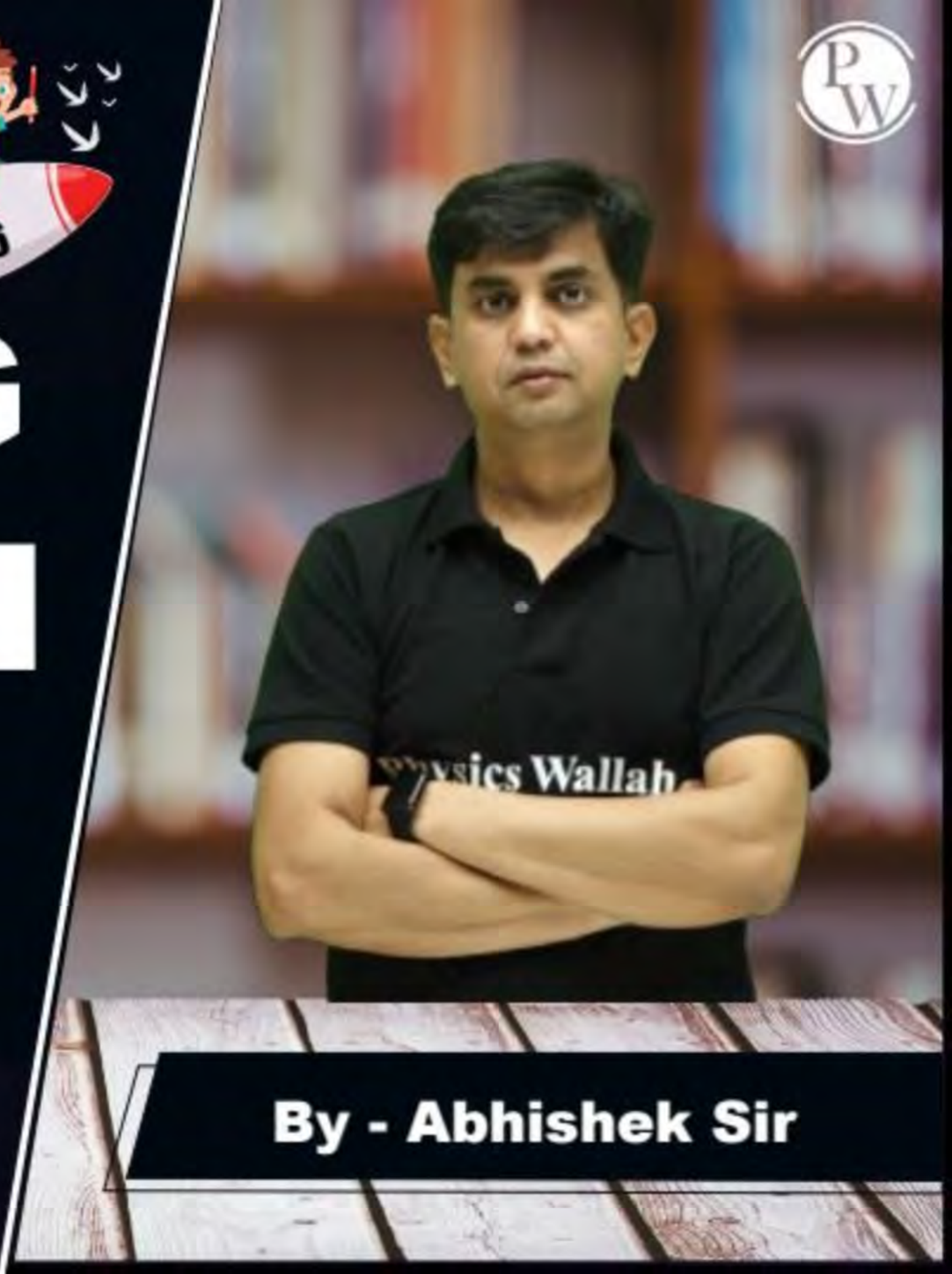
CS & IT ENGINEERING

Computer Network

IPv4 Header

Lecture No. - 04



By - Abhishek Sir

Recap of Previous Lecture

Topic Fragmentation at Router

Topics to be Covered

Topic Fragmentation and Reassembly

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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[NAT] [GATE-2016] [2 Mark]

#Q. An IP datagram of size 1000 bytes arrives at a router. The router has to forward this packet on a link whose MTU (maximum transmission unit) is 100 bytes. Assume that the size of the IP header is 20 bytes. The number of fragments that the IP datagram will be divided into for transmission is _____ .

