

CSE/EE 461 – Lecture 4



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Last Time ...



- How do multiple parties share the air or a wire?
 1. Partitioning schemes
 2. Statistical multiplexing
 3. Random access protocols (CSMA variants / Ethernet)
- Introduction to the Medium Access Control (MAC) layer

This Time

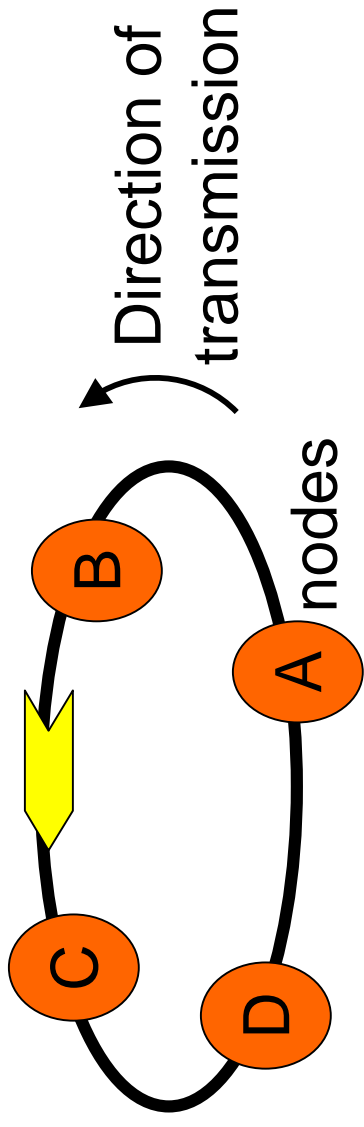


- More on the MAC layer:
 1. Contention-free protocols
 2. Return to wireless schemes

1. Contention-free Protocols

- Collisions are the main difficulty with random schemes
 - Inefficiency, limit to scalability
- Q: Can we avoid collisions?
- A: Yes. By taking turns or with reservations
 - Token Ring / FDDI, DQDB, Cable Modems
- Tradeoffs
 - complexity, efficiency, scalability, access latency, “QoS”

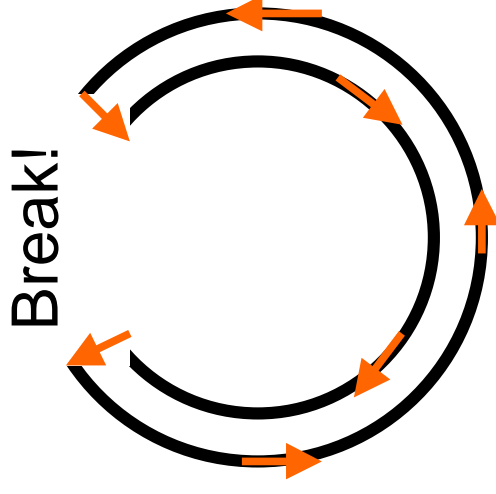
Token Ring (802.5)



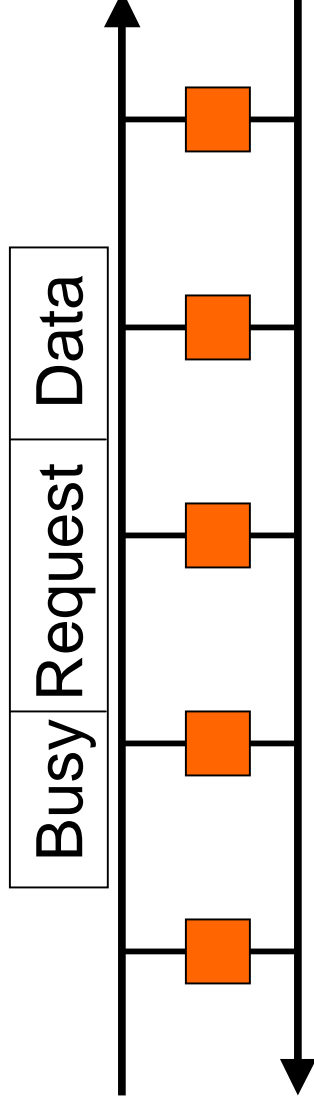
- Token rotates permission to send around node
- Sender injects packet into ring and removes later
 - Maximum token holding time (THT) bounds access time
 - Round robin service, acknowledgments and priorities
- Monitor nodes ensure health of ring

