Networking

- Networking is about moving information from one point to the next
- Four Fundamental Problems

  1. Encoding
     - How do we encode it?
     - Convert info into a form that we can move.
  2. Decoding
     - How do we convert info we've encoded into a form we can look at?
     - This will be ween in HW1, where we will implement an FM demodulator
  3. Transport
     - Mediums
       - WIFI
       - Radio signal
       - Optical communication
       - Etc.
  4. Reliability
     - TCP Protocol

Example 1

Situation: Person 1 and Person 2 are talking on a cup phone connected by a wire/string. Person 1 talks into the cup and the message is transferred to other cup so Person 2 can hear.

- The form of encoding/the encoding strategy is the amplitude modulation (AM)
- However, there is no reliability in this. For example, the string might get bent and distort the message.

Designs/Networking Architectures

1. Simplex
   - Communication happens only in one direction.
   - Examples: Intercoms, radio, TV
2. Half-Duplex
   - Communication happens in both directions, but if such a way that only one can party can communicate at a time.
   - Examples: VHF Radio
3. Full-Duplex
   - Communication happens in both directions, possibly at the same time.
   - Examples: Cell Networks

Example 2

Situation: You have a telegraph, which is half-duplex. There are two offices using telegraphs to communicate.

- The encoding strategy is Morse code.
- In order for the two telegraph offices to communicate, they send the message as some voltage over time where a long spike of high voltage is a dash and a short spike of high voltage is a dot.
- Certain problems arise
  - How long is a dot?
  - How long is a dash.
  - How much space in time is it between a dot and a dash?
  - How do we know when the message is over?
  - How do we know the message is good? Are there mistakes?

The OSI Model

1. Application Layer
   - Where the user write code
   - Examples: Mail servers, bit torrent
2. Presentation Layer
   - Data Encryption, Compression
3. Session Layer
   - Authentication
4. Transport Layer
   - In charge of transporting data from end to end
   - Node to node transport
5. Network Layer
   - Responsible for routing and configuration between nodes; overall transport
   - Implemented on routers
   - Unable to use dijkstra's, instead implement distributed shortest path algorithm
6. Data Link Layer
   - Flow Control
   - Responsible for getting data from one node to another node
7. Physical Layer
   - How we get physical signals on our medium
   - Responsible for wire
   - How to build an SDR (software defined radio) in order to put anything we want on our layer

Decode Database Signal

Situation: Use a mic to pick up an audio signal.

- We can use an analog to digital converter (ADC) to convert audio to a digital value
- The Rule for Sampling: Sample at least twice the frequency

ADC

- Two major components of an ADC
  - Sample and Hold Component
    - The signal is received
    - The signal is held at a particular level for a period of time until the next sample
  - Quantizer
    - A collection of resistors
    - Takes the analog signal and produces a digital value
    - However, it does not create a perfect reconstruction due to Quantization error
- ADC is driven by a common clock
  - Every clock cycle, a sample is taken of the signal
  - The largest frequency to sample is limited by the clock

Mixer

F_1, F_2 are frequency inputs while F_3 is the frequency output

$$F_3 = F_1 \pm F_2, if F_1 > F_2$$
$$F_3 = F_2 \pm F_1, if F_2 > F_1$$

Example 3

A radio station operating a frequency of $550kHz$

$$F_1 = 550Hz$$

ADC running at most $200ksps$ (kilosamples per second)
What does $F_@$ need to be in order to feed F_3 to ADC to pick something up?

$$F_3 = 100kHz$$
$$F_3 = F_1 \pm F_2$$
$$100 = 550 \pm x$$
$$x = 450kHz$$
$$= 100, 1000kHz$$

Software Defined Radio (SDR)

An antenna is directly fed into ADC. It is limited to which frequencies to look at. We also often put a mixer between antenna and ADC

Example 4

Scenario 1

$$\begin{aligned} F_2 &= 90.9Hz \\ F_1 &= 91.1Hz \\ F_3 &= ? \\ &= .2, 182.0Hz \end{aligned}$$

Scenario 2

$$\begin{aligned} F_2 &= 91.3Hz \\ F_1 &= 91.1Hz \\ F_3 &= ? \\ &= .2, 182.0Hz \end{aligned}$$