Ans = 13

Total Length = 1000 bytes
Header Size = 20 bytes

Old Payload Size = [Total Length - Header Size] bytes
= (1000 − 20) byte = 980 byte

MTU = 100 bytes

New Payload Size = [MTU - Header Size] bytes
= (100 − 20) bytes = 80 byte

$$\text{Total Number of IP fragments [N]} = \left\lceil \frac{\text{Old Payload Size}}{\text{New Payload Size}} \right\rceil$$

$$= \left\lceil \frac{980 \text{ byte}}{80 \text{ byte}} \right\rceil$$

$$= 13$$

[MCQ] [GATE-IT-2004] [2 Mark]

#Q. A TCP message consisting of 2100 bytes is passed to IP for delivery across two networks. The first network can carry a maximum payload of 1200 bytes per datagram and the second network can carry a maximum payload of 400 bytes per datagram, excluding network overhead. Assume that IP overhead per packet is 20 bytes. What is the total IP overhead in the second network for this transmission?

A 40 bytes

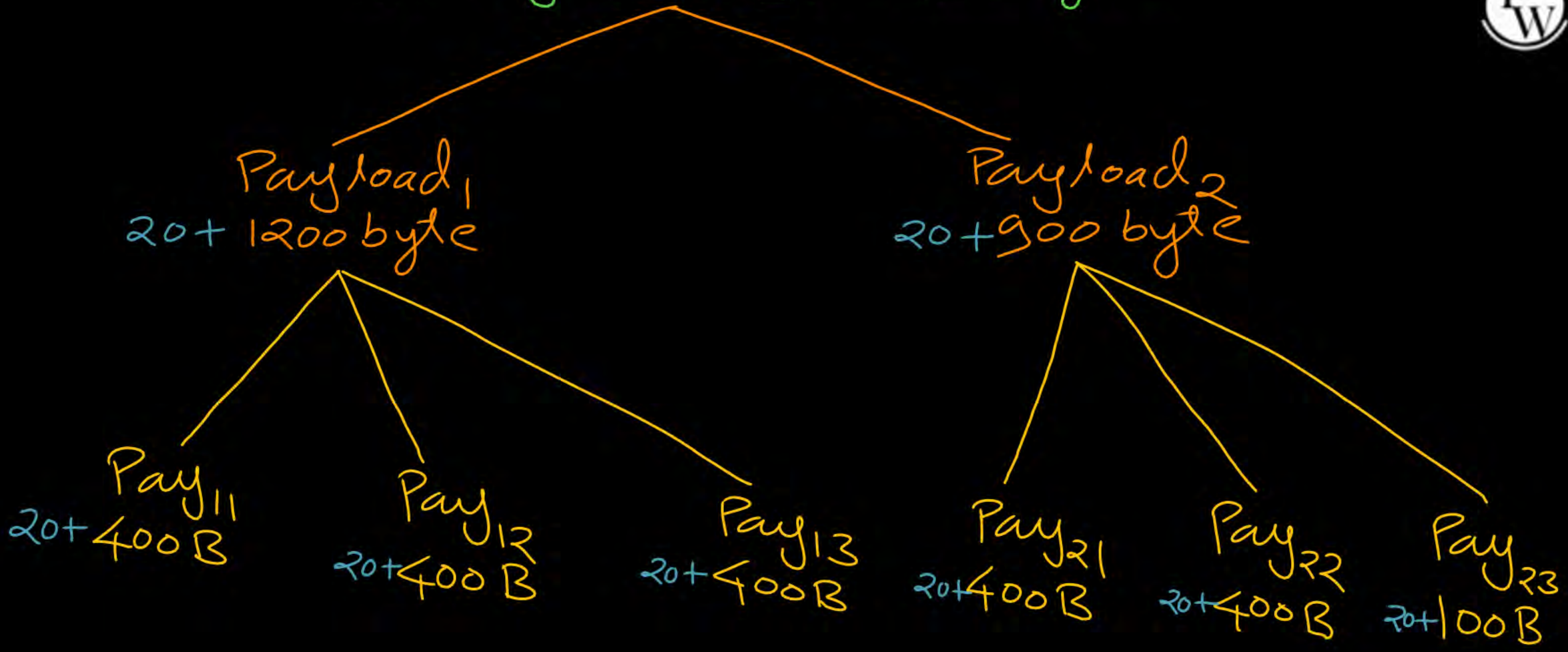
B 80 bytes

C 120 bytes

