Where Are We?

Basics:
Network Classification
Network Architecture
Delay Models

Implementation:
Protocol Design

Layered Architecture

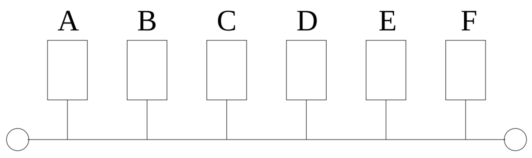
Application
Transport
Network
Data Link
Physical

Data Link Layer

Functionality

- Reliable Delivery of Frames
- Flow Control
- Error Detection
- Error Correction

Multiaccess Media



Multiaccess Media

Wavelan

Cocktail Party

Multiaccess Media

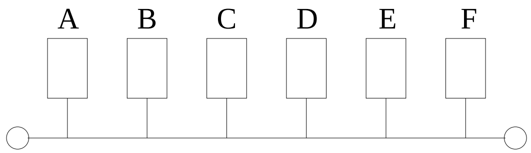
Rules

- "Don't interrupt when someone else is speaking"
- "Raise your hand if you have a question"
- "Give everyone a chance to speak"

Multiaccess Protocols

- Channel Partitioning (Wireless Communication)
- Random Access (Ethernet)
- Taking Turns (Token Ring)

Protocols for Multiaccess Networks



- Hosts broadcast packets
- When a collision occurs, all transmitted packets are lost
- Lost packets have to be retransmitted

=> **Need Multiaccess Protocol**

Protocols for Multiaccess Networks

Goal:

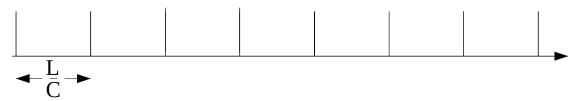
- Understand Multiaccess Protocols
- Understand Ethernet Protocol

Issues:

- How to deal with collisions? $(->$ Protocol design)
- Maximal traffic load? $(->$ Protocol performance)

Model - Slotted Aloha

- Time is divided into slots:



unit time = $\frac{L}{C}$ seconds

- Packet arrival rate (over all hosts) of λ packets/time unit
- Collision or Perfect Reception
- Immediate Feedback: $0, 1, e$
- Retransmission Probability: q_r
- Infinite number of hosts i.e. each node has at most one packet to transmit)

Model - Slotted Aloha

Questions

- Throughput?

- How to choose q_r?

  Would $q_r = 1$ work?
  Probability for retransmission after $k-1$ slots:
  Average time until retransmission:

Model - Slotted Aloha

Notation

- λ: aggregated arrival rate
- n: number of backlogged packets
- $G(n) = nq_r$: average number of arrivals per time slot

Want to compute

- P_{succ}: probability of successful transmission in a time slot (as a function of $G(n)$)
- Throughput = $\frac{P_{succ}}{1}$

Model - Slotted Aloha

$$P_{succ} = nq_r\Big(1-q_r\Big)^{n-1} = \frac{nq_r}{1-q_r}\Big(1-q_r\Big)^n$$

For q_r small, we have

$$\Big(1-q_r\Big)^n \approx e^{-nq_r} \qquad \text{and} \qquad \frac{nq_r}{1-q_r} \approx nq_r,$$

and we obtain

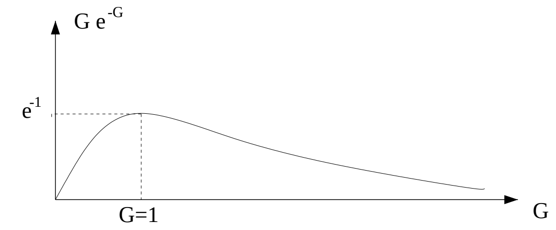
$$P_{succ} \approx nq_r e^{-nq_r} = G(n)e^{-G(n)}$$

where $G(n) = nq_r$

Note: Poisson distribution with parameter G:

$$p_k = \frac{G^k}{k!}e^{-G}$$

Model - Slotted Aloha



- If $G(n)e^{-G(n)} > \lambda$:
- If $G(n)e^{-G(n)} < \lambda$:
- Optimal $G(n) = nq_r = 1$, or

$$q_r = \frac{1}{n}$$

Model - Slotted Aloha

What did we learn?

- $\lambda_{max} = e^{-1} \approx 0.368$
- q_r should dynamically change

Binary Exponential Backoff

- $q_r = 2^{-k}$