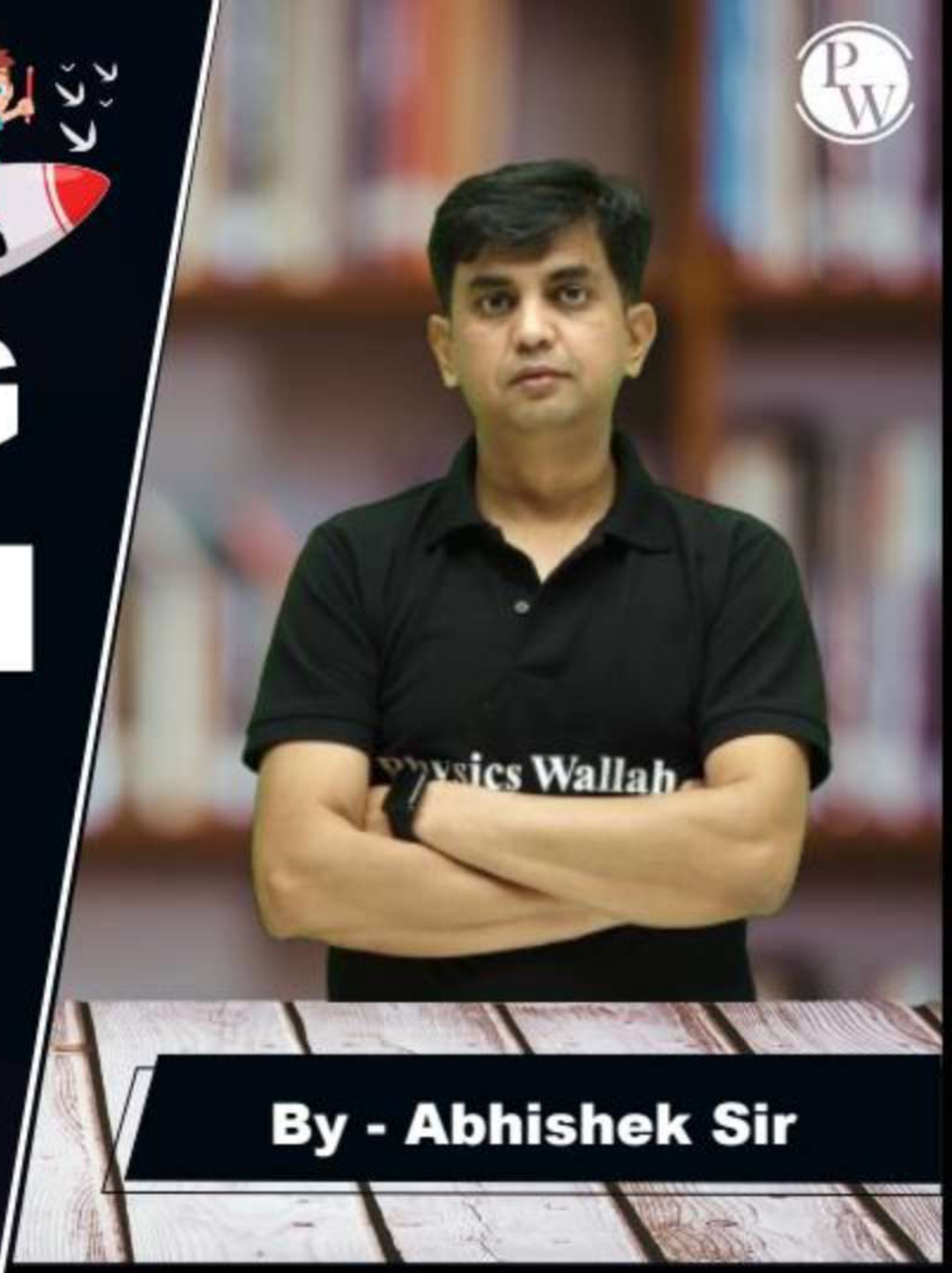
CS & IT ENGINEERING

Computer Network

IPv4 Header

Lecture No. - 05



Recap of Previous Lecture

Topic Fragmentation Offset

Topic Flag bits

Topics to be Covered

Topic Fragmentation Offset

Topic Flag bits

ABOUT ME

Hello, I'm Abhishek

- GATE CS AIR - 96
- M.Tech (CS) - IIT Kharagpur
- 12 years of GATE CS teaching experience

