CS6504

Mobile Computing

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Multiple Access Protocols

Outline

- Review of random-access Multiple Access Protocols
  - ALOHA
  - CSMA
  - CSMA/CD
  - CSMA/CA
- Multiple Access in Wireless LANs
  - MACA

Multiple Access

- Nodes or stations connected to or use a *common* link called a broadcast link → the need for a multiple access protocol to coordinate access to the link
- Multiple-access
  - Random-access protocols
    - ALOHA, CSMA, CSMA/CD, and CSMA/CA
  - Controlled-access protocols
    - Reservation, polling, and token passing
  - Channelization protocols
    - FDMA, TDMA, and CDMA

Random-Access

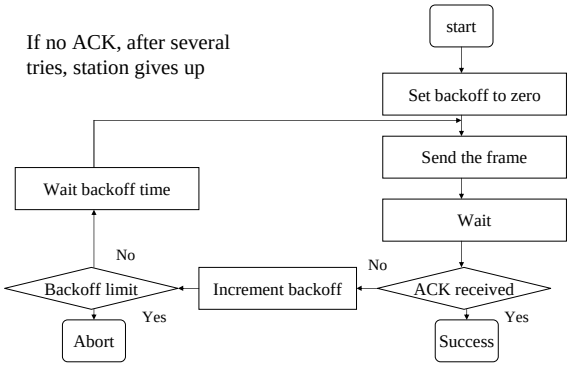
- Each station has the right to the medium without being controlled by any other station
- If more than one station tries to send, a *collision* occurs and the the frames will be garbled
- We need a protocol that answers the following questions
  - When can the station access the medium?
  - What can the station do if the medium is busy?
  - How can the station determine the success or failure of the transmission?
  - What can the station do if there is a collision?

ALOHA 1/2

- University of Hawaii, early 1970s
- Base station is a central controller
- Every station sends to BS, which relays to intended recipient
- Different upload/download frequencies
- Multiple Access: Any station sends a frame when it has a frame to send
- Acknowledgement: After sending the frame, the station waits for an acknowledgement, if no ACK during (2* *maximum propagation delay*), assume frame lost and try sending again after a random amount of time (using a *backoff strategy*)

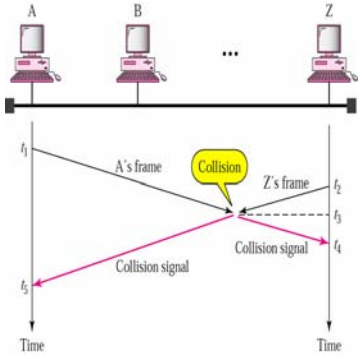
ALOHA 2/2

If no ACK, after several tries, station gives up



CSMA 1/3

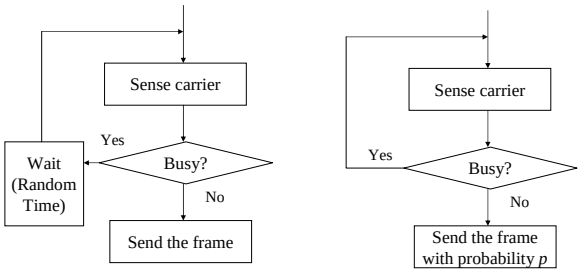
- Sense the medium before trying to use it
- Cannot eliminate collision (can reduce possibility of collision)
  - ➢propagation delay
  - ➢When a station sends a frame, it takes a while for the first bit to reach every station and for every station to sense it



CSMA 2/3

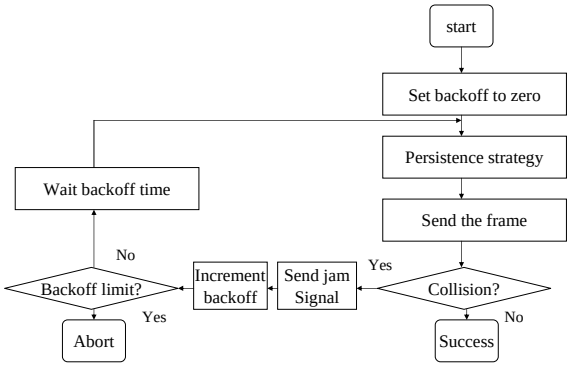
- Persistence strategy (*What to do when you sense a busy medium?*)
  - ➢Non-persistent
  - ➢Persistent
    - ✓1-persistent
      - ❑send frame if line is idle with probability 1
    - ✓*p*-persistent
      - ❑send frame if line is idle with probability *p*
      - ❑Assume p = 0.2. Generate a random number *N* between 1 and 100.
      - ❑If $N < 20$ *then* send *else* refrain from sending
  - ➢CSMA does not define the procedure for a collision

