different users may be using completely different hardware platforms. In fact communication over a network is sometimes the easiest way to exchange data with someone who uses a different hardware platform.

Layering provides a framework for the design of protocols, which are the actual rules which govern a particular exchange of data. If we take the Physical Layer of the OSI model, that is, the layer where the data is actually carried from A to B, then a variety of protocols exist for communication at this level. One example is the RS332 protocol. This standard was developed to govern communication between computers and modems and it is used in all personal computers. The standard specifies the type of connection (size/shape of plug and socket/arrangement of wires) to be used at the modem and the special control codes that will be used to control the modem. This allows manufacturers to produce modems, knowing that they will interface with any computer that uses the RS232 protocol. Note that the modem manufacturer need not be concerned about what the data is, how it is formed into packets or addressed. These are all tasks that are dealt with by other layers.

(l) Transmission Errors and Bandwidth

When data is transmitted there is always the possibility that errors will occur so that the data received is not exactly the same as the data that was sent. This can happen for a number of reasons, but transmission along wire cable is particularly susceptible to outside interference.

As long as data is received the only errors that can occur with digital data are:

> The data has been corrupted, so that some 1's have become 0's and vice versa.
> Some data has been lost so that some of what was transmitted is not received.
> Additional 1's and 0's have been inserted into the valid data.

Of course any combination of the above can occur within a single transmission.

The various error detection techniques are designed to identify when errors in transmission have occurred and they all involve adding extra data to what is transmitted. Error detection is rather like validation in that if the error detection method flags that an error has occurred then there must be an error in the transmitted data. However if the error detection method does not flag an error then there is no guarantee that the received data is error free.

Parity Check

A single bit parity check is the simplest method of checking for transmission errors. If data is sent in groups of bits then a single bit parity check will add one bit to each group. The

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value of the bit is set to 1 or 0 to make the total number of bits in the group an even number. This is known as even parity.

It is mostly used for text transmission because a grouping of seven bits provides enough different patterns to represents all the characters that need to be transmitted. Digital computer systems are structured to handle bits in powers of 2 because of their binary nature and so it is actually easier to send bits using groups of eight rather than the seven needed to represent each character. The spare bit is used as a parity bit and has its value set to make the total number of 1's in each group of eight an even number. If a group of eight bits is received containing an odd number of 1's then there must have been a transmission error.

The diagram shows the first six letters of the alphabet represented as groups of binary digits. The right-most seven bits are the actual data. The left-most bit is the single parity bit used to make the total number of 1's in each code even.

A	0	1	0	0	0	0	0	1
B	0	1	0	0	0	0	1	0
C	1	1	0	0	0	0	1	1
D	0	1	0	0	0	1	0	0
E	1	1	0	0	0	1	0	1
F	1	1	0	0	0	1	1	0

7-bit ASCII code with added even parity

The underlying code being used is the ASCII (American Standard Code for Interchange of Information), in which the number 65 (binary 1000001) is used to represent an uppercase A.

Odd parity is occasionally used instead of even parity. The difference, as you would expect, is that with odd parity the parity bit is set to make the total number of bits in a group an odd number.

Parity will always detect an error if only a single bit has been corrupted during transmission. However if an even number of bits have been changed then the parity will remain correct and the error will not be detected. The term Burst Error is used to describe a situation when more than one bit is affected by error.

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