FDDI (Fiber Distributed Data Interface)

- Roughly a large, fast token ring
 - 100 Mbps and 200km vs 4/16 Mbps and local
 - Dual counter-rotating rings for redundancy
 - Complex token holding policies for isochronous traffic
- Token ring advantages
 - No contention, bounded access delay
 - Support fair, reserved, priority access
- Disadvantages
 - Complexity, reliability, scalability



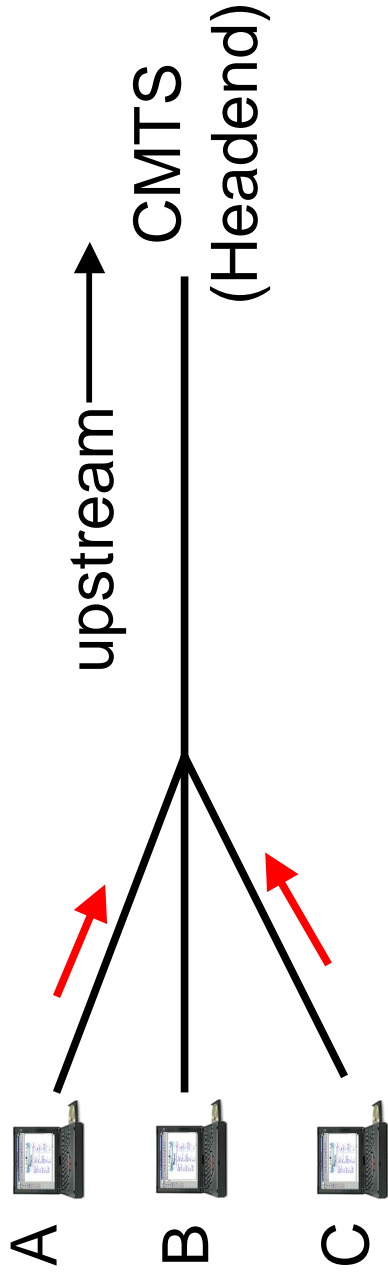
DQDB (Distributed Queue Dual Bus)



- Nodes maintain a distributed FIFO queue
 - Packets (cells) are marked busy/free and can signal request
 - Two counters: RC (requests), CD (countdown)
 - To send, wait for downstream requests
 - Copy RC to CD, decrement CD on free slot, send when CD=0
- Highly scalable, efficient, but not perfectly fair

Cable Modems (DOCSIS)

- Problem shaped by characteristics of cable plant
 - CSMA won't work; headend is a natural for controller; noise problems

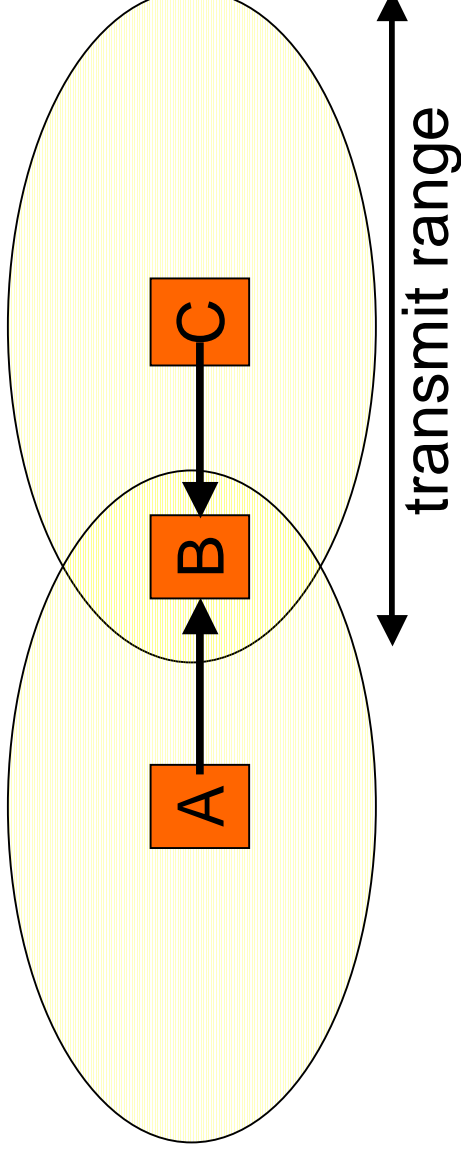


- Downstream only CMTS sends; relays between A, B, C
- Upstream time is divided into reserved minislots that are granted to A, B, C by CMTS using ALOHA on contention minislots

