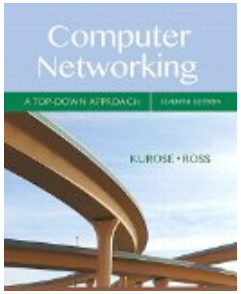
COMP 375: Lecture 37



- **News & Notes:**
  - Project #5 due Friday @ 10PM
  - Quiz #9 in class Friday
- **Reading (Fri, May 4)**
  - Sections 8.{1-3} (Crypto and Authentication)

Project 5 Clarifications

- Protocol must be **robust**
  - Gracefully handle info request for non-existent song ID
  - Gracefully handle request to play a non-existing song ID
- FileSender must be **memory efficient**
  - Do **not** read whole file into array then try to send that array.
- Make sure you test with multiple clients

Section 6.3

MEDIA ACCESS

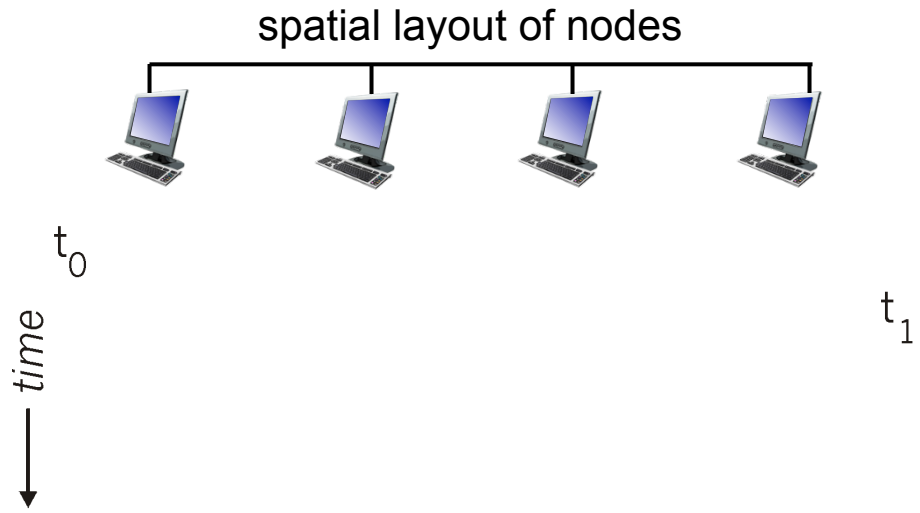
Carrier Sensing Multiple Access (CSMA) has nodes listen before transmitting.

- If channel sensed **idle:** transmit
- If channel sensed **busy**: defer transmission.

Discuss: Can we always tell if someone else is currently transmitting?

Collisions can still occur in CSMA because of **propagation delay**.

