

# Announcements

- Reading
  - Today: Chapter 2 (2.3-2.4)

# Transmission Media

- **Magnetic Media**

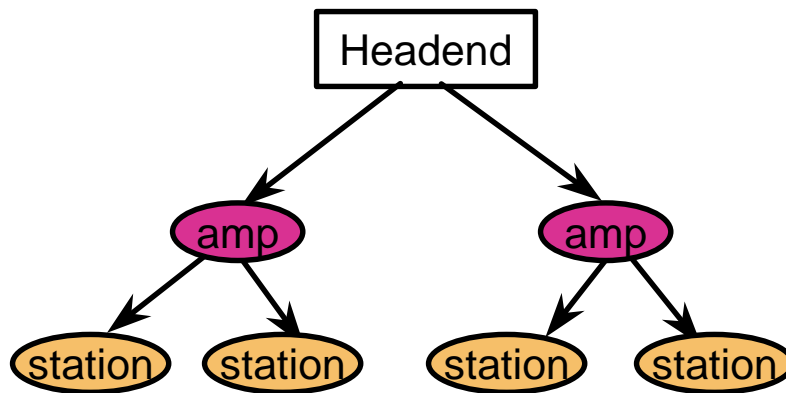
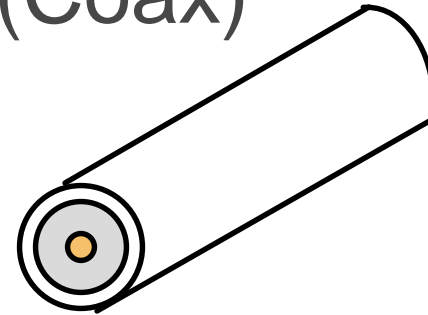
- tapes hold 40GB today
- a van can carry 2,000 tapes (or 80 TB)
- want to move data from DC to Baltimore
  - 80 TB/hour = 166 Gb/sec
- what about latency?
  - get all 80TB at once
  - need to read/write all of these tapes

- **Twisted Pair**

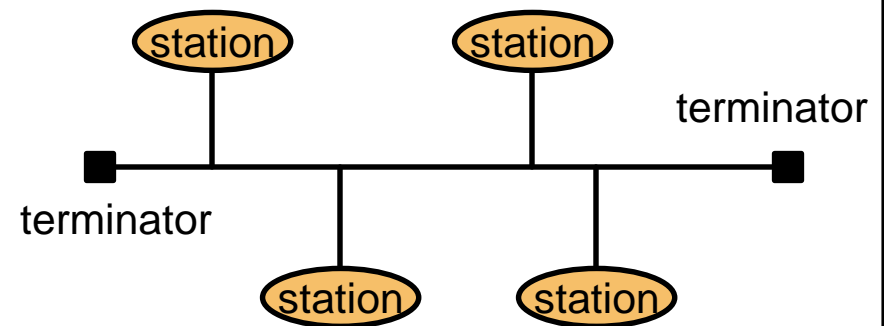
- copper wires (1.5 Mbps long haul)
- 100Mbps with two pairs for short distances

