Link Layer

Link Layer

- Delivers *packets* using *streams of bits*
- Standard services:
  - addressing
  - error control
  - flow control
  - QoS

Components of Link Layer

- **Data Link Control**
  - addressing
  - framing
  - error detection and correction
  - flow control
  - QoS
- **Media Access Control** (MAC)
  - controlling access to the shared medium

Channel Capacity

- Shannon's (noisy-channel coding) Theorem:

$$C = B \cdot \log_2\left(1 + \frac{S}{N}\right)$$

C - channel capacity

B - channel bandwidth

S/N - signal to noise ratio

Multiplexing

... allowing multiple simultaneous transmissions

- “Space multiplexing”
- Time Division Multiplexing (TDM)
- Frequency/Wavelength Multiplexing (WDM)
- Code Division Multiplexed Access (CDMA)

Media Access Control

- **Objective:** Arbitration of access to the shared medium - prevention or avoidance of collisions.
- **Deterministic** - collisions are prevented
  - centralized
  - distributed
- **Stochastic** - some collisions are permissible

Stochastic (random)

- **ALOHA:**
- Transmit at will...
- Listen to own transmission to detect collisions with transmissions of other nodes
- Random back-off if collision is detected

ALOHA Improvements

- Listen before you talk:
  - Carrier Sense Multiple Access (**CSMA**)
  - What to do after someone else's transmission is over (**Persistency**)
- Stop talking when you detect a collision:
  - Collision Detect (**CD**)
- Result: *1-persistent CSMA/CD* (a.k.a. Ethernet)