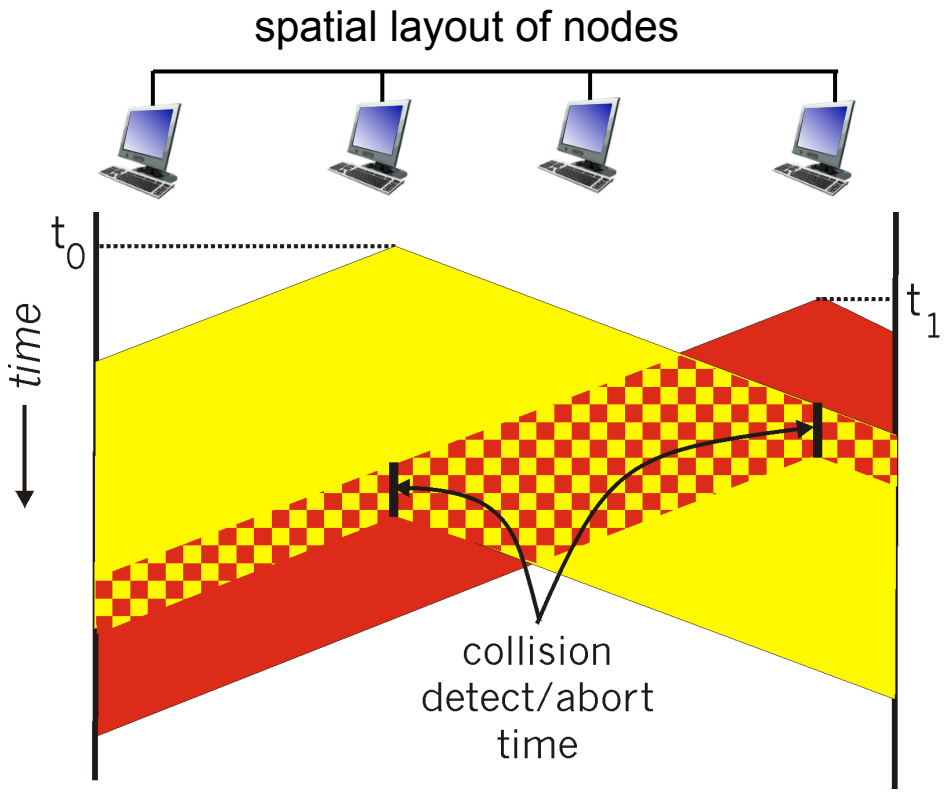
- Node may not hear that another has started transmitting already.
- Distance partly determines collision probability.



CSMA can add **collision detection** to cut down on wasted transmission time.

- **Easy in wired LANs**: measure signal strengths, compare transmitted, received signals
- **Difficult in wireless LANs**: received signal strength overwhelmed by local transmission strength

CSMA/CD (**C**ollision **D**etection)



CSMA/CD in Ethernet

1. NIC receives datagram from network layer, creates frame
2. If NIC senses channel idle, starts frame transmission. If NIC senses channel busy, waits until channel idle, then transmits.
3. If NIC transmits entire frame without detecting another transmission, NIC is done with frame!
4. If NIC detects another transmission while transmitting, aborts and sends jam signal
5. After aborting, NIC enters ***binary (exponential) backoff***

Exponential Back Off adapts retransmissions to number of collisions.

- After m^{th} collision, NIC chooses K at random from $\{0,1,2, \ldots, 2^m-1\}$.
- NIC waits K·512 bit times, then returns to checking if the channel is idle
- Longer back off interval with more collisions

How many of our desired properties does ***CSMA/CD*** give us?

1. If only one node wants to transmit, it can send at rate R.

2. When M nodes want to transmit, each can send at average rate R/M (fairness)

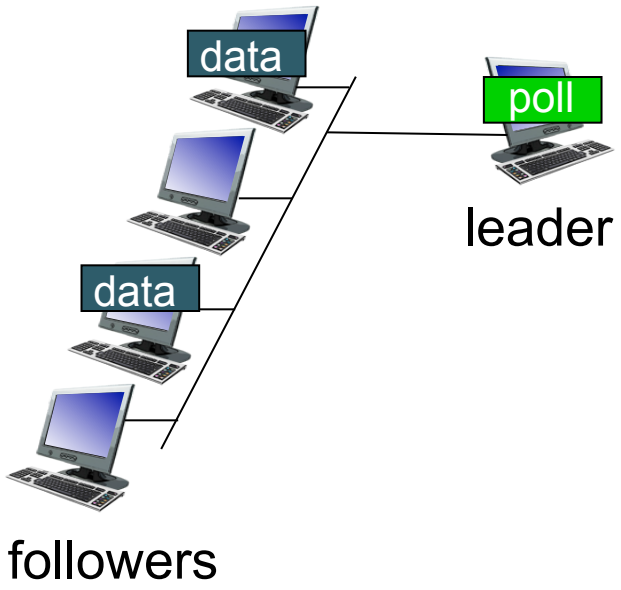
3. Fully decentralized:

- no synchronization of clocks, slots
- no special node to coordinate transmissions

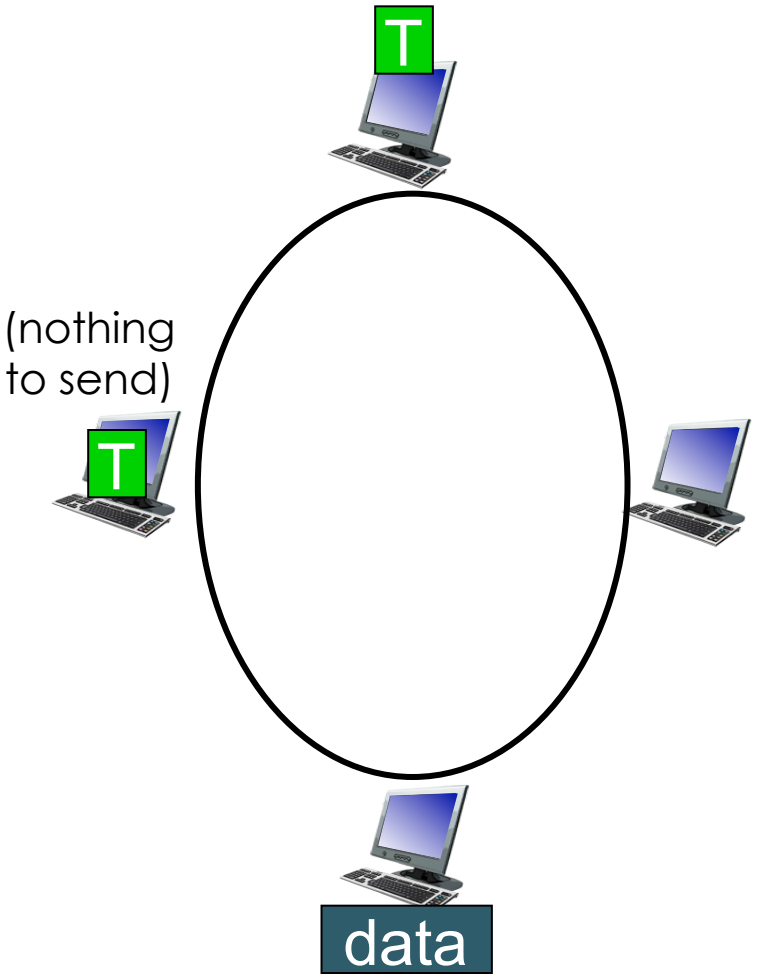
4. Simple

A.	0
B.	1
C.	2
D.	3
E.	4

Taking-turns: Polling



Taking-turns: Token Passing



How many of our desired properties does ***token passing*** give us?

1. If only one node wants to transmit, it can send at rate R.

2. When M nodes want to transmit, each can send at average rate R/M (fairness)

3. Fully decentralized:

- no synchronization of clocks, slots
- no special node to coordinate transmissions

4. Simple

A.	0
B.	1
C.	2
D.	3
E.	4

In practice, techniques are often combined.

