

Lecture 24:

Media Access Control

CSE 123: Computer Networks
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Lecture 24 Overview



- Methods to share physical media: **multiple access**
 - ◆ Fixed partitioning
 - ◆ Random access
- Channelizing mechanisms
- Contention-based mechanisms
 - ◆ Aloha



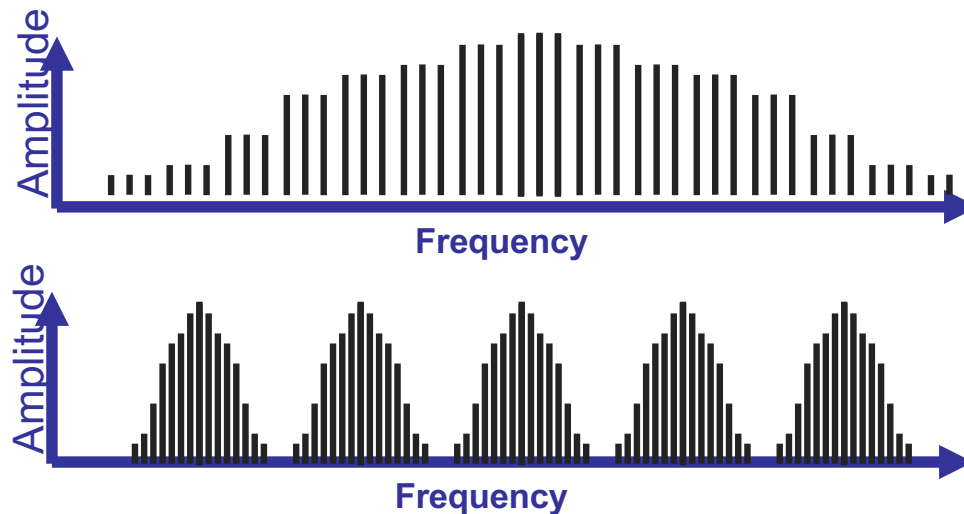
Fixed Partitioning

- Need to share media with multiple nodes (n)
 - ♦ Multiple *simultaneous* conversations
- A simple solution
 - ♦ Divide the channel into multiple, separate **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
 - ♦ _____ **Multiple Access** madlibs...

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



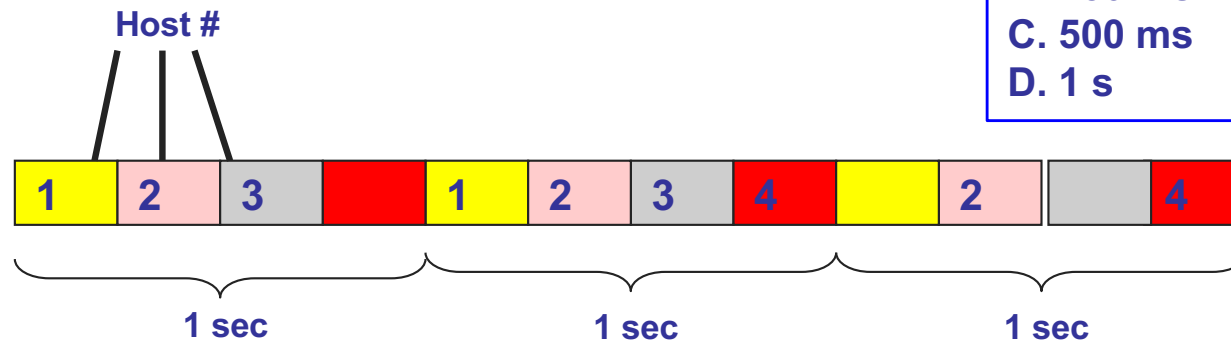


Time Division (TDMA)

