UNIT IV : DATA COMMUNICATIONS.

Data Communication Circuits :

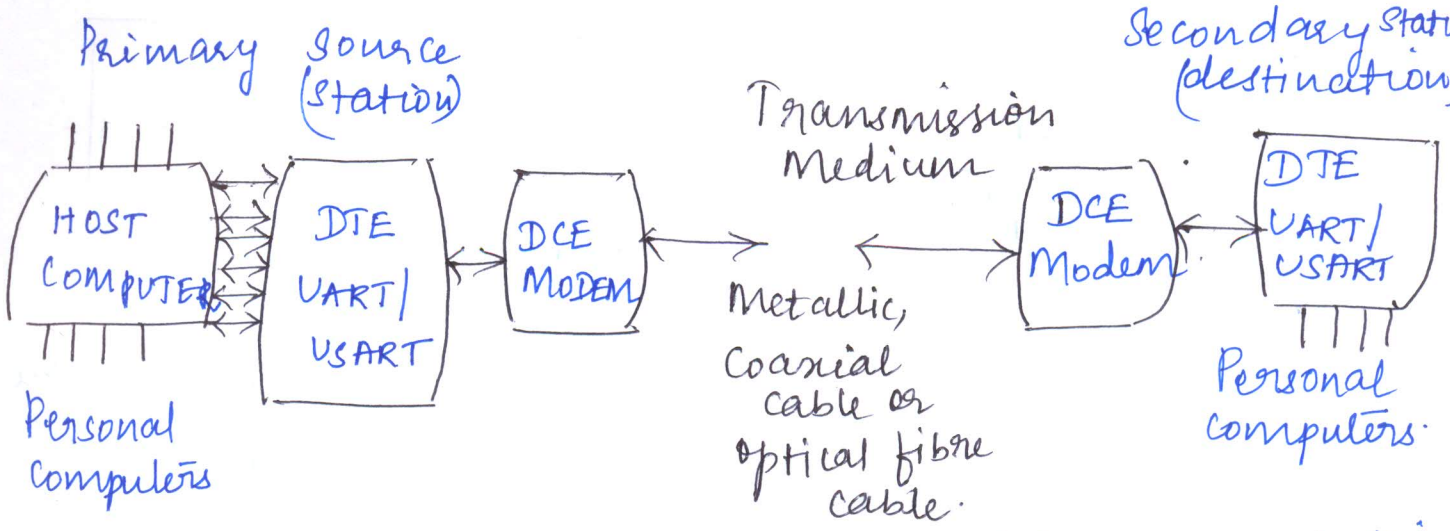


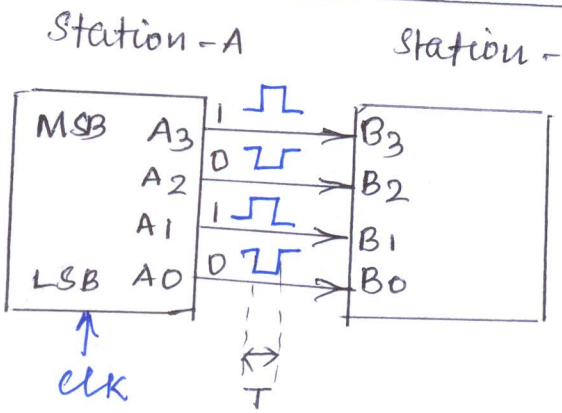
fig 1 : Simplified Block diagram of data communication Network.

Data terminal equipment (DTE) : It is a general term that describes the interface equipment used at the stations to adapt the digital signals from the computers and terminals to a form more suitable for transmission.

Data Communication equipment (DCE) :
It is a general term that describes the equipment that converts digital signals to analog signals and interfaces the data terminal equipment to the analog transmission medium.

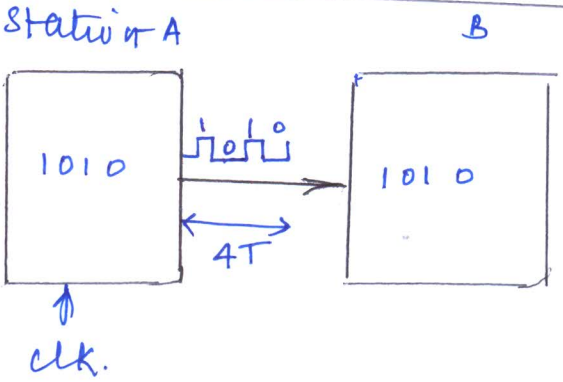
Data transmission : Binary information can be transmitted either in parallel or serially.

