CS 372 Lecture #35

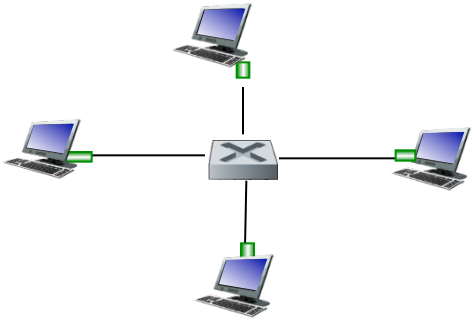
Multiple Access

- links
- protocols

Note: Many of the lecture slides are based on presentations that accompany *Computer Networking: A Top Down Approach,* 6th edition, by Jim Kurose & Keith Ross, Addison-Wesley, 2013.

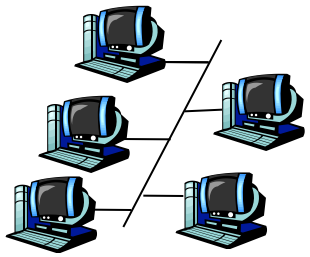
Two types of links to adjacent nodes

- point-to-point (not the same as peer-to-peer)
  - e.g., point-to-point link between host and Ethernet switch



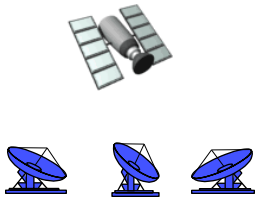
switched network
(e.g., Ethernet)

- broadcast (shared medium)
  - Multiple Access protocol required
  - e.g., old Ethernet, 802.11 wireless LAN



shared wire (e.g., cabled Ethernet)

shared RF
(e.g., 802.11 WiFi)



shared RF
(satellite)

Multiple access protocols

- For broadcast links, need Multiple Access protocol
  - distributed algorithm that determines how nodes share channel
    - single shared broadcast channel
    - protocol determines when node can transmit
    - protocol communication about channel sharing must use channel itself!
      - no out-of-band channel for coordination
    - two or more simultaneous transmissions by nodes cause interference
      - collision if node receives two or more signals at the same time

- "Ideal" multiple access protocol criteria, for broadcast channel of rate *R* bps:
  1. when only one node wants to transmit, it can send at rate R.
  2. when M nodes want to transmit, each can send at average rate R/M
  3. fully decentralized:
     - no special node to coordinate transmissions
  4. simple

Multiple Access Protocols

Three classes, no "ideal"

- Channel Partitioning (discussed in earlier lecture)
  - divide channel into smaller "pieces"
    - TDM (time-division), FDM (frequency-division)
  - allocate piece to node for exclusive use
  - easy to implement, but does not satisfy criterion #1
- Random Access
  - allow collisions
  - recover from collisions
  - difficult to guarantee criterion #2
- "Taking turns"
  - nodes with more to send can take longer turns
  - supervisor required, does not satisfy criterion #3

Random Access Protocols

- When node has packet to send
  - transmit at full channel data rate R.
  - no supervised coordination among nodes
- two or more nodes transmitting simultaneously causes collision
- random access MA protocol specifies
  - how to detect collisions
  - how to recover from collisions (e.g., via delayed retransmissions)
  - example: CSMA

CSMA (Carrier Sense Multiple Access)

- **CSMA** listen before transmit
  - If channel sensed idle: transmit entire frame
  - If channel sensed busy: defer transmission

- Collisions can still occur:
  - propagation delay means two nodes may not sense each other's transmission
  - entire packet transmission time wasted

CSMA with Collision Detection

- **CSMA/CD**
  - carrier sensing, deferral as in CSMA
  - collisions *detected* within short time
  - colliding transmissions aborted, reducing channel wastage
  - used in wired LANs
- Collision detection:
  - easy in wired LANs
    - measure signal strengths, compare transmitted, received signals
  - difficult in wireless LANs
    - received signal strength overwhelmed by local transmission strength

