Lecture 12
Plan: introduction to medium access control protocols

Review

- physical layer: how data (bits) is transformed into signals and sent for transmission
- data link layer: How bits are organized into frames and how to handle frame transmission (PPP: point to point protocol is currently used on Internet on router to router lines)

Bytes	1	1	1	1 or 2	Variable	2 or 4	1
	Flag 01111110	Address 11111111	Control 00000011	Protocol	Payload	Checksum	Flag 01111110

  - flag is 01111110 and byte stuffing is used in payload
  - address is always 255. default is broadcasting. → every one can read this frame and avoid datalink addresss
  - control: 3 means no sequence numbers for frames (i.e. don't support frame re-assembly)
  - Protocol: specify the purpose of the frame
    - NCP (network control protocol) is used to request ip for the host with protocol id as x8021.
    - LCP (link control protocol) is used to setup or bring down a link
    - etc including appletalk
  - payload: default is 1500 bytes
  - checksum is 2 bytes by default (32 bits can be arranged) – checksum is usually a 32bit or 16 bit CRC code

Look ahead for chapter 4:
Deals with aspects of data link layer that are important in broadcast networks other than point-point networks (**LAN**)

- multiple access protocols (the most interesting one)
- addressing
- topology

Layer that does this job: Medium Access Layer → the lower half of data link layer
Goal: Enable (logical) point to point connection between each pair of host in the LAN

1. Topology
Motivation: it is not cost effective to build point-point connections for each pair
Q:/ if we have n hosts, how many connections do we need?
A:/ $n(n-1)/2 \sim O(n^2)$

Requirement: so long as there are enough links for each host to contact any other host

Common topologies

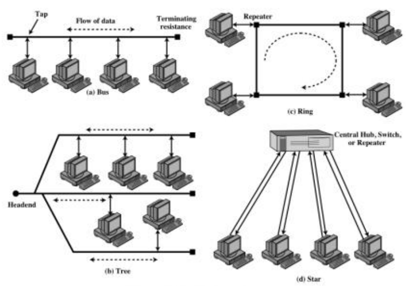


Figure 15.2 LAN Topologies

Bus/tree topology (Ethernet)
(signal prorogates in both directions, gone at the end)

Ring topology (IBM token ring)
(signal is unidirectional and gone when returned to the original host)

start topology (ATM LAN)
(two links for each host; also needs a central hub)

2. Multiple Access Protocols
Basic Problem: How to allocate a single broadcast channel among competing users? – How to share in a video conference?

Q:/ Why can't we use FDM or TDM
A:/ Traffic is too bursty (1000:1 is normal from peak to mean). FDM and TDM are basically static methods

Q:/ Why can't we use bus arbitration like in computers?
A:/ Hard to require every LAN to have a central arbiter.

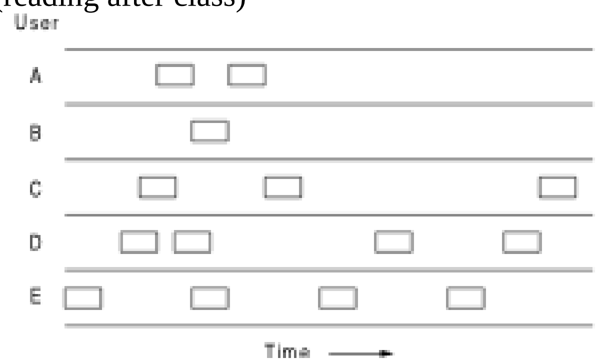
Solution #1: Use a *distributed* arbitration scheme and allow *collision*
Assumptions

- Station: N independent stations with unique station number
- channel: a single broadcast channel used by all stations. No extra control channel
- collisions: when two or more stations transmit at the same time, a collision occurs. Every station can detect a collision. Collision will corrupt all frame sent by those stations.
- Time
  - continuous: a station can send whenever its ready
  - slotted: time is divided into discrete intervals

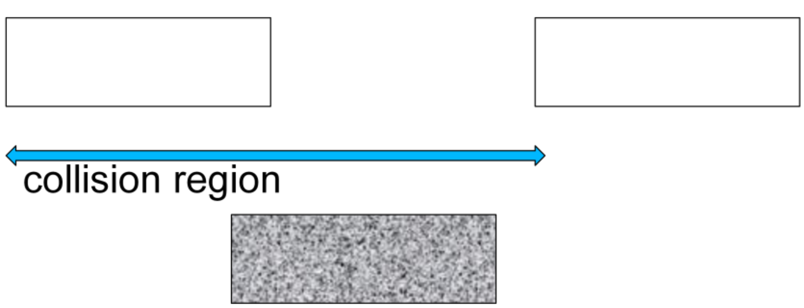
- Carrier sensing
    - yes: stations may listen to the channel to hear if the channel is busy before transmitting
    - no: station starts transmission without listening. Then detect collision when it occurred.