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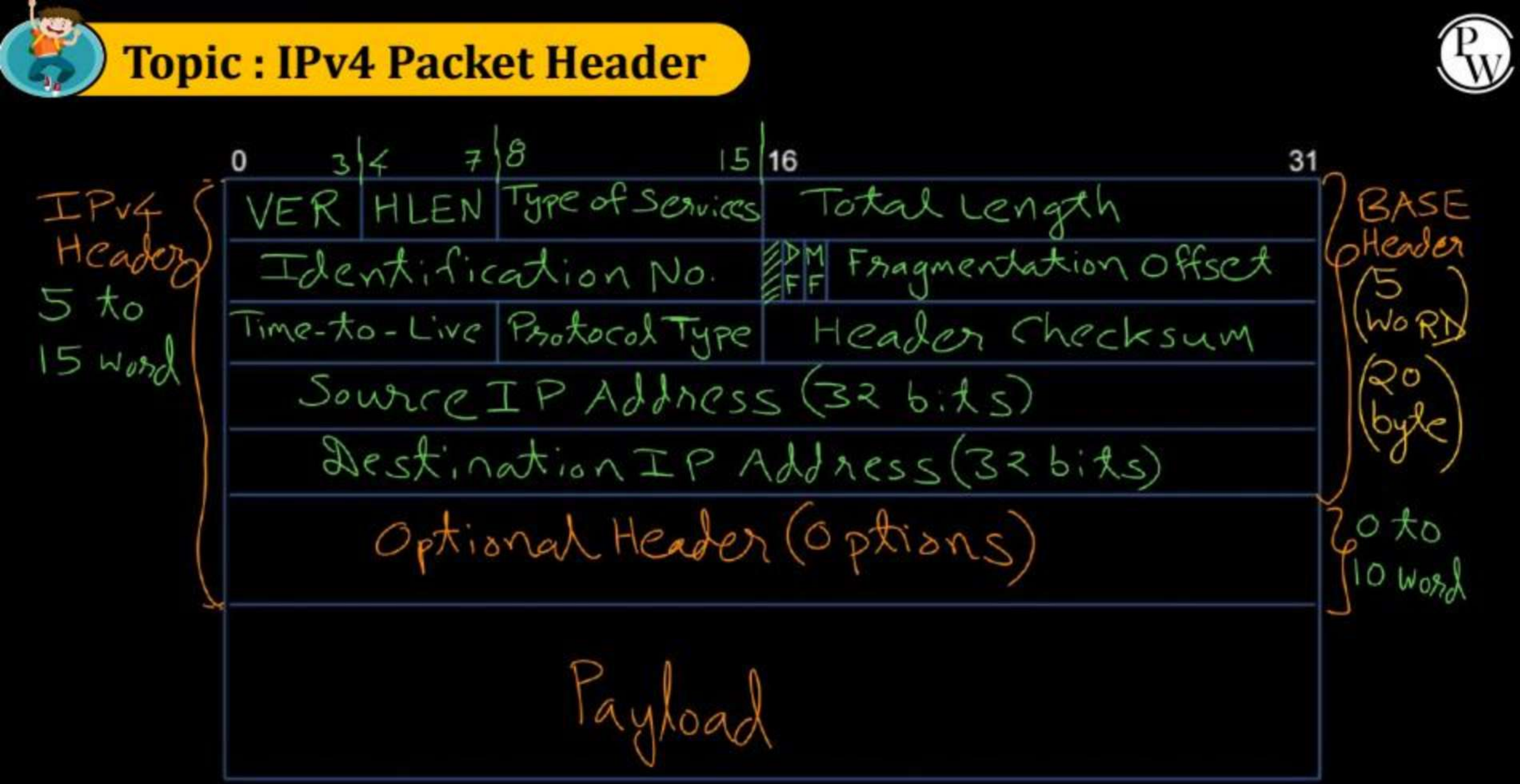
Topic : IPv4 Packet Header



