Why Packets?

Reason 1: Transmission of data results in errors or lost data. Breaking the data into small packets makes error detection easier.

Reason 2: Most networks use shared media. To ensure fair access to all users, a network cannot allow one user to deny access to others.

Examples

(1) Consider sending a 5 MB file across a network at 56 Kbps.

(2) Suppose the file is broken into 1000-byte packets.

(3) Suppose there are only two computers on the network.

(a) Both send a 5 MB file.

(b) One sends a 5 MB file and the other a 10 KB file.

Packets and Frames

packet - the generic term for a small parcel of data.

frame or hardware frame - the form of a packet in a specific hardware technology.

Example: For ASCII data, there are two characters set up to mark the start and the end of a transmission.

- **soh** - start of header, ASCII character 1.
- **eot** - end of transmission, ASCII character 4.

Advantage

- Accommodates transmission problems.
  - A missing **eot** indicates the sending computer crashed.
  - A missing **soh** indicates the receiving computer missed the beginning of the message.

Disadvantage

- Incurs extra overhead to send additional characters which carry no data.

Byte Stuffing

byte stuffing - a technique in which extra data is inserted to distinguish between data values and packet control data.

Example:

Character in Data	Character Sent
soh	**esc x**
eot	**esc y**
esc	**esc z**

Transmission Errors

error detection - sending additional information so that incorrect data can be detected and rejected.

error correction - sending additional information so that incorrect data can be corrected and accepted.

Parity Checking

parity - the even or odd quality of a number.

Example: ASCII data and the 7-bit binary representation of ASCII characters.

The parity of a binary number is the evenness or oddness of the number of 1s.

- 0101101 has even parity.
- 0100101 has odd parity.

parity bit - an extra bit transmitted with each character denoting the parity of that character.

even parity - adding a parity bit to a character so that the total number of 1s is even.

odd parity - adding a parity bit to a character so that the total number of 1s is odd.

parity checking - the process of sending a parity bit along with a character to allow the receiver to confirm the sender's value and check if a possible transmission error occurred.

Example: Using even parity, 0101101 has parity bit 0.

Using odd parity, 0101101 has parity bit 1.

Example: Suppose even parity. To send the character 0101101, 0101101+0 would be sent.

- Receiving 0101001+0 would be interpreted as incorrect data.
- Receiving 0100001+0 would be interpreted as correct data.

Checksums

checksum - the sum total of the data binary values.

Example: Send the word BOAT.

B	O	A	T
1000010	1001111	1000001	1010100

Sum is 100100110. Since this is a 9-digit number, the two extra carry bits are added to the other 7 to get the checksum 0101000.

Example:

1000000	1001101	1000011	1010110
@	M	B	V

has the same checksum.

Cyclic Redundancy Check (CRC)

CRC uses two hardware components:

- An exclusive-or unit.
- A shift register.

Theorem: Suppose 16 0 bits are appended to a message and the CRC computed for the extended message. Suppose the CRC is computed again for the message followed by the first CRC. The result of the second computation is 0.