Example Protocols

1. Aloha
- Early 1970's in Hawaii to implement a radio broadcast network
- Basic Idea:
    - any host can transmit whenever it's ready
    - The sender can detect if a collision occurred by listening to the broadcast channel. if (sent!=listened) → collision
    - the receiver can detect collision by using checksum
    - If collision occurred, all senders wait a random time then try again.
- Pro: simple, no central arbitration at all
- Con: too many collisions. max efficiency is only 18% (only 18% doesn't have collision) (reading after class)



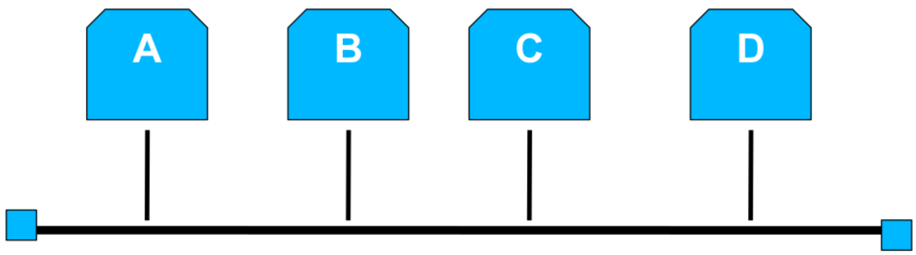
2. Slotted Aloha
- Time is divided into discrete intervals (needs a central clock)
- each slot is for each frame
- A transmission can start only at the beginning of a slot
- This cuts the probability of a collision in half – efficiency is 37%
  Q:/ Why doubled?
  A:/ now the only collision is on the beginning. (draw the picture)



In pure aloha, it is possible that the collision happens at the front or the end. In slotted aloha, only collision at the end can happen.

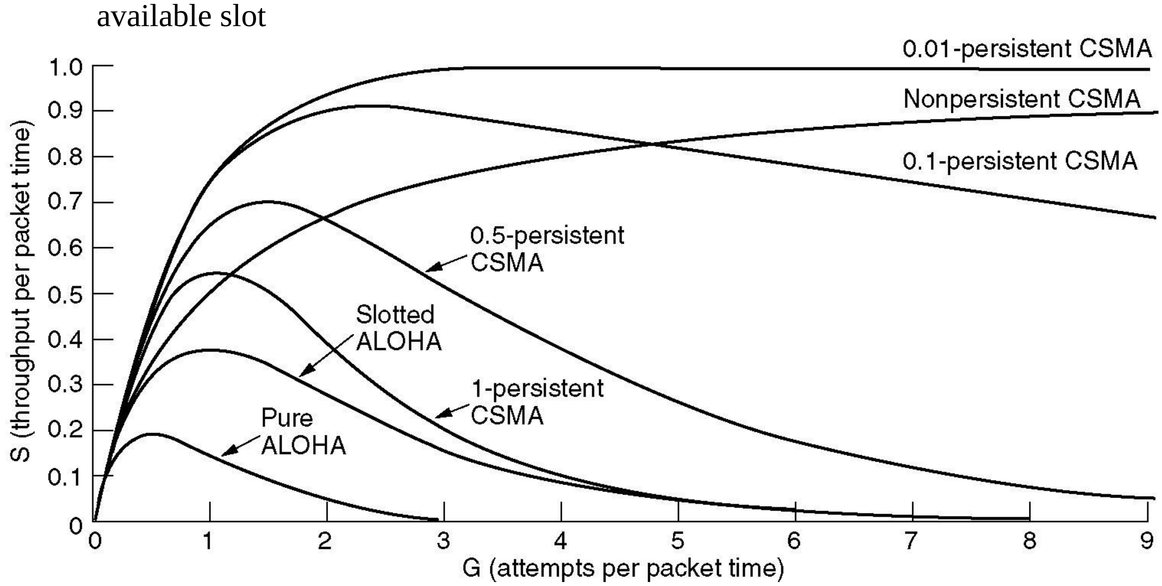
3. CSMA (Carrier Sense Multiple Access)

- adds carrier sensing → The station listens to the channel before transmitting
  - if channel free → start transmission
  - if channel busy → wait then try again
- It reduces (but not eliminate) probability of collisions (due to propagation delay)



If A sends C a frame and D senses the line before the AC frame arrives?

- 1-persistent: keep sensing the channel. Once is free, start transmission
- non-persistent: if the channel is busy, then wait a random time then sense again
- p-persistent: Used with slotted version of the protocol. p= probability to use the next available slot



4. CSMA / CD (CSMA with collision detection)

- Used by Ethernet
- Sender monitors the line during transmission.
- If collision happens, then it stops immediately and sends a jamming signal.

- wait a random time then try again

All models we talked about allow collisions. – **random access or contention protocols**
light traffic: good
heavy traffic: bad

Key: get rid of collisions once for all