Ethernet and Switching & Types - Part I

Complete Course on Computer Networks - Part II

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Functions of Physical Layer

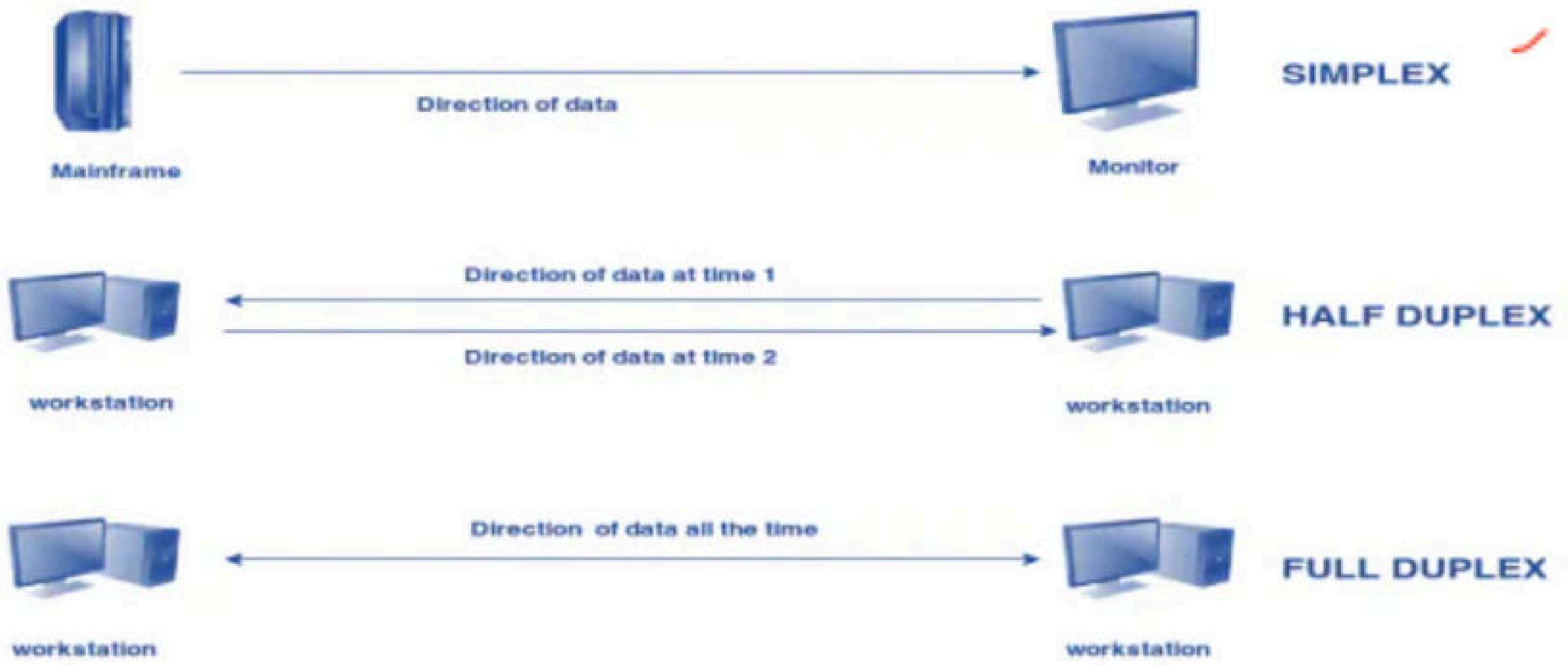
ISO
1) PL
2) DLL
3) NL

1.) Physical Layer is electrical, mechanical, procedural and functional characteristics of physical links

It depends upon the type of links we are using to communicate.

If it is a copper wire then messages will be converted into electrical signals.
If link is an optical fibre then messages will be converted to light signals.
In case of Wireless communication, messages are sent into form of Electro Magnetic Waves.

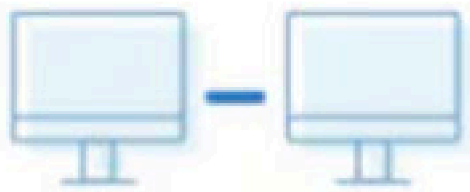
2.) Physical Layer also includes the Transmission Mode – Simplex / Duplex



3.) Physical Layer also deals with Topologies

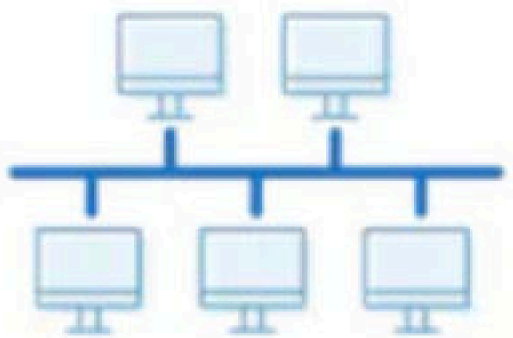
Point to Point topology is the simplest topology which connects two nodes directly together with a common link.

1 Point to point



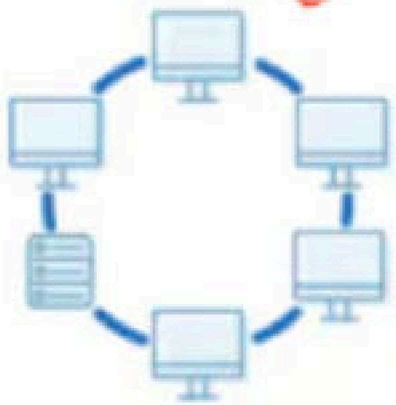
A bus topology orients all the devices on a network along a single cable running in a single direction from one end of the network to the other

2 Bus



Ring topology is where nodes are arranged in a circle (or ring). The data can travel through the ring network in either one direction or both directions, with each device having exactly two neighbors.

3 Ring

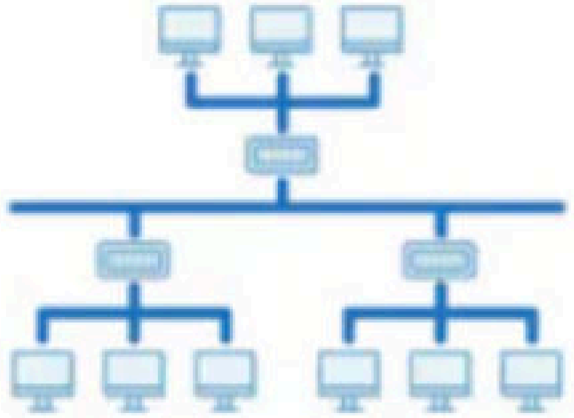


A star topology, the most common network topology, is laid out so every node in the network is directly connected to one central hub via coaxial, twisted-pair, or fiber-optic cable. Acting as a server, this central node manages data transmission—as information sent from any node on the network has to pass through the central one to reach its destination—and functions as a repeater, which helps <u>prevent data loss</u>.

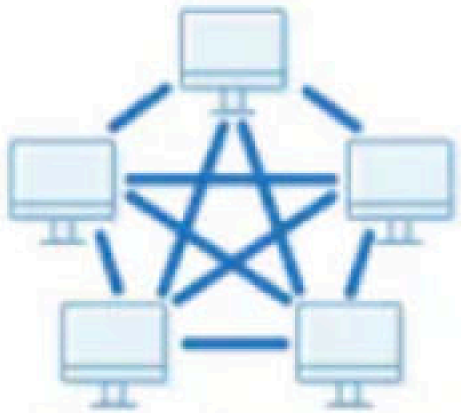
4 Star

Each node in a star topology is directly connected to the central hub, a tree topology has a parent-child hierarchy to how the nodes are connected.

5 Tree

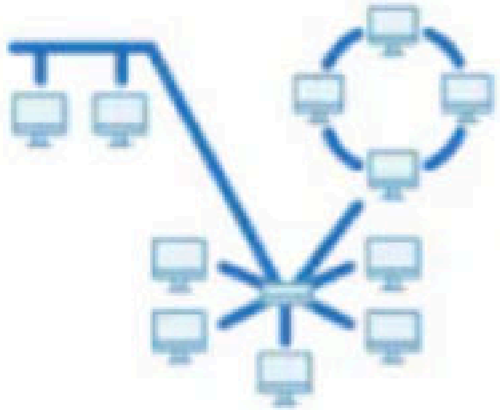


6 Mesh



A mesh topology is a network setup where each computer and network device is interconnected with one another.