- **Book Example**: DOCSIS

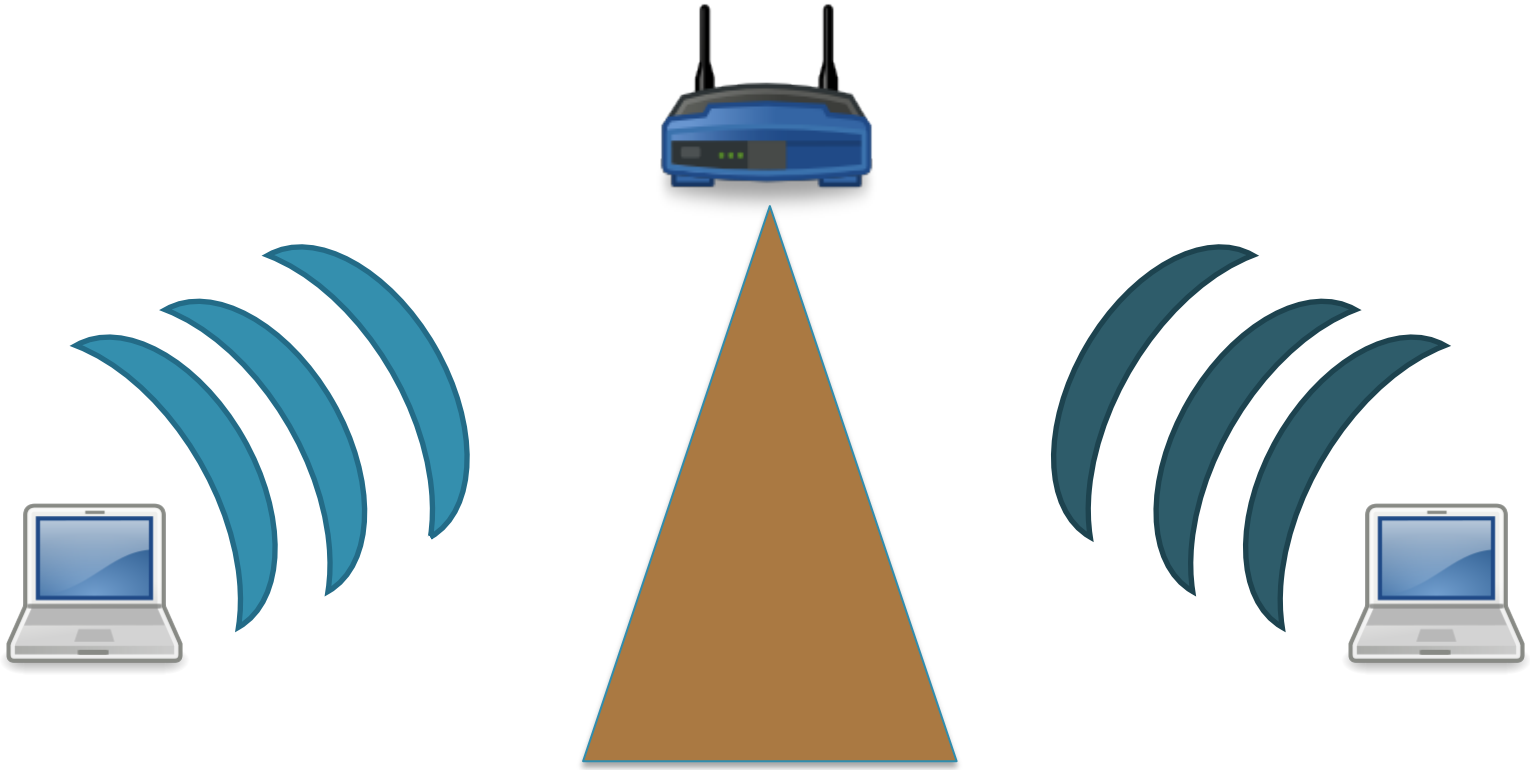
- **Class Example**: 802.11 Wireless

WiFi (802.11) senders do carrier sensing, like Ethernet.

