Data Communication Concepts

- Code
- Transmission
- Signal
- Modulation
- Service

Types of Coding

- Human code
  - Morse code
  - Dot and dash
- Machine code
  - Binary states
  - Binary digit (bit)
  - Byte

Machine Codes

- Characteristics
  - Two-state code
  - Same number of bits
  - Perfectly formed
  - Same duration
- Code points: possible combination
- Types of characters
  - Alphanumeric
  - Format effector
  - Control (device & transmission)

Specific Codes

- Baudot code
- American standard code for information interchange (ASCII)
- Extended binary coded decimal interchange code (EBCDIC)
- Unicode or ISO10646

Baudot Code

- 5 bits (32 code points)
- ESC key
  - Figure shift (uppercase)
  - Letter shift (lowercase)
- Teletypewriters before 1965
- No error checking

American Standard Code for Information Interchange (ASCII)

- By American National Standards Institute (ANSI)
- 7 bits: easy sorting by computers and understand by human
- Eighth-bit for parity bit (error checking)
- 6-4 most most significant bits (MSB) 3-0 bits Least significant bits (LSB)
- Used by microcomputers

Extended binary Coded Decimal Interchange Code (EBCDIC)

- 8-bit code

- IBM mainframe computers

- 0-3 most most significant bits (MSB) 4-7 bits Least significant bits (LSB)

Unicode or ISO 10646

- 16-bit
- By Unicode Consortium for international languages
- Used by Windows NT

Code Conversion

- Harder from larger no. of bits code to smaller no. of bits code
- Use ESC mechanism

Transmission

- Equipment
- Physical Connection
- Timing
- Direction

Transmission Equipment

- Data terminal equipment (DTE): computer
- Data circuit terminating equipment or data communication equipment (DCE): modem

Physical Connection

- Parallel transmission
  - Fast
  - Simple
  - Line cost
  - Impractical for data communication
  - Centronics (36 pins)
- Serial transmission
  - Complicated transmitter and receive
  - serial cable, port, DB-25 connector, DB-9 connector, M-block
  - Serial transmission standard: RS-232-C by EIA
- Serial/parallel conversion
  - Universal asynchronous receiver transmitter (UART)
- Breakout Box

RS-232-C Interface Standard

- Voltage (+5 to +15 for zero, -5 to -15 for one)
- 25-pin connector for signal
  - Pin 2 transmitted data
  - Pin 3 received data
  - Pin 4 request to send
  - Pin 5 clear to send
  - Pin 6 data set ready
  - Pin 20 data terminal ready
  - Pin 15 transmit clock
  - Pin 17 receive clock
  - Pin 8 carrier detector
  - Pin 22 ringing indicator

Handshaking for Computer and Terminal - I

- Computer and terminal raise DTR (data terminal ready, 20) signal to modem
- Modem raise DSR (data set ready, 6) signal
- Computer raises RTS (request to send, 4) signal
- Computer's modem sends a carrier signal

Handshaking for Computer and Terminal -II

- Terminal's modem detects carrier and raises CD (carrier detect, 8) signal to computer's modem

- Computer sends data on TD (transmit data, 2)

- Computer's modem modulates data onto the carrier wave

- Terminal's modem demodulates data onto RD (received data, 3)

Handshaking for Computer and Terminal -III

- Computer lowers RTS (request to send 4) signal

- Computer's modem drops CTS (clear to send, 5) and carrier wave

- Terminal's modem drops CD (carrier detect 8)

- Transmission is complete

Transmission Timing

- Asynchronous transmission
  - Start/stop bits for character synchronization
  - Mark (0) /space (1) bits for bit synchronization
  - Idle line using stop bits
  - Simple, inexpensive, inefficient, slow speed transmission
  - For personal computer and terminals
- Synchronous transmission
  - Clock circuitry
  - One to four synchronization characters (SYN) for each block of data at the beginning and end
  - More efficient
  - Mainframe computer

Transmission Direction

- Simplex
- Half-duplex
  - Two-wire
- Full-duplex
  - four-wire or lease line
- Echo cancellation: digital signal processors (DSP)

Transmission Efficiency

- Types of bits in a character
  - Information bits
  - Noninformation bits (parity bit, SYN)
- Definition: No. of information bits divided by the total no. of bits in a transmission block

Signals

- Types
  - Digital
  - Analog
- Measurement
  - Signal rate (baud)
    - No. of signal changes (amplitude, frequency, or phase) on a circuit per second
  - Speed (bps)
    - No. of bits that a circuit can carry in 1 second
    - Bits per second (bps) used for measurement

Digital Transmission of Digital Signals

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

Analog Signals

- Signal frequency
  - Sine wave
  - Cycle
  - Hertz (Hz): frequency per second
    - Kilohertz (kHz)
    - Megahertz (MHz)
    - Gigahertz (gHz)
- Bandwidth
- Guard channel or guardband

Analog Signals Measurement

- Amplitude
  - Loudness
- Frequency
  - Vibration speed
- Phase
  - Relative position of wave measured in degree
  - A shift of departure from normal continuous pattern of the wave

Modems

- Modulation and Demodulation
- Analog lines to transmit digital signals
- Methods
  - Amplitude modulation (AM)
  - Frequency modulation (FM)
  - Phase modulation (PM)
  - Quadrature amplitude modulation (QAM)

Modulation

- Amplitude modulation (AM)
  - Height of the signals
  - Susceptible to noise and interference
- Frequency modulation (FM)
  - Frequency shift keying (FSK)
  - Width of the signals
  - Less interference than AM
- Phase modulation (PM)
  - Phase shift keying (PSK): a change from 1 to 0, or 0 to 1
  - 180 degree (1 bit), 90 degree (2 bits), 45 degree (3 bits)
- Quadrature amplitude modulation (QAM)
  - Phase and amplitude
  - 16QAM: 16 different events with 4 bits/baud

Services

– Analog
  - Plain old telephone service (POTS)
  - Voice-grade lease

– Narrow-band digital
  - Digital data service (DDS)
  - Digital service level 0 (DS-0)

– Broad-band digital
  - T1
  - T3

– Digital dial-up
  - Integrated services digital network (ISDN)
  - Switched 56K