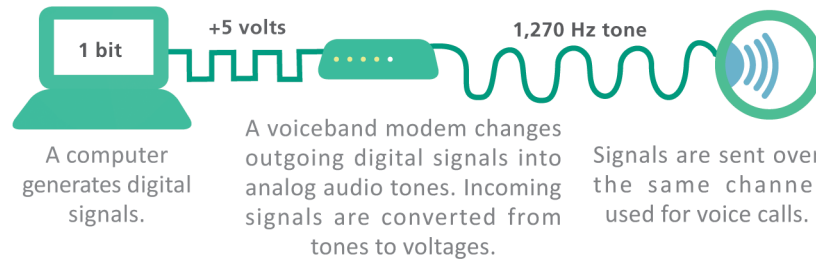
# Cable Internet Service

- CATV coaxial and fiber-optic cables have plenty of bandwidth to carry television signals for hundreds of channels in addition to digital data.
- CATV cables provide bandwidth for television signals, incoming data signals, and outgoing data signals.
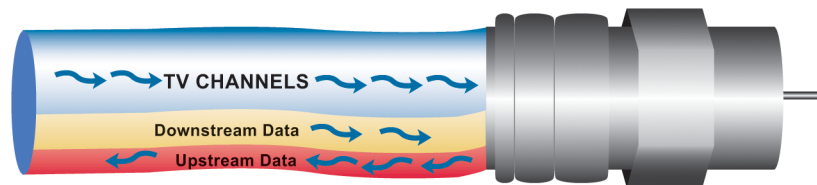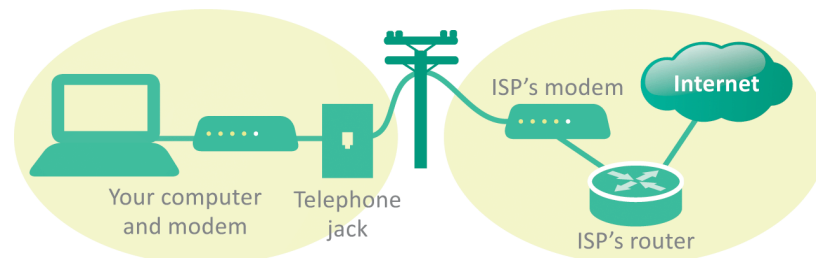


# Telephone Network Internet Service

- Telephone companies offer four types of service: dial-up, ISDN, DSL, and FTTH
- A **dial-up** connection is a fixed Internet connection that uses a voiceband modem and the telephone company's circuit-switched network to transport data between your computer and your ISP
- A **voiceband modem** converts digital signals from a computer into audible analog signals that can travel over telephone lines

# Telephone Network Internet Service



**+5 volts**

**1 bit**

**1,270 Hz tone**

A computer generates digital signals.

A voiceband modem changes outgoing digital signals into analog audio tones. Incoming signals are converted from tones to voltages.

Signals are sent over the same channel used for voice calls.

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# Telephone Network Internet Service

- When you use a dial-up connection, a voiceband modem places a regular telephone call to your ISP; the circuit remains connected for the duration of the call to carry data between your computer and the ISP.



ISP's modem

Internet

Your computer and modem

Telephone jack

ISP's router

# Telephone Network Internet Service

- *ISDN* stands for *I*ntegrated *S*ervices *D*igital Network; it divides a telephone line into two channels, one for data and one for voice, by using packet switching.
- *DSL* (*D*igital *S*ubscriber *L*ine) is a high-speed, digital, always-on, Internet access technology that runs over standard phone lines; it's offered by AT&T's U-verse service.

# Telephone Network Internet Service

- *FTTH* (*F*iber-*T*o-*T*he-*H*ome) is the use of high-capacity fiber-optic cables, rather than coaxial cables, to connect homes to broader municipal networks.

# Satellite Internet Service

- Satellite Internet service is a means of distributing broadband asymmetric Internet access by broadcasting signals to a satellite.
- In many rural areas, satellite Internet service is the only alternative to a slow dial-up connection.
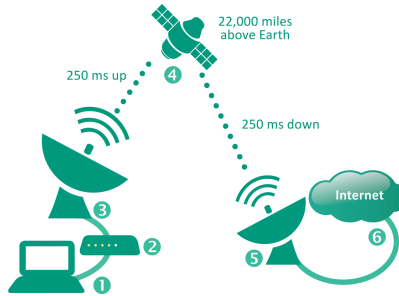


# Wi-Fi Hotspots

- A Wi-Fi hotspot is a wireless local area network that offers Internet access to the public.
- The network has an Internet connection and device called an access point that broadcasts Wi-Fi signals within a range of about 150 feet.
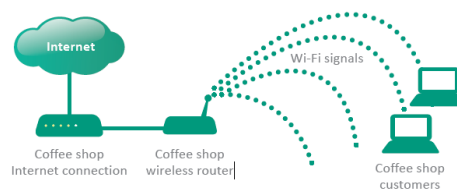
# Wi-Fi Hotspots

- Low: Browsing.
  - When using a Wi-Fi hotspot for simple browsing activities such as checking sports scores, reading Google news, and looking for directions, your security risk is fairly low if your computer's antivirus software is up to date.

# Wi-Fi Hotspots

- Low: Using secure sites.
  - Your security risk is low when you are accessing secured Web sites that have addresses beginning with HTTPS.
  - These secured sites, which are used for activities such as online banking, accessing medical records, and making credit card purchases, encrypt the data that you enter to keep it safe from eavesdroppers.

# Wi-Fi Hotspots

- MED: File sharing.
  - Eavesdroppers might be able to access the files on your computer if you have file sharing turned on.
  - When using public networks, you should turn file sharing off. You can do so manually if your operating system does not offer that option when you connected.

# Wi-Fi Hotspots

- HIGH: Using unsecured sites.
  - When you log in to unsecured sites while using public Wi-Fi hotspots, a wireless eavesdropper could potentially snag your user ID and password information, then use it later to access your accounts.
  - Logging in to your Webmail account, for example, could be risky if your user ID and password are transmitted over an unsecured connection.