

C. Transmission Media

C1. Analog and Digital Transmission

- **Analog transmission:**
 - It refers to the transmission of analog signals without regard to content.
 - Amplifiers are used to boost the energy in an analog signal (including noise components), but there is no intermediate attempt to recover the data from the signal.
- **Digital transmission:**
 - It refers to the transmission of digital data, using either an analog or digital signal.
 - A repeater recovers the digital data, and retransmits a new signal (and overcomes the attenuation and reduces noise signals).
- The table below summarizes the methods of data transmission: See Table 3.1 (p.75).

C2. Transmission Media

- A path to transmit data between two devices using either a physical connection or electromagnetic waves.

- Two types of transmission media :
 - (1) **Guided transmission media (or hardware media):**
 - most widely used:
 - twisted pair (unshielded and shielded),
 - coaxial cable,
 - optical fiber.
 See Figure 4.2 (p.97).
 - transmission characteristics of guided media:
 - See Table 4.1 (p.96).
 - twisted pair categories and classes:
 - See Table 4.3 (p.100).
 - (2) **Unguided transmission media (or software media)**
(for wireless transmission):
 - terrestrial microwave transmission,
 - broadcast radio wave transmission,
 - satellite microwave transmission.
 See Figure 4.6 (p.112), Figure 4.8 (p.117).
- The electromagnetic spectrum :
 - indicates the frequencies at which various guided media and unguided transmission techniques operate.

- is given in Figure 4.1 (p.95).

C3. Transmission Modes

- The directions of signal/data transfers:
 - Simplex transmission
 - Half-duplex transmission
 - Full-duplex transmission

C4. Transmission Methods

- Two methods by which data bits can be transmitted:
 - Serial transmission
 - Parallel transmission
- Serial interface and transmission standards:
 - DB-25 or DB-9 connectors with RS-232/EIA-232 standard for PCs via modems.
 - M-block connector with V.35/ITU standard for high-speed transmissions.
- Parallel interface and transmission standards:
 - DB-25 or Centronics (36-pin) connectors with de facto standards.

See Section 6.6 Interfacing (textbook, p.193).

C5. Transmission Impairments and Errors

- The received signal differs from the transmitted signal due to various transmission impairments, which may degrade the quality of analog signals, introduce bit errors to digital signals.
- The most significant impairments are :
 - attenuation, delay distortion, and noise.

(1) Attenuation

- reduction in signal strength with distance:
 - for software media, it is proportional to the square of the distance from the transmitter.
 - for hardware media, it is generally logarithmic.
- an increasing function of frequency:
 - See Figure 4.3(d) (p.98).

(2) Delay distortion

- because the velocity of propagation of a signal through a guided transmission medium varies with frequency.
 - ⇒ various frequency components of a signal will arrive at the receiver at different times.

- for digital data, some of the signal components of one bit position will spill over into other bit positions, causing **intersymbol interference (ISI)**.

⇒ set an upper bound on the data rate.

(3) Noise

- there are 4 main categories:
 - Thermal noise
 - Impulse noise
 - Intermodulation noise
 - Cross-talk