D 160 bytes

Ans: C

TCP segment size = 2100 bytes



Ans = 6 * 20B = 120 byte

Example 8 :-

[NAT]

#Q. Consider UDP segment of size 1000 bytes is passed to IPv4 protocol for delivery. MTU for source network is 400 bytes and IPv4 header size is 20 bytes. Calculate total number of IPv4 fragments required to carry the UDP segment after fragmentation ?

Ans = 3

MTU = 400 bytes

IPv4 Header Size = 20 bytes

Maximum Payload Size = [MTU - Header Size] bytes

= (400 − 20) byte

= 380 byte

= if MF bit is one
the max^m payload size
should be 376 byte

UDP Segment Size = 1000 bytes

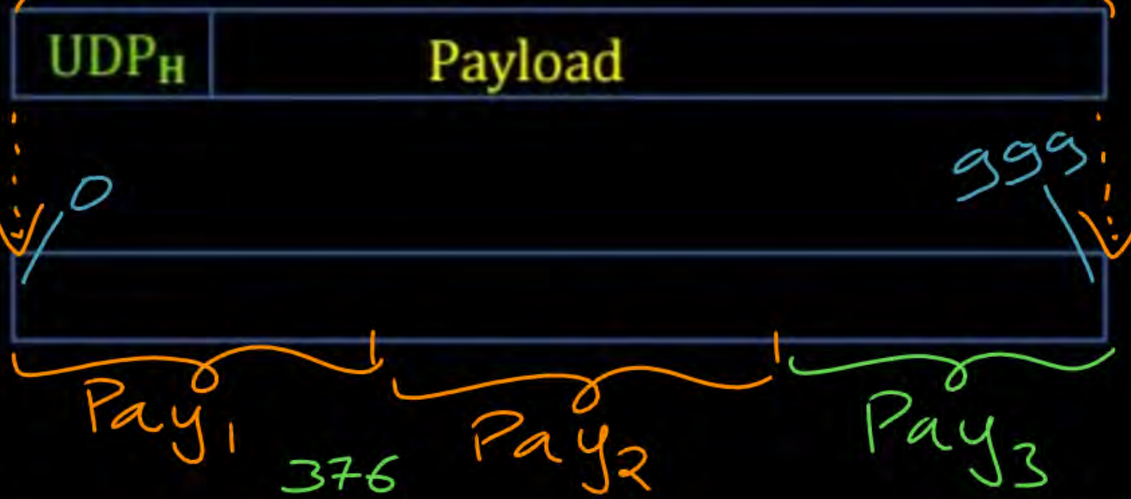
$$\text{Total Number of IP fragments [N]} = \left\lceil \frac{\text{UDP Segment Size}}{\text{Payload Size}} \right\rceil$$

$$= \left\lceil \frac{1000 \text{ byte}}{380 \text{ byte}} \right\rceil$$

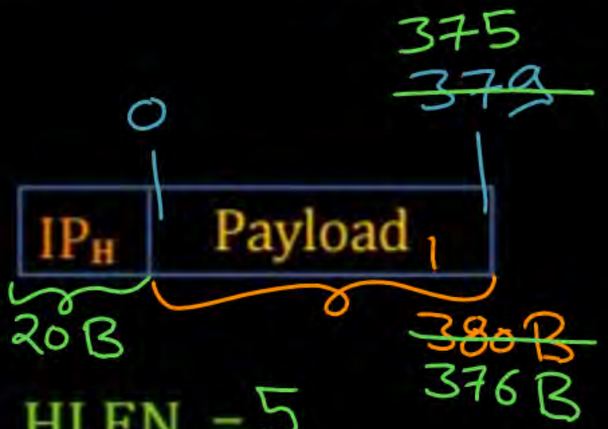
$$= \left\lceil \frac{1000 \text{ byte}}{376 \text{ byte}} \right\rceil = \lceil 2.65 \rceil$$