#Q. Suppose TCP segment of size 1000 bytes is passed to Network layer for delivery. MTU for source network is 400 bytes and IPv4 header size is 20 bytes then calculate total number of fragments?

① offset of last fragment.

TCP Segment Size = 1000 byte
(SDU for N/w layer)

MTU = 400 byte
Header size = 20 byte

Payload Size =
[MTU − Header Size]
= (400 − 20) byte = 380 byte

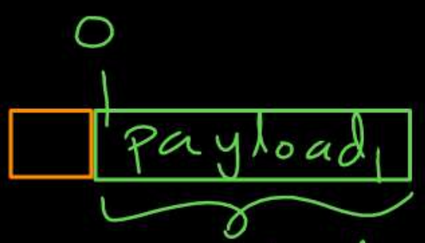
Payload size = 380 byte
[is not in multiple of 8 byte (words)]
* 376 byte = 47 word

$$\Rightarrow \left\lfloor \frac{\text{Payload Size}}{8} \right\rfloor * 8 = \left\lfloor \frac{380}{8} \right\rfloor * 8$$

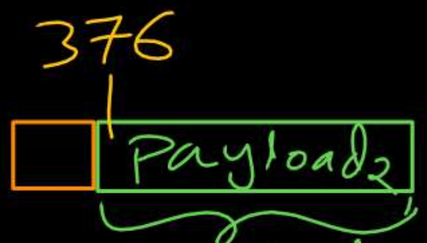
No. of fragments (N) = $\left\lceil \frac{\text{SDU size}}{\text{Payload size}} \right\rceil$

$$N = \left\lceil \frac{1000 \text{ byte}}{376 \text{ byte}} \right\rceil = \lceil 2.65 \rceil = 3$$

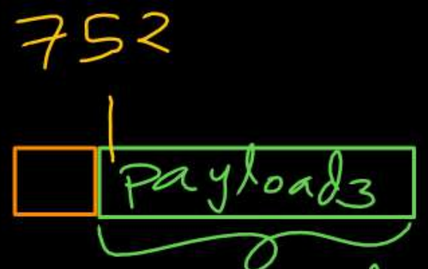
VER = 4
HLEN = 5
Id = Y
D = 0



TL = 396
off = 0 = 0/8
M = 1



TL = 396
off = 47 = 376/8
M = 1



TL = 268
off = 94 = 752/8
M = 0

#Q. Consider an IP packet with a length of 4,500 bytes that includes a 20-byte IPv4 header and 40-byte TCP header. The packet is forwarded to an IPv4 router that supports a Maximum Transmission Unit (MTU) of 600 bytes. Assume that the length of the IP header in all the outgoing fragments of this packet is 20 bytes. Assume that the fragmentation offset value stored in the first fragment is 0. The fragmentation offset value stored in the third fragment is _____ .

[GATE 2018]

H. W.

#Q. Consider sending an IP datagram of size 1420 bytes (including 20 bytes of IP header) from a sender to a receiver over a path of two links with a router between them. The first link (sender to router) has an MTU (Maximum Transmission Unit) size of 542 bytes, while the second link (router to receiver) has an MTU size of 360 bytes. The number of fragments that would be delivered at the receiver is _____ .

[GATE 2024, Set-1, 2-Mark]

H.W.

#Q. Suppose UDP datagram of size 532 bytes is passed to Network layer for delivery. MTU for source network is 200 bytes and IPv4 header size is 20 bytes then calculate total number of fragments?