# 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

# Transmission Media (cont.)

- Coax

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- Fiber

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

# 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-encryption

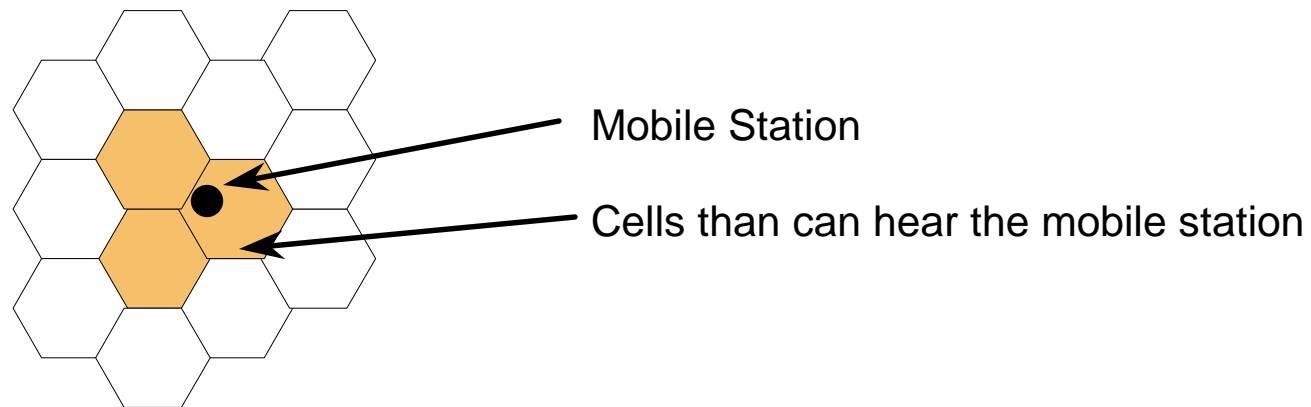
- Infrared

- 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 (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



# Transmission: Satellites

- **Different Orbits Possible**
  - orbit affects many communication properties
- **Geosynchronous**
  - always over the same spot on the earth
  - 36,000 Km orbit is required
  - only 180 slots possible
  - uses one uplink and one down link frequency
  - large round-trip latencies
- **LEO (Low Earth Orbit)**
  - each satellite keeps moving into and out of range
    - solution: use a large number of satellites
    - sort of like cells, but the cells are the ones moving
  - lower round-trip latency

# Sending More Than one Signal At Once

- Called multiplexing
  - original goal of Bell was to MUX multiple telegraph signals
- Time Division Multiplexing
  - everyone gets whole bandwidth
  - but only when its their turn