7 Hybrid

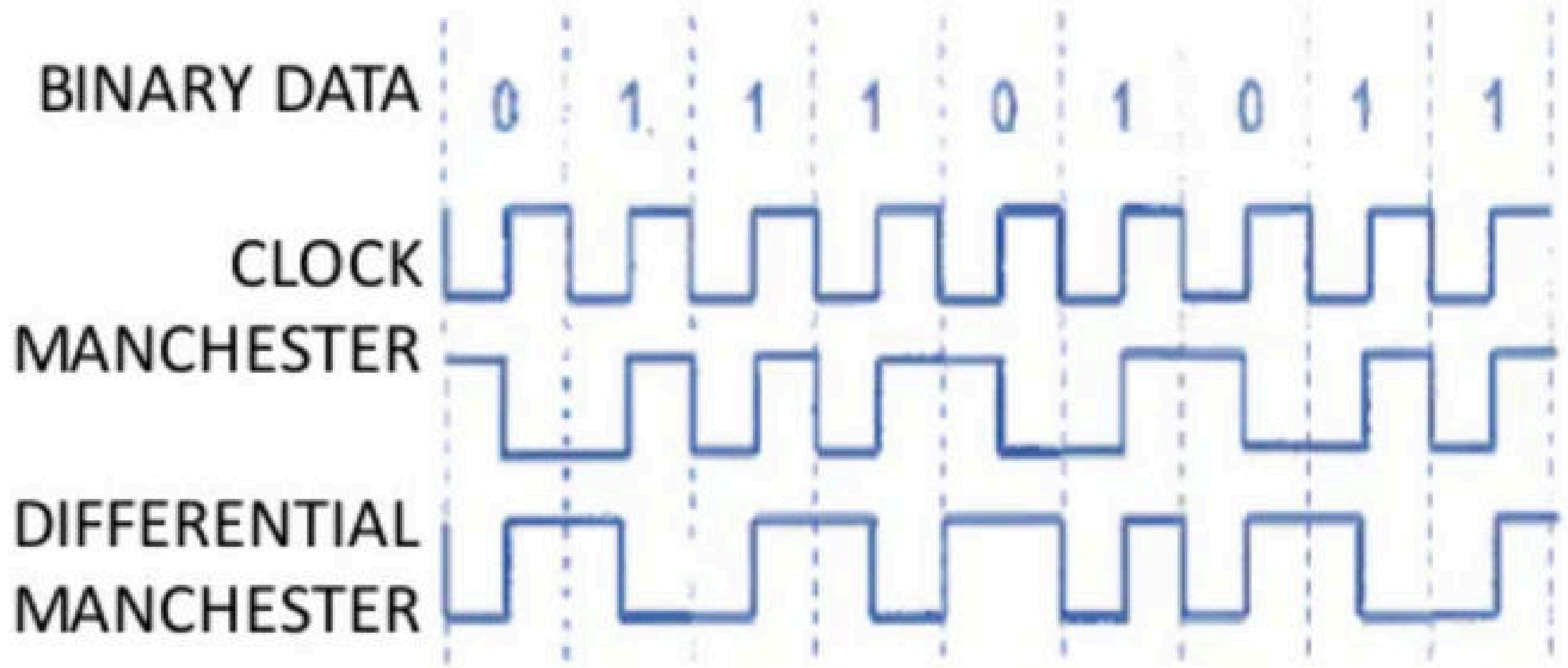


Hybrid topology is an integration of two or more different topologie s to form a resultant topology

4.) Encoding -

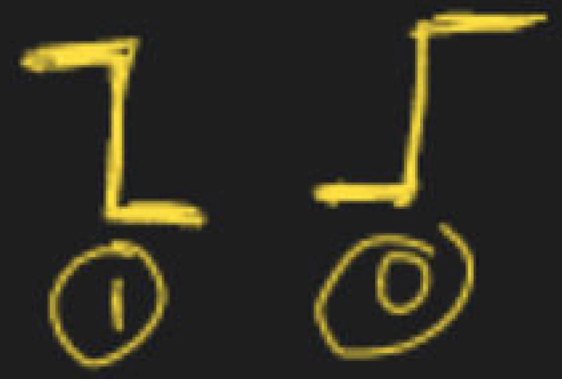
Encoding is a method of converting a stream of data bits into a predefined code. 1- To provide a predictable pattern that can be recognized by both the sender and the received. 2- To distinguish data bits from control bits and provide better media error detection. 3- To provide codes for control purposes such as identifying the beginning and end of a frame.

Signaling, the Physical layer must generate the electrical, optical, or wireless signals that represent the "1" and "0" on the media.



Baud rate = 2*bit rate

Manchester



→ 110011 manches

1 bit - 2 times

DME:

start with edge - 0

no edge - 1

10 bits - 20

K bits - 2K

K bps - 2K b/sec

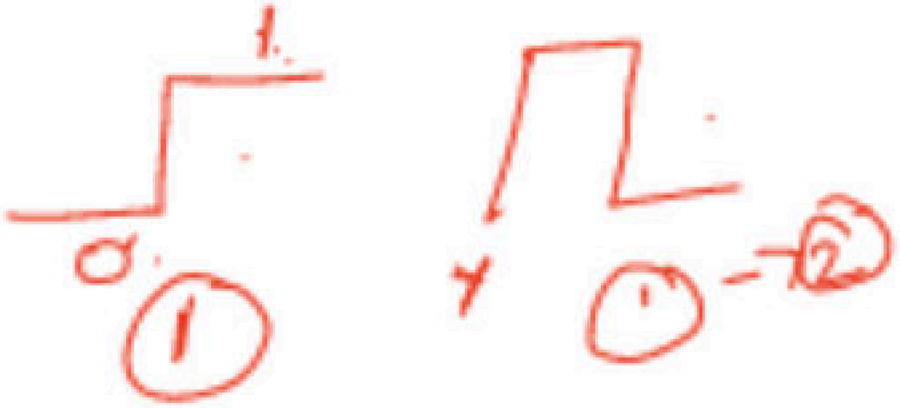
Baud

~~1 Bit - 1/2~~

$\boxed{\text{Baud} = 2 \text{ bit}}$

Computer Networks

Data Link Layer



Functions of DLL

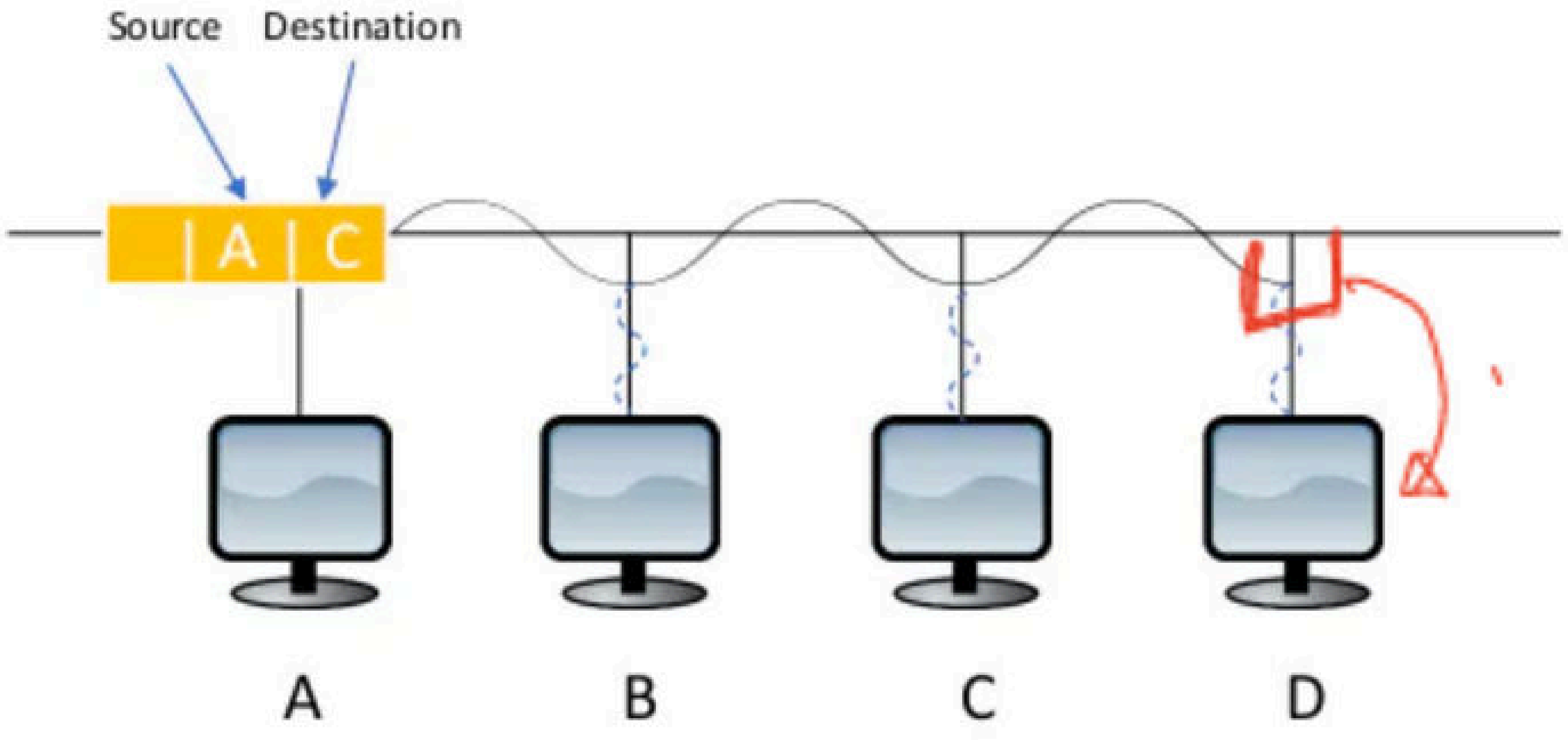
- Error Control — CRC
- Flow Control — GBN
- Access Control — CSMA/CD
- Framing — | T | D | H |
- Physical Addressing — MAC