CSMA 3/3



Non-persistent Persistent

CSMA/CD 1/2



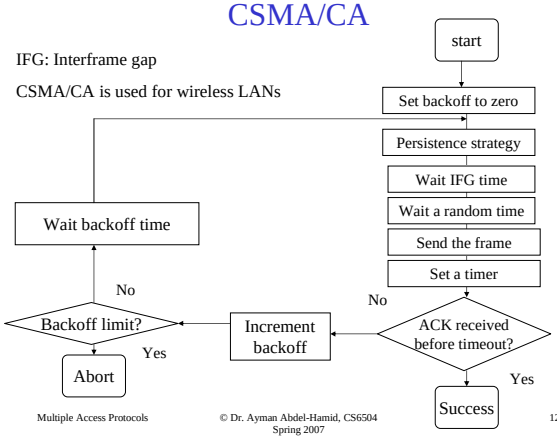
CSMA/CD 2/2

- Exponential backoff method
  - Wait a random amount of time between
    - 0 and 2^N * maximum_propagation_delay
  - where *N* is the number of attempted transmissions
- Why a jam signal?
  - ➢ Inform other stations about the collision
- Backoff limit is usually 15
- CSMA/CD is used in traditional Ethernet

CSMA/CA

IFG: Interframe gap

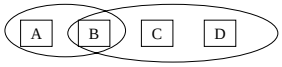
CSMA/CA is used for wireless LANs



CSMA/CD not suitable for Wireless LANs 1/2

•Collision detection implies that a station must be able to send data and receive collision signals at the same time → *costly stations and increased bandwidth requirements*

•Collision may not be detected because of *hidden terminal problem*



➢A and B are within each other's range and can potentially interfere with one another

➢C can interfere with B and D but not with A

➢A is transmitting to B and C senses the medium to send to B?

➢B transmitting to A and C senses the medium to send to D?

CSMA/CD not suitable for Wireless LANs 2/2

•Distance between stations can be great, signal fading could prevent a station at one end from hearing collision at the other end

•Exposed terminal problem

➢well-sited station X can hear far away station Y

➢X is too far from Y to interfere with its traffic to nearby stations

➢X defers to Y, wasting opportunity to reuse channel locally

MACA 1/2

Phil Karn, " MACA - A New Channel Access Method for Packet Radio ," in *Proceedings of the 9th ARRL Computer Networking Conference*, London, Ontario, Canada, 1990.

•Later used as basis for IEEE 802.11 Wireless LAN standard

•Sender stimulates the receiver into outputting a short frame (nearby stations avoid transmitting for the duration of the upcoming data frame)

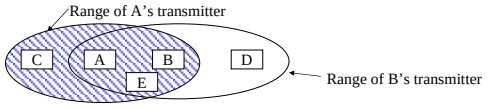
•A sends RTS (Request to Send) to B (RTS contains length of data frame to follow)

•B replies with a CTS (Clear to Send) (upon receipt of CTS, A starts transmission, CTS contains length of data copied from RTS)

•Any station hearing RTS: too close to A, remains silent enough for CTS to be transmitted back to A without conflict

•Any station hearing the CTS, too close to B, must remain silent during the upcoming data transmission

MACA 2/2



•C within range of A but not within range of B

➢hears RTS from A but not CTS from B

➢As long as it does not interfere with the CTS, it is free to transmit while the data frame is sent

•D within range of B but not A

➢Does not hear RTS but hears CTS

➢Defers from sending anything until that frame is expected to finish

•E hears both control messages, silent until data frame completed

•B and C could both send RTS to A at the same time. Use exponential backoff in case of collision