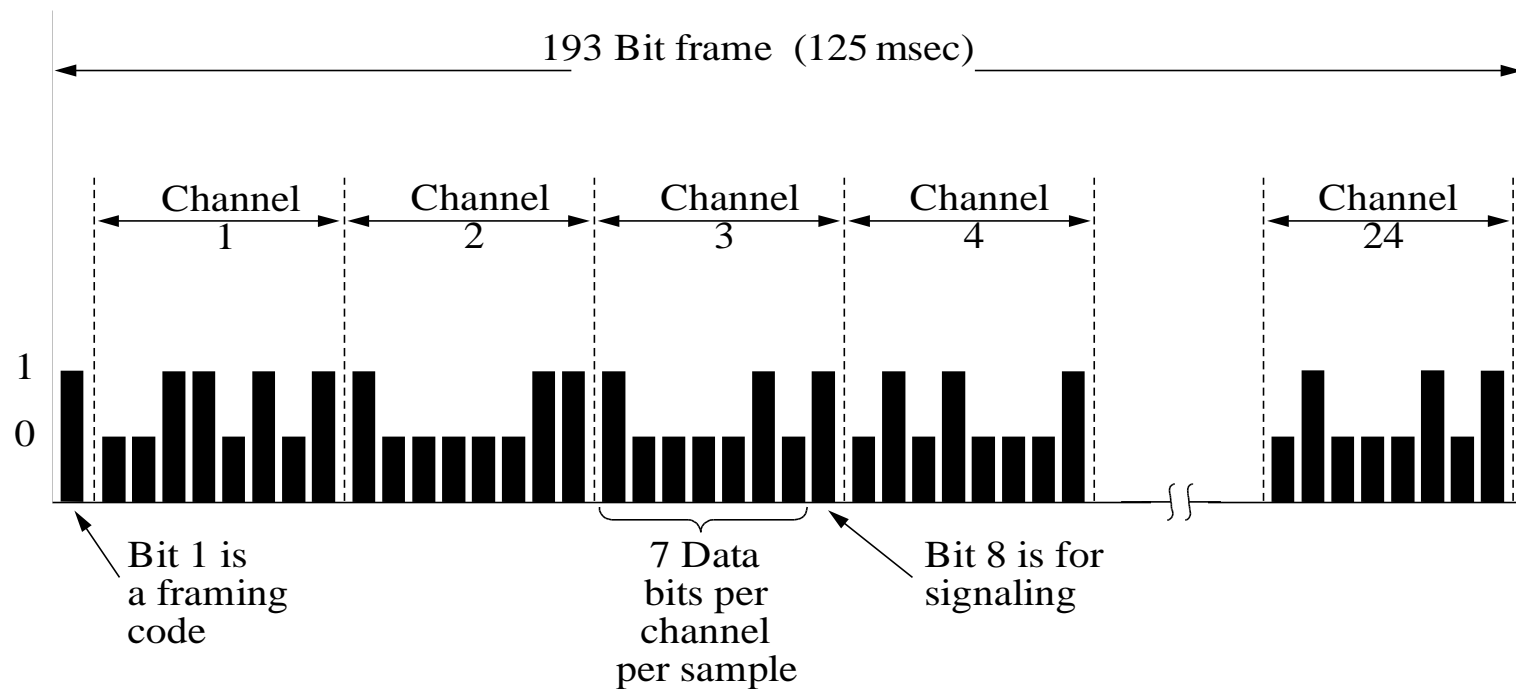


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# Frequency Division Multiplexing

- Frequency Division

- everyone gets to talk at once
- but only in their own frequency

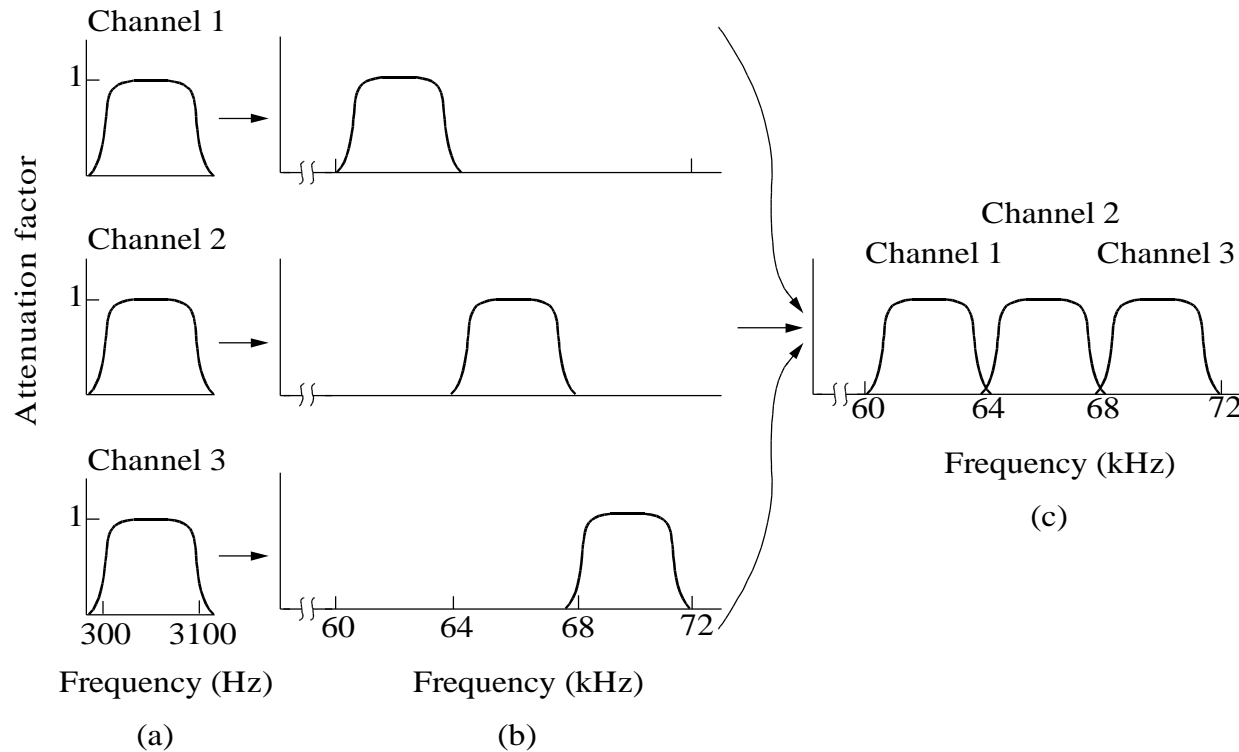


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# ATM Switching

- Requirements

- be able to switch 360,000 cells/sec per input link
- switch cells with as low a discard rate as possible
- never reorder the cells on a virtual circuit

- Issues

- multiple cells destined for the same output at once
  - need to buffer one of them
  - must ensure fairness is maintained
- head-of-line blocking
  - possible that a blocked output is holding up cells that could be delivered