UDP Packet Size = 532 byte
(SDU for N/w layer)

MTU = 200 byte
Header Size = 20 byte

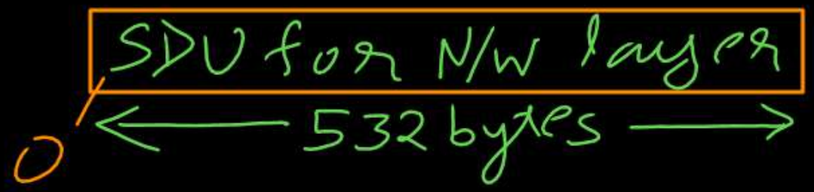
Payload Size = [MTU - HeaderSize]
= (200 - 20) byte = 180 byte
[Not in words/multiple of 8]
= 176 byte

No of fragments (N)

$$N = \left\lceil \frac{SDU\ Size}{Payload\ Size} \right\rceil = \left\lceil \frac{532\ byte}{176\ byte} \right\rceil$$

$$N = \lceil 3.027 \rceil = 4$$

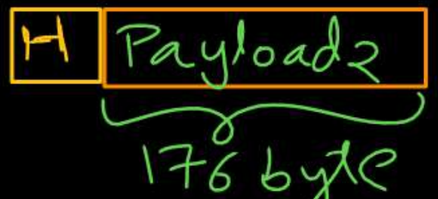
Ans: 3



TL = 196

off = 0

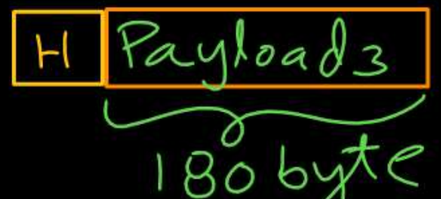
M = 1



TL = 196

off = 22

M = 1



TL = 200

off = 44

M = 0

#Q. Consider an IPv4 datagram, where values in total length field and HLEN field are 500 and 10 respectively. Determine the value of more fragment (MF) flag?

TL = 500 bytes
HLEN = 10 words

Payload size = [TL − (HLEN * 4)] byte
= [500 − (10 * 4)] byte
= 460 byte
[Not Multiple of 8]
It is the last fragment in the sequence

Ans:
M = 0

#Q. Consider an IPv4 datagram, where values in total length field and HLEN field are 500 and 5 respectively. Determine the value of more fragment (MF) flag?

TL = 500 byte
HLEN = 5 word

Payload size = [TL − (HLEN * 4)] byte
= [500 − (5 * 4)] byte
= 480 byte
[Multiple of 8 byte]

M = ?

Ans:

Can't determine

[Zero or one]

Topic : Fragmentation Offset

→ For all IPv4 intermediate fragments (except last, those have MF Flag = 1), payload size should be in words [multiple of 8 bytes]

→ For IPv4 last fragment in the sequence (MF Flag = 0), No any restriction on payload size

→ The IPv4 fragment in which offset value is "Zero", is the first fragment in the sequence

Topic : Reassembly of Fragments

→ Reassembly of fragments, only at destination host

→ if any of the fragment is missing (or lost) in the sequence, this may lead reassembly failure

#Q. Which of the following statements about IPv4 fragmentation is/are TRUE?

[GATE 2024, Set-2, 1-Mark]

(A) The fragmentation of an IP datagram is performed only at the source of the datagram FALSE

(B) The fragmentation of an IP datagram is performed at any IP router which finds that the size of the datagram to be transmitted exceeds the MTU TRUE

(C) The reassembly of fragments is performed only at the destination of the datagram TRUE

(D) The reassembly of fragments is performed at all intermediate routers along the path from the source to the destination FALSE

Ans: B & C

#Q. Consider two hosts P and Q connected through a router R. The maximum transfer unit (MTU) value of the link between P and R is 1500 bytes, and between R and Q is 820 bytes. A TCP segment of size 1400 bytes was transferred from P to Q through R, with IP identification value as 0x1234. Assume that the IP header size is 20 bytes. Further, the packet is allowed to be fragmented, i.e., Don't Fragment (DF) flag in the IP header is not set by P. Which of the following statements is/are correct?

