Hamming Distance:

to correct d bit error we need hamming distance =2d+1

1. **Choose the 4-bit data:**
   Let's use the data bits `1011`.

2. **Determine positions for parity bits:**
   Parity bits are placed at positions that are powers of 2: positions 1, 2, and 4. So, our 7-bit code will look like this initially:

   Copy code
   ```
   P1 P2 D1 P4 D2 D3 D4
   ```

3. **Place the data bits:**

   Copy code
   ```
   _ _ 1 _ 0 1 1
   ```

4. **Calculate the parity bits:**

   - **P1** covers bits 1, 3, 5, 7:

     csharp Copy code
     ```csharp
     P1 ⊕ D1 ⊕ D2 ⊕ D4 = 0 ⊕ 1 ⊕  ⊕ 1 = 0 (P1 is 0)
     ```


4. **Calculate the parity bits:**

   - **P1** covers bits 1, 3, 5, 7:

     csharp Copy code
     ```csharp
     P1 ⊕ D1 ⊕ D2 ⊕ D4 = 0 ⊕ 1 ⊕ 0 ⊕ 1 = 0 (P1 is 0)
     ```

   - **P2** covers bits 2, 3, 6, 7:

     csharp Copy code
     ```csharp
     P2 ⊕ D1 ⊕ D3 ⊕ D4 = 0 ⊕ 1 ⊕ 1 ⊕ 1 = 1 (P2 is 1)
     ```

   - **P4** covers bits 4, 5, 6, 7:

     csharp Copy code
     ```csharp
     P4 ⊕ D2 ⊕ D3 ⊕ D4 = 0 ⊕ 0 ⊕ 1 ⊕ 1 = 0 (P4 is 0)
     ```

5. **Insert the parity bits:**

   Copy code
   ```
   0 1 1 0 0 1 1
   ```

Error Detection and Correction:

Suppose during transmission, the received code is `0110111` (the 5th bit got flipped).

1. **Received code:**

```
0 1 1 0 1 1 1
```

2. **Check parity bits to find the error:**

   - **Check P1 (bits 1, 3, 5, 7):**

```vbnet
0 ⊕ 1 ⊕ 1 ⊕ 1 = 1 (Error detected in P1's set)
```

   - **Check P2 (bits 2, 3, 6, 7):**

```vbnet
1 ⊕ 1 ⊕ 1 ⊕ 1 = 0 (No error in P2's set)
```

2. **Check parity bits to find the error:**

   - **Check P1 (bits 1, 3, 5, 7):**

```vbnet
0 ⊕ 1 ⊕ 1 ⊕ 1 = 1 (Error detected in P1's set)
```

   - **Check P2 (bits 2, 3, 6, 7):**

```vbnet
1 ⊕ 1 ⊕ 1 ⊕ 1 = 0 (No error in P2's set)
```

   - **Check P4 (bits 4, 5, 6, 7):**

```vbnet
0 ⊕ 1 ⊕ 1 ⊕ 1 = 1 (Error detected in P4's set)
```

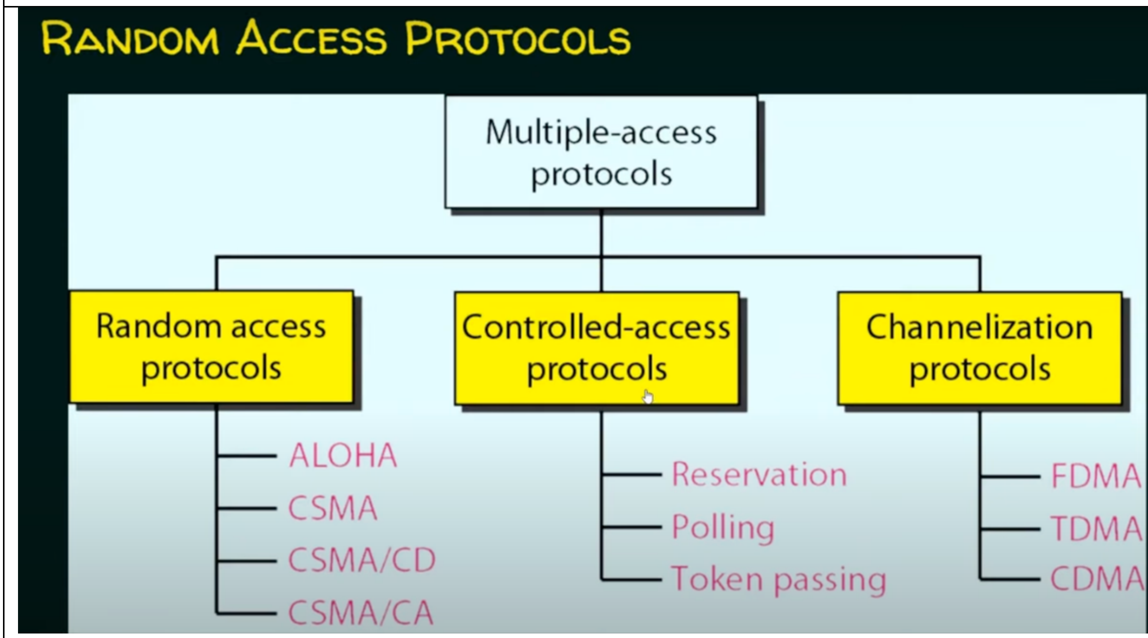
   The error position in binary is formed by combining the results of these checks, with P4, P2, and P1 forming the bits. Thus, the binary number `101` (in positions P4, P2, P1) gives us the position of the error: position 5.