PARALLEL TRANSMISSION



1) Each bit position $A_0 - A_3$ has its own transmission line.
2) All 4-bits can be transmitted simultaneously during the time of single clock Pulse T.
3) This type of transmission is called as parallel by bit or serial by character.

SERIAL TRANSMISSION



1) Single transmission line used to transmit entire word.
2) Only one bit can be transmitted at a time, then it requires four clock pulses to transmit entire word.
3) otherwise called as serial by bit.

CONFIGURATIONS!

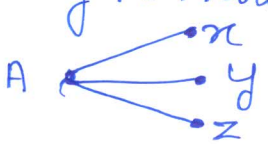
- Two point
- Multipoint.

Two Point Configuration

→ It involves two locations or stations only.
→ Transfer of information between mainframe & remote computer terminals

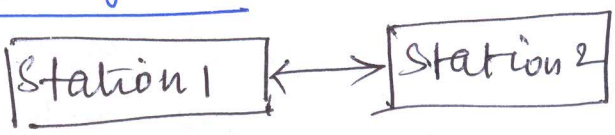
Multipoint configuration

It involves three or more stations.
Used to interconnect a single mainframe computer to many remote computer terminals.

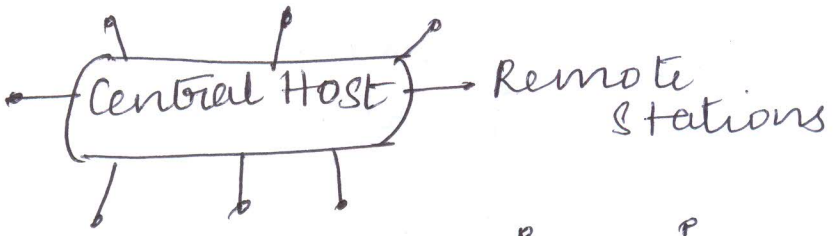


Data Network topologies :-

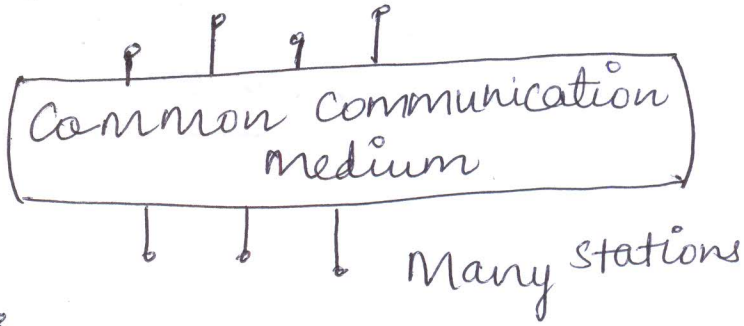
1) Point to point :



2) Star :



3) Bus or Multidrop :



4) Ring or loop :-

5) Mesh :

Transmission Modes :- (Four types)

1) Simplex mode : Data transmission is unidirectional, information can be sent only in one direction. Also called as receive only, transmit only, one way only lines.
   Ex : TV, Radio Systems.
2) Half-duplex mode (HDX) : Data transmission is possible in both directions, but not at the same time. Also called as two way alternate or either-way lines.
   Ex : Walky-Talky.
3) Full-duplex mode (FDX) : Data transmissions are possible in both directions simultaneously, but they must be between same two stations. otherwise called as duplex or both way lines.
   Ex : standard telephone systems.

Error control can be divided into two categories,

1) Error detection
2) Error correction.

ERROR DETECTION:

→ It is the process of monitoring the received data and determining when a transmission error has occured.
→ It is not able to identify that which bit is in error.
→ The purpose of error detection is not to prevent errors from occuring but to prevent undetected errors from occuring.

Error detection techniques :

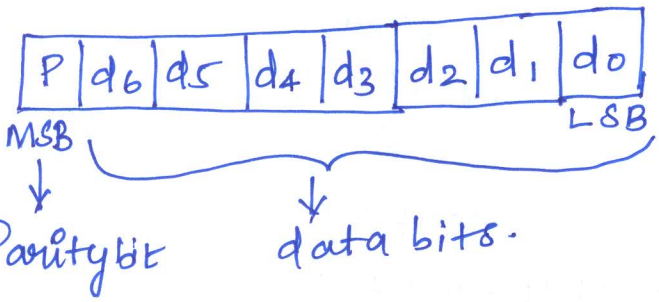
1) Redundancy: It involves transmitting each character twice. If the same character is not received twice in succession, a transmission error has occured.
2) Echoplex : full duplex operation, ie character is transmitted after it has been typed into the transmit terminal, then it has beenreceived at the receiver. Immediately it is transmitted back to the transmiter screen. Manually error can be detected.
3) Exact-count encoding : With exact count-encoding, the number of 1's in each character is the same.
4) Parity Coding : It is the simplest error detection scheme used for data communication systems and is used with vertical & horizontal redundancy checking.