2. Wireless Communication

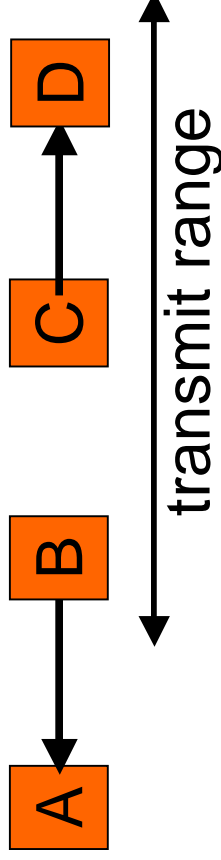
- Wireless is more complicated than wired ...
- Cannot detect collisions
 - Transmitter swamps co-located receiver
- Different transmitters have different coverage areas
 - Asymmetries lead to hidden/exposed terminal problems

Hidden Terminals

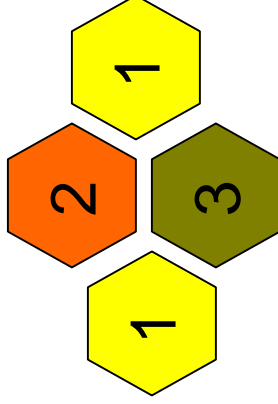


- A and C can both send to B but can't hear each other
 - A is a hidden terminal for C and vice versa
- CSMA will be ineffective - want to sense at receiver

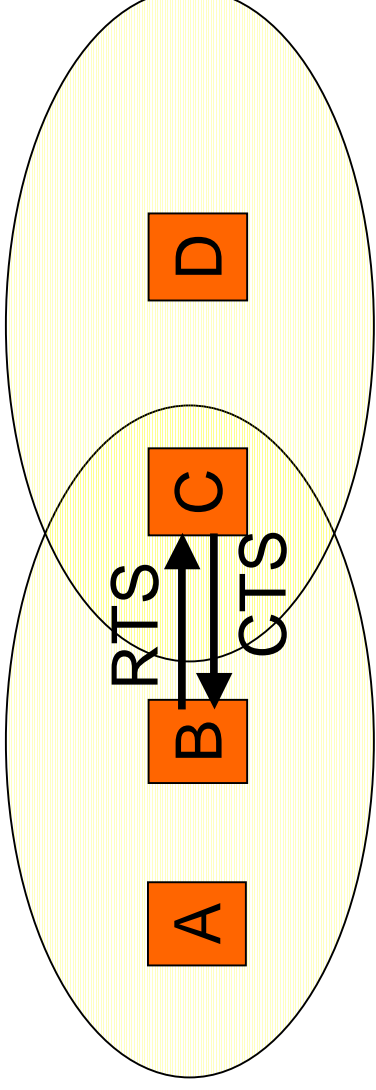
Exposed Terminals



- B and C can hear each other but can safely send to A, D
- Compare to spatial reuse in cell phones:



RTS / CTS Protocols (MACA)



1. B stimulates C with Request To Send (RTS)
2. A hears RTS and defers to allow the CTS
3. C replies to B with Clear To Send (CTS)
4. D hears CTS and defers to allow the data
5. B sends to C

802.11 Wireless LANs

- Emerging standard with a bunch of options/features ...



- Wireless plus wired distribution system or ad hoc
- Avoids collisions (CSMA/CA (p-persistence), RTS/CTS)
- Built on CDMA, freq. hopping, or diffuse IR at 2.45GHz

Key Concepts



- There are contention-free MAC protocols
 - Turn taking and reservations
- The complexities of wireless communication
 - Hidden and exposed terminals