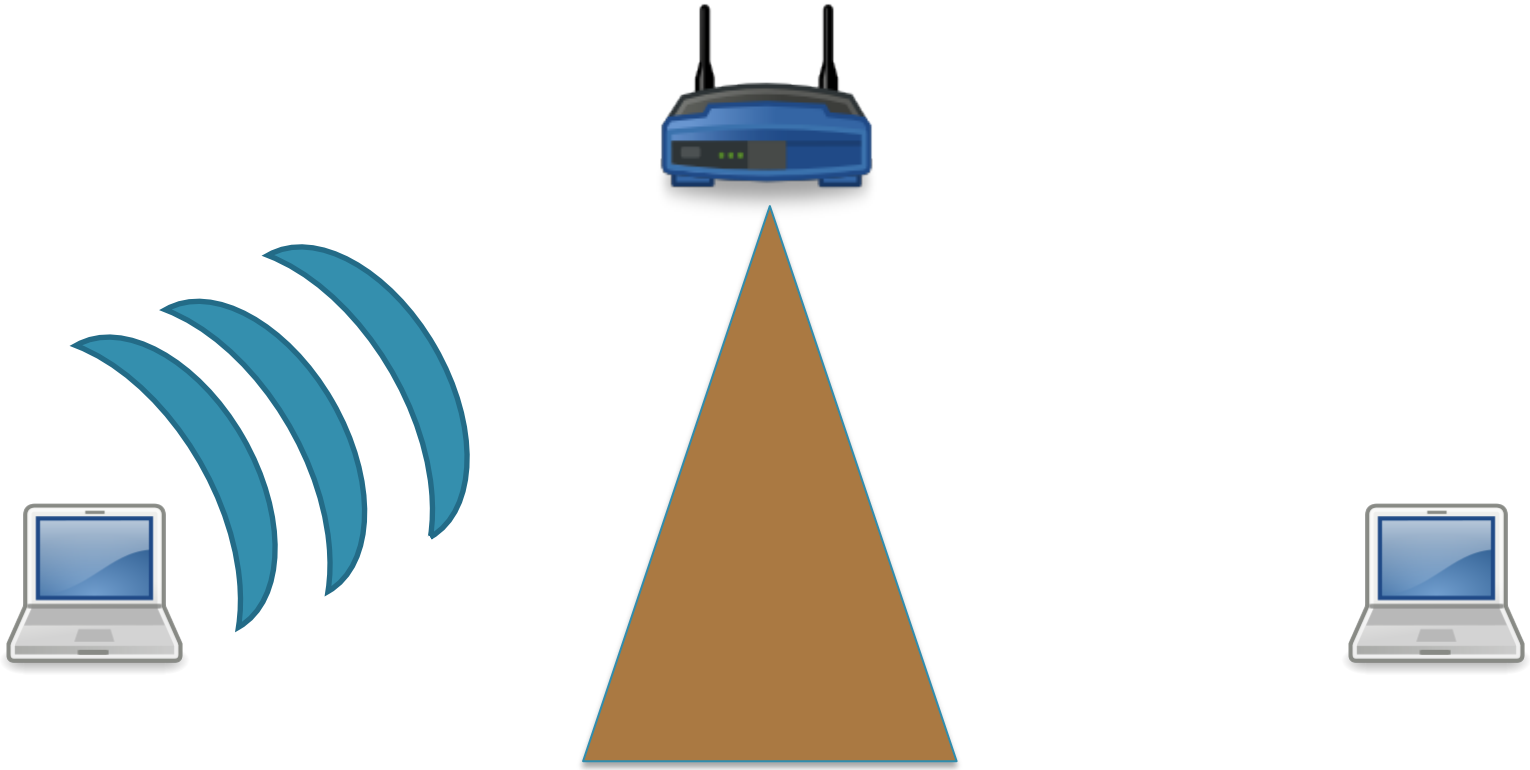
Assumes hosts can hear each other!

Senders collide at receiver, but they can't hear each other!