$$= 3$$

UDP segment = 1000 byte



SDU for N/W layer = segment

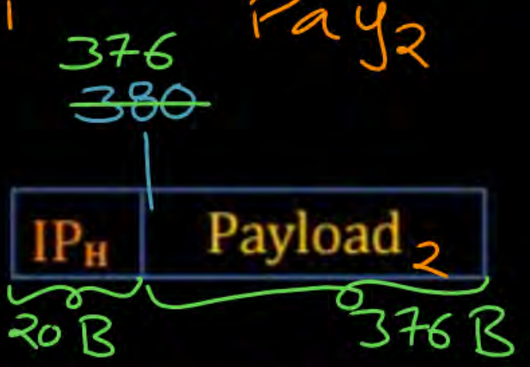


HLEN = 5

TL = 396

Offset = $\frac{0}{8} = 0$

MF bit = 1

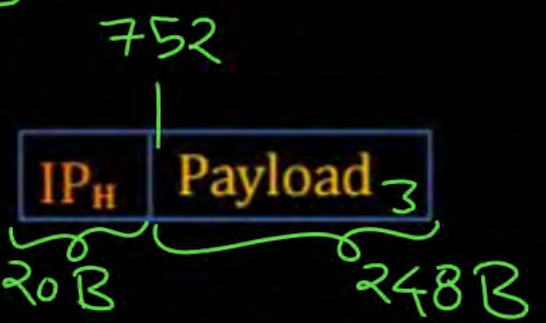


HLEN = 5

TL = 396

Offset = $\frac{380}{8} = \frac{376}{8} = 47$

MF bit = 1



HLEN = 5

TL = 268

Offset = $\frac{752}{8} = 94$

MF bit = 0

[NAT] IIT-G, H.W [GATE-2018][2 Mark]

#Q. Consider an IP packet with a length of 4,500 bytes that includes a 20-byte IPv4 header and a 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 _____ .

[NAT] IISC, H.W. [GATE-2024][2 Mark]

#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-2025]

Example 9 :-

[NAT]

#Q. Consider UDP segment of size 380 bytes is passed to IPv4 protocol for delivery. MTU for source network is 400 bytes and IPv4 header size is 20 bytes. Calculate total number of IPv4 fragments required to carry the UDP segment after fragmentation ?

