CS 348: Computer Networks

- CSMA; 13th Aug 2012

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Clicker Question

Suppose a MAC protocol does not impose any constraints and permits any sender to immediately transmit whenever it has data.

What do you feel about implementing such a protocol?

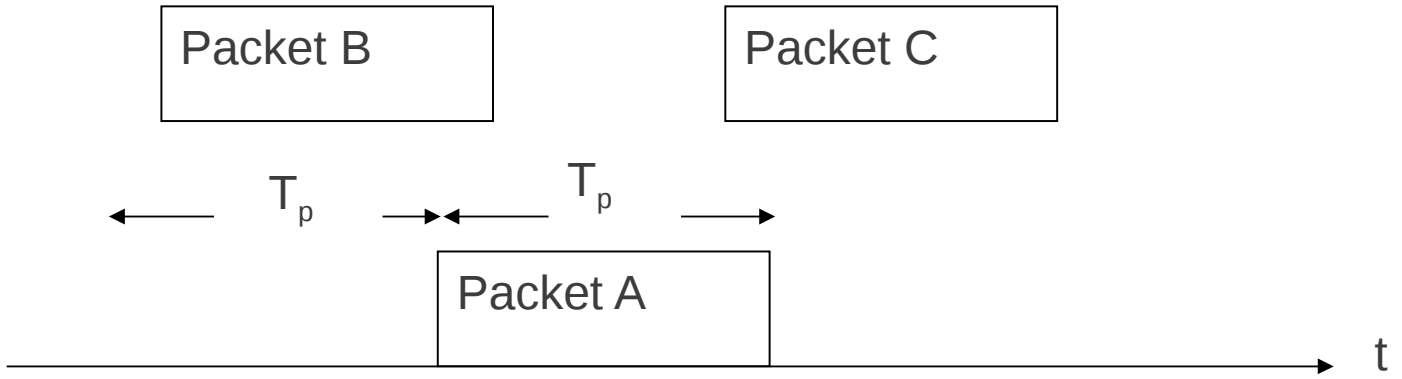
1. It would be too inefficient and is not worth implementing.	2. It would be easy to implement and is worth considering.
3. It can cause unbounded delays for the upper layers.	4. It can be used for senders having stream data.

Contention-based MAC: ALOHA

- Users transmit whenever they have data to send
- Collisions occur, and if packet is lost, then source has to retransmit
- Collision are detected by
  - listening while transmitting
  - loss of acknowledgements
- If collision, then sender waits random time to avoid repeated collision

Vulnerable interval

- For a given frame, the time when no other frame may be transmitted if a collision is to be avoided.
- Assume all packets have same length (L) and require T_p seconds for transmission
- Each packet vulnerable to collisions for time V_p= ??



ALOHA: Vulnerable interval

- Suppose packet A sent at time t_0
- If pkt B sent any time in $[t_0 - T_p$ to $t_0]$
  - end of packet B collides with beginning of packet A
- If pkt C sent any time in $[t_0$ to $t_0 + T_p]$
  - start of packet C will collide with end of packet A
- Total vulnerable interval for packet A is $2T_p$

- Can we do something to improve the efficiency?