H.W.

[GATE 2021, Set-1, 2-Mark]

(A) Two fragments are created at R and the IP datagram size carrying the second fragment is 620 bytes.

(B) If the second fragment is lost, R will resend the fragment with the IP identification value 0×1234.

(C) If the second fragment is lost, P is required to resend the whole TCP segment.

(D) TCP destination port can be determined by analysing only the second fragment.

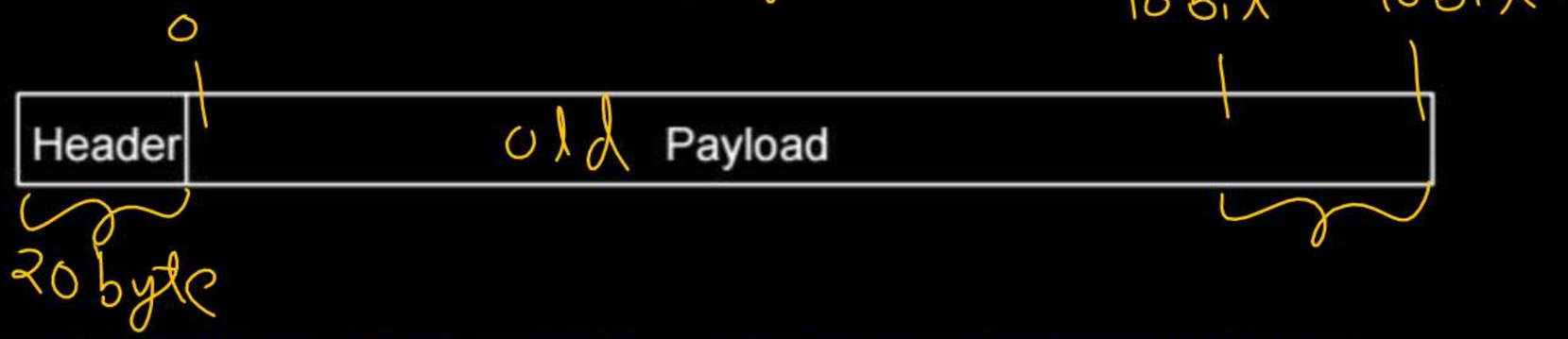
Topic : Fragmentation Offset

Why fragmentation offset is in word (of 8 bytes)?

→ Total Length field size = 16-bits

→ Maximum Ipv4 datagram size = $[2^{16} - 1]$ bytes

→ Fragmentation Offet field size = 13-bits



→ Fragmentation may be needed at any intermediate router

→ Solution : Fragmentation Offset in Words [word size = 8 bytes]

Topic : Time-to-Live

→ Time-to-live (TTL) is 8-bit field

→ Life time of an IP datagram

→ Avoid indefinite traversing of an IP datagram in the network [due to routing loops]

Topic : Time-to-Live

→ Each intermediate router decrement TTL value by one // TTL--;

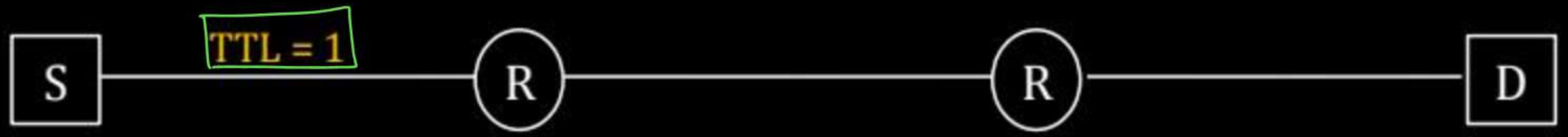
→ if TTL value decremented to zero // [TTL ≤ 0]
then router discard the datagram
and send ICMP error message "Time Exceeded" to source host