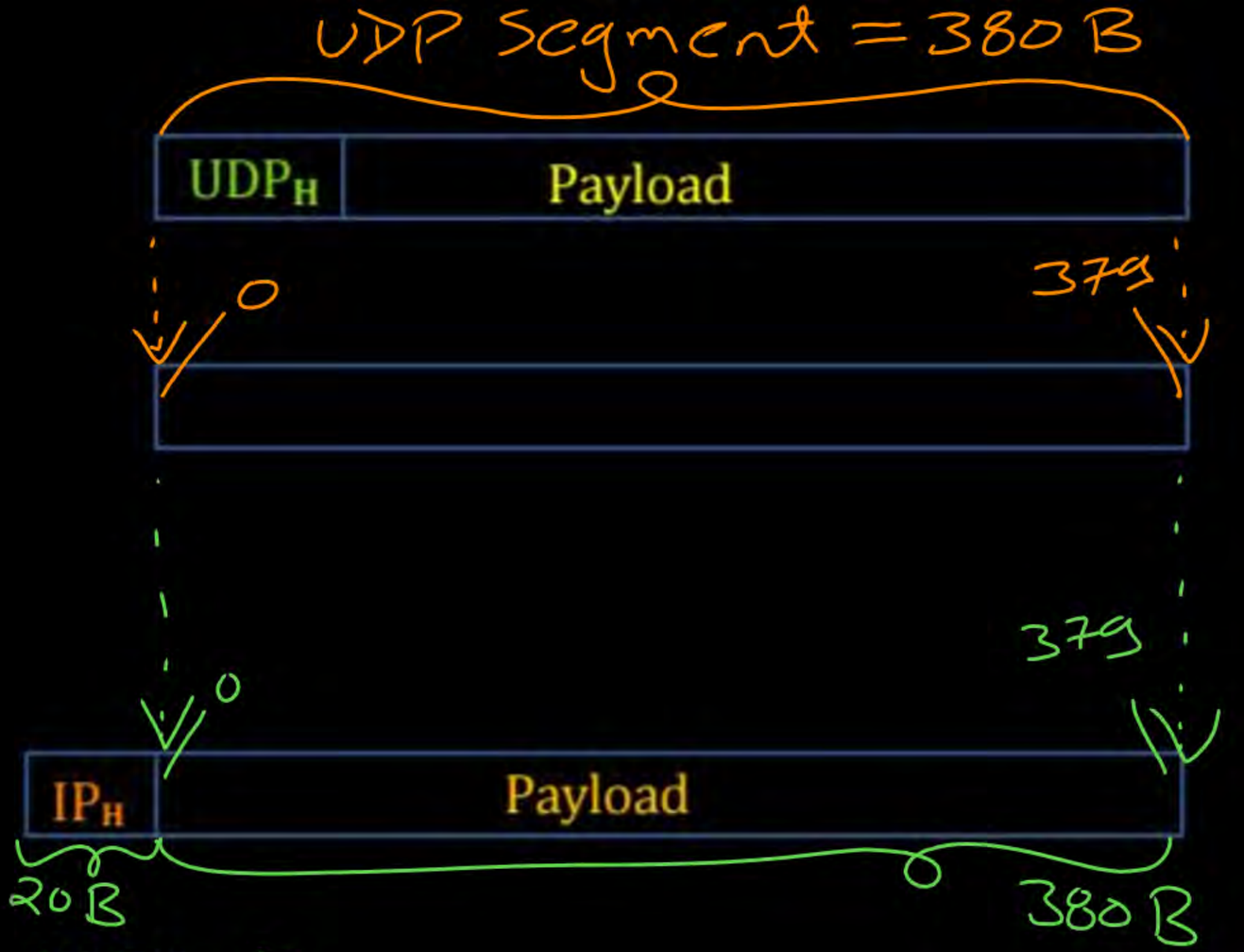
Ans = 1

UDP Segment Size = 380 bytes

MTU = 400 bytes
IPv4 Header Size = 20 bytes

Maximum Payload Size = [MTU - Header Size] bytes
= (400 - 20) byte
= 380 bytes

if M bit is one then
max^m payload size = 376 byte



HLEN = 5

TL = 400

Offset = 0

MF bit = 0

Example 10 :-

[NAT]

#Q. Consider UDP segment of size 381 bytes is passed to IPv4 protocol for delivery. MTU for source network is 400 bytes and IPv4 header size is 20 bytes. Calculate total number of IPv4 fragments required to carry the UDP segment after fragmentation ?

