

- Yaha par hamne numbering left to right ki hai ~~for~~ Joh ki Tennanbaum ne de hai but Forogen mein, Right to left de hai.
- Joh definitely code word same nahi aayega lekin error detection ki technique same hi apply hogi kahi farak nahi aayega.
- But Joh Tennanbaum mein likha hai hum usko hi sahi manegay.
- Counting kaha se start karo data bits toh aaischi fill karna hai, i.e left to right.
- Now in Redundant bit ko kaise find out karna hai- Redundant bit find out karne k liye hum har number ko two ki power mein lik rahi hai-

$$1 = 2^0$$

$$2 = 2^1$$

$$3 = 2^0 + 2^1$$

$$4 = 2^2$$

$$5 = 2^2 + 2^0$$

$$6 = 2^2 + \cancel{2^0} + 2^1$$

$$7 = 2^2 + 2^1 + 2^0$$

$$8 = 2^3$$

$$9 = 2^3 + 2^0$$

$$10 = 2^3 + 2^1$$

$$11 = 2^3 + 2^1 + 2^0$$

$$12 = 2^3 + 2^2$$

11	12
L	0

- Hamare har number ko two ki power mein likhahi

- Joh pahali redundant bit kansi 2^0 , toh yeh 2^0 wali bit ko kaise compute karu.
- Ham kansi parity scheme le kar chal rahi hai odd, agar by default kahi parity scheme nahi di hui hai exam mein toh odd parity likh chahiye hai.
- Now considering odd parity, now 2 ki power 0 ki-kun number k expansion mein present hai 1, 3, 5, 7, 9, 11 matlab sare odd positions.

- Joh including 2^0 , and sare odd position mein number of 1's kitane hone chahiye odd.

Job	1	0
1		
3	✓	
5		✓
7	✓	
9	✓	
11	✓	

Joh number of 1's kitane hai four but hamko kitane chahiye odd toh 2^0 wali position par kya aayega one.

- 2^0 par one aayega.

- Now next hamko kisko count karana hai 2^1 ko, toh 2^1 ki-kis k expansion mein hai, 2, 3, 6, 7, 10, and 11.

	1	0
2		
3	✓	
6		✓
7	✓	
10		✓
11	✓	

→ Joh total number of 1's is three i.e odd toh 2^1 wali position par 0 aayega.

• Now aab 2^2 ko compute karna hai toh kisko dekogay 4, 5, 6, 7, 12.

	1	0
4		
5		✓
6		✓
7	✓	
12		✓

• Number of 1's kitana aayaha hai one i.e odd, toh 2^2 wali position par kitana aayega 0.

• Now aab 2^3 ko compute karna hai toh 2^3 kin-kin number k expansion mein aayaha hai.

	1	0
8		
9	✓	
10		✓
11	✓	
12		✓

- The number of 1's kitani horahai hai toh i.e even toh 2^3 wali position par kya aayega 1.
- Ek parity bit dusri parity bit k computation mein kabhi nahi aayegi.
- A.i.e Agar 2^0 ko compute karrahai hai toh $2^1, 2^2, 2^3$ ki jaruri hi nahi paregi.
- Yeh technique error detecting k sath error correcting technique bhi hai.

* It can correct one bit error.

Now hum dek rahai hai yeh technique error ko kaise ~~de~~ correct karte hai aur kaise detect karte hai.

- # Now error correct kaise hote hai, jab error ki position pata chal jaye, toh us position par kahi bhi bit ko usko invert kar do.

How To CORRECT SINGLE BIT ERROR BY USING HAMMING CODE

10[^] Data:- 10011010
Data bit with redundant bit 1010@0111010

- Now 5th bit kitani hai 0, suppose during transmission yeh 5th bit 0 k jagah one hogayi.
during corruption.

- Aur hum yeh cha raha hai ki 5th bit hi corrupt hui hai yeh receiver ko kaise bata chaloge

1	2	3	4	5	6	7	8	9	10	11	12
1	0	1	0	1	0	1	1	1	0	1	0

→ corrupted.

- Now sabse pahle receiver kya karta hai har parity bit ko compute karta hai, to check whether woh parity bit sahi aurahi hai ki nahi aa rahi hai.
- Jo receiver sabse pahle kisko compute karega 2⁰ ko, toh 2⁰ mein kya hota hai 2⁰ ko milake number of ones kitane hone chahiye, odd hone chahiye. (odd position par)
- Now hum ~~ka~~ count kar ke dekhte hai ki number of ones kitane hai.
- Number of ones = 6 i.e even hai. But odd hone chahiye the but yaha par even aa rahi hai,
- Jo konsi parity bit sahi nahi aa rahi hai 2⁰ wali.
- Now aab hum check karte hai 2¹ wali parity bit, kon-kon se position check karne hai 2, 3, 6, 7, 10 & 11.
- Number of ones = 3 = odd = sahi hai. matlab 2¹ galat nahi hai.

- 2^1 wali mein koi problem nahi aayi.
- Now aab hum check karke 2^2 mein problem aaraha hai ki nahi aaraha hai.
- 2^2 k liye kisko check karu ~~4, 5, 6, 7, 12~~.