A single bit called parity bit, is added to each character to force the total number of 1's in the character to be either an odd or even number.

Odd Parity :- If the parity bit is added such that there are odd number of 1's, then it is called as odd parity coding.

Even parity : If the parity bit is added such that there are even number of 1's, then it is called as even parity coding.

* The simplest technique for detecting errors is to add an extra bit known as parity bit to each word being transmitted.



Even Parity

Ex:

Transmitter Receiver

o/p has odd number of 1's.

Single or odd number of error is checked at receiver and indicates there is an error. Then receiver ignore the received byte and give request for retransmission of same byte to the transmitter.

→ This method is not applicable to detect two or any even number of error.

→ cannot able to correct the error.

Sender | During transmission | Receiver

Hex value - 50

Binary value = 1010000 ⇒ [P 1010000] ⇒ P [1010000]

P = 0, for even parity.

VERTICAL & HORIZONTAL REDUNDANCY CHECKING :- [VRC & LRC]

VRC is an error detection scheme that uses parity to determine if a transmission error has occured within a character. VRC also called as character parity. (odd or even Parity)

Horizontal or Longitudinal redundancy checking [HRC or LRC) is an error detection scheme that uses parity to determine if a transmission error has occured in a message and is therefore sometimes called as message parity. It use only even parity.

VRC :- [odd or Even parity].

- odd parity :- No. of 1's in the given bit inclusive of parity bit is odd
- Even Parity :- No. of 1's in the given bit inclusive of parity bit is even.

sender | During transmission | Receiver

20

↓↓

010 0000 ⇒ [P][010 0000] ⇒ [P] [0100000]

For odd parity, P = 0 ; if P = 1 is recovered at the receiver means the mismatch which indicates the error has been introduced.

Frame Check Sequence : FCS or BCS.

BCS → Block check Sequence.

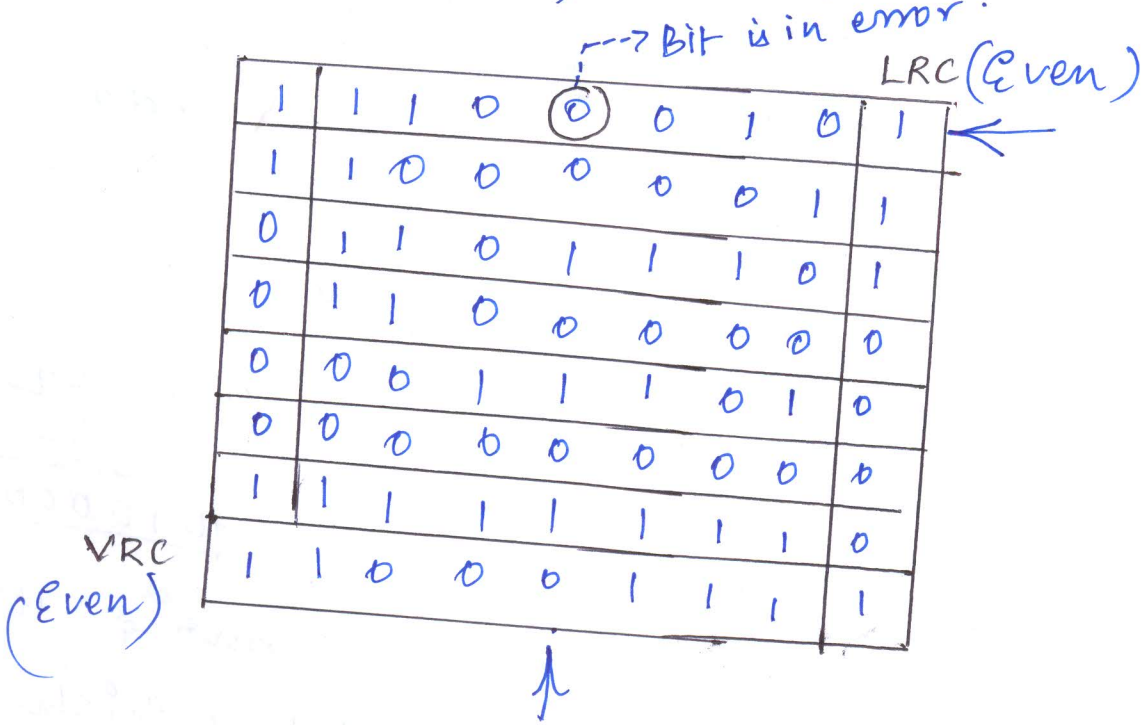
The group of characters forming a message is called as block or frame of data. Hence, the bit sequence for LRC is called as FCS or BCS.