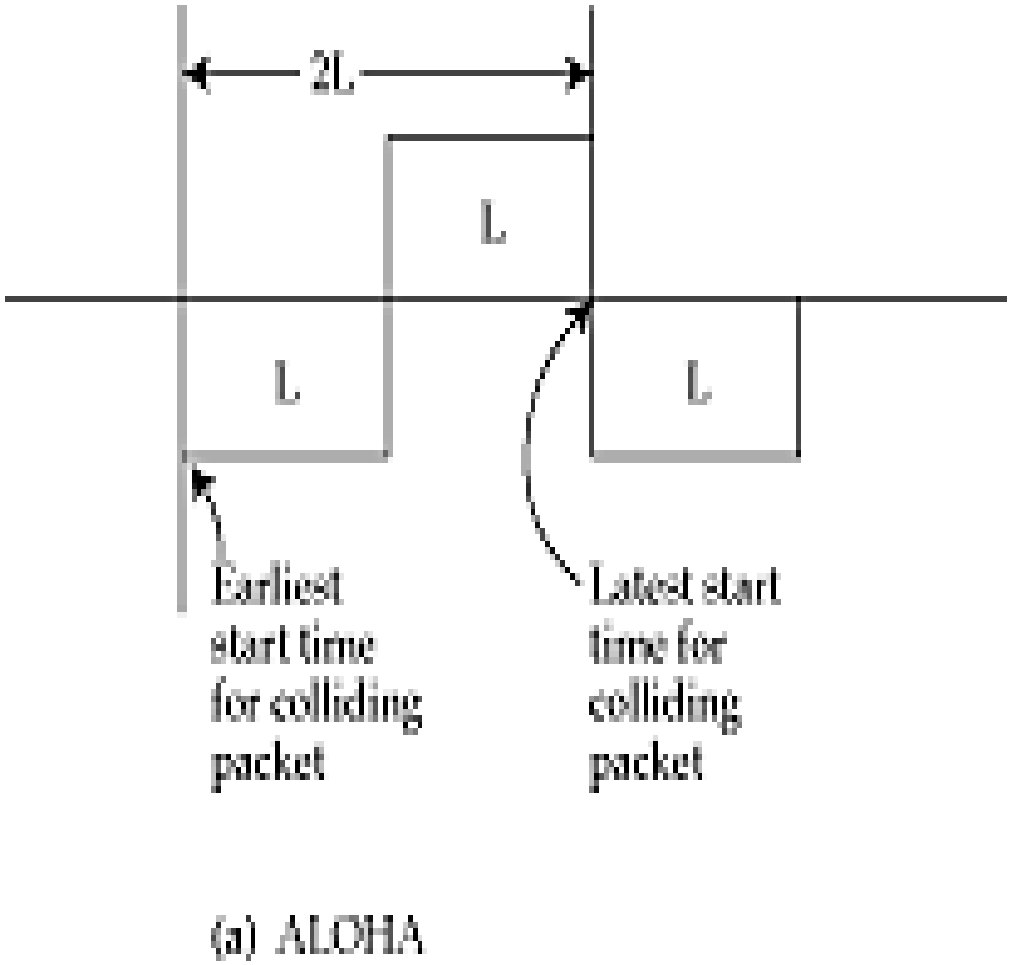
Slotted ALOHA

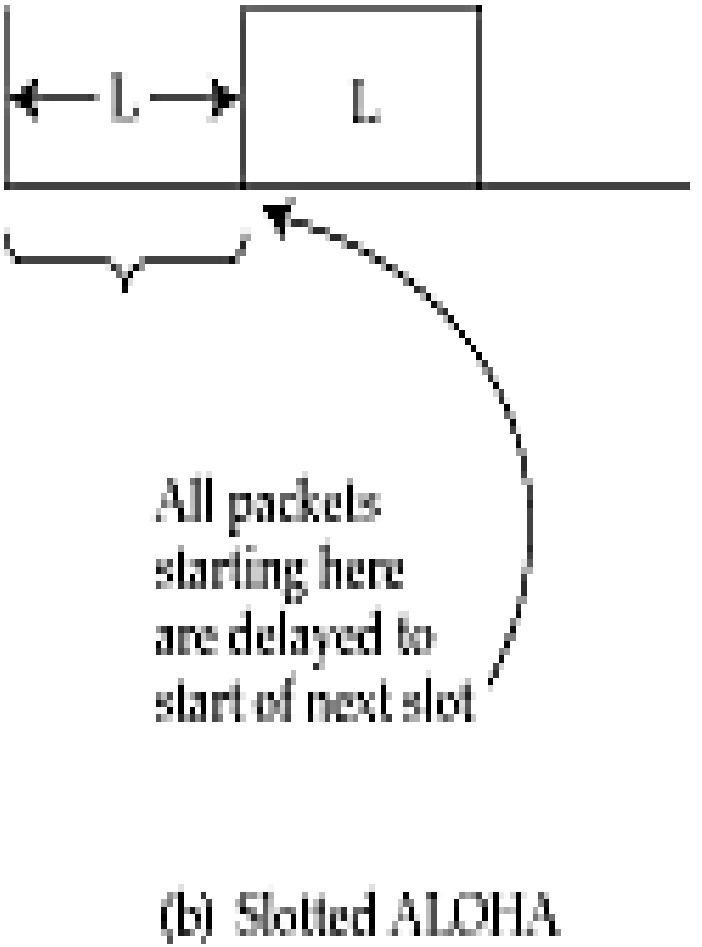
- A simple way to double ALOHA's capacity
- Make sure transmissions start on a slot boundary
- Halves *vulnerability interval*

- Requires global synchronization
- Master station generates *synchronization pulses* for time-slots

- Used in cellular phone uplink

Slotted ALOHA





Carrier Sense Multiple Access

- Listen before you speak
- Check whether the medium is active before sending a packet (i.e *carrier sensing*)
- If medium is idle, then transmit
- If collision happens, then detect and resolve

Activity: Think-Pair-Share

Suppose your group now has to work out the details:

- What are needed to enable collision detection?
- How does a station recover from collision?

- Hint: Typical Ethernet (10BaseT; 100BaseT) has
  - A minimum frame size (64 bytes).
  - A maximum segment length (100 meters?).
  - Think about why these are required and how these numbers are arrived at.

1 - Persistent CSMA

- Sense the channel.
- IF the channel is *idle*, THEN transmit.
- IF the channel is *busy*, THEN continue to listen until channel is *idle.*
- Now transmit immediately.

P - Persistent CSMA

- Sense the channel.
- IF the channel is *idle*, THEN
  - with probability p transmit and
  - with probability (1-p) delay for *one time slot* and start over.
- IF the channel is *busy*, THEN delay *one time-slot* and start over.

  - Time slot is usually set to the maximum propagation delay.
  - as p decreases,
    - stations wait longer to transmit, but
    - the number of collisions decreases

Non-Persistent CSMA

- Sense the channel.
- IF the channel is *idle*, THEN transmit.
- If the channel is *busy,* THEN wait a *random amount of time* and start over.

- Random time needs to be chosen appropriately.