EC

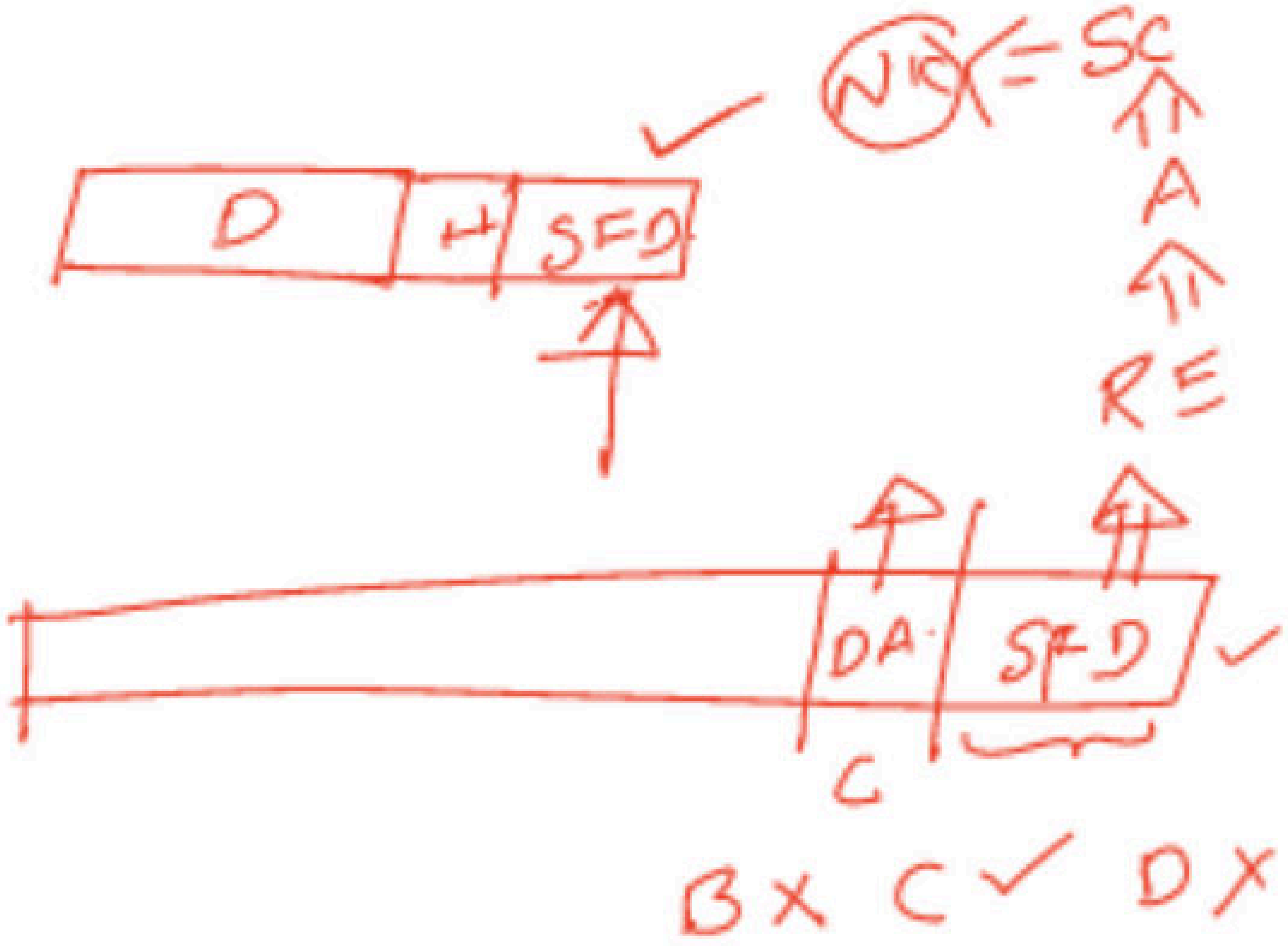
LLC → Flow control ✓

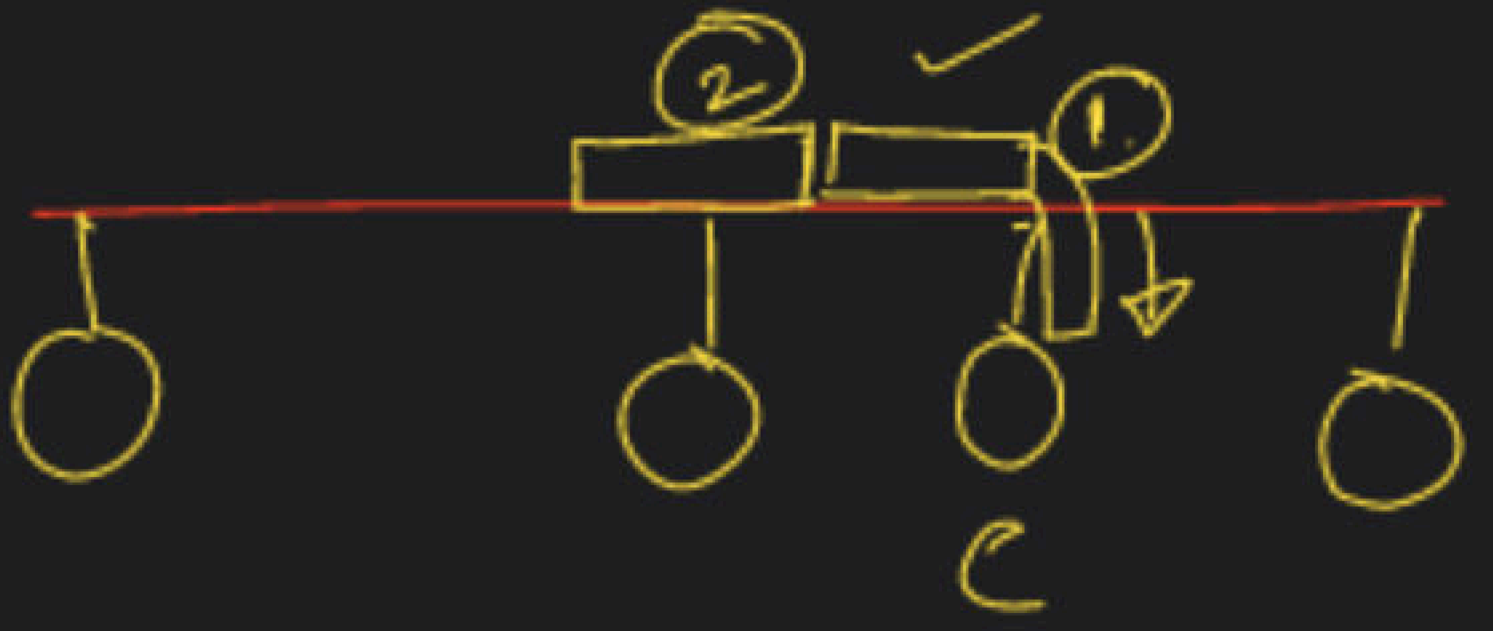
MAC → PA, AC, Framing.

FRAMING



Suppose A wants to send a message to C.
It will send a frame which includes A and C as Source and Destination respectively.
The message would received by every node connected to the link but accepted by the one in the destination address of the message.
The question is,
When should any node look for a message?
Also, all the must only check the beginning of the Frame and see whether that frame is for them or no,
How will they know the beginning of the frame?



