Link Layer

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Lecture 17

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CSMA (Carrier Sense Multiple Access)

- in slotted ALOHA
  - a node's decision to transmit is made independently of the activity of the other nodes
  - a node neither pays attention to whether another node happens to be transmitting when it begins to transmit, nor stops transmitting if another node beings to interfere with its transmission
- human analogy: don't interrupt others!
  - listen before speaking
    - node listen to the channel before transmitting, **carrier sensing**
    - if a frame from another node is currently being transmitted into the channel, a node then waits until it detects no transmissions for a short amount of time and then begins transmission
  - if someone else begins talking at the same time, stop talking
    - **collision detection**: listens to the channel while transmitting
    - if detect an interfering frame, stops and waits a random amount of time before repeating the sense-and-transmit-when-idle cycle

CSMA Collisions

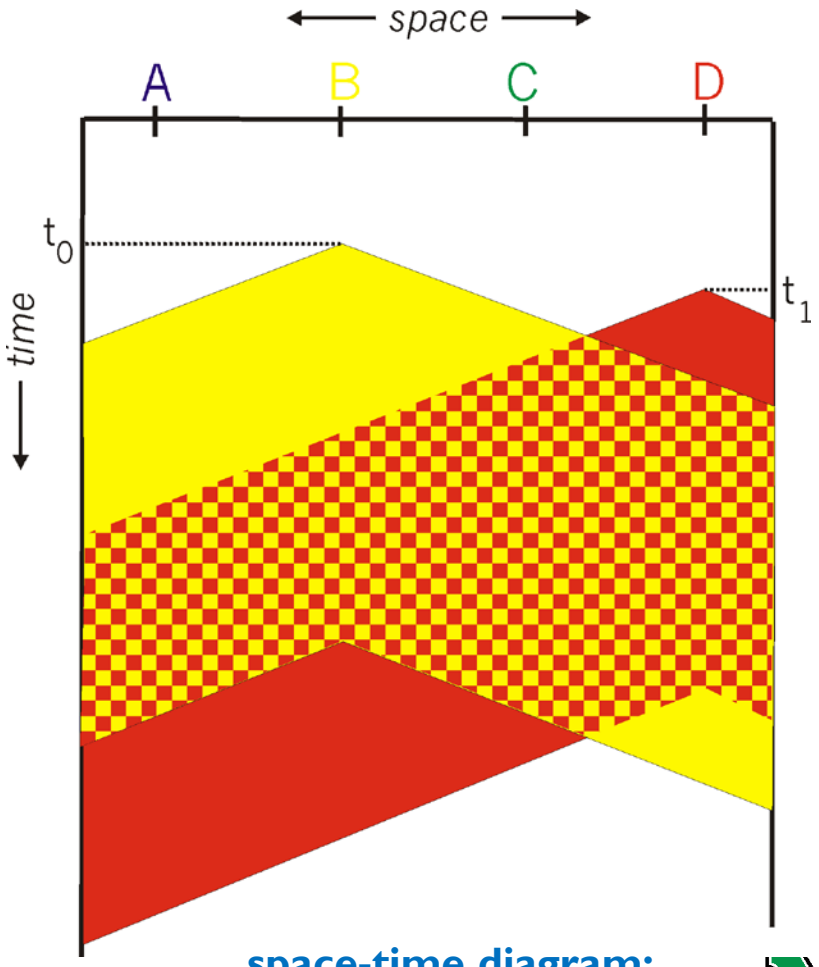
If all nodes perform carrier sensing, do collisions occur in the first place??

channel propagation delay

collisions can still occur:
propagation delay means two nodes may not hear each other's transmission

collision:
entire packet transmission time wasted

note: role of distance & propagation delay in determining collision probability
→ longer propagation delay, larger the chance that a carrier-sensing node is not yet able to sense a transmission

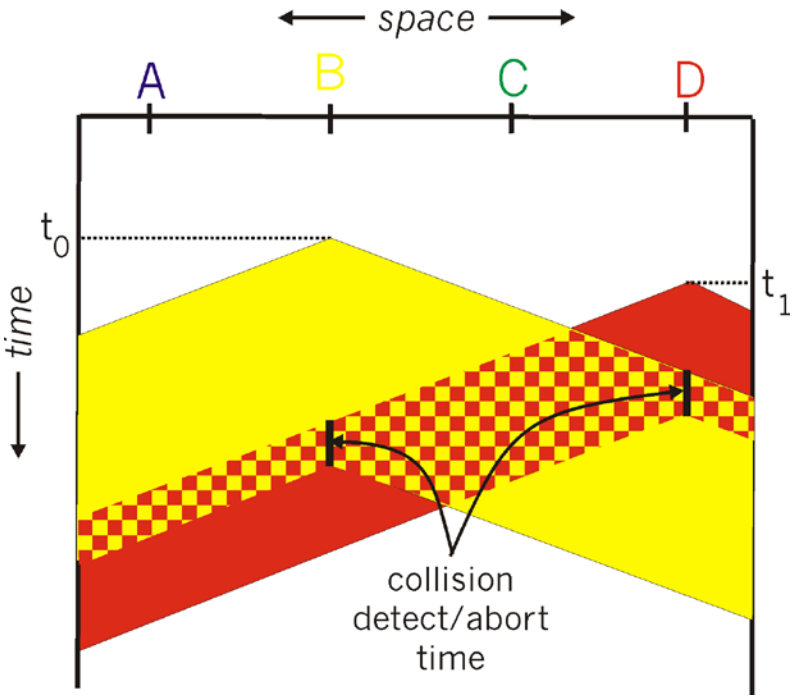


space-time diagram: spatial layout of nodes

CSMA/CD (Collision Detection)