- 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

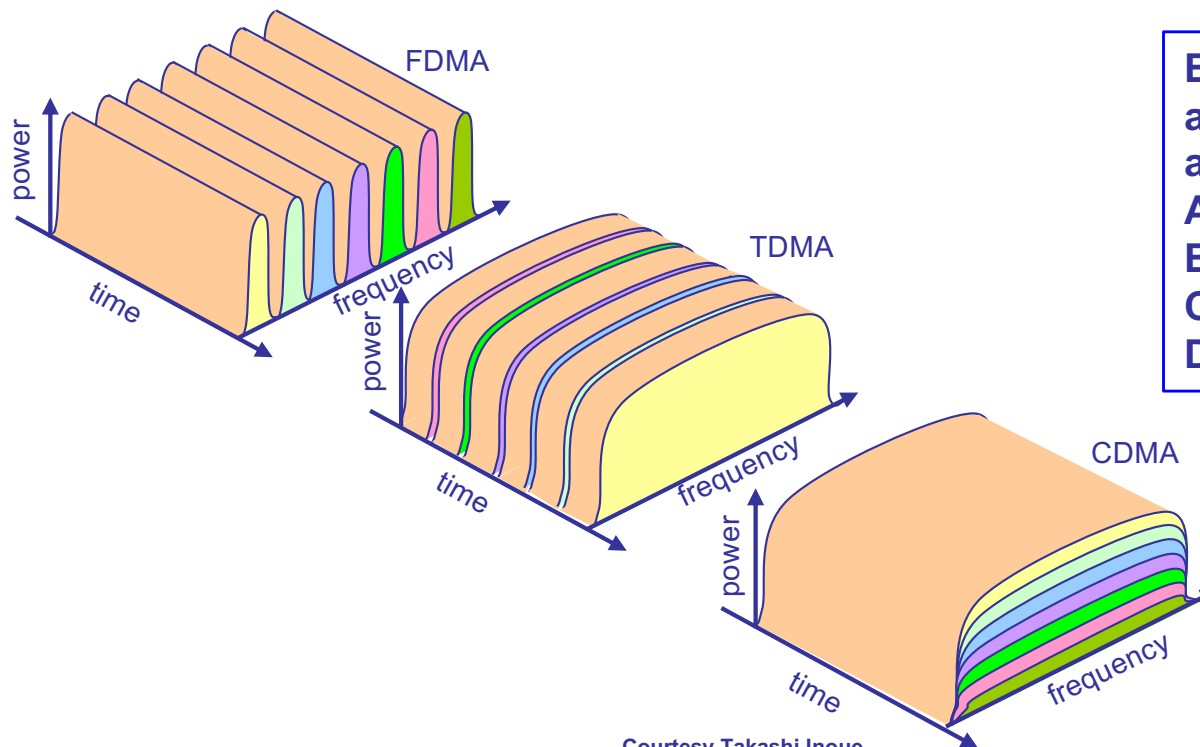




Code Division (CDMA)

- 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

Partitioning Visualization



Courtesy Takashi Inoue

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

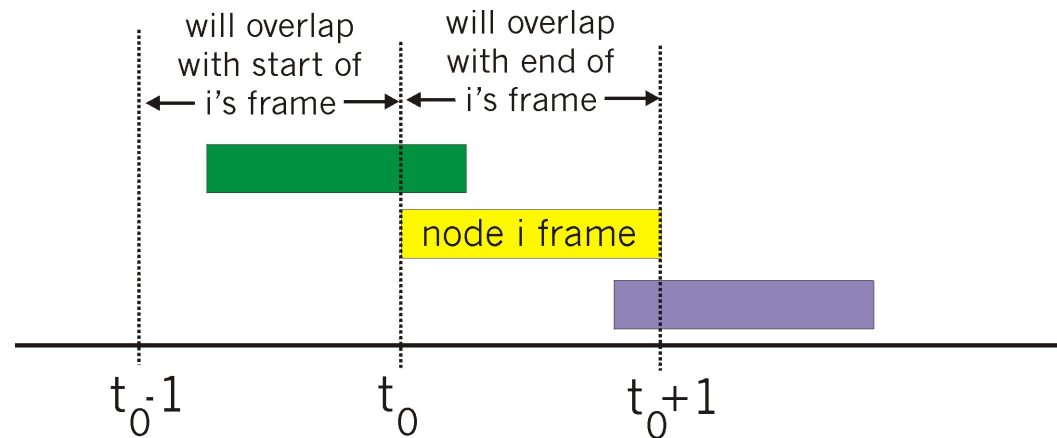


- Designed in 1970 to support wireless data connectivity
 - ◆ Between Hawaiian Islands—rough!
- Goal: distributed access control (no central arbitrator)
 - ◆ Over a shared *broadcast* channel
- Aloha protocol in a nutshell:
 - ◆ When you have data **send it**
 - ◆ If data doesn't get through (receiver sends acknowledgement) then **retransmit after a random delay**
 - ◆ Why not a fixed delay?