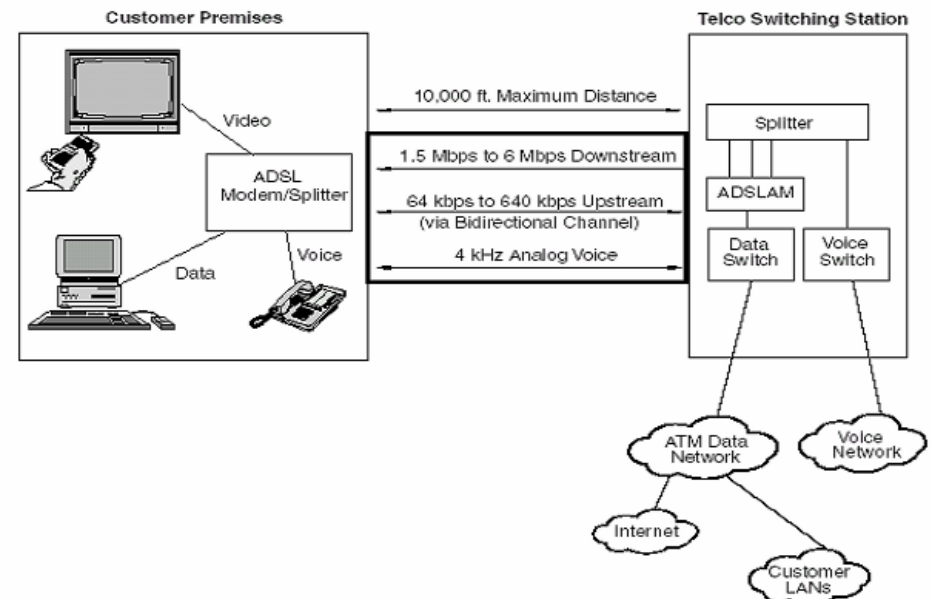
C6. Design Considerations of a Data Transmission System for Networking

- Two main concerns:
 - data rate (or channel capacity) and distance.
- Key design factors are:
 - Bandwidth
 - Encoding and decoding of signals
 - Transmission impairments
 - Interference
 - Number of receivers (e.g., point-to-point, multipoint)

- Applications for the Internet access:

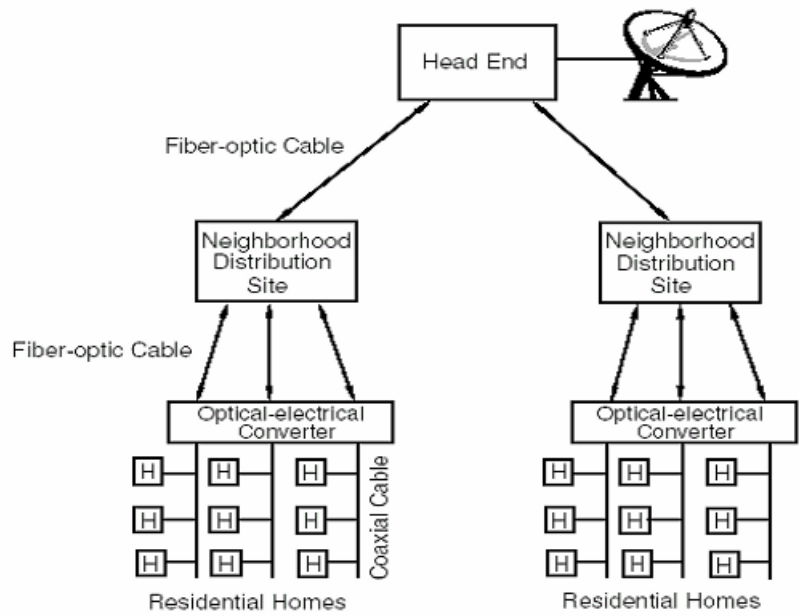
e.g.

ADSL (Asymmetric Digital Subscriber Line):



An ADSL connection involves ADSL modems at the local site and a "splitter" and ADSL access multiplexer (ADSLAM), which incorporates an ADSL modem, at the telco switching station. (The splitter can also be incorporated within the ADSLAM device along with the ADSL modem.) The splitter is used to separate voice and data signals. ADSL's maximum local loop distance is approximately 2 miles, its downstream rates range from 1.5 to 6 Mbps, and its upstream rates range from 64 to 640 kbps, which is provided via a bidirectional channel. A 4-kHz channel is also partitioned from the DSL link for conventional analog voice service. Source: adapted from Aber, 1997.

Cable modems:



When completed, the upgraded cable network will be able to provide high-speed two-way transmissions for data, voice, and video service. Source: adapted from Fitzgerald, 1996.