Topic : Time-to-Live

→ Destination Host also decrement TTL value by one `// TTL--;`

→ if TTL value decremented to less then zero `// [ TTL < 0 ]`
then destination host discard the datagram
and send ICMP error message "Time Exceeded" to source host

CASE I :



TTL = 1

TTL = ~~1~~ 0

[Discard,
Send ICMP Error]

CASE II :

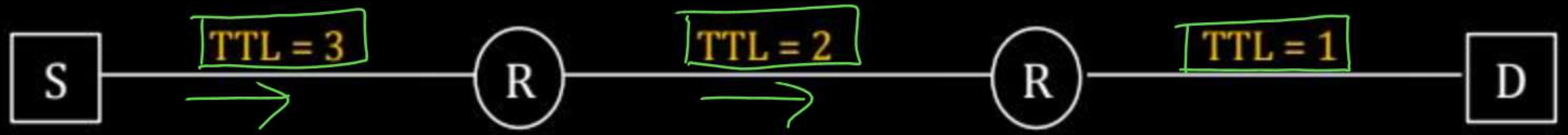
TTL = 2

TTL = ~~2~~ 1

TTL = ~~1~~ 0

[Discard,
Send ICMP Error]

CASE III :



TTL = 3

TTL = ~~3~~ 2

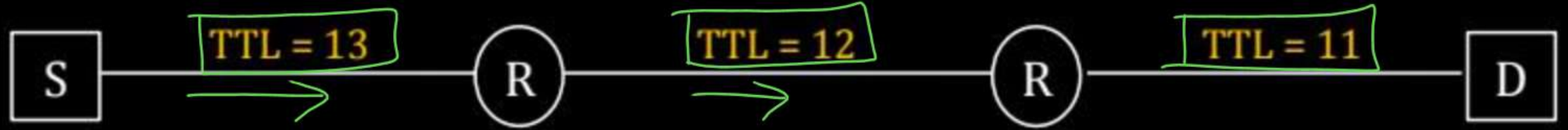
TTL = ~~2~~ 1

TTL = ~~1~~ 0

[Forward to higher layer]

Accept

CASE IV :



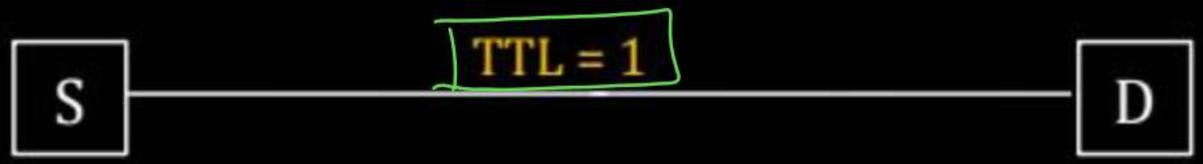
TTL = 13

TTL = ~~13~~ 12

TTL = ~~12~~ 11

TTL = ~~11~~ 10
[Forward
to higher layer]

CASE V :



TTL = 1

TTL = ~~1~~ 0
[Forward
to higher layer]

Note : TTL = 1, can use when source and destination host are directly connected.

#Q. For which one of the following reasons does Internet Protocol (IP) use the time-to-live (TTL) field in the IP datagram header?

[GATE 2006]

(A) Ensure packets reach destination within that time

(B) Discard packets that reach later than that time

(C) Prevent packets from looping indefinitely

(D) Limit the time for which a packet gets queued in intermediate routers.

Ans: C

#Q. One of the header fields in an IP datagram is the Time to Live (TTL) field. Which of the following statements best explains the need for this field?

