**CIS-427 – Computer Networks and Disc Processes**

**Personal Notes – Demetrius Johnson**

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**With Professor Dr. Zheng Song**

# Lecture 1 (8-30-22) – Introduction to Computer Networks (chapter 1: roadmap)

* We ultimately have internet access when we reach the ISP (Internet Service Provider).
* Digital signal = high and low voltage transmissions on a wire (but the actual high and low voltages transmitted = analog, since the high and low voltage can vary in strength, but they have a large enough threshold to divide them so that they can be converted back to digital = discrete.)
  + This translation from digital to analog takes time and is what causes slower transmission speeds.
  + Sometimes the interface card is the limiting factor for transmission speed and reliability.
  + Sometimes it is the media (the wire) that limits transmissions speed and reliability.
* Packet transmission delay = L (bits) / R (bits/sec), where L is packet size (in bits), and R is transmission rate (bits/second).
* One bit = 1 or 0 = high or low voltage.
* Wireless radio signal = half duplex (between a sender and receiver), meaning
  + Wireless communication has big security concern because all messages have to be broadcast in the air, and light behaves as a particle and a wave and there is no way to get around that; so if you wirelessly send a message, anyone else with a receiver can and will receive the message as well. So, security is critical as by default wireless is a huge security compromise because of the broadcast nature of radio waves (=light).
* Doppler effect is a major issue with satellite communication because they high frequency waves necessary.
* We will study the network core: how to use protocols (method/language/mode of communication) in order to transmit packets.
* Each router maintains a routing table for port forwarding to a given link to reach or move towards reaching a given destination.
* Routing: help decide the overall path (a global behavior)
* Forwarding: decide the local port to transmit on (local behavior)
* Packet switching (one packet is transmitted from one router to another router): cut up a message into packets, store the packet while we wait for the entire packet to arrive, forward the packet once the entire packet is received.
  + Also, sometimes a router may get overloaded with packets and needs to maintain a queue for sending packets; so it needs memory to store the packets while it is processing transmission of other packets.
  + This queuing up of packets on the router is what causes latency and lagging (like on a video game).
  + So: Also queuing delay slows down transmission speed (as does translation from digital to analog signal), and also packets can be dropped if a routers memory (queue) becomes to full = overloaded.
* We use the packet method to improve reliability and speed (retransmit from other routers – and be able only to transmit smaller amounts of data instead of retransmits the entire file; use parallel transmission networking = load balancing).
* Circuit switching v packet switching: circuit switching guarantees performance because it is not a shared resource like packet switching resources; rather, circuit switching has dedicated resources to one or some set of devices over a media/for a circuit at a given time 🡪if someone is using the resource, then no one else can use it.
  + So essentially: packet switching 🡪 shared channels; circuit switching 🡪 dedicated channels (which can include shared channels, but that channel is split up into dedicated segmented logical channels).
* Two kinds of circuit switching: FDM and TDM (frequency or time division multiplexing).
  + FDM is used for wires (most efficient).
  + TDM is used for wireless (necessary because of how light works).
* We have to worry about data collisions on the wire and over the air.
* For packet switching, there is no guarantee of performance; but it is the dominate method of communication.
* How to calculate number of users possible in a system (lecture 1, slide 35).
  + P(k) = C(n,k) \* 10%^k \* (100% - 10%)^(n-k)
    - Above: Probability of k users in the system for 100mbps per user when active with an active rate of 10% over a 1gbps link.
    - Max number of users that can transmit at the same time = 1gbps/100mbps = 10 users.
    - Answer is that the system can support up to 35 users with not many collisions based on the probabilities and the situation described above.
  + THIS WILL BE ON EXAM
* Circuit switching not really used anymore: alternative is packet switching, and using packet switching to do virtual circuit switching (a virtual circuit).
* Packet switching
  + Good for bursty data but introduces collisions.
  + So, we need a solution for the collisions to reduce collision rate and improve reliability to the same or better level of circuit switching.
* The internet is a hierarchical connection structure to reduce total number of connections necessary so that any two devices can connect over IP.
  + Higher level routers could be for example international router (say, a set of routers with route tables that are dedicated to send traffic from America to China).
* Internet is not a hierarchical tree structure because of security and failure (unreliability); we need redundancy and security.
  + Rather: Internet is a hierarchical network (a web) that imitates a tree-like structure, but it is a not a pure hierarchal tree structure.

# Lecture 2 (9-1-22) – Introduction to Computer Networks (chapter 1: roadmap (continued))

* There are other types of delays besides transmission (convert from digital to analog🡪voltage and place it on the link) delay and queuing (held in buffer) delay:
  + There is also signal propagation delay: time it takes for (light) the signal to actually travel along its medium.
  + There is also nodal processing: check for bit errors and determine output link (forwarding)
* Remember two main functions of router: routing (thus storing while you route), and forwarding (on link necessary to get to next necessary hop).

# Special Topic: Service Polymorphism – Edge Computing

* Most network applications have a latency of 200ms
* We aim to use edge devices (such as DNS servers close to users) to reduce latency and improve QoS.
* We aim to invoke different functions (whichever one is optimal for the given user at a given time and location) that does an equivalent service for a device, but at the optimal speed (minimized latency).
* We do this using equivalent functions and data models from QoS reports of devices using various services.

# Special Topic: Smarts Locks and MQTT

* Note: wifi modules user much less power when listening and use about 3x the amount of power required for listening when transmitting.
  + Solution: use a bridge devices for IoT wireless devices, so that the IoT device **only needs to listen** to the bridge (much less power usage), while the bridge (which does not require batteries and has better processing power) does the pull requests from cloud services (transmit) which also reduce latency for the wireless IoT device connected to the bridge.