

CSE/EE 461 – Lecture 6

Wireless and Contention-Free Protocols

David Wetherall
djw@cs.washington.edu

Last Time ...

- The multi-access problem
 - Medium Access Control (MAC) sublayer
- Random access protocols:
 - Aloha
 - CSMA variants
 - Classic Ethernet (CSMA/CD)

Application
Presentation
Session
Transport
Network
Data Link
Physical

This Lecture

More on multiple-access schemes:

- Wireless schemes
- Contention-free protocols

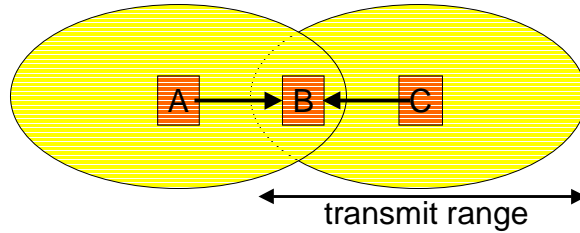
Application
Presentation
Session
Transport
Network
Data Link
Physical

1. 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

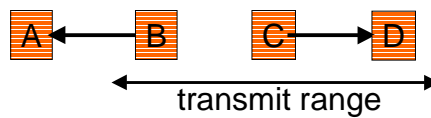


- A and C can both send to B but can't hear each other
 - A is a hidden terminal for C and vice versa
- CSMA will be ineffective – want to sense at receiver

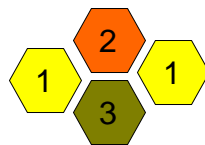
djw // CSE/EE 461, Autumn 2001

L6.5

Exposed Terminals



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



djw // CSE/EE 461, Autumn 2001

L6.6

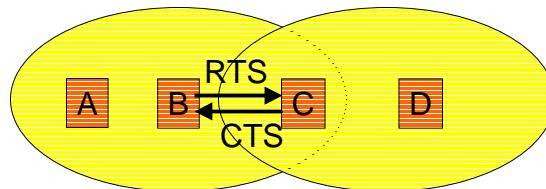
CSMA with Collision Avoidance

- Since we can't detect collisions, we avoid them
 - CSMA/CA as opposed to CSMA/CD
 - Not greedy like Ethernet
- When medium busy, choose random backoff interval
 - Wait for that many idle timeslots to pass before sending
 - Remember p-persistence ... a refinement
- When a collision is inferred, retransmit with binary exponential backoff (like Ethernet)
 - Use CRC and ACK from receiver to infer "no collision"
 - Again, exponential backoff helps us adapt "p" as needed

djw // CSE/EE 461, Autumn 2001

L6.7

RTS / CTS Protocols (MACA)



- B stimulates C with Request To Send (RTS)
- A hears RTS and defers to allow the CTS
- C replies to B with Clear To Send (CTS)
- D hears CTS and defers to allow the data
- B sends to C

djw // CSE/EE 461, Autumn 2001

L6.8

802.11 Wireless LANs

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

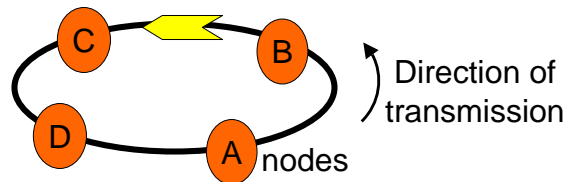


- Wireless plus wired system or pure wireless (ad hoc)
- Avoids collisions (CSMA/CA (p-persistence), RTS/CTS)
- Built on new links (spread spectrum, or diffuse infrared)

2. 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
- More generally, what else might we want?
 - Deterministic service, priorities/QOS, reliability

Token Ring (802.5)



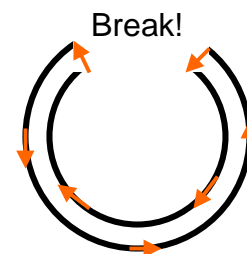
- Token rotates permission to send around node
- Sender injects packet into ring and removes later
 - Maximum token holding time (THT) bounds access time
 - Early or delayed token release
 - Round robin service, acknowledgments and priorities
- Monitor nodes ensure health of ring

djw // CSE/EE 461, Autumn 2001

L6.11

FDDI (Fiber Distributed Data Interface)

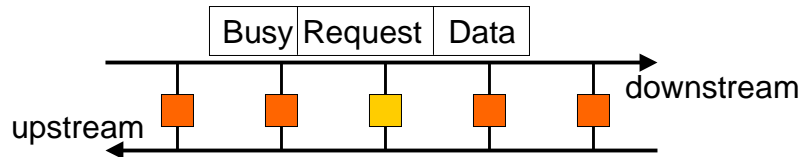
- Roughly a large, fast token ring
 - 100 Mbps and 200km vs 4/16 Mbps and local
 - Dual counter-rotating rings for redundancy
 - Complex token holding policies for voice etc. traffic
- Token ring advantages
 - No contention, bounded access delay
 - Support fair, reserved, priority access
- Disadvantages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



djw // CSE/EE 461, Autumn 2001

L6.12

DQDB (Distributed Queue Dual Bus)



- Two unidirectional buses that carry fixed size cells
 - Cells are marked busy/free and can signal a request too
- Nodes maintain a distributed FIFO queue
 - By sending requests they are reserving future access

djw // CSE/EE 461, Autumn 2001

L6.13

DQDB Algorithm

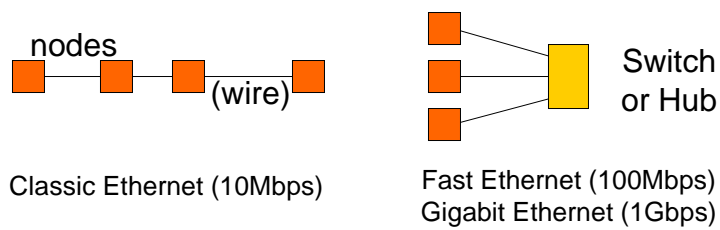
- Two counters per direction (UP, DN)
 - RC (request count), CD (countdown)
- Consider sending downstream (DN):
 - Always have RC count UP requests, minus free DN cells if larger than zero
 - This is a measure of how many others are waiting to send
 - To send, copy RC to CD, decrement CD for each free DN cell, send when zero
 - This waits for earlier requests to be satisfied before sending
- Highly scalable, efficient, but not perfectly fair

djw // CSE/EE 461, Autumn 2001

L6.14

Modern Ethernet

- A key concern is manageability
 - centralized vs. distributed layout
- Another is performance scalability
 - Switches vs. Hubs



djw // CSE/EE 461, Autumn 2001

L6.15

Key Concepts

- Wireless communication is relatively complex
 - No collision detection, hidden and exposed terminals
- There are contention-free MAC protocols
 - Based on turn taking and reservations, not randomization

djw // CSE/EE 461, Autumn 2001

L6.16