Link Layer & Wireless

Link Layer

- Bottom layer
  - Can be split into MAC and Physical layers.
- Payload data comes from the upper layer, typically the IP layer.
- Packet Format
  - Wired internet uses Ethernet V2 packet format.
  - Bluetooth, WLAN, etc. define their own custom formats.
  - Syncword to distinguish packet boundaries. Escape sequences to handle syncword in data.
  - Checksums to handle errors.
- MTU: Maximum Transmission Unit
  - Typically 1500 bytes.

Link Layer Addressing

- MAC addresses: Media Access Control
  - 6 byte address space.
  - Every networked device has a unique MAC address, unless overridden by software.
- Switch: Central node that routes traffic between connected nodes
  - Operates at the Link Layer: unaware of IP addresses.
- Broadcast MAC address: "*ff:ff:ff:ff:ff:ff*"
  - Every connected device can receive packets sent to this address.
- Address Resolution Protocol (ARP)
  - Flood all nodes in your network to find the IP⇨MAC mapping.
- Broadcast IP address: *255.255.255.255*
  - Every node on the network can receive packets sent to this address.
- Dynamic Host Configuration Protocol (DHCP)
  - Every connecting node gets a unique IP address from the DHCP server.

Physical Layer

- Line coding:
  - Hold +1 when data bit is 1 ("Level triggered")
  - Problems occur when transferring continuous data bits of 1. How to separate them?
- Manchester Coding:
  - 0-1 for 1, 1-0 for 0 ("Edge triggered")
- Modulation:
  - Amplitude
  - Frequency
  - Phase

Wireless

- Radio waves
  - Broadcast by default
- SINR: **S**ignal to **I**nterference plus **N**oise **R**atio
  - Signal strength diminishes quadratically with distance travelled.
- Multipath
  - Total signal = Sum of several components with delay.
  - Multiple Input, Multiple Output (MIMO)
- Half Duplex vs. Full Duplex:
  - Wireless devices are typically half duplex.

Wireless contd.

- Multiple Access possible
  - Made more efficient with Time Division using Carrier Sensing or Scheduling
- Carrier Sensing problems
  - Hidden Terminal Problem
  - Exposed Terminal Problem
  - Request to Send/Clear to Send (RTS/CTS) protocol to mitigate the above problems.
- Collision detection
  - Sender waits for Ack, and resends if no Ack.
  - Backoff time calculation is non-trivial

Wireless Contd.

- Backoff strategies
  - Fixed backoff not advisable
  - Slotted Aloha protocol
    - In every time slot, every node transmits with probability 1/n.
  - Random Exponential Backoff
  - Duty Cycling
- Time Division
- Frequency Division
- Space Division
- Code Division
  - Walsh-Hadamard Code