3. **Correct the error:**

   Flip the bit at position 5:

```markdown
0  1  1  0  **0**  1  1
```

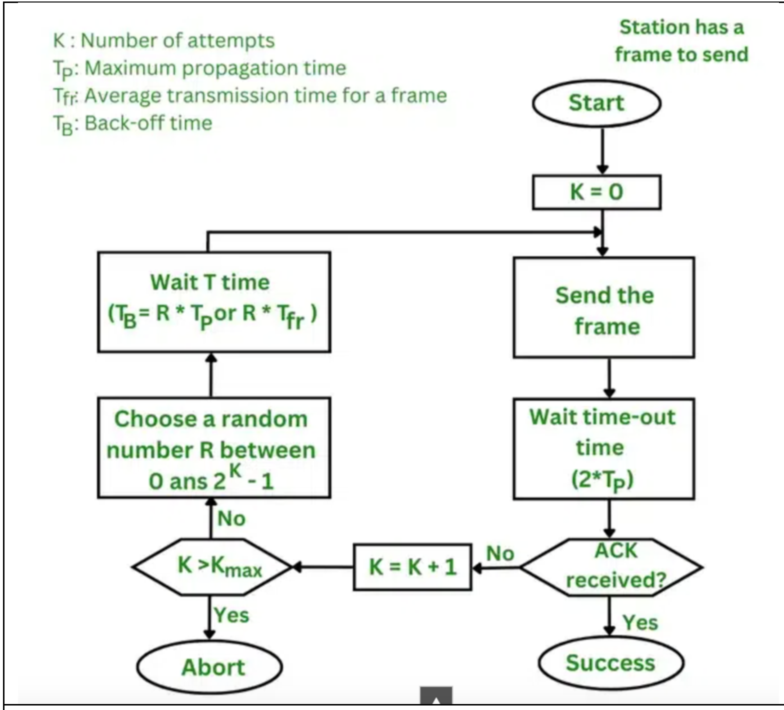
The corrected code is `0110011`, which matches the original encoded message.



Pure Aloha

Pure Aloha can be termed as the main Aloha or the original Aloha. Whenever any frame is available, each station sends it, and due to the presence of only one channel for communication, it can lead to the chance of collision.

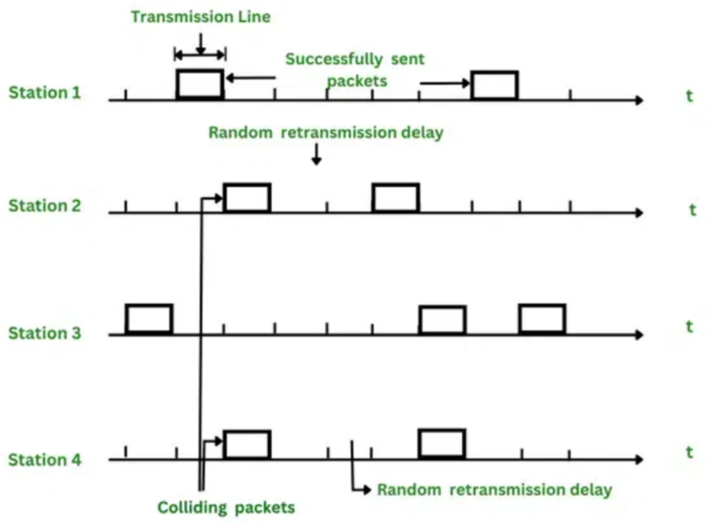
In the case of the pure aloha, the user transmits the frame and waits till the receiver acknowledges it, if the receiver does not send the acknowledgment, the sender will assume that it has not been received and sender resends the acknowledgment.