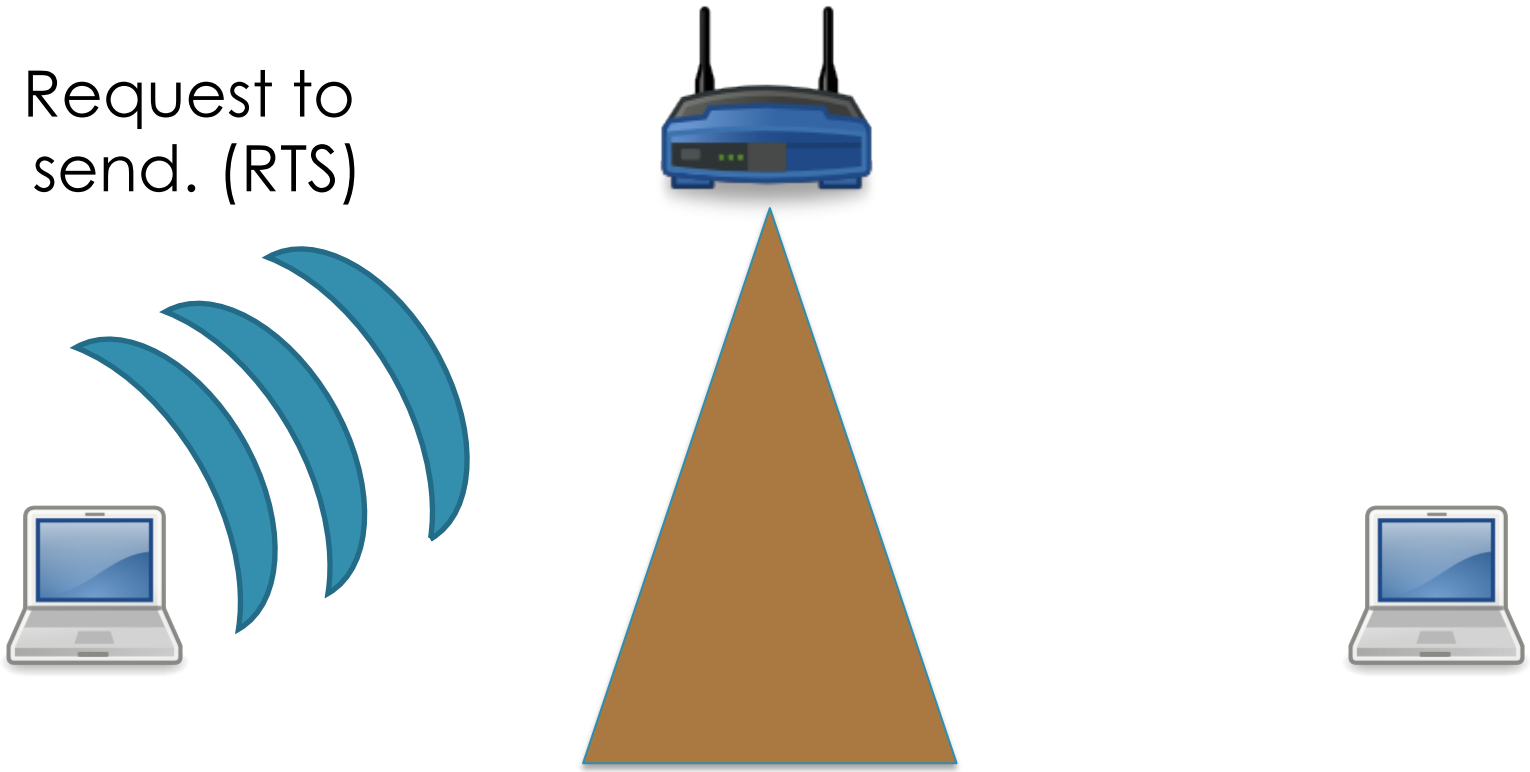
This is known as the "Hidden Terminal" problem.



If sending a small frame, just send it.