Ans = 2

UDP Segment Size = 381 bytes

MTU = 400 bytes

IPv4 Header Size = 20 bytes

Maximum Payload Size = [MTU - Header Size] bytes

$= (400 - 20)$ bytes

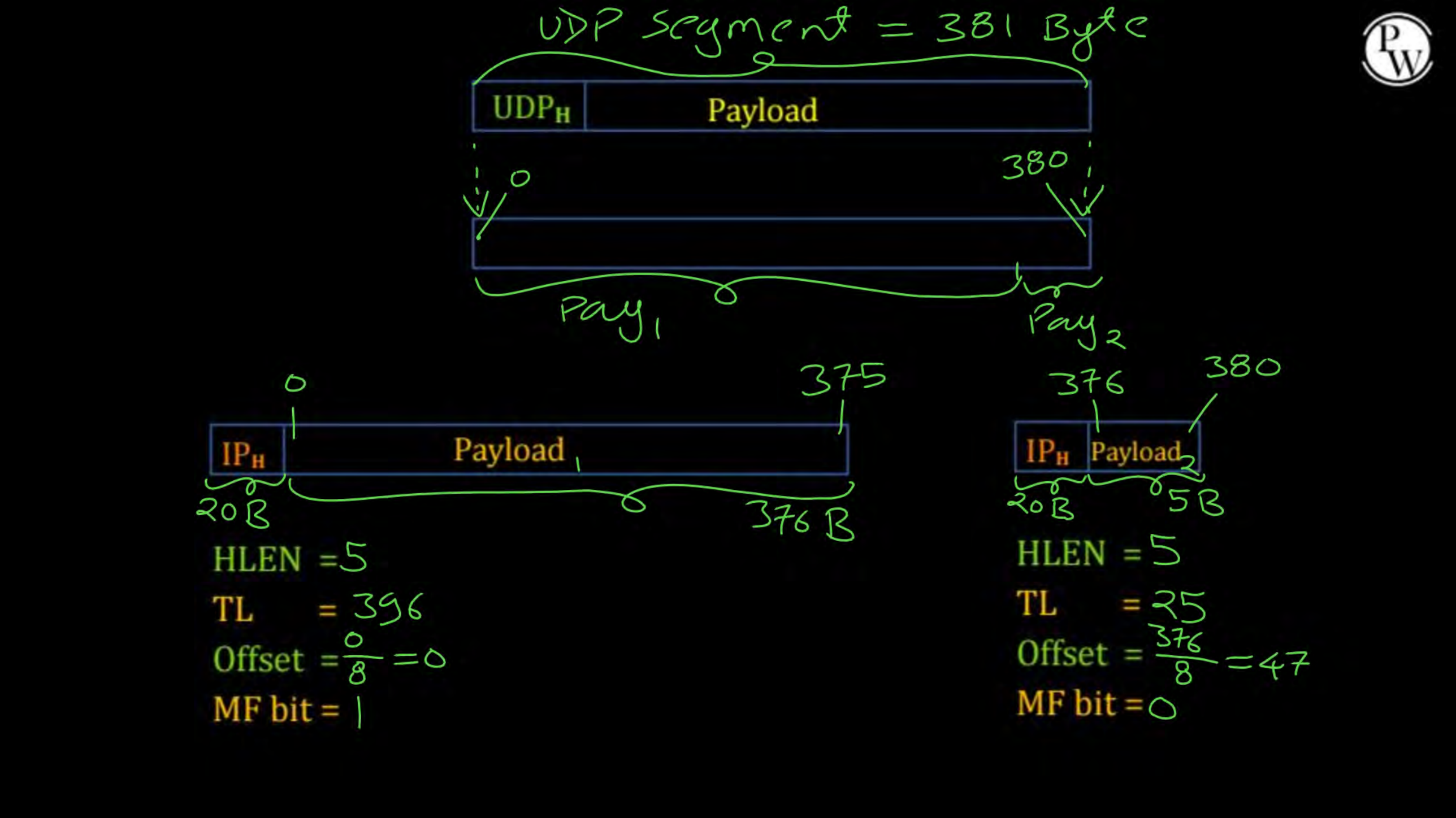
$= 380$ byte

if M bit is zero

max payload size = 380 byte

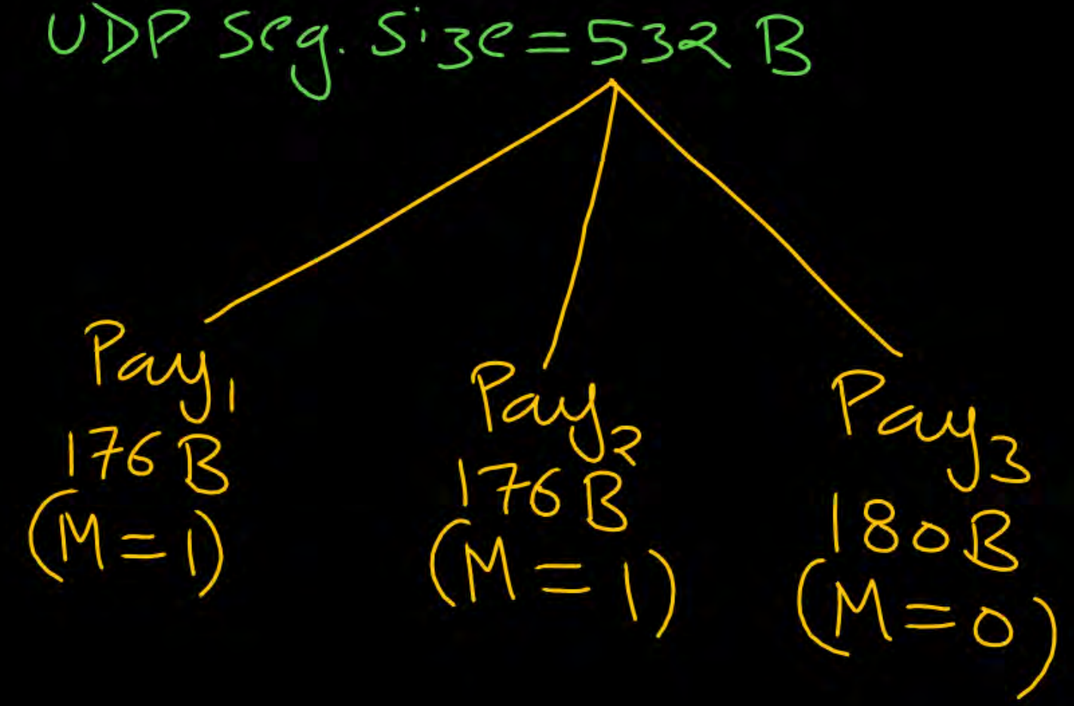
if M bit is one

max payload size = 376 byte


UDP segment = 381 Byte
UDP_H
Payload
0
380
Pay_1
Pay_2
0
375
IP_H
Payload_1
20 B
376 B
376
380
IP_H
Payload_2
20 B
5 B
HLEN = 5
TL = 396
Offset = 0/8 = 0
MF bit = 1
HLEN = 5
TL = 25
Offset = 376/8 = 47
