Shared Access Networks

Outline

- Bus (Ethernet 802.2/3)
- Token ring
- Wireless (802.11)

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Ethernet Overview

- The most successful Local Area Networks
- Bandwidth: 10Mbps, 100Mbps (Fast), 1Gbps
- Avoid Simultaneous on a Shared Line: CSMA/CD
  - multiple access
  - carrier sense:
    - listen before transmitting.
    - distinguish an idle and busy link.
  - collision detection
    - listen while transmitting.
    - Collision: What you hear is different from what you listen

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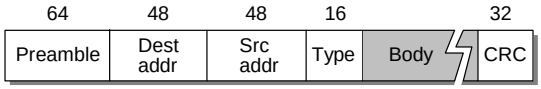
Ethernet Frame



- Frame Format
- Addresses
  - unique, 48-bit unicast address assigned to each adapter
    - example: **`8:0:e4:b1:2`**
  - Every body hears the frame (shared media). But the one with matching destination address picks up.
  - broadcast: all **`1`**s
  - multicast: first bit is **`1.`** The host can configure its adaptor to accept some multicast addresses
- Preamble (a seq. alternating 0s and 1s) indicates the start of a frame
- Type: high-level protocols

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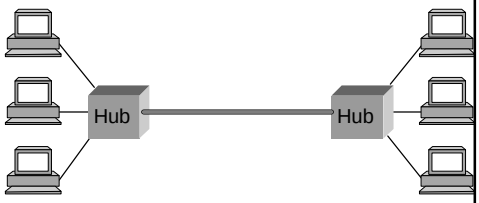
Ethernet Repeater

- Repeaters
  - Amplifier forwarding signals
  - Segments separated by repeqters are in the same collision domain
- Max Length: 2500m
  - A coaxial copper cable of up to 500m
  - segments with 4 repeaters
  - max round-trip delay: 51.2us



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Transmit Algorithm

- If line is idle…
  - send immediately
  - upper bound message size of 1500 bytes
    - Limited occupancy on the line.
  - must wait 9.6us between back-to-back frames
    - To allow other hosts to send.
- If line is busy…
  - wait until idle and transmit immediately

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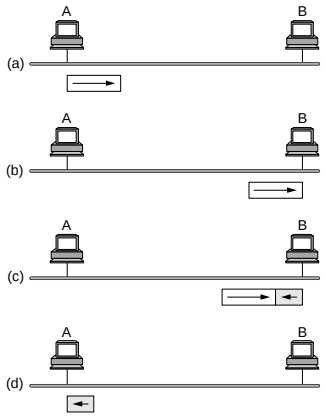
Collisions

- The remote side may send its frame before it hears the frame currently being sent
  - Both sides detect an idle line
  - Due to the propagation delay
- For A to detect the collision
  - Collisions can only be detected during transmission
  - 51.2us •10Mbps = 64 bytes



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Upon Collision

- Send 32 jam bits, then stop transmitting frame
  - To ensure other hosts to detect conllision
- minimum frame is 64 bytes (header + 46 bytes of data)
- delay and try again: exponential backoff
  - 1st time: 0 or 51.2us selected at random
  - 2nd time: 0, 51.2, or 102.4us
  - *nth* time: *k* x 51.2us, for randomly selected k=0..2^n - 1
  - give up after several tries (usually 16)

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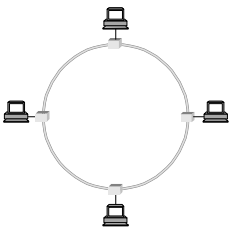
Token Ring

- Idea
  - Frames flow in one direction: upstream to downstream
  - special bit pattern (token) rotates around ring
  - must capture token before transmitting
  - release token after done transmitting
  - remove your frame when it comes back around
  - stations get round-robin service
- Lost Token
  - no token when initializing ring
  - bit error corrupts token pattern
  - node holding token crashes
- Generating a Token



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Wireless LANs

- IEEE 802.11
- Bandwidth: 1 - 11 Mbps
- Physical Media
  - diffused infrared (10m)
    - Diffused: the sender do not need a clear line of sight.
  - spread spectrum radio (2.4GHz): 11 Mbps $\Rightarrow$ 54Mbps

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Spread Spectrum

- Idea
  - spread signal over wider frequency band than required
  - Minimize the impact of interference between different LANs
  - originally designed to thwart jamming
- Approach I: Frequency Hopping
  - transmit over random sequence of frequencies
  - sender and receiver share pseudorandom number generator and seed
  - 802.11 uses 79 x 1MHz-wide frequency bands

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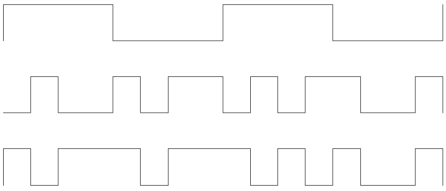
Spread Spectrum (cont)

- Approach II: Direct Sequence
  - for each bit, send XOR of that bit and *n* random bits
  - The receiver counts the number of 1s in each symbol
  - random sequence known to both sender and receiver
  - 802.11 defines an 11-bit chipping code
    - Requires a frequency band *n* times wider
    - The signal looks like noise to any receiver with different pseudorandom sequence



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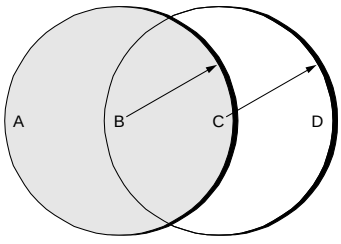
Collisions Avoidance

- Similar to Ethernet: Wait until link idle
- Problem: *hidden* and *exposed* nodes
  - A ⇒ C; C ⇒ B;
    - Collides at B
    - A, C cannot detect: hidden nodes
  - B ⇒ A; C ⇒ D;
    - C assumes collision
    - Actually no collision at A or D



- Cannot (listen) detect collision when transmit

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Multiple Access with Collision Avoidance (MACA)

- Sender transmits **`RequestToSend`** (RTS) frame
  - Specifying how long to hold the medium
- Receiver replies with **`ClearToSend`** (CTS) frame
- Neighbors…
  - see CTS: keep quiet
  - see RTS but not CTS: receiver cannot hear me, ok to transmit
- Receive sends ACK when has frame
  - neighbors silent until see ACK
- Collisions
  - no collisions detection
  - known when don't receive CTS or ACK
    - The cost of collision with RTS/CTS is much smaller
  - exponential backoff

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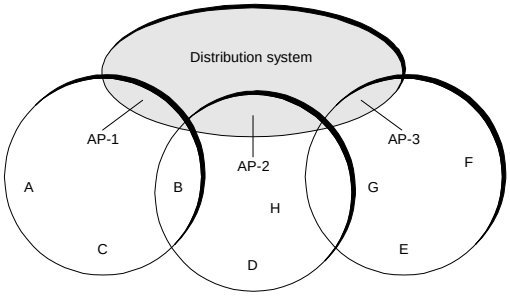
Supporting Mobility

- Case 1: *ad hoc* networking
- Case 2: *access points* (AP)
  - Tethered
  - each mobile node associates with an AP (base station)
  - Mobile nodes sends to AP first; AP forwards



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Mobility (cont)

- Scanning (selecting an AP)
  - node sends **`Probe`** frame
  - all AP's w/in reach reply with **`ProbeResponse`** frame
  - node selects one AP; sends it **`AssociateRequest`** frame
  - AP replies with **`AssociationResponse`** frame
- When
  - active: when join or move
    - Signal with old AP weakened
    - new AP informs old AP via tethered network
  - passive: AP periodically sends **`Beacon`** frame

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