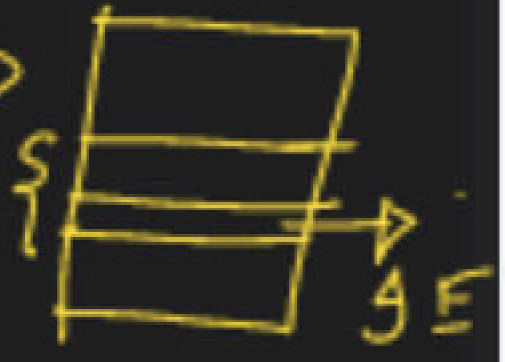


(i) Fixed length ✓

↳ > lenght → ✓

< less → padding

OS → paging →



⇓

Segment

(ii) VL ✓

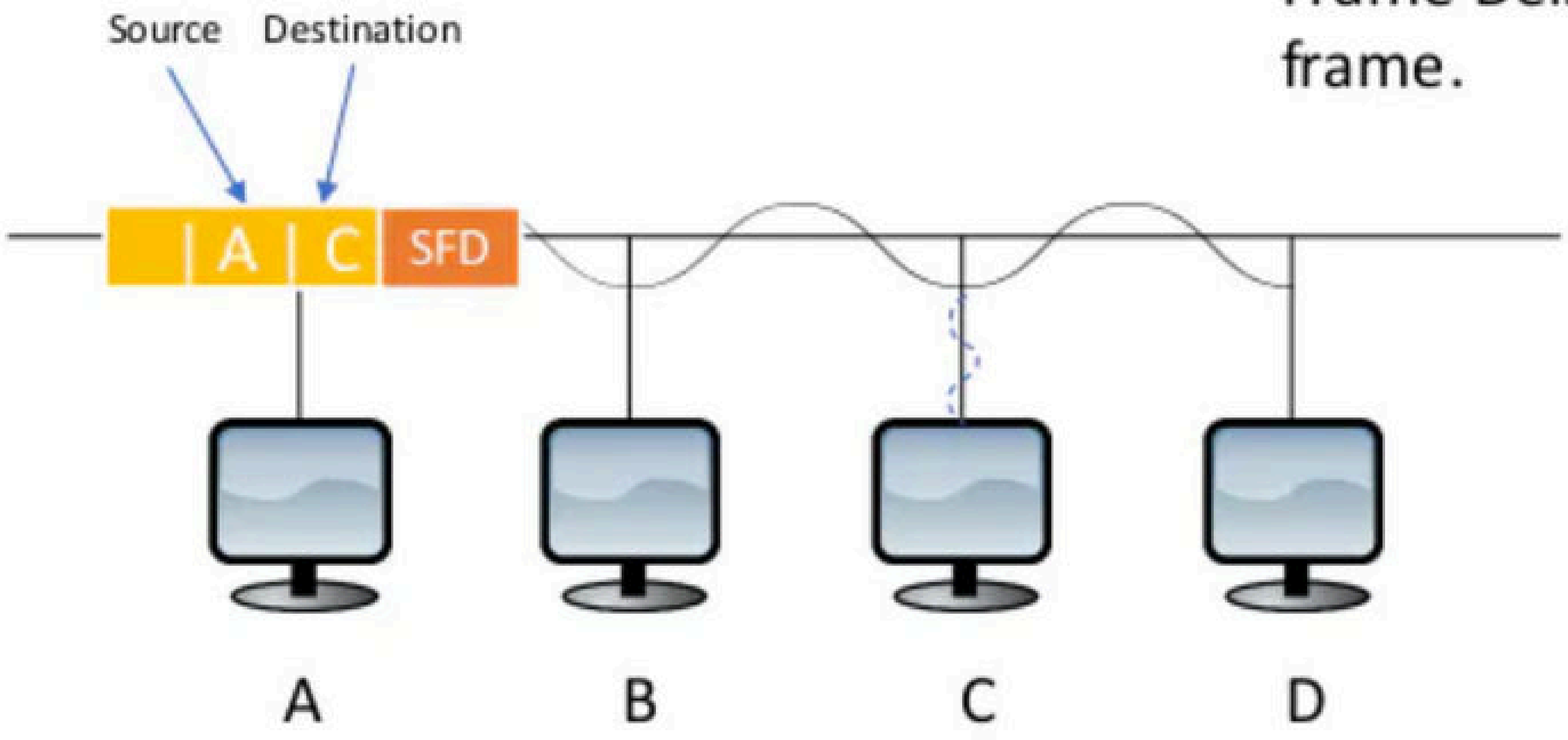
✓ Len ✓

ether

end D. ✓

Token Y

FRAMING



Start Frame Delimiter

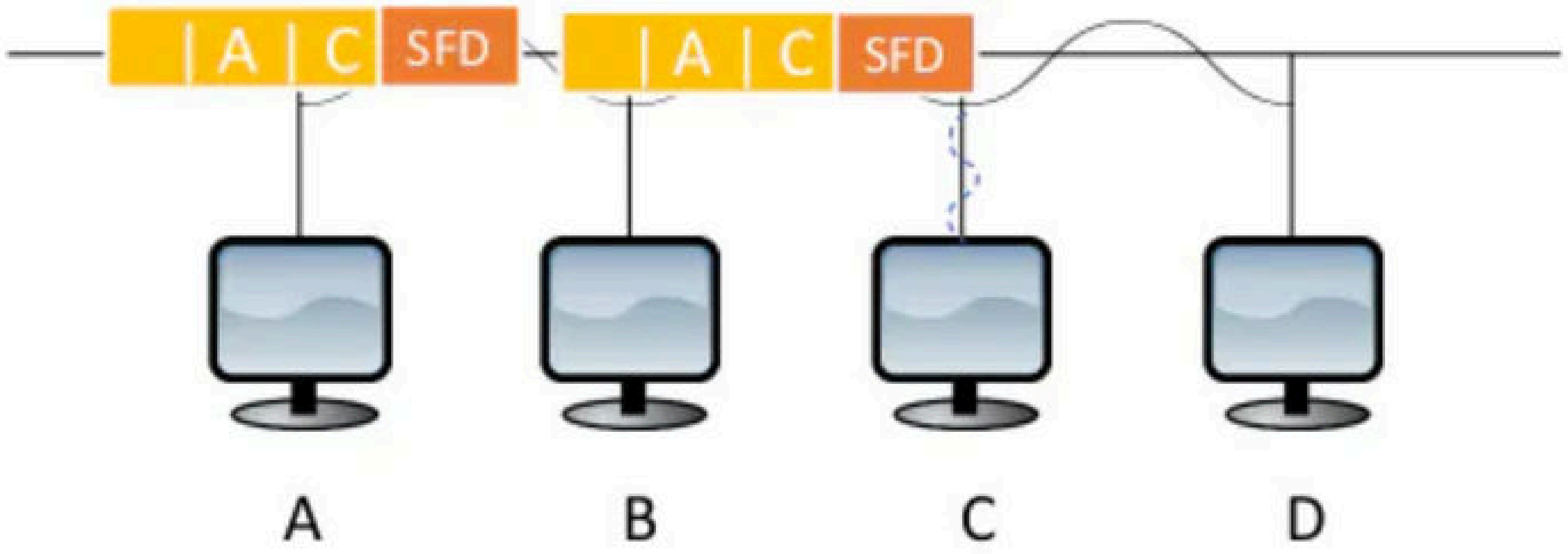
It is a 1 byte field which is always set to 10101011. The last two bits “11” indicate the end of Start Frame Delimiter and marks the beginning of the frame.

- The above two fields are added by the physical layer and represents the physical layer header.
- Sometimes, Start Frame Delimiter (SFD) is considered to be a part of Preamble.
- That is why, at many places, Preamble field length is described as 8 bytes.

SFD will be added at the beginning of the frame, So that the hosts will come to know that a data packet has arrived and they have to check the destination address that is after the SFD

FRAMING

Suppose after sending this frame,
A or some other station sends one more frame then C should know the end of the First frame i.e when it has to stop reading.



FRAMING

FIXED LENGTH

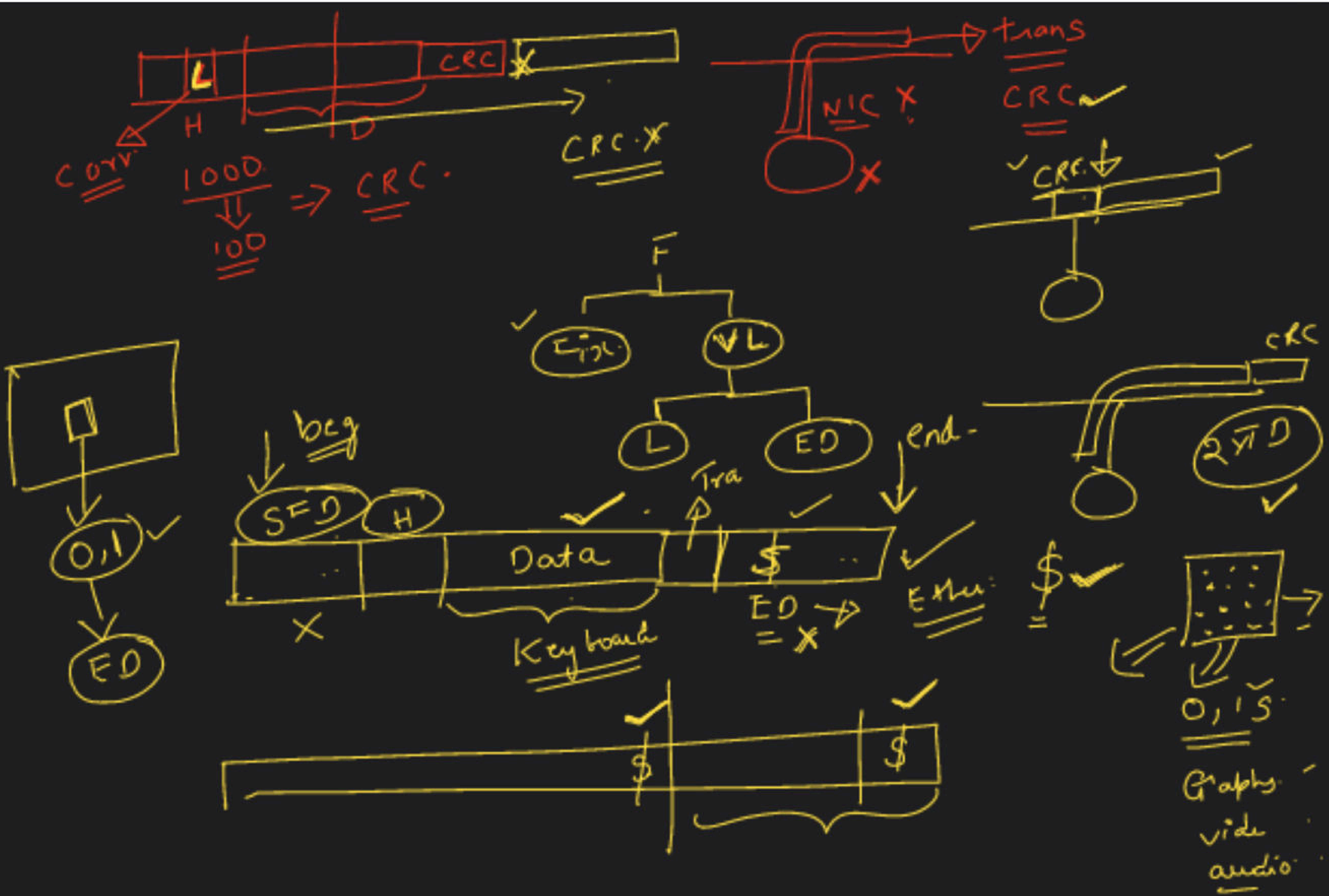
Here the size of the frame is fixed and so the frame length acts as delimiter of the frame. Consequently, it does not require additional boundary bits to identify the start and end of the frame.