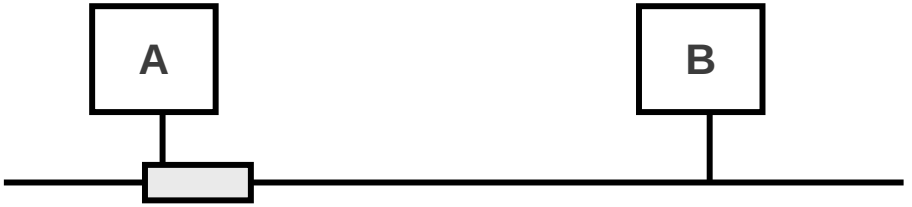
Collision detection (CSMA/CD)

- All aforementioned scheme can suffer from collision.

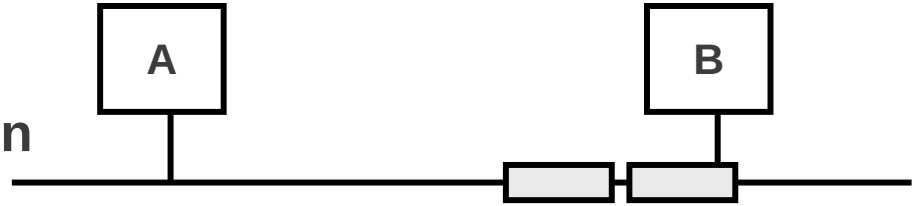
- Device can detect collision by:
  - Listen while transmitting.
  - Transmit for 2 * propagation delay.
  - Jamming signal.

Contention Interval - 2D

t = 0: A begins transmission



t = D - ε : packet almost at B
B begins transmission

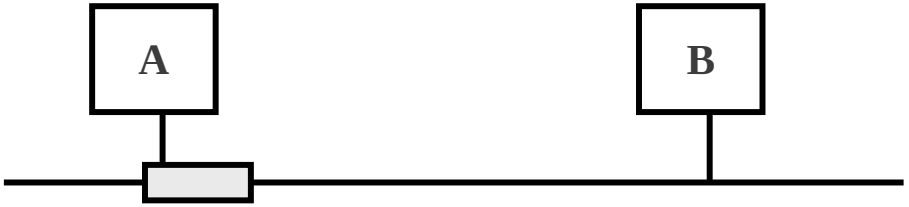


t = D: B detects collision,
stops transmitting

t = 2D - ε : A detects collision

Minimum frame size

t = 0: A begins transmission



t = D - ε : packet almost at B
B begins transmission

t = D: B detects collision,
stops transmitting

t = 2D - ε : A detects collision

Minimum frame size

- It takes A a complete RTT (2D) to detect collision
- When B detects collision (gets more power than it is putting out) it generates 48-bit noise burst (“Jam” bits) to warn all other stations
- Min. frame size equal to number of bits transmitted during one RTT:
  - slotTime: number of bits transmitted by a source during the max. RTT (2D = 51.2 µsec) for any Ethernet network.
  - Collisions must be detected by sources while still transmitting
  - All frames must be at least 1 slot (on 10Mbps, this is 512 bits)

Collision recovery

- On collision detection wait for random time before retrying.
- Binary Exponential Backoff Algorithm:
  - Reduces the chances of two waiting stations picking the same random time.

Binary Exponential Backoff

1.On detecting 1st collision for packet x

station A chooses a number r between 0 and 1.

waits for r * slot time and transmit.

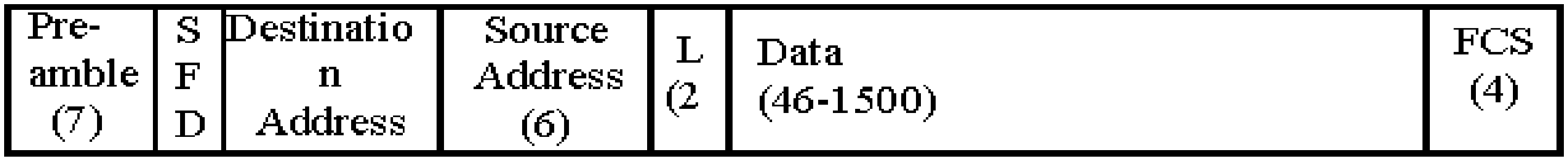
k. On detecting kth collision for packet x

choose r between 0,1,..,(2^k –1)

- When value of k becomes high (10), give up.
- Randomization increase with larger window, but delay increases.
- Slot time is 2 * propagation delay.

Frame: Ethernet (IEEE 802.3)

- CSMA/CD with jamming
- Ethernet Address (48 bits)
  - Example: 08:00:0D:01:74:71
- Ethernet Frame Format
  - Why 46-1500 bytes?



Activity: Pair-Solo

Consider two nodes communicating using the CSMA/CD protocol (as in Ethernet).

- Suppose the bandwidth is 100 Mbps, the frame size is 1500 bytes and propagation speed is 3x10^8 m/sec.
- Calculate the maximum possible distance between the nodes such that the sender can detect any collision.

- Pair - Discuss the solution approach with your neighbour.
- Solo - Work out the answer by yourself.