Announcements

- **Reading**
  - Chapter 2 (2.3, 2.4.5, 2.6.3, 2.7-2.8)

- **Project #4 will on the web**
  - Note policy about project #3 missing components

- **Homework #1**
  - Due 11/6/01
    - Chapter 6: 4, 12, 24, 37

- **Midterm #2**
  - 11/8/01 in class

Max Data Rates Over A Channel

- **Shannon/Nyquist limit**
  - max data rate is $2H \log_2 V$ bits/sec
    - H - bandwith of the channel
    - V - number of levels used to encode data
  - for example, a noiseless 3khz channel can carry
    - 6,000 bps for binary traffic but
    - 12,000 bps for quadary (4 level) traffic
- **What about noise?**
  - noise is measured as the ratio of signal to noise power
  - normally measured in db or $10 \log_{10}(S/N)$
  - Shannon limit:
    - max bits/sec = $H \log_2(1+S/N)$
    - 3khz, 30dB channel limited to 30,0000 bps

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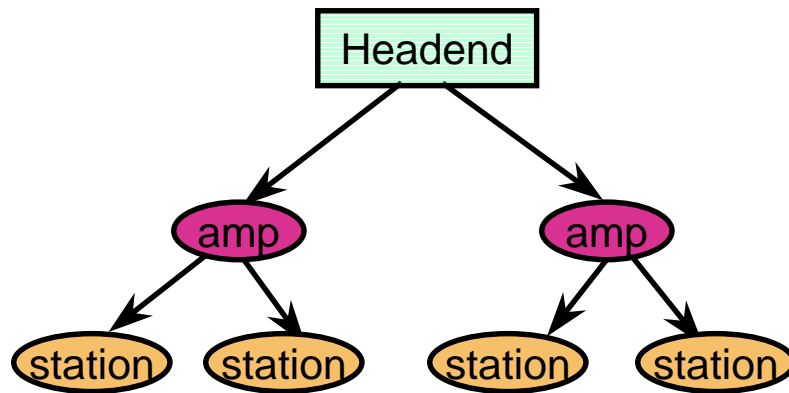
Transmission Media

- **Magnetic Media**
  - tapes hold 100GB today
  - a van can carry 2,000 tapes (or 200 TB)
  - want to move data from DC to Baltimore
    - 200 TB/hour = 415 Gb/sec
  - what about latency?
    - get all 80TB at once
   - need to read/write all of these tapes

- **Twisted Pair**
  - copper wires (1.5 Mbps long hall)
  - 1Gbps with two pairs for short distances
    - Needs 4 pairs of wires

Transmission Media (Coax)

- copper with an insulator between it
  - 75 ohm - common for T.V.
  - 50 ohm - common for data transmission
- rates: 10's of Mbps baseband, 100's MPS broadband
  - supports multiple drops
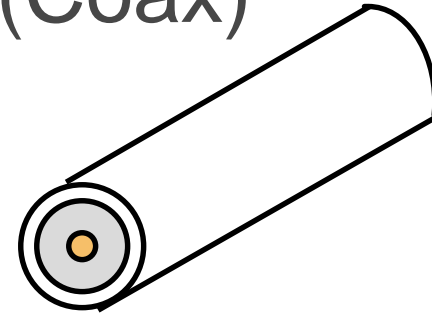
Broadband Network

Baseband Network

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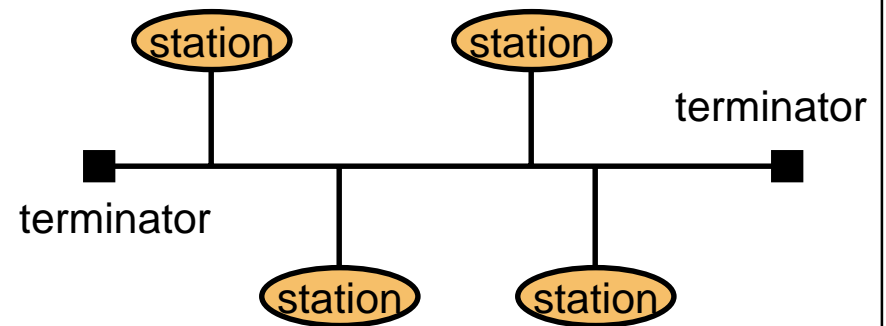
Transmission Media (cont.)

- **Fiber**
  - uses principal of total internal reflection
    - get light to "bounce" along the fiber
  - point to point communication
  - 100's Mbps to several Gbps

- **No cables**
  - Limited bandwidth
  - Regulated space
  - Much easier to setup

Transmission: No Cables

- **Microwave**
  - above 100MHz
  - uses directional (parabolic antenna)
  - with 100m towers, can space them every 80km
  - security:
    - directional signal
    - can add hop-by-hop encryption

- **Infrared**
  - uses: television remote, computer TANs (Table Area Nets)
  - signal will not pass through walls
  - security:
    - signal confined to a single room
    - anyone in the room can hear the signal though

Transmission: No Cables

- **2.4 Ghz**
  - Range:
    - few yards to few hundred feet with normal ant.
    - Several km with direction antenna
  - Services:
    - 802.11b – 11 Mbps Ethernet
      - form of cellular network
    - Cordless phones
    - Blue tooth
  - Security:
    - Frequency hopping spread spectrum
      - But useless if everyone knows the protocol
    - Link (and higher) encryption required
    - Can't trust WEP to provide 802.11b security

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Transmission: No Cables (cont.)

- ● **Cellular Radio (AMPS)**
  - – divide service areas into cells
    - • each unit talks to a base station in the cell
    - • 832 duplex channels (allocated to two providers)
  - – security
    - • virtually none
    - • easy to eavesdrop
    - • ease to "clone" cell phones

Mobile Station

Cells that can hear the mobile station