VARIABLE LENGTH

Here, the size of each frame to be transmitted may be different. So additional mechanisms are kept to mark the end of one frame and the beginning of the next frame.

Two ways to define frame delimiters in variable sized framing are :

- **Length Field** – Here, a length field is used that determines the size of the frame. It is used in Ethernet (IEEE 802.3).
- **End Delimiter** – Here, a pattern is used as a delimiter to determine the size of frame. It is used in Token Rings. If the pattern occurs in the message, then two approaches are used to avoid the situation –
  - **Character-Stuffing** – A byte is stuffed in the message to differentiate from the delimiter. This is also called character-oriented framing.
  - **Bit – Stuffing** – A pattern of bits of arbitrary length is stuffed in the message to differentiate from the delimiter. This is also called bit – oriented framing.


CRC
L
H
D
conv.
1000
100
CRC.
CRC. X
trans
NIC X
CRC
CRC.
F
VL
L
ED
beg
SFD
H
Data
$
Tra
end
0,1
ED
X
Keyboard
ED
Ethe
$
crc
0,1's
Graphs
vide
audio

pic, vid, .

sender ⇒ \0$ ⇒ char stuffing

\n ✓

GATE 2004 IT

In a data link protocol, the frame delimiter flag is given by 0111. Assuming that bit stuffing is employed, the transmitter sends the data sequence 01110110 as

A. 01101011

B. 011010110

C. 011101100

D. 0110101100

In the data link layer, bits stuffing is employed then bit stuffing is done using the flag delimiter. If there is a flag of n bits then we will compare the data sequence with the flag and for every n-1 bits matched found, a bit 0 is stuffed in the data sequence.

Thus using the above logic,

Delimiter flag: 0111

Data sequence: 01110110

So, for a flag of 4 bits we will compare data sequence with a pattern of 3 bits, i.e., 011.

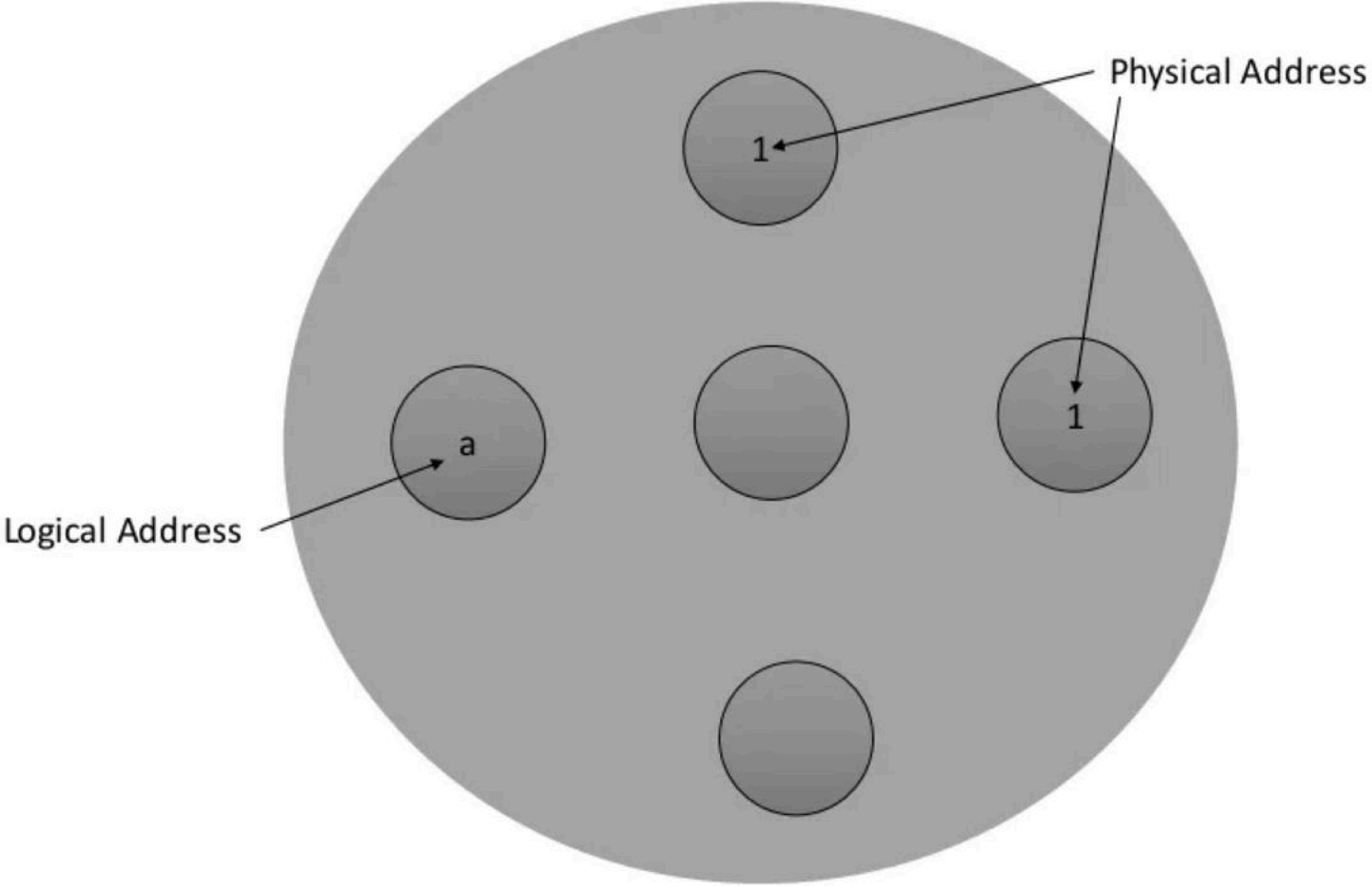
0 1 1 0 1 0 1 1 0 0

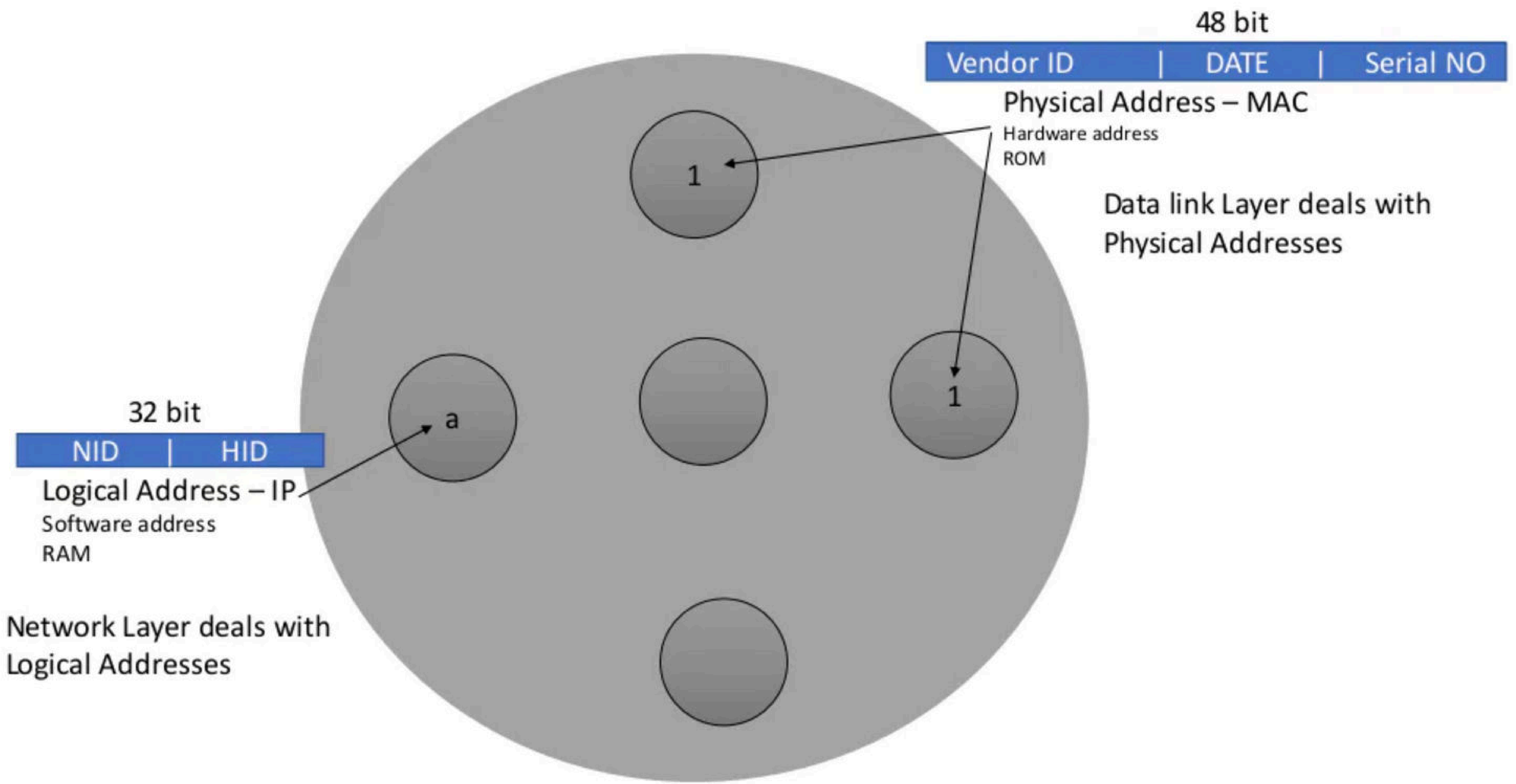
In the above pattern the underlined bits are found matched. Hence, 0 in italics is stuffed. Thus resulting in the data sequence as 0110101100

