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Data Transmission and Modems

Agenda

- Circuit
- Mode of transmission
- Digital transmission
- Analog transmission for digital signals - modems
  - Methods
  - Classification
  - Interfaces
  - Functions
  - Selection Criteria

Circuit

- Signal rate
  - No. of signal changes (amplitude, frequency, or phase) on a circuit per second
  - Baud
  - Types: dibits, tribits, and quadbits
- Speed
  - No. of bits that a circuit can carry in 1 second
  - Bits per second (bps) used for measurement

Mode of Transmission

- Data flow
- Physical connection
- Timing

Data Flow - US

- Simplex transmission
  - Television and radio
- Half-duplex (HDX) transmission
  - CB radio, terminal
- Full-duplex (FDX) transmission
  - Telephone, computer to computer

Physical Connection

- Parallel transmission
  - Fast
  - Simple
  - Line cost
- Serial transmission
  - Complicated transmitter and receive
  - Decomposing and reconstructing

Timing

- Asynchronous transmission
  - Start/stop bits for character synchronization
  - Mark (1or stop) /space (0 or start) bits for bit synchronization
  - Simple, inexpensive, slow speed transmission
  - For personal computer
- Synchronous transmission
  - Clock circuitry
  - One to four synchronization characters for each block of data
  - Large amount of data on dedicated line

Digital Signals

- Unipolar (positive voltage for 1, no voltage for 0)
- Bipolar, nonreturn-to zero (NRZ)
  - Manchester coding (low-to-high is 1, high-to- low is 0)
  - Differential Manchester (no transition at the beginning of the bit period is 1, second transition at the beginning of the bit period is 0)
  - Benefits: self-clocking, and error detection
- Bipolar, return-to-zero

Benefits of Digital Transmission

- Better data integrity (detect & correct error)
- Higher capacity cables (fiber-optic)
- Easier integration (voice, data, video, etc.)
- Better security and privacy (encrypt data)
- Lower cost (large-scale integrated circuitry)

Digital Transmission of Analog Signals

- Quantization
  - Quantizing noise or digitizing distortion
- Codec (coder/decoder): analog-to-digital (A/D) converter & digital-to-analog (D/A) converter
- Methods
  - Pulse code modulation (256 integers, 8000 per second)
  - Adaptive differential pulse code modulation (difference)
  - Delta modulation (1 for +, 0 for -)

Digital Transmission of Digital Signals

- Digital transmitter/receiver (data service unit/channel service unit (DSU/CSU))
  - Simpler & cheaper
- Transmitter for shaping & timing the signal, interface between DTE and line
- Receiver for protection of excessive voltage, diagnostic and testing

Analog Transmission of Digital signals (Modems – I)

- Modulation and Demodulation
  - Receiver (modulation), control unit (auto dial & auto answer), transmitter (demodulation), & power supply
  - Equalizer in transmitter & adaptive equalizer in receiver (adjust to fit the characteristics of the telephone line)
- Methods
  - Frequency shift keying (FSK)
  - Phase shift keying (PSK): 180 degree (1 bit), 90 degree (2 bits), 45 degree (3 bits)
  - Differential phase shift keying (DPSK)
  - Quadrature amplitude modulation (QAM): combination of 8 phases & 4 relative amplitudes

Modems - II

- Methods
  - Trellis code modulation: signal processor, error correction for error free transmission, high speed
- Standards by ITU-T
  - V.32 for 9.6 kbps & V.32bis for 14.4 kbps
  - V.34 for 28.8 kbps & V.34+ or V.34bis for 33.6 kbps
  - V.90 for 56 kbps

Modems - III

- Handshaking
  - Exchange signals between modems
  - Test the characteristics of circuit and quality
  - determine baud rate, modulation technique and error control
- Data compression
  - V.42bis by ITU-T
  - Microcom Networking Protocol (MNP 7 or 10) by Microcom, Inc.

Modem Classification

- Simplex, half-duplex, full-duplex transmission modems
- Asynchronous or synchronous transmission modems
- Acoustically coupled modems (portable)
- Limited distance modems/short haul modems (less than 20 miles)
- Modem eliminators/null modems (cable less than several thousand feet)

Modem Classification - II

- Facsimile modems
  - Error correction and data compression
- Modem for fiber-optics circuits
  - Digital-electrical to digital-optical
- Cable modems
  - DTE to cable television system cable
  - Data Over Cable Service Interface Specification (DOCSIS) by CableLabs
  - For large files and not logon process