[GATE 2010]

(A) It can be used to prioritize packets

(B) It can be used to reduce delays

(C) It can be used to optimize throughput

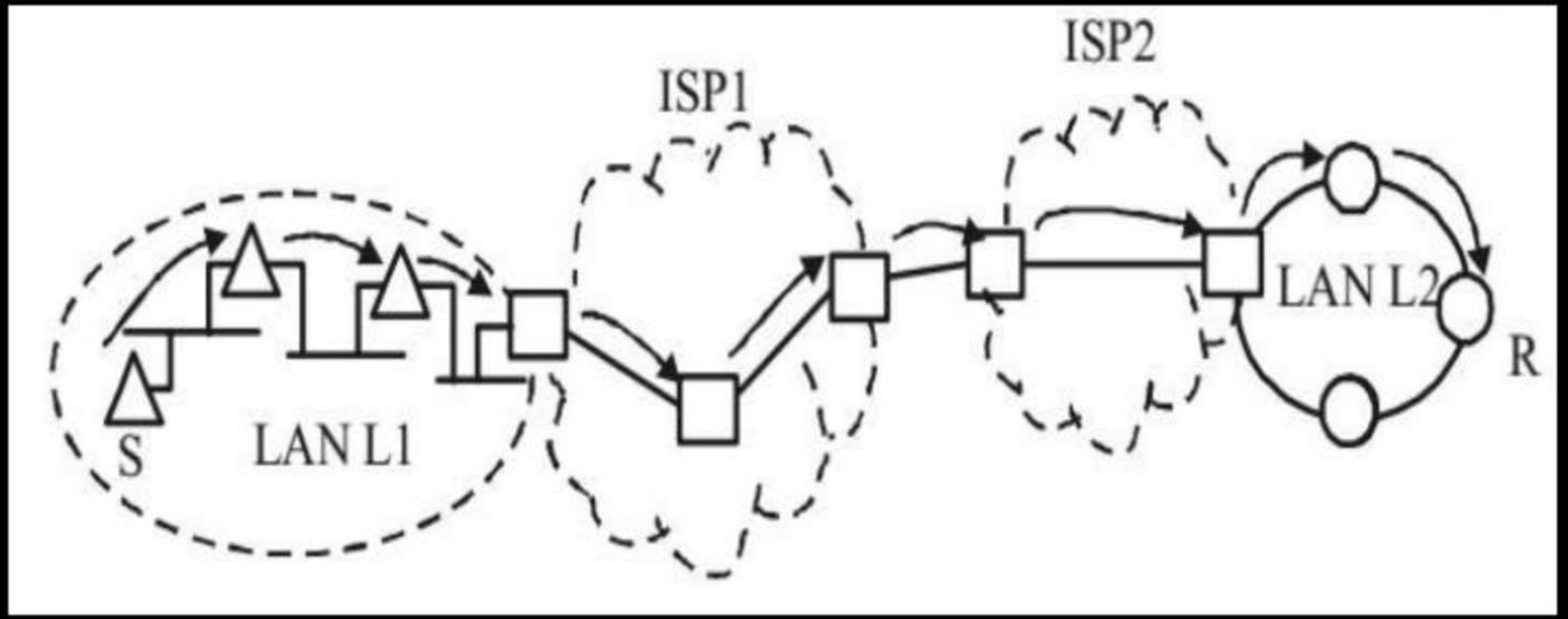
(D) It can be used to prevent packet looping

Ans : D

#Q. In the diagram shown below L1 is an Ethernet LAN and L2 is a Token-Ring LAN. An IP packet originates from sender S and traverses to R, as shown. The link within each ISP, and across two ISPs, are all point to point optical links. The initial value of TTL is 32. The maximum possible value of TTL field when R receives the datagram is _____ .

[GATE 2014]

IIT KGP H.W



Topic : Time-to-Live

→ Hop Limit 8-bit field in IPv6 Header

→ Same as Time-to-live (TTL) field of IPv4 Header

2 mins Summary

Topic Fragmentation Offset

Topic Flag bits

Time-to-Live

THANK - YOU