Computer Networks

Data Link Layer

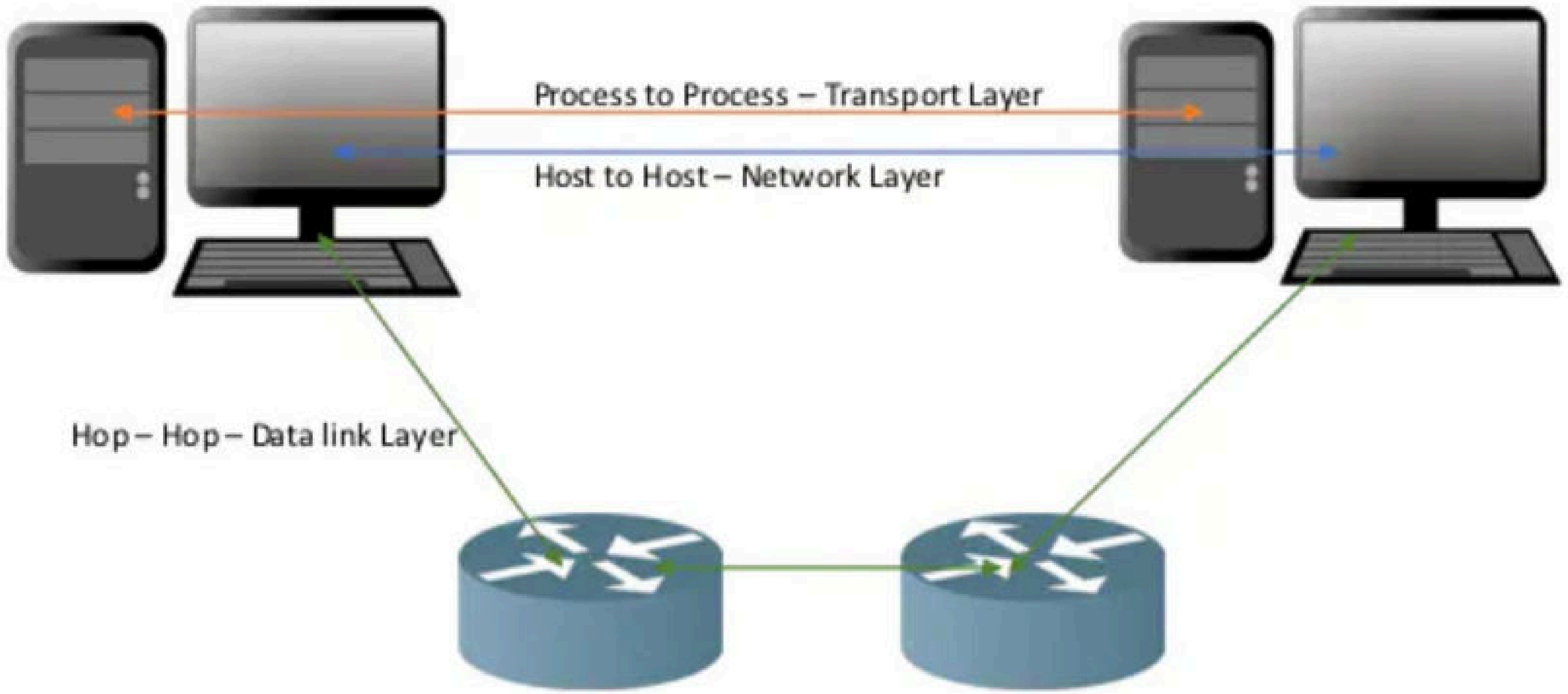
Understanding Addresses




48 bit
Vendor ID | DATE | Serial NO
Physical Address – MAC
Hardware address
ROM
Data link Layer deals with Physical Addresses
1
1
a
32 bit
NID | HID
Logical Address – IP
Software address
RAM
Network Layer deals with Logical Addresses

Computer Network

Network Layer


Process to Process – Transport Layer
Host to Host – Network Layer
Hop – Hop – Data link Layer

Functions of Network Layer

- Host to Host Connectivity
- Logical Addressing
- Switching
- Routing

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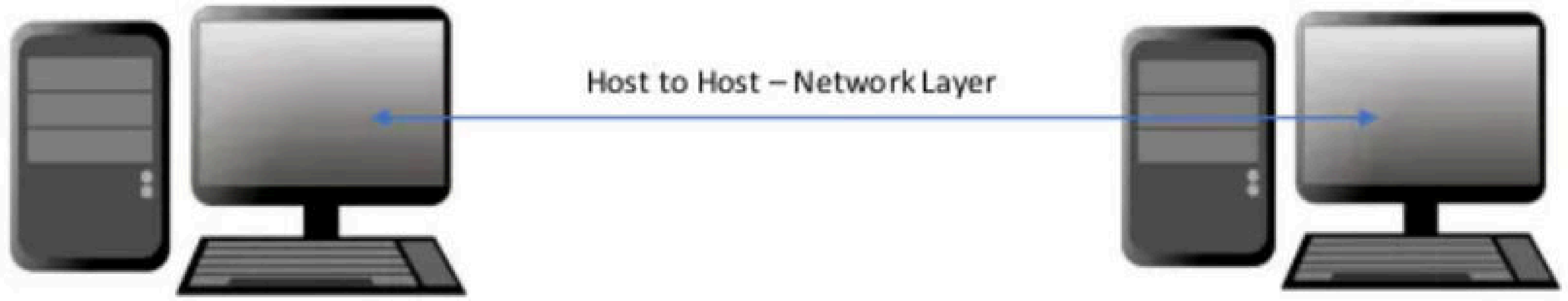

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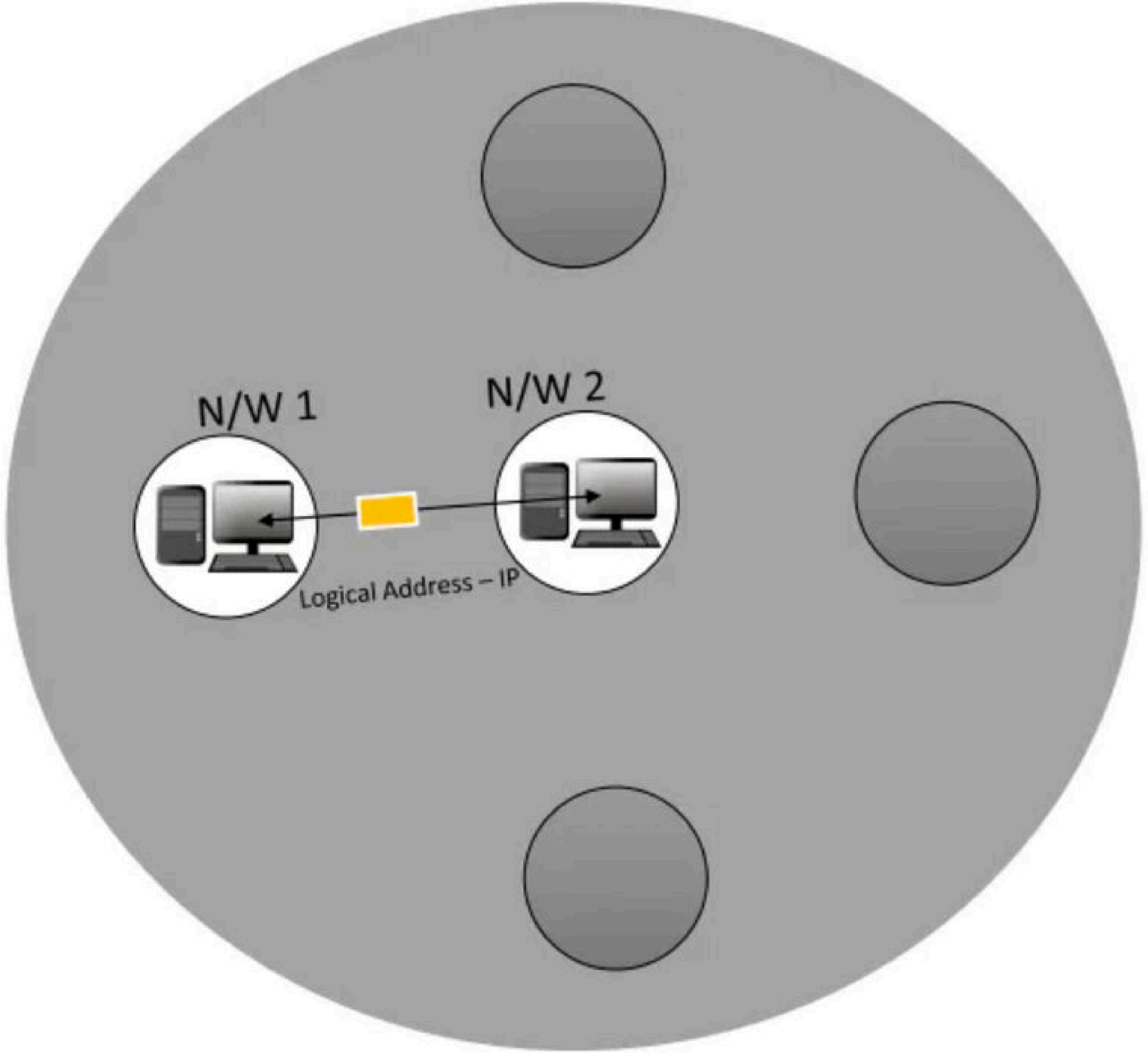