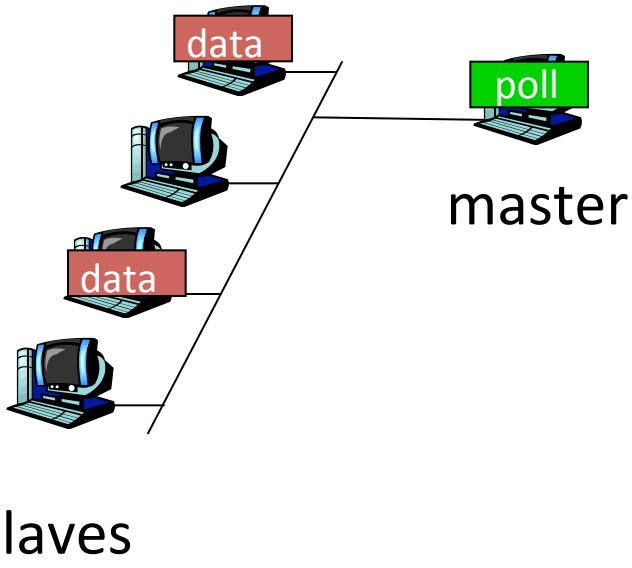
CSMA with Collision Avoidance

- **CSMA/CA** carrier sensing, deferral as in CSMA
- Wireless uses *collision avoidance* (CA) instead of collision detection (CD)
  - Transmitting computer sends very short "reservation" message to receiver
  - Destination responds with short message reserving slot for sender
- Response from destination is *broadcast* so all potential senders are notified of the reservation

- More later on wireless

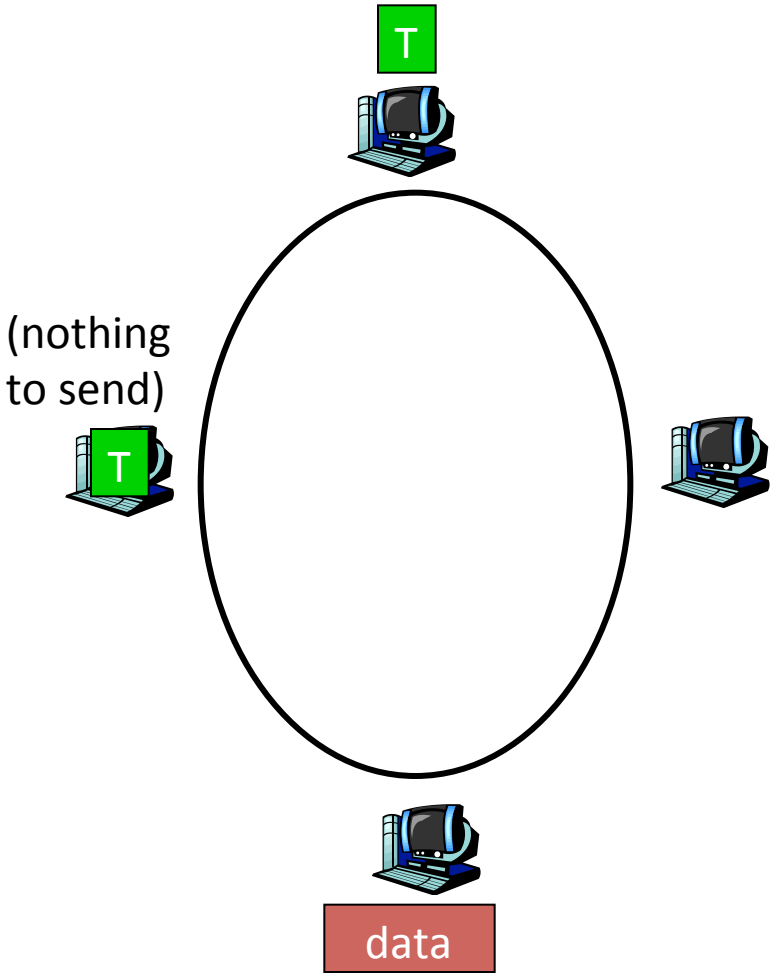
“Taking Turns” protocols

- **Polling**
  - master node “invites” slave nodes to transmit in turn
- typically used with “dumb” terminals
- concerns:
  - polling overhead, latency
  - single point of failure (master)



"Taking Turns" MA protocols

- **Token passing**
- token message
  - control token passed from one node to next sequentially.
- concerns
  - token overhead, latency
  - single point of failure (token)



Summary Lecture #35

- Broadcast links
- Multiple Access protocols
  - Channel partitioning (already covered)
  - Random access
    - CSMA, CSMA/CD, CSMA/CA
  - Taking turns
    - polling, token passing