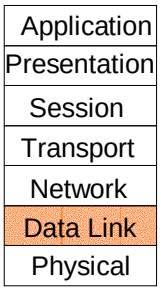
CSE/EE 461
Wireless and Contention-Free Protocols

Last Time …

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



CSMA vs. CSMA/CD

- CSMA:
  - The least you could do with without getting laughed at.
  - Don't speak if you hear another speaking
  - But, keep speaking even if somebody interrupts you
  - Why is this an issue?
- CSMA/CD
  - Stop speaking if someone interrupts you
- Will the difference reveal itself at high load or low load?
- How will the difference reveal itself?

Utilization Under Load

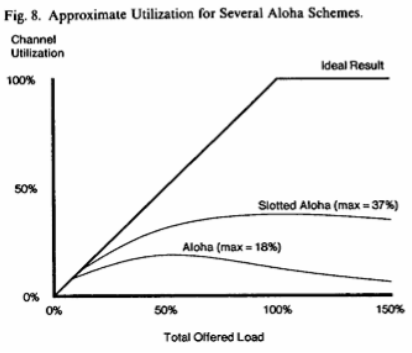


Fig. 8. Approximate Utilization for Several Aloha Schemes.

CSMA

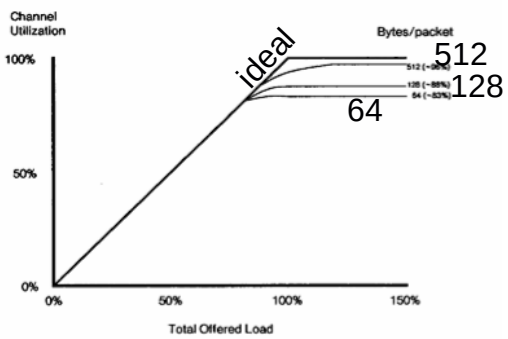
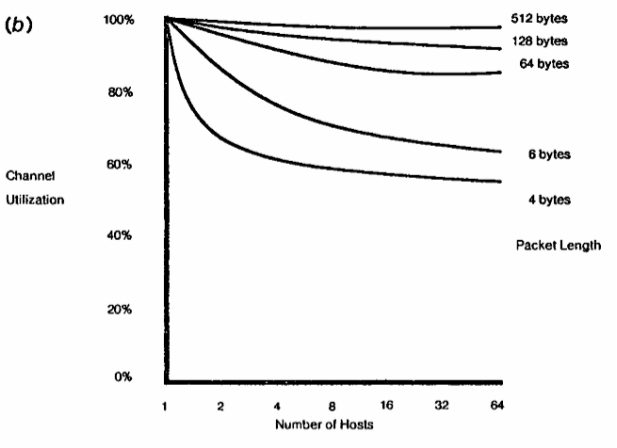


Fig. 9. Measured Utilization of the Ethernet Network under High Load.

CSMA/CD

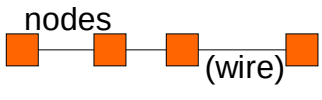
CSMA/CD, Utilization and Scalability



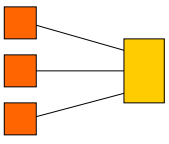
But, just 3 Mb/s!

Modern Ethernet

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



Classic Ethernet (10Mbps)

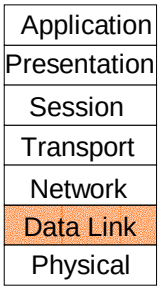


Fast Ethernet (100Mbps)
Gigabit Ethernet (1Gbps)
(eliminates contention)

This Lecture

More on multiple-access schemes:

1. Wireless schemes
2. Contention-free protocols

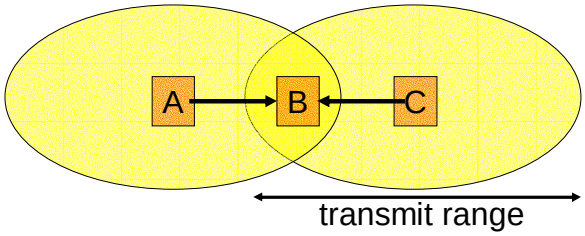


1. Wireless Communication

Wireless is more complicated than wired …

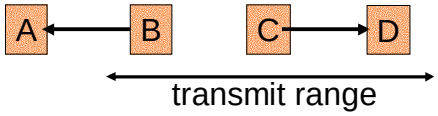
1. Cannot detect collisions
   - Transmitter swamps co-located receiver
     - Means you can't sense your own collisions
       - Like screaming so loud that you can't hear others talking
2. Different transmitters have different coverage areas
   - Asymmetries lead to hidden/exposed terminal problems

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
  - A can't tell it's colliding with C, and vice versa
  - Must sense collision at sense at receiver

Exposed Terminals

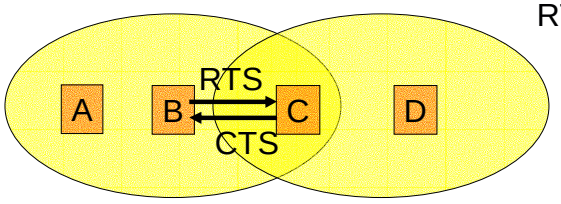


- B, C can hear each other but can safely send to A, D
  - Should be allowed when possible

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 quickly "hunt" for the right amount of deference time

RTS / CTS Protocols

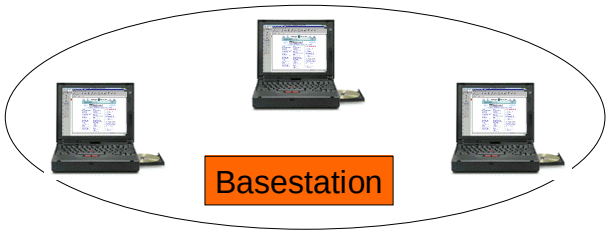


RTS/CTS say: *how long*

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 …

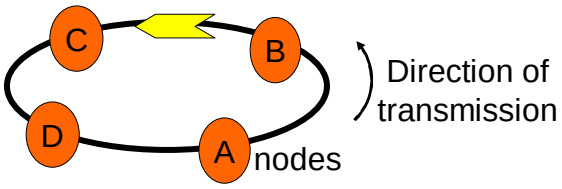


- Wireless plus wired system or pure wireless (ad hoc)
- Avoids collisions (CSMA/CA (exp-backoff), RTS/CTS)
- Built on new links (spread spectrum, or diffuse infrared)

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
  - Token Ring / FDDI
- Can be a building block for more..
  - Deterministic service, priorities/QOS, reliability

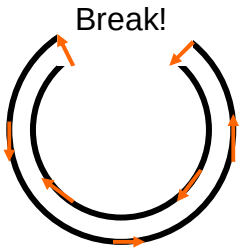
Token Ring (802.5)



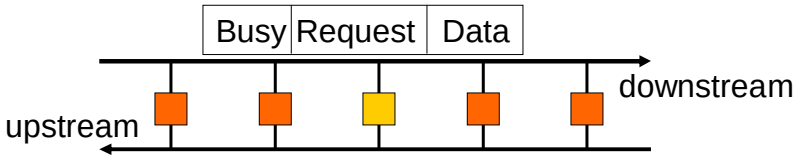
- Token rotates permission to send around node
- Sender injects packet into ring and removes later
  - Maximum token holding time (THT) bounds access time
  - Early or delayed token release
  - Round robin service, acknowledgments and priorities
- Monitor nodes ensure health of ring

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



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

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

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