Slotted Aloha

Slotted Aloha is simply an advanced version of pure Aloha that helps in improving the communication network. A station is required to wait for the beginning of the next slot to transmit. The vulnerable period is halved as opposed to Pure Aloha.

Slotted Aloha helps in reducing the number of collisions by properly utilizing the channel and this basically results in the somehow delay of the users. In Slotted Aloha, the channel time is separated into particular time slots.



Differences Between Pure Aloha and Slotted Aloha

Pure Aloha	Slotted Aloha
In this Aloha, any station can transmit the data at any time.	In this, any station can transmit the data at the beginning of any time slot.
In this, The time is continuous and not globally synchronized.	In this, The time is discrete and globally synchronized.
Vulnerable time for Pure Aloha = 2 x Tt	Vulnerable time for Slotted Aloha = Tt
In Pure Aloha, the Probability of successful transmission of the data packet $= G \times e^{-2G}$	In Slotted Aloha, the Probability of successful transmission of the data packet $= G \times e^{-G}$
In Pure Aloha, Maximum efficiency = 18.4%	In Slotted Aloha, Maximum efficiency = 36.8%
Pure Aloha doesn't reduce the number of collisions to half.	Slotted Aloha reduces the number of collisions to half and doubles the efficiency of Pure Aloha.

G is defined as average no of frames generated by the system in one frame transmission time.
Average number of successful transmissions, S(Pure Aloha) = $G * e^{(-2G)}$

CSMA/CD : Maximum Transmission delay RTT(Round Trip time = 2 * Tp

CSMA/CA

Consider a network using the pure ALOHA medium access control protocol, where each frame is of length 1,000 bits. The channel transmission rate is 1 Mbps (=10^6 bits per second). The aggregate number of transmissions across all the nodes (including new frame transmissions and retransmitted frames due to collisions) is modelled as a Poisson process with a rate of 1,000 frames per second. Throughput is defined as the average number of frames successfully transmitted per second. The throughput of the network (rounded to the nearest integer) is ____________

A 180

B 160

C 135

D 115

Consider the cyclic redundancy check (CRC) based error detecting scheme having the generator polynomial $X^3 + X + 1$. Suppose the message $m_4m_3m_2m_1m_0 = 11000$ is to be transmitted. Check bits $c_2c_1c_0$ are appended at the end of the message by the transmitter using the above CRC scheme. The transmitted bit string is denoted by $m_4m_3m_2m_1m_0c_2c_1c_0$. The value of the checkbit sequence $c_2c_1c_0$ is

A 101

B 110

C 100

D 111

Consider the sliding window flow-control protocol operating between a sender and a receiver over a full-duplex error-free link. Assume the following:

The time taken for processing the data frame by the receiver is negligible.
The time taken for processing the acknowledgement frame by the sender is negligible.
The sender has infinite number of frames available for transmission.
The size of the data frame is 2,000 bits and the size of the acknowledgement frame is 10 bits.
The link data rate in each direction is 1 Mbps ($= 10^6$ bits per second).
One way propagation delay of the link is 100 milliseconds.

The minimum value of the sender's window size in terms of the number of frames, (rounded to the nearest integer) needed to achieve a link utilization of 50% is ____________

A 82

B 51

C 44

D 65

________ can detect burst error of length less than or equal to degree of the polynomial and detects burst errors that affect odd number of bits.

A Hamming Code

B CRC

C VRC

D None of the above

Consider a binary code that consists of only four valid code words as given below:
00000,01011,10101,11110
Let the minimum Hamming distance of the code be p and the maximum number of erroneous bits that can be corrected by the code be q. Then the values of p and q are

- A p = 3 and q = 1
- B p = 3 and q = 2
- C p = 4 and q = 2
- D p = 4 and q = 1

A computer network uses polynomials over GF(2) for error checking with 8 bits as information bits and uses $x^3 + x + 1$ as the generator polynomial to generate the check bits. In this network, the message 01011011 is transmitted as

- A 01011011010
- B 01011011011
- C 01011011101
- D 01011011100

The message 11001001 is to be transmitted using the CRC polynomial $x^3 + 1$ to protect it from errors. The message that should be transmitted is:

- A 11001001000
- B 11001001011
- C 11001010
- D 110010010011

A network has a data transmission bandwidth of 20×10^6 bits per second. It uses CSMA/CD in the MAClayer. The maximum signal propagation time from one node to another node is 40 microseconds. The minimum size of a frame in the network is _____ bytes.

- A 200
- B 400
- C 100
- D 600