MF bit = 0

Example 11 :- [NAT]

#Q. Consider UDP segment of size 532 bytes is passed to IPv4 protocol for delivery. MTU for source network is 200 bytes and IPv4 header size is 20 bytes. Calculate total number of IPv4 fragments required to carry the UDP segment after fragmentation ?



Ans = 3

MTU = 200 bytes

IPv4 Header Size = 20 bytes

Maximum Payload Size = [MTU - Header Size] bytes

= (200 − 20) bytes

= 180 bytes

if (M = 1) Max^m payload size = 176 byte

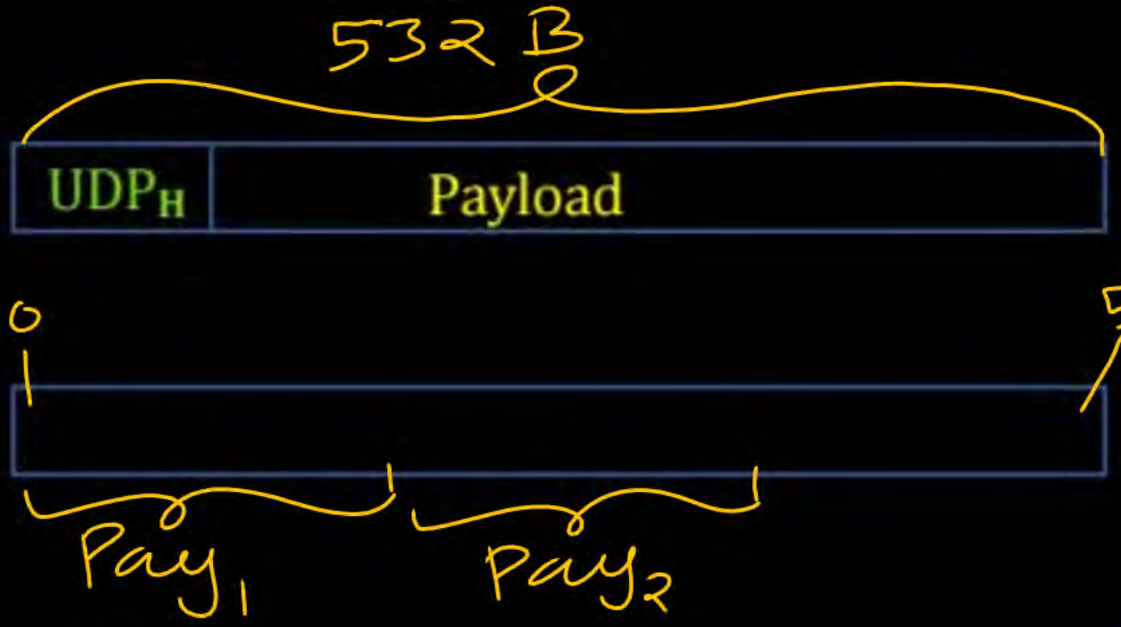
if (M = 0) Max^m payload size = 180 byte

