Definition
- Broadband Internet Access
  - Anything that substantially exceeds the speed of dial-up modems (56kbits/sec)
- Several Possible Implementations
  - Use the existing twisted pair local loop
  - Use the Cable TV plant
  - Use Wireless (3G, WiMax, etc.)
  - Install new cables (Fiber to the ...)
  - Use existing power lines

Dial-Up
- Designed to work over voice lines
  - Take digital data from the computer
  - Convert to analog signal
    - 300 to 3300 Hz
  - Receiving modem reconstructs digital information

ISDN-BRI
- Integrated Services Digital Network - Basic Rate Interface
  - Recognize that the rest of the net is digital, why not the local loop?
  - ISDN BRI uses the existing wires
  - Transmits at 128kbits/sec
  - Faster than dial-up, but not by much
  - Voice takes up 64kbits
Cable TV Network

- Good News
  - High capacity (800MHz)
  - Digital Fiber and Coax Hybrid
    - So Cable “modems” are not really modems
- Bad News
  - All the capacity is shared among users (viewers) for broadcast
  - Originally all data was flowing one way (out)

Cable Modems

- Cable Network Redesign
  - Two way (asymmetric)
  - Splits the network
    - Not too many users have to share
    - Use fiber
  - Cable box gets an upgrade (and an Ethernet port)
  - Voice over IP completes the “triple play”

DSL

- Telephone Companies
- Need to use existing copper local loops
  - ISDN is too slow
  - New encoding scheme:
    - Digital Subscriber Line (DSL)
      - Many versions
        - Mostly asymmetric
        - Speeds are very dependent on distance

DSL

- Uses full bandwidth available on the wire
  - Longer distances, less bandwidth
  - Leaves the 0-4kHz voice band alone
- Local Loops vary in quality
  - Loading Coils
    - Used to improve voice quality, impairs DSL
    - Other impairments (taps, partial repairs, etc.)
    - OK for voice, not for DSL
**DSL Components**

- **Customer side**
  - Splitter or Filter
  - Separate voice and data
  - DSL “modem” (really a data adapter)

- **Central Office**
  - DSLAM - Digital Subscriber Line Access Module
  - Send voice to the central office switch
  - Route packets to an Internet Service Provider

**DSL Service**

- **Telephone Company**
  - Can provide ISP services or route to a 3rd party
  - Voice is bundled with most DSL services
  - Some telephone companies will sell data-only DSL
  - Can’t get to “triple play” with DSL
    - Video is missing
    - Replacing local loop with Fiber fills this in
    - Example: Verizon FIOS
  - Expensive to install - high population areas only

**Wireless**

- **3G cell service**
  - “Tethering” of laptops to smart phones
  - Data only adapters

- **Stationary receivers**
  - Wide area wireless LAN service
  - WiMAX
    - Wireless data service designed for many different frequency bands

- **Coverage depends very much on terrain**