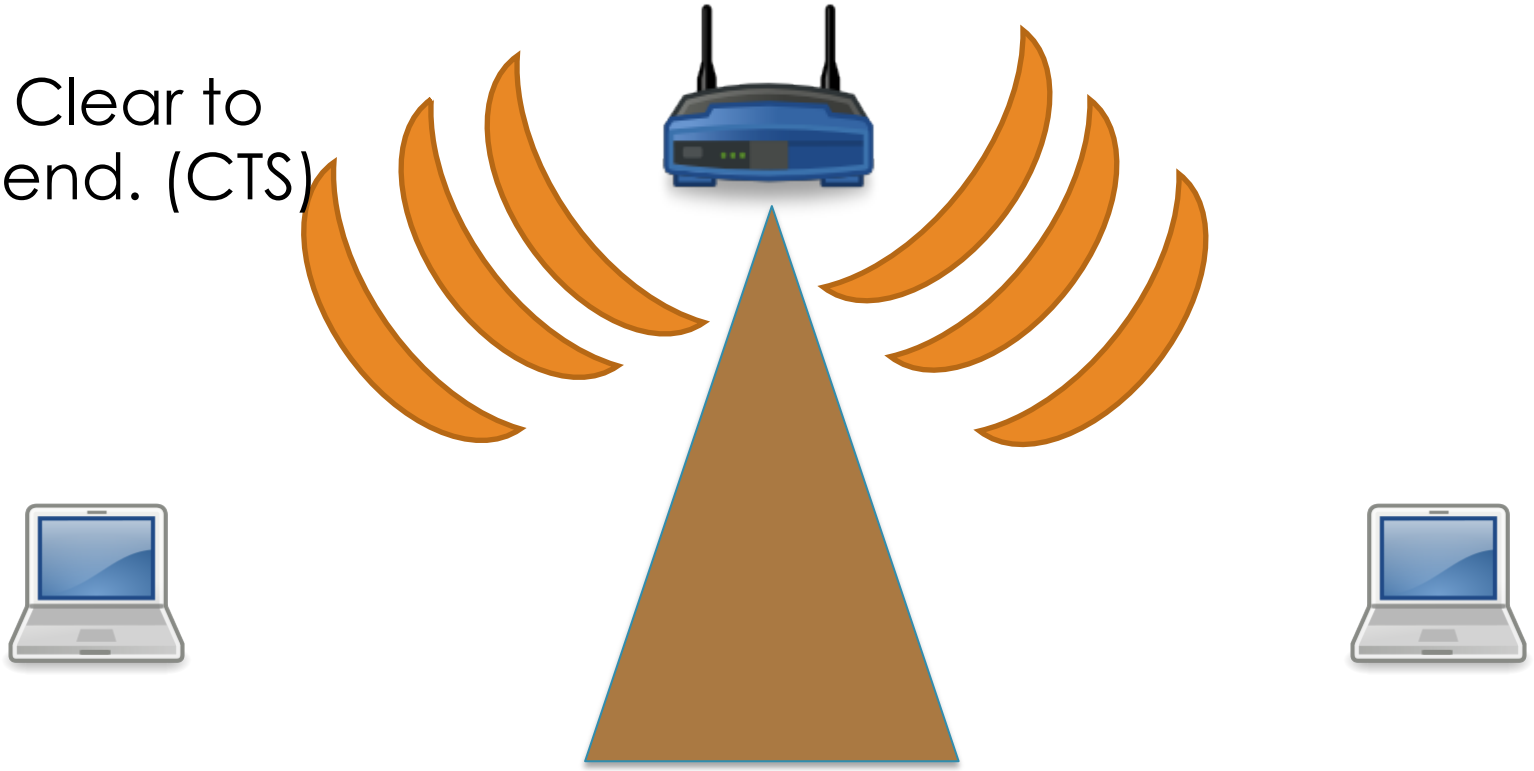


If sending large frame, node asks for permission first.

