The Internet: Notes

In this lesson:
- What is the Internet?
- Building a Network:
- IP and DNS
- How Information Travels
- Layers of the Internet
- Digital Divide

What is the Internet:
- The Beginning of the Internet:
  - The Internet was the result of the ARPANET experiment
    - A defense department project
    - Paul Baran wanted to find a network that could survive a nuclear attack on the United States
    - He found that a distributed network was better than a centralized network
    - Distributed Packet Switching Network: break messages into blocks and send them to every network location
- Who controls the internet?
  - No one and everyone
    - Internet comes from a series of independently operated networks to your own provider
- Internet: a global network of computing devices communicating with each other in some way (e.g. sending emails, downloading files, sharing websites)
  - It is an open network: any device can join as long as they follow rules
  - In networking, the rules are known as protocols and they define how each device must communicate with each other
- Ingredients of the Internet
  - Wires & Wireless: physical connections between devices plus protocols for converting electromagnetic signals into binary
  - Internet Protocol (IP): a protocol that uniquely identifies devices using IP addresses and provides a routing strategy to send to a destination IP address
  - TCP (Transmission Control Protocol)/ UDP (User Datagram Protocol): protocols that can transport packets of data from one device to another and check for errors along the way
  - TLS (Transport Layer Security): a secure protocol for sending encrypted data so that attackers can't view private information

○ HTTP/DNS: the protocols powering the World Wide Web, what the browser uses every time you load a webpage

Building a Network:

- Computing device: a machine that can run a program, including computers, tablets, servers, routers, and smart sensors
- Computing system: a group of computing devices and programs working together for a common purpose
- Computing network: a group of interconnected computing devices capable of sending or receiving data
- Path: a series of connections between computing devices on a network starting with a sender and ending with a receiver
- Bandwidth: maximum amount of data that can be sent in a fixed amount of time, usually measured in bits per second
- Routing: the process of finding a path from sender to receiver; usually dynamic on the Internet, not specified in advance

IP and DNS:

- The Internet is a design philosophy/architecture expressed in a set of protocols (a well known set of rules/standards used to communicate between machines)
  ○ This allows the Internet to adapt and absorb new communication technologies because it just needs protocols
- IP (Internet Protocol): one of the most important protocols in internet communication
  ○ Describes how 2 computers communicate with each other
  ○ Used by every computer
  ○ Each computer has an IP address
  ○ Computer asking another computer for information
    ■ Computer sends other computer its IP address and its origin address so the other computer knows where to send its response
    ■ Number is unique to each device on the network
    ■ Set up in a hierarchy, split into 4 numbers from 0-255
    ■ Traditional IP addresses are 32 bits long (8 bits per each part)
      ● country/network, region/network, subnetwork, device
    ■ This is IPv4 - provides for 4 billion unique addresses (1973)
    ■ IPv6 is in the process: 128 bits per address - 340 undecillion unique addresses
- DNS (Domain Name System): associates names (www.-----.com) with corresponding addresses
  ○ Computer uses the DNS to look up domain names and get the associated IP address which connects your computer to internet destination
  ○ DNS servers are connected in a distributed hierarchy

- - ■ Divided into zones, splitting up responsibilities for each major domain (.org, ,com, etc.)
  - ○ It is an open public communication protocol
    - ■ Susceptible to cyber attacks
    - ■ DNS Spoofing: when a hacker goes into a DNS server and changes it to match a domain name with the wrong UP address (takes you to wrong website)
    - ■ Gives humans a easy way to find where we want to go on the internet
  - ○ Domains - IP addresses
    - ■ Every domain name we type maps to an IP address, but computer figures it out
      - ● Checks local cache
      - ● Asks ISP cache
      - ● Asks home servers

How Information Travels:

- ● How is the Internet like the US Post Office?
  - ○ Communication systems (trucks/wires)
  - ○ Deliver information (magazines/websites)
  - ○ Have size limits for individual packages
  - ○ Large shipments are broken up into small pieces
- ● Circuit v. Packet Switching
  - ○ Circuit Switching: once you create a connection, you keep it until all of your message is sent
  - ○ Packet Switching: message is broken up and many messages are sent sharing a connection
    - ■ Selected for the Internet because it is more flexible
    - ■ The selected route can be optimized at each moment in time and it allows for packages of unlimited size
- ● Methods to send bits of info (atoms of the Internet):
  - ○ Electricity: connected by copper wire
    - ■ 0 - off, 1 - on : binary information
    - ■ Bits can be also be counted by time (bit/sec)
    - ■ To go faster, increase bandwidth (maximum transmission capacity of a device)
    - ■ Another measure of speed is latency (time it takes for a bit to travel from one place to another)
    - ■ Pro: cheap
    - ■ Cons: signal loss (with ethernet wire)

- ○ Light: send bits as light beams using fiber optic cable (thread of glass engineered to reflect light)
  - Can send multiple bits at a time because of angle of beams sent
  - Pros: really fast, no signal lost (can connect continents)
  - Cons: expensive, hard to work with
- ○ Radio waves (wireless: uses radio signal to send bits from one place to another)
  - Translate 0 and 1 to binary radio waves frequency
  - Pros: totally mobile
  - Cons: short range
- Packet: small segment of data that's bundled for sending over transmission media; contains address of computer of peripheral device to which it's being sent
  - ○ Information is sent in packets of data
  - ○ Many kinds of digital information can be sent with IP packets bit there are limits
    - Different packets are sent in a different route with the IP address it came from and where it's going then are reassembled
    - Routers: "traffic managers" that keep the packets moving through networks smoothly
    - Packets try to travel the cheapest way (time, politics, relations with companies) which is usually not the most direct
    - Fault tolerant: network can keep sending packets even if something goes horribly wrong (key principle for reliability)
- TCP (Transmission Control Protocol): manages sending and receiving of all data as packets
  - ○ Completes inventory to make sure all packets are delivered
  - ○ If it is, its signs and verifies packets
  - ○ TCP and router systems are scalable (can work for 8 or 8 billion devices)
    - Because of fault tolerance and redundancy, growing and scaling occurs without interrupting service
- Networks connect, communicate, and collaborate because of agreed upon protocols
  - ○ Nodes: connecting points to route the data traffic
  - ○ Server: a computer that waits and responds to requests for data
  - ○ Client: a computer that requests data stored on a server

Layers of the Internet:
- Datastream: information passed through the internet in packets
- Packet metadata: data about data; data added to packets to hep route them through the network and reassemble the original message
- TCP (Transmission Control Protocol): a protocol for sending packets that does error checking to make sure all packets are received and properly ordered

- UDP (User Datagram Protocol): a protocol for sending packets quickly with minimal error-checking and no resending of dropped packets
- Web Browsing
  - Enter your web address or URL (Uniform Resource Locator)
  - Your computer connects/talks to a server, usually far away and they communicate in milliseconds in HTTP (Hypertext transfer protocol)
- The Internet is completely open, connections are shared. Information is sent in plain text which makes it easier hackers to see your information
- Scalability: the capacity for the system to change in size and scale to meet new demands
- World Wide Web (WWW): a system of linked pages, programs, and files (NOT THE INTERNET)
- HTTP (Hypertext Transfer Protocol): protocol for computers to request and share pages that make up WWW and internet
- Layers of the Internet
  - The internet is made up of protocols that work together to move information around the network
  - Higher layers rely on lower ones
  - From lowest to highest: Physical network, IP, TCP/UDP, HTTP and DNS

Digital Divide
- The fact that some people have access on the internet and know how to use it effectively, while other people don't
- Or people cannot financially afford Internet-accessing devices or access the Internet
- Internet access is required in order to access opportunities, education, and other necessary resources in today's world: education, applying for jobs, filing taxes, bus schedules, medical care
- Factors:
  - Lack of internet infrastructure and resources
    - Urban v. Rural
    - Poor v. Rich
    - Old v. Young
  - Government censorship of the Internet
    - North Korea, Iran, Russia