	0	1
4	✓	
5		✓
6	✓	
7		✓
12	✓	

- Number of ones = 2 \Rightarrow even, odd aare change the matlab galat aaraha hai matlab 2^2 bhi galat hai.
- Jo 2^0 incorrect aayi 2^1 correct aayi, 2^2 incorrect aayi.
- Now aab hum check karke hai 2^3 correct aayi ki incorrect aayi.

- 2^3 k liye kisko check karu ~~8, 9, 10, 11, 12~~.

	0	1
8	✓	✓
9		✓
10	✓	
11		✓
12	✓	

- Number of ones = 3 \Rightarrow odd matlab 2^3 sahi hai.
- Jo kon-kon se parity bit incorrect aarahai hai, toh it is 2^0 and 2^2 , toh 2^0 & 2^2 ka sum kitana i.e 5.
- It means 5^{th} bit is incorrect.
- * yeh technique sirf ek bit ki error ko correct kar sakte hai agar ek se jada ki error aaye toh yeh technique ~~so~~ fail hojayege.
- Jitani bhi error correcting techniques hai, woh sab forward error detection techniques kabalati hai.
- * Practically Hamming code technique is also not used.
- * Jo practically kya use kiya jata hai, hamming CRC, toh hamming use karna chahiye kya toh ~~isara~~ hamming mein itana sara overhead karne k baad sirf ek bit ki error hi correct hoti hai aur practically ek bit ki error kabhi soti hi nahi hai.
- Error hamara burst error k form mein hi aati hai.
- Jo practically hum CRC error detection technique use karte hai.
- * Backward Error detection technique:-
When an error is detected in a frame, the sender

Stop & wait protocol :-

* is asked to retransmit the data/frame. This approach is known as Automatic Repeat Request (ARQ) technique.

FLOW CONTROL :-

- Flow Control kya kahata hai?? toh woh kahata hai synchronous sender and receiver.
- Agar sender fast hai toh usko slow karneko.
- Now ham flow control k. different ways/different protocol discuss kar rahi hai.
- Data link layer par hamara kya assumption hota hai ki sender aur receiver directly connect hai, unke bich mein kahi intermediate station nahi hai, because data-link layer works for a single link.
- Flow control ka sabse pahla protocol hum discuss kar rahi hai Stop and wait.

STOP AND WAIT PROTOCOL :-

Ques:- Yeh protocol kya karta hai??

Ans:-> Sender should send a frame and wait for acknowledgement.

- Jaisehi first frame ka acknowledgement aaye, uske baad hi ~~send~~ ^{second} frame send karne.

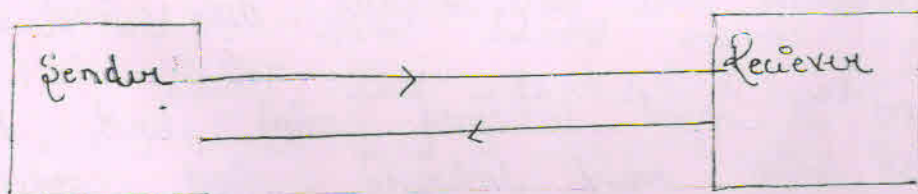
- Stop Kab hojayege, jab sender ne frame send kar di jab and wait till the acknowledgement of that frame not come.
- Then send second frame then stop and wait for its acknowledgement.

• Now is protocol mein problem kya hai??

Ans- Sabse pahali problem toh yahi hai ki sender kab tak wait karega. kitane der tak wait karega, infinite toh wait nahi kar sakta, agar utani der tak wait karne mein agar acknowledgement nahi aaya toh sender kya kare?? Toh sender jis frame ka acknowledgement nahi aaya usko phir se send karuga.

Ques: Question yeh hai sender kitani der tak wait karne chahiye??

Ans:→



- Sender ne data ki pahali bit channel par rakhi, jaisehi pahali bit channel par aayi, hamara data transmission start hogaya, ab sender ki sari bit jo usne send ki the woh kaha aagayi Receiver tak aagayi.
- Phir Receiver ne channel par kya rakha start kiya acknowledgement, then acknowledgement traverse

hoke kaha chalogaya sender ki pass.

- Joh kaam-se-kaam itane time mein procedure mein jitana time lagta hai, atleast utana time toh sender ko wait karna hi chahiye.

✓ Transmission of first bit of data

- Sender should wait for the time period equal to the time difference between the transmission of first bit of data and receiving of last bit of acknowledgement by sender.

- Joh sender should wait for atleast this time period.

① Aur yahi time-difference kya kahalata hai RTT, Round trip Time.

- Ideally sender should wait for the time period equal to RTT (Round trip Time).

- Kaam-se-kaam itana toh usko wait karna hi chahiye.

★ Ideally sender should wait for the time-period slightly equal to RTT.

- Now question yeh hai how to compute RTT??

→ Joh RTT ko compute karne k liye, hum do parameter ko discuss karrahai hai.