LOCATE A BIT IN ERROR :-

A single error in any bit will result in a incorrect LRC in one of the rows and incorrect VRC in one of the columns. The bit which is common to row and column is the bit in error.

PROBLEM :- The following bit stream is encoded using VRC, LRC, even parity. and locate & correct the error if it is present.

11000011, 11110011, 10110010, 00001010, 00101010, 00101011, 10100011, 01001011, 11100001.



CYCLIC REDUNDANCY CHECKING (CRC).

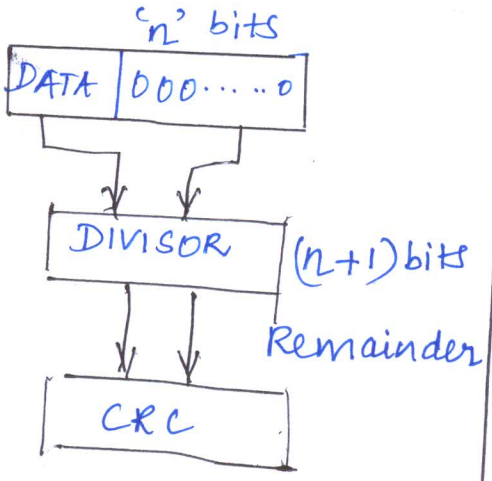
This is the most reliable scheme for error detection. Approximately 99.9% of all transmission errors are detected.

The most common CRC code is CRC-16.

A sequence of redundant bits are called as CRCode.

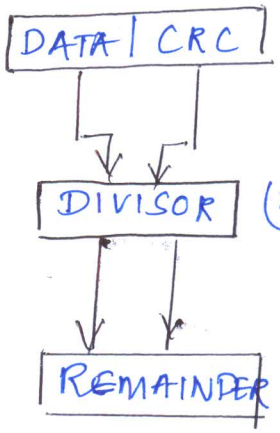
STEPS INVOLVED IN $\frac{0}{0}$

SENDER SIDE



* 'n' number of 0's are appended to the data unit. The number n is one less than the number of bits in the predetermined divisor, ie (n+1).
* New data unit is divided by divisor using process called binary division.
* The Remainder is called as CRC.

RECEIVER SIDE



Rem = 0 → no error occured

* CRC is appended to the original data unit.
* New data unit is divided by same divisor.
* If the remainder is zero, then there is no error occured, otherwise there is an error.

CHECK SUM: It is simply the least significant byte of the arithmetic sum of the binary data being transmitted. While data are being transmitted, each character is added with the accumulated sum of the previously transmitted characters. The LSB of the sum is appended to the end of the message and transmitted. The receive terminal replicates the summing operation & determines its own sum and checksum character. The LSB of receiver's sum is compared with the checksum appended to the message. If they are same, it is assumed to be no transmission error.

ERROR CORRECTION

There are three methods to correct an error.

i) Symbol Substitution: It was designed to be used in a human environment - when there is a human being at the receive terminal to analyze the data and make decisions on its integrity.

Ex: BAT ⟶ $AT

↑ Symbol.

An operator could not determine the character and retransmission is required.

ii) Retransmission :

It is the process of retransmitting the entire message to the receiver, whenever the receiver founds that the received message is in error.

Since the receiver automatically calls for a retransmission of the entire message, this process of retransmission is called as automatic repeat request (ARQ).

iii) Forward Error Correction :

It is the only error correction scheme, that detects and corrects error without retransmission. The redundant bits are used to detect which bit is in error.

Most popular code is Hamming code.

→ Hamming code is a single bit error correction method using redundant bits.

→ For a data unit of 'm' bits, use the formula, $2^n \geq m+n+1$, to determine the number of redundant bits needed.

The number of hamming bits must be added to a character is determined from the expression.

$2^n \geq m+n+1$, $n \rightarrow$ no/- of hamming bits

$m \rightarrow$ no/- of bits in the character.