Announcements

- Reading
  - Today: 4.3 & 4.4
Ethernet Cable Options

- **10base5: Thicknet - first Ethernet**
  - Thick cable, doesn’t bend well
  - vampire taps used to “tap” the network
  - max run is 500 meters
- **10Base2: Thin coax (cheaper net),**
  - uses “T” connectors
  - max run is 200 meters
- **10baseT: twisted pair**
  - uses a central hub
  - easier to find faults and problems
  - max run is 100 meters to hub
Manchester Encoding

- **Problem: How to send zero/ones?**
  - need to know timing information
  - when does on bit end?
- **Answer: Force many transitions**
  - every bit is half low and half high
  - 1 is high then low
  - 0 is low then high
  - but this doubles bandwidth
- **Differential Manchester Encoding**
  - better noise immunity
  - 0 is a transition at the start, 1 none
  - both transition during the middle
**Ethernet Frame Format**

<table>
<thead>
<tr>
<th>Bytes</th>
<th>7</th>
<th>1</th>
<th>2 or 6</th>
<th>2 or 6</th>
<th>2</th>
<th>0-1500</th>
<th>0-46</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preamble</td>
<td>Destination address</td>
<td>Source address</td>
<td>Data</td>
<td>Pad</td>
<td>Checksum</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Preamble used to sync clock**
- **Addresses**
  - 48 bits
  - if it starts with a 0 it is globally unique (assigned by IEEE)
  - if it starts with a 1 it is locally unique
- **Length**
  - 0 to 1500 bytes
  - min length is 46 bytes
    - ensures frame reaches end of cable before end of frame is sent
- **Checksum**
  - 32 bit CRC to detect garbled data at link level
Collision Management

- **Binary Exponential Backoff**
  - after collision, divide into slot times
  - after first collision, wait either 0 or 1 slot times
  - after second collision, wait either 0, 1, 2, or 3 slot times
  - limited to 1023 slots
  - after 16 collisions, link layer gives up

- **Performance**
  - each station wants to transmit with probability $p$, then
    - $A = k \left[p^{k-1}(1-p)^{k-1}\right]$  
    - $A \rightarrow 1/e$ as $k \rightarrow \infty$
  - probability a contention interval has $j$ slots is $A(1-A)^{j-1}$
  - mean number of slots per contention is:
    $$\sum_{j=0}^{\infty} jA(1-A)^{j-1} = \frac{1}{A}$$
    mean contention interval is then $2\tau/A$
• A discussion of the project was held