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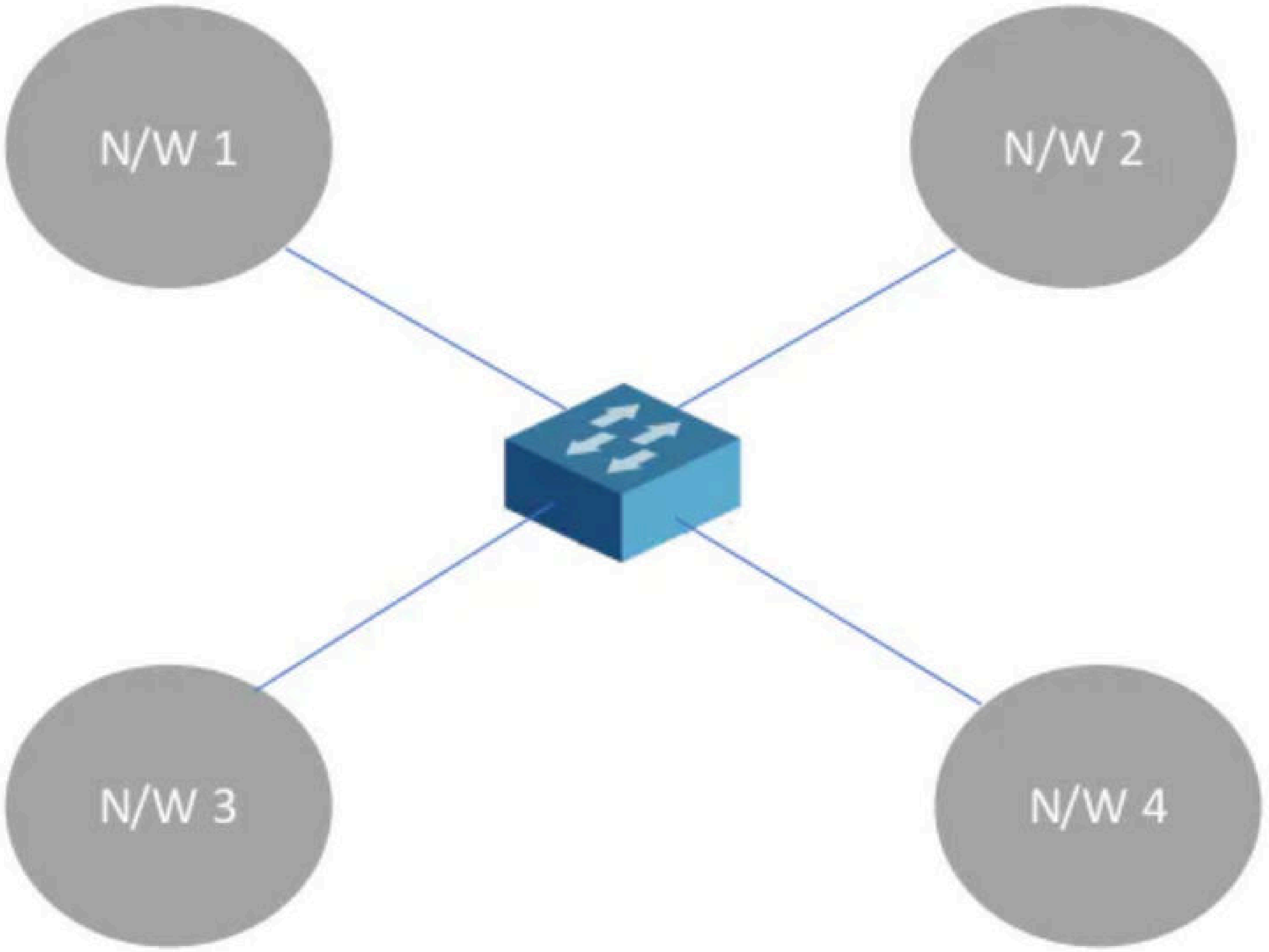

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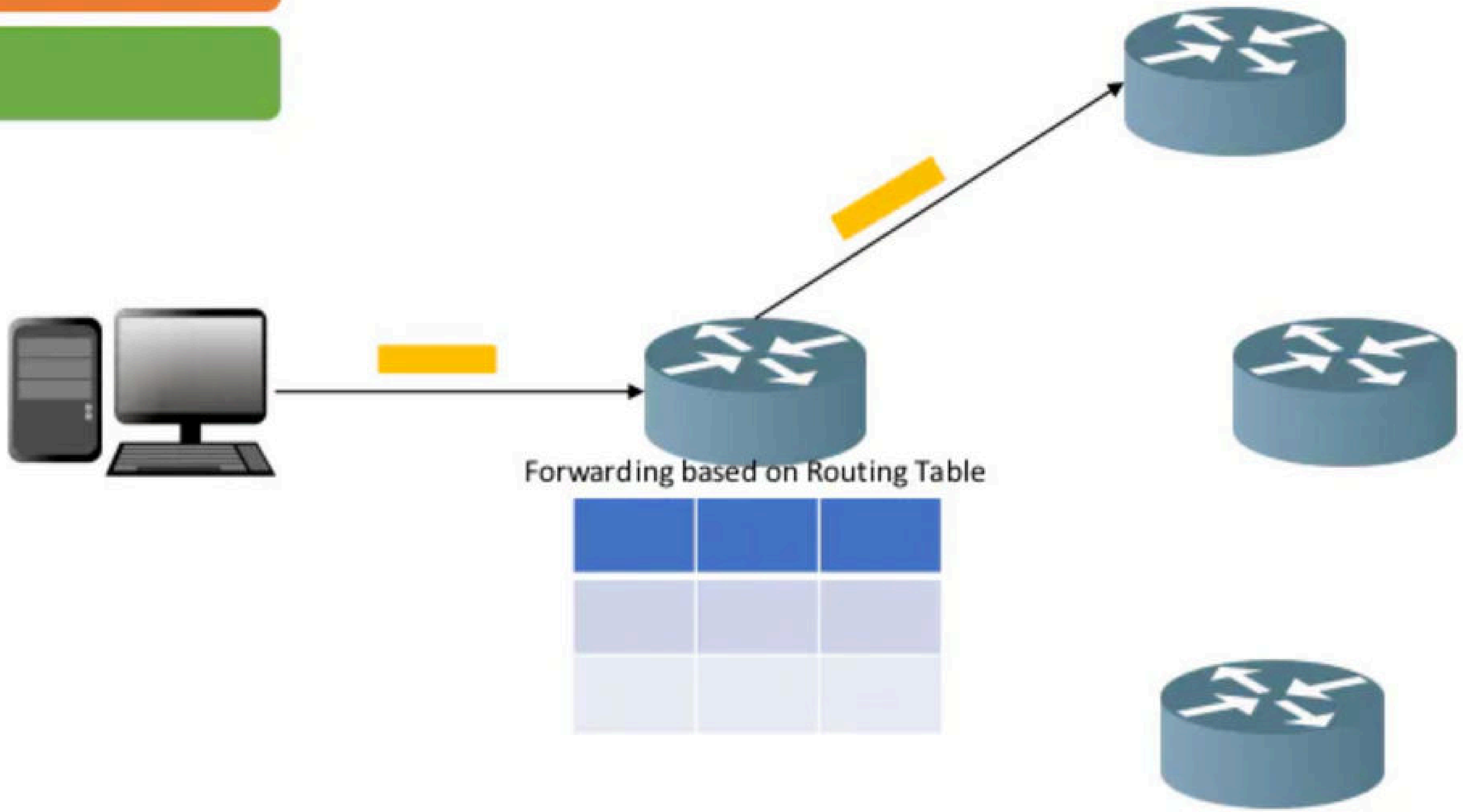

Computer Networks

GATE QUESTIONS

1.) An organization requires a range of IP addresses to assign one to each of its 1500 computers. The organization has approached an Internet Service Provider (ISP) for this task. The ISP uses CIDR and serves the requests from the available IP address space 202.61.0.0/17. The ISP wants to assign an address space to the organization which will minimize the number of routing entries in the ISP's router using route aggregation. Which of the following address spaces are potential candidates from which the ISP can allot any one to the organization? [GATE 2020]

I. 202.61.84.0/21

II. 202.61.104.0/21

III. 202.61.64.0/21

IV. 202.61.144.0/21

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I. 202.61.84.0/21

II. 202.61.104.0/21

III. 202.61.64.0/21

IV. 202.61.144.0/21

Solution: Option C

Given CIDR IP is 202.61.0.0/17 and for HID 32 - 17 = 15 bits can be used.

