Link Layer (II)

Random access protocols
- when node has packet to send
  - transmit at full channel data rate R
  - no priori coordination among nodes
- two or more transmitting nodes → “collision”
- random access MAC protocol specifies:
  - how to detect collisions
  - how to recover from collisions (e.g., via delayed retransmissions)
- examples of random access MAC protocols:
  - slotted ALOHA
  - CSMA, CSMA/CD, CSMA/CA

Slotted ALOHA
- Assumption
  - all packets (frames) same size
  - time divided into equal size slots (time to transmit 1 packet)
  - nodes start to transmit only at the beginning of a slot
  - nodes are synchronized
  - if 2 or more nodes transmit in slot, all nodes detect collision
- Operation
  - when node obtains fresh packet, transmits in next slot
  - if no collision: node can send new frame in next slot
  - if collision: node retransmits frame in each subsequent slot with prob. p until success

- Advantages
  - single active node can continuously transmit at full rate of channel
  - highly decentralized: only slots in nodes need to be in sync
  - simple
- Disadvantages
  - collisions, wasting slots
  - idle slots
  - clock synchronization
CSMA

- **CSMA**: carrier sense multiple access
- **listen before transmit**:
  - if channel sensed **idle**, transmit entire packet
  - if channel sensed **busy**, defer transmission
- **human analogy**: don’t interrupt others!
- **collisions**:
  - **collisions can still occur**: propagation delay means two nodes may not hear each other’s transmission
  - when occurs: **entire packet transmission time wasted**
    - distance & propagation delay play role in determining collision probability

CSMA/CD (collision detection)

- **CSMA/CD**: carrier sensing, deferral as in CSMA
  - collisions detected within short time
  - colliding transmissions aborted, reducing channel wastage
- **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 (hidden terminal)
  - **human analogy**: the polite conversationalist
- If senses channel idea, starts frame transmission. If senses channel busy, waits until channel idle, then transmit.
- If detects another transmission while transmitting, aborts and enters exponential backoff stage.
  • longer backoff interval with more collisions.

### Hidden Terminal Problem

- A & C are in B’s communication range. So, B can send messages to both A & C and can sense A and C’s transmission.
- A can transmit to B and can sense B’s transmission, but cannot detect C.
- C can transmit to B and can sense B’s transmission, but cannot detect A.
- So, A doesn’t know whether C is transmitting to B, even if using CSMA/CD. So as for C.
- Therefore, the collisions can happen when both A and C transmit to B simultaneously.
- We call this issue Hidden Terminals.
CSMA/CA (collision avoidance)
- avoid data frame collisions completely using small reservation packets

- RTS (request-to-send): sent by the sender
- CTS (clear-to-send): AP broadcasts in response to RTS
- all nodes hear CTS: sender transmits data frame, others defer transmissions