- **CSMA/CD:** carrier sensing, deferral as in CSMA
  - when a node performs collision detection
    - it ceases transmission as soon as it detects a collision

Perform collision detection: two nodes each abort their transmission a short time after detecting a collision

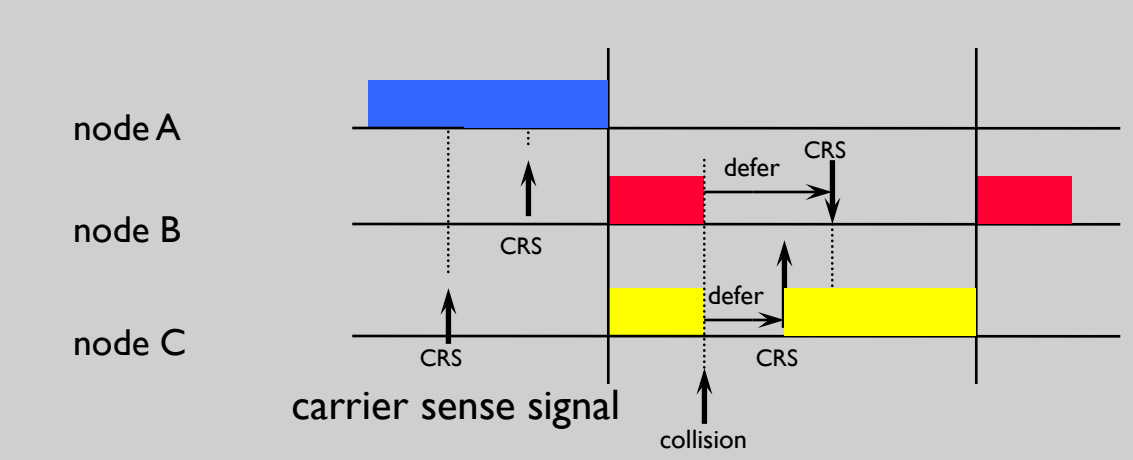


CSMA/CD (Collision Detection)

- **CSMA/CD** operations:
  1. the node obtains a datagram from the network layer, prepares a link-layer frame
  2. if the node senses that the channel is ***idle***, it starts to transmit the frame.
     - if the node senses that the channel is ***busy***, it waits until it senses no signal energy and then starts to transmit the frame
  3. while transmitting, the node ***monitors*** for the presence of signal energy coming from other nodes
  4. if the node transmit the entire frame without detecting signal energy from other nodes, the node is finished with the frame.
     - if the node ***detects signal energy*** from other nodes while transmitting, it aborts the transmission
  5. after aborting, the node waits a random amount of time and then returns to step 2

CSMA/CD (Collision Detection) (cont.)

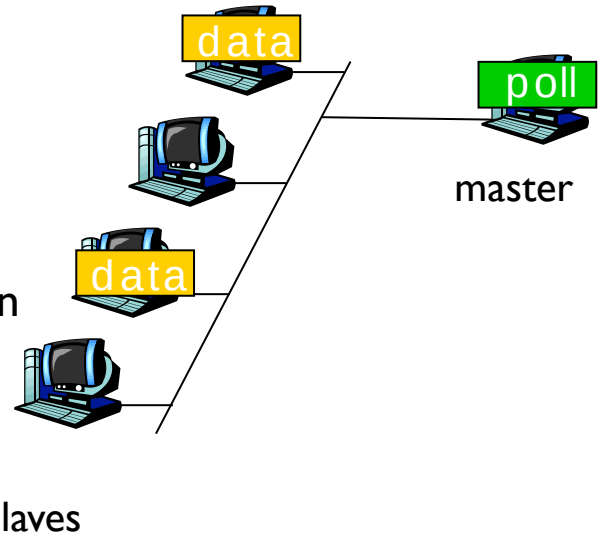
- for example,
  - if channel is sensed **idle**, transmit entire frame
  - if channel is sensed **busy**, defer transmission
    - wait a random amount of time (**back off**) and again sense the channel



"Taking Turns" MAC Protocols

polling protocol:

- designate a master node
- master node "**invites**" slave nodes to transmit in turn
  - tell node 1 that it can transmit some frames
  - after node 1 is done, tell node 2 that it can transmit some frames
- eliminate the collisions
- concerns:
  - polling overhead
  - latency
  - single point of failure (master)



"Taking Turns" MAC Protocols (cont.)

token passing protocol:

- control **token** passed from one node to next sequentially
- when a node receives a token, it holds onto the token only if it has frames to transmit.
  - if it has some frames, it sends up to a maximum number of frames, and then forwards the token to next node
  - otherwise, it immediately forwards the token to next node
- concerns:
  - token overhead
  - latency
  - single point of failure (token)
  - neglect to release the token