And to Assign an IP address for 1500 computer, we require 11 bit from HID part.

So NID + SID = 17 + 4 = 21 bits and HID = 11 bits

NID HID

202.61.0 0000 000.00000000

So, from the given option, possible IP Address is

I. 84 - >0 1010 100 (Because in HID bit 1 is not possible)

II. 104 ->0 1101 000

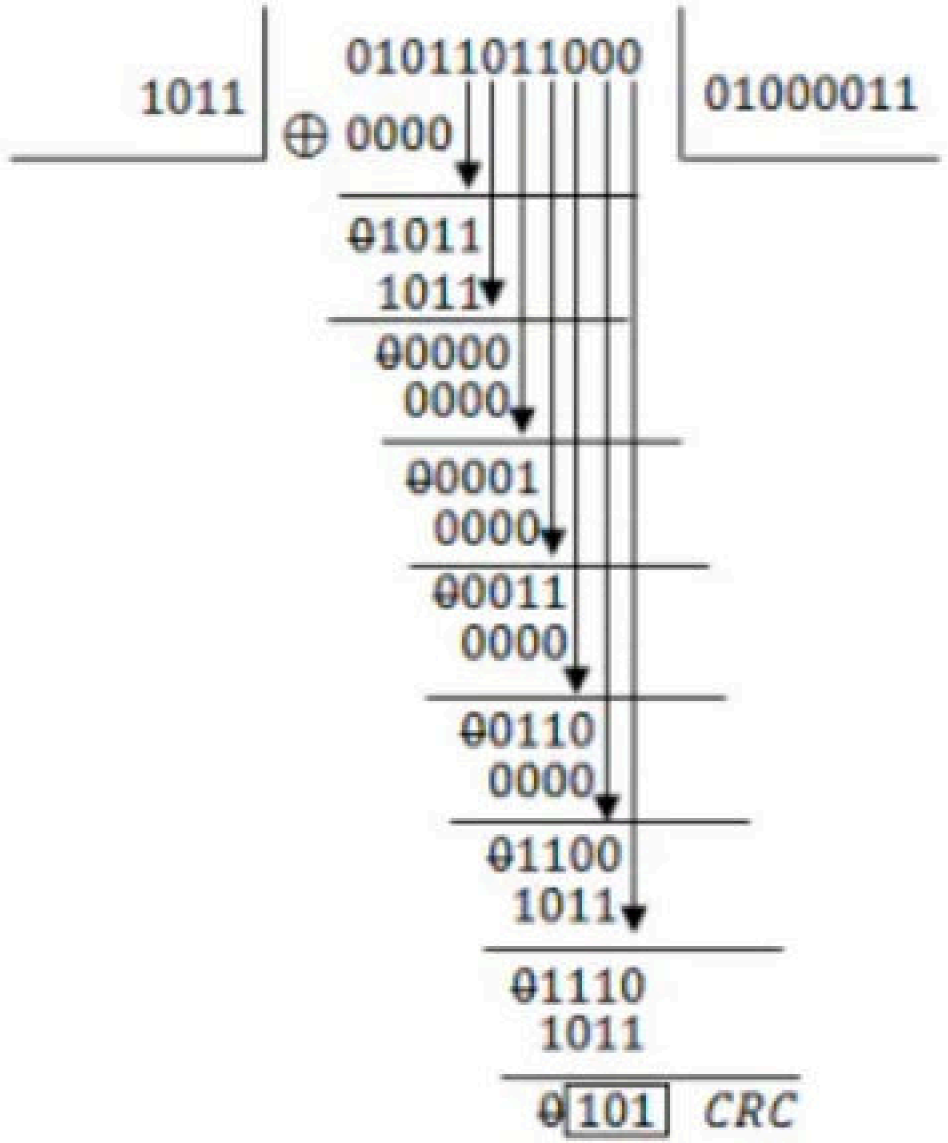
III. 64 -> 0 1000 000

IV. 144->1 0010 000 (Because in NID bit 1 is not possible)

2.) A computer network uses polynomials over GF(2) for error checking with 8 bits as information bits and uses x3 + x + 1 as the generator polynomial to generate the check bits. In this network, the message 01011011 is transmitted as [GATE 2017]

A	01011011010
B	01011011011
C	01011011101
D	01011011100

Solution:
Given CRC generator polynomial = x3+x+1
= 1·x3+0·x2+1·x1+1·x0
=1011
Message =01011011



So, the message 01011011 is transmitted as $\boxed{0101\ 1011\ 101}$

3.)The value of parameters for the Stop-and-Wait ARQ protocol are as given below:

Bit rate of the transmission channel = 1 Mbps.
Propagation delay from sender to receiver = 0.75 ms.
Time to process a frame = 0.25 ms.
Number of bytes in the information frame = 1980.
Number of bytes in the acknowledge frame = 20.
Number of overhead bytes in the information frame = 20.

Assume that there are no transmission errors. Then, the transmission efficiency (expressed in percentage) of the Stop-and-Wait ARQ protocol for the above parameters is _________ (correct to 2 decimal places). [GATE 2017]

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Solution:

Given Data:

B = 1Mbps, L = 1980Bytes, Overhead = 20Bytes

TProc = 0.25ms, LAck = 20Bytes

Tp=0.75ms

Total Data size(L) = (L + overhead) = 1980+20 = 2000Bytes

Efficiency of Stop & Wait ARQ?

Tt = L/B = 2000Bytes/1Mbps = (2000×8bits)/(106 b/s) = 16msec

TAck = LAck/B = (20×8bits)/(106 bits/sec) = 0.16msec

∴ In Stop and Wait ARQ, efficiency

η = Tt/(Tt+TAck+2Tp+TProc) = 16ms/(16+0.16+2×0.75+0.25ms)

= 16ms/17.91ms = 0.8933 $\approx \boxed{89.33\%}$

4.)A sender uses the Stop-and-Wait ARQ protocol for reliable transmission of frames. Frames are of size 1000 bytes and the transmission rate at the sender is 80 Kbps (1Kbps = 1000 bits/second). Size of an acknowledgement is 100 bytes and the transmission rate at the receiver is 8 Kbps. The one-way propagation delay is 100 milliseconds.

Assuming no frame is lost, the sender throughput is _________ bytes/second. [GATE 2016]

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Assuming no frame is lost, the sender throughput is _________ bytes/second. [GATE 2016]

Solution:
Given,
Frame size (L) =1000 bytes
Sender side bandwidth (BS) = 80 kbps = 10 * 103 bytes/sec
Acknowledgement size (LA) =100 bytes
Receiver side bandwidth (BR) = 8 kbps = 1 * 103 bytes/sec
Propagation delay (Tp) =100 ms
By formula:
Transmission delay (Tt) = L/BS = 1000 bytes / 10 * 103 bytes/sec = 100 ms
Acknowledge delay (Tack) = LA / BR = 100 bytes / 1 * 103 bytes/sec = 100 ms
Total cycle time = Tt + 2 * Tp + Tack = 100 ms + 2 * 100 ms + 100 ms = 400 ms
Efficiency (η) = Tt / Total cycle time = 100 ms / 400 ms = 1 / 4 = 0.25
Throughput = Efficiency (η) * Bandwidth (BS) = 0.25 * 10 *103 bytes/s = 2500 bytes/second

5.) A network has a data transmission bandwidth of 20 × 106 bits per second. It uses CSMA/CD in the MAC layer. 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. [GATE 2016]

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Solution:

For frame size to be minimum, its transmission time should be equal to twice of one way propagation delay. i.e, Tt = 2 × TP

Given,

Bandwidth (B) = 20 × 106 bps

TP = 40 μs ⇒ 40 × 10- 6 sec

Suppose minimum frame size is L.

Tt = 2 × TP ⇒ L / B = 2 × TP

⇒ L = 2 × TP × B = 2 × 40 × 10-6 × 20 × 106 = 1600 bits ⇒ 200 bytes

Therefore, L = 200 bytes

6.) Consider a 128×103 bits/ second satellite communication link with one way propagation delay of 150 milliseconds. Selective retransmission (repeat) protocol is used on this link to send data with a frame size of 1 kilobyte. Neglect the transmission time of acknowledgement. The minimum number of bits required for the sequence number field to achieve 100% utilization is __________ [GATE 2016]

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Solution:

To achieve 100% efficiency, the number of frames that we should send N = 1 + 2 * a

a = Tp / Tt where Tp is propagation delay, and Tt is transmission delay.

Given, B = 128 kbps, Tp = 150 msec,

L = 1 KB = 1 * 8 * 210 bits

Tt = L / B ⇒ 1 * 8 * 210 bits / 128 * 103 bps ⇒ 0.064 sec = 64 msec

So, a = 150 msec / 64 msec = 2.343

Efficiency (η) = 100 % ⇒ 1 = N/ 1 + 2 * a

So, N = 1 + 2 * a ⇒ 1 + 2 * 2.343 = 5.686

No. of sequence numbers requires in SR is 2*N = 2 *5.686 = 11.375

Minimum No. of bits required in the sequence number = [log2 (11.375)] = 4