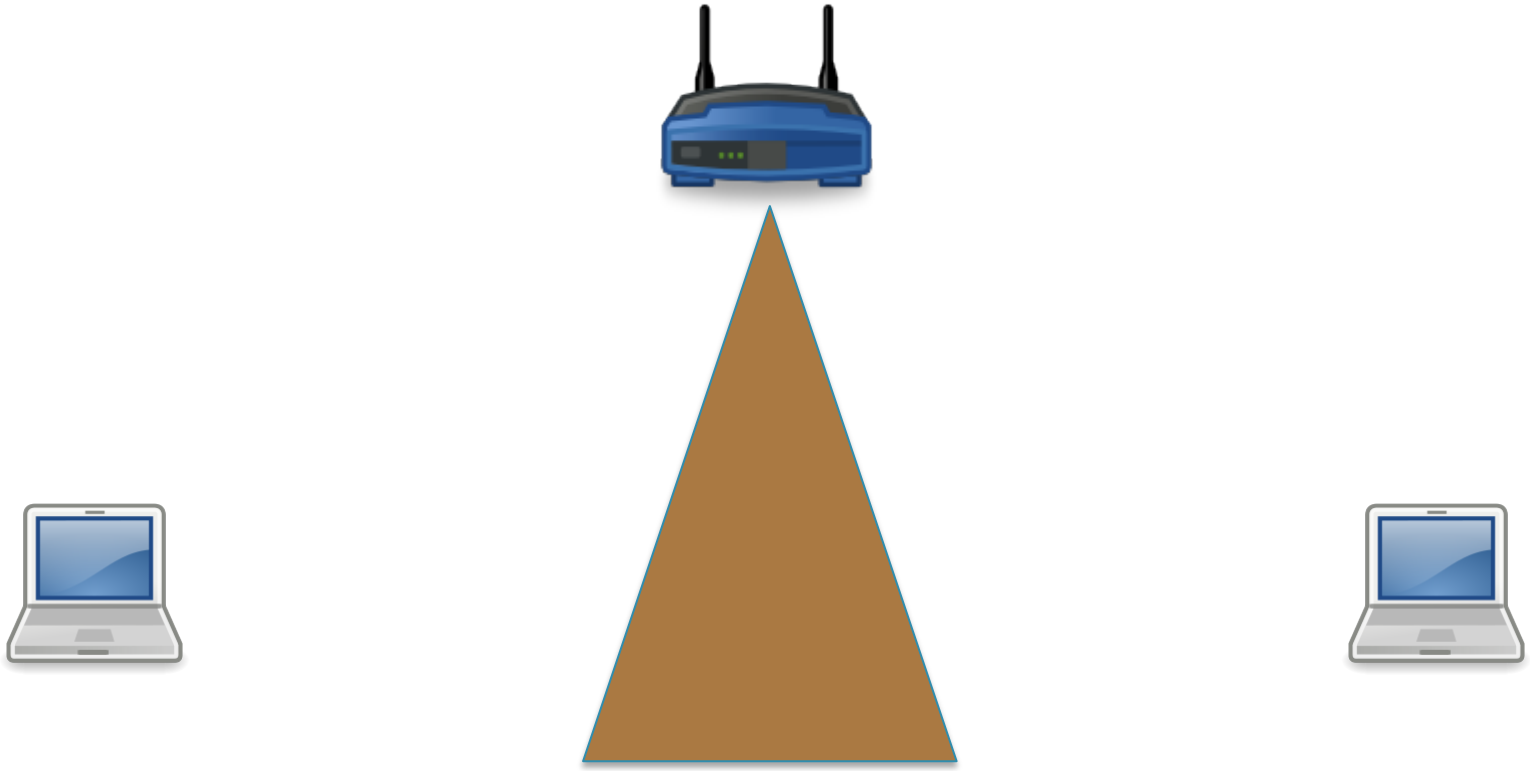


If granted, it will be heard by everyone.

Clear to send. (CTS)



RTS/CTS is considered **collision avoidance** and similar to "Taking Turns."



MAC protocols: Summary

- *Channel partitioning,* by time, frequency or code
  - Time Division, Frequency Division
- *Random access* (dynamic),
  - ALOHA, S-ALOHA, CSMA, CSMA/CD
  - CSMA/CD used in Ethernet
  - CSMA/CA used in 802.11
- *Taking-turns*
  - Polling used by Bluetooth
  - Token Passing used by FDDI and token ring