Lecture 23: Media Access Control

CSE 123: Computer Networks
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HW 4 DUE MONDAY
Lecture 23 Overview

- Methods to share physical media: multiple access
  - Fixed partitioning
  - Random access

- Channelizing mechanisms

- Contention-based mechanisms
  - Aloha
Fixed Partitioning

- Need to share media with multiple nodes \((n)\)
  - Multiple *simultaneous* conversations

- A simple solution
  - Divide the channel into multiple, separate \textit{channels}

- Channels are physically separate
  - Bitrate of the link is split across channels
  - Nodes can only send/receive on their assigned channel

- Several different ways to do it
  - _____ \textit{Multiple Access} madlibs…

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Frequency Division (FDMA)

- Divide bandwidth of $f$ Hz into $n$ channels each with bandwidth $f/n$ Hz
  - Easy to implement, but unused subchannels go idle
  - Used by traditional analog cell phone service, radio, TV
Time Division (TDMA)

- Divide channel into rounds of $n$ time slots each
  - Assign different hosts to different time slots within a round
  - Unused time slots are idle
  - Used in GSM cell phones & digital cordless phones

- Example with 1-second rounds
  - $n=4$ timeslots (250ms each) per round

If a sender has a signal to send, how long can they expect to wait until they can transmit?

A. No waiting  
B. 250 ms  
C. 500 ms  
D. 1 s

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Code Division (CDMA)

- Do nothing to physically separate the channels
  - All stations transmit at same time in same frequency bands
  - One of so-called spread-spectrum techniques

- Sender modulates their signal on top of unique code
  - Sort of like the way Manchester modulates on top of clock
  - The bit rate of resulting signal much lower than entire channel

- Receiver applies code filter to extract desired sender
  - All other senders seem like noise with respect to signal

- Used in newer digital cellular technologies
Broadband modulation is a form of which media access scheme?
A. Frequency  
B. Time  
C. Code  
D. None of the above
Problem w/Channel partitioning

- Not terribly well suited for random access usage
  - Why?

- Instead, design schemes for more common situations
  - Not all nodes want to send all the time
  - Don’t have a fixed number of nodes

- Potentially higher throughput for transmissions
  - Active nodes get full channel bandwidth
Aloha

- Designed in 1970 to support wireless data connectivity
  - Between Hawaiian Islands—rough!

- Goal: distributed access control (no central arbitrator)
  - Over a shared broadcast channel

- Aloha protocol in a nutshell:
  - When you have data **send it**
  - If data doesn’t get through (receiver sends acknowledgement) then **retransmit after a random delay**
  - Why not a fixed delay?
Collisions

- Frame sent at $t_0$ collides with frames sent in $[t_0-1, t_0+1]$
  - Assuming unit-length frames
  - Ignores propagation delay
Slotted Aloha

- Time is divided into equal size slots (frame size)
- Host wanting to transmit starts at start of next slot
  - Retransmit like w/Aloha, but quantize to nearest next slot
- Requires **time synchronization** between hosts

Example has 3 successes out of 9 slots. Is that performance...?

A. Worse than expected  
B. Better than expected  
C. About right  
D. A miracle!
Channel Efficiency

Q: What is max fraction slots successful?
A: Suppose $n$ stations have packets to send
  - Each transmits in slot with probability $p$
  - $\text{Prob}[\text{successful transmission}], S$, is:
    
    $S = p \cdot (1-p)^{(n-1)}$

  - any of $n$ nodes:
    
    $S = \text{Prob[one transmits]} = np(1-p)^{(n-1)}$
    
    (optimal $p$ as $n \to \infty = 1/n$)
    
    $= 1/e = .37$

*At best:* channel used for useful transmissions 37% of time!
Carrier Sense (CSMA)

- Aloha transmits even if another host is transmitting
  - Thus guaranteeing a collision

- Instead, listen *first* to make sure channel is idle
  - Useful only if channel is frequently idle
  - Why?

- How long to be confident channel is idle?
  - Depends on maximum propagation delay
  - Small (<<1 frame length) for LANs
  - Large (>>1 frame length) for satellites
Retransmission Options

- **non-persistent CSMA**
  - Give up, or send after some random delay
  - Problem: may incur larger delay when channel is idle

- **1-persistent CSMA**
  - Send as soon as channel is idle
  - Problem: blocked senders all try to send at once

- **P-persistent CSMA**
  - If idle, send packet with probability $p$; repeat
  - Make sure $(p \times n) < 1$
Even with CSMA there can still be collisions. Why?

- If nodes can detect collisions, abort! (CSMA/CD)
  - Requires a minimum frame size (“acquiring the medium”)
  - $B$ must continue sending (“jam”) until $A$ detects collision

- Requires a full duplex channel
  - Wireless is typically half duplex; need an alternative
For Next Time

- NO CLASS FRIDAY
- HW 4 due on Monday
- Have a great Thanksgiving break!