Collisions



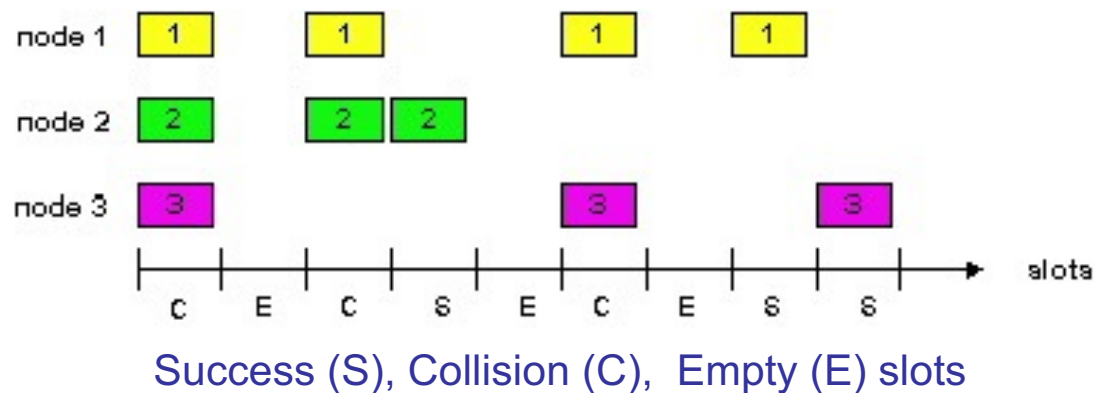
- Frame sent at t_0 collides with frames sent in $[t_0-1, t_0+1]$
 - ♦ Assuming unit-length frames
 - ♦ Ignores propagation delay





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



Channel Efficiency



Q: What is max fraction slots successful?

A: Suppose n stations have packets to send

- ◆ Each transmits in slot with probability p
- ◆ Prob[successful transmission], S , is:

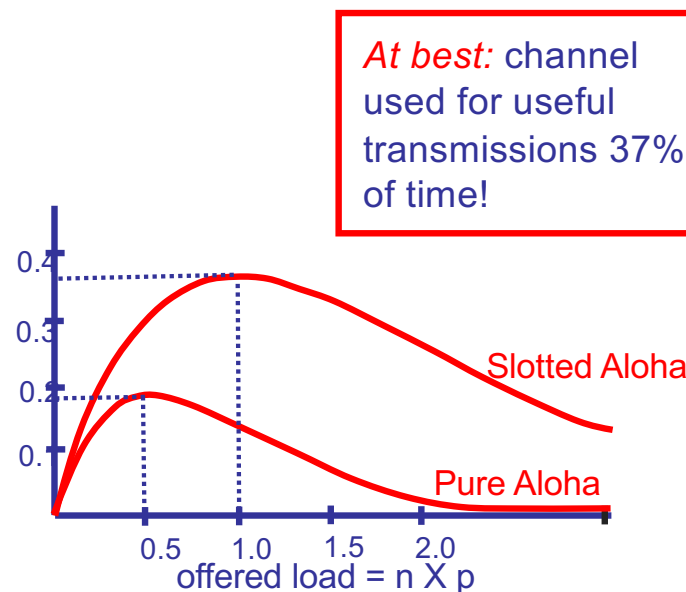
$$S = p (1-p)^{(n-1)}$$

- ◆ any of n nodes:

$$S = \text{Prob}[\text{one transmits}] = np(1-p)^{(n-1)}$$

(optimal p as $n \rightarrow \text{infinity} = 1/n$)

$$= 1/e = .37$$





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 ($\ll$ 1 frame length) for LANs
 - ♦ Large ($\gg$ 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 $(p * n) < 1$

For Next Time

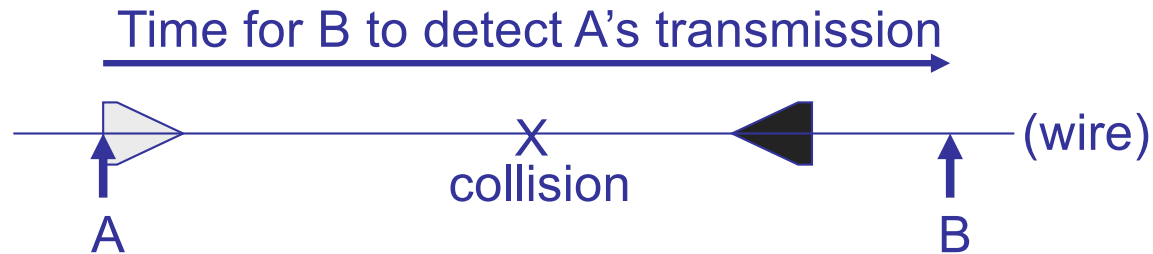


- Project 2b due Monday

Jamming



- 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