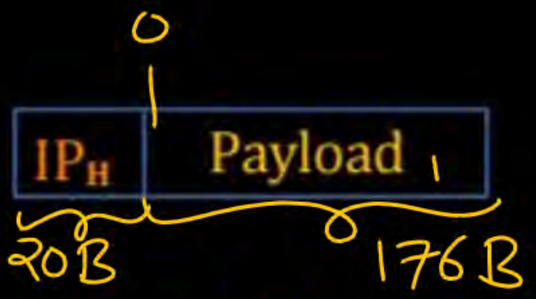
UDP Segment Size = 532 bytes

Total Number of IP fragments [N] = $\left\lceil \frac{\text{UDP Segment Size}}{\text{Payload Size}} \right\rceil$

$$N = \left\lceil \frac{532 \text{ bytes}}{176 \text{ bytes}} \right\rceil$$

$$N = \lceil 3.02 \rceil$$



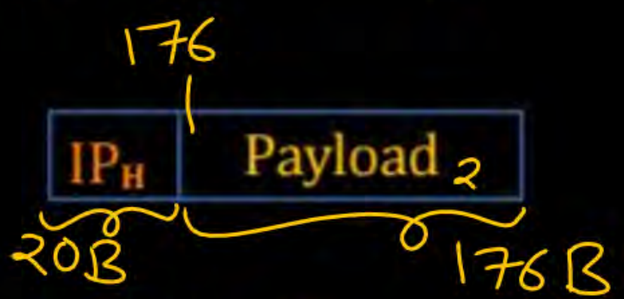


HLEN = 5

TL = 196

Offset = 0

MF bit = 1

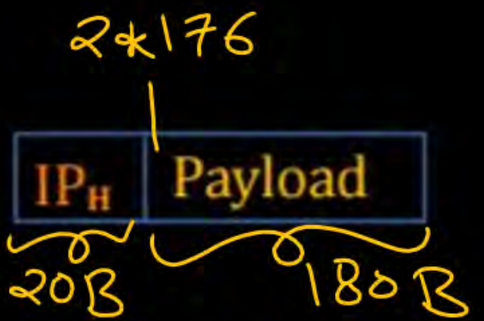


HLEN = 5

TL = 196

Offset = 22

MF bit = 1



HLEN = 5

TL = 200

Offset = 44

MF bit = 0

Example 12 :- [NAT]

#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 ?

Ans = 0

HLEN = 10 words

Total Length = 500 bytes

Old Payload Size = [Total Length - (HLEN * 4)] bytes

$= [500 - (10 * 4)]$ bytes

$= 460$ bytes

[Is not multiple of 8 bytes]

*Definitely MF bit is zero.

Example 13 :-

[NAT]

#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 ?

Ans: Can't determine

HLEN = 5 word

Total Length = 500 byte

Old Payload Size = [Total Length − (HLEN * 4)] bytes

= [500 − (5 * 4)] bytes

= 480 bytes

[Payload size is multiple of 8 bytes]

MF = 1 OR 0

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

[MSQ] IISC, H.W. [GATE-2024][1 Mark]

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

A. The fragmentation of an IP datagram is performed only at the source of the datagram

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

C. The reassembly of fragments is performed only at the destination of the datagram

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

[MSQ] IIT-B, H.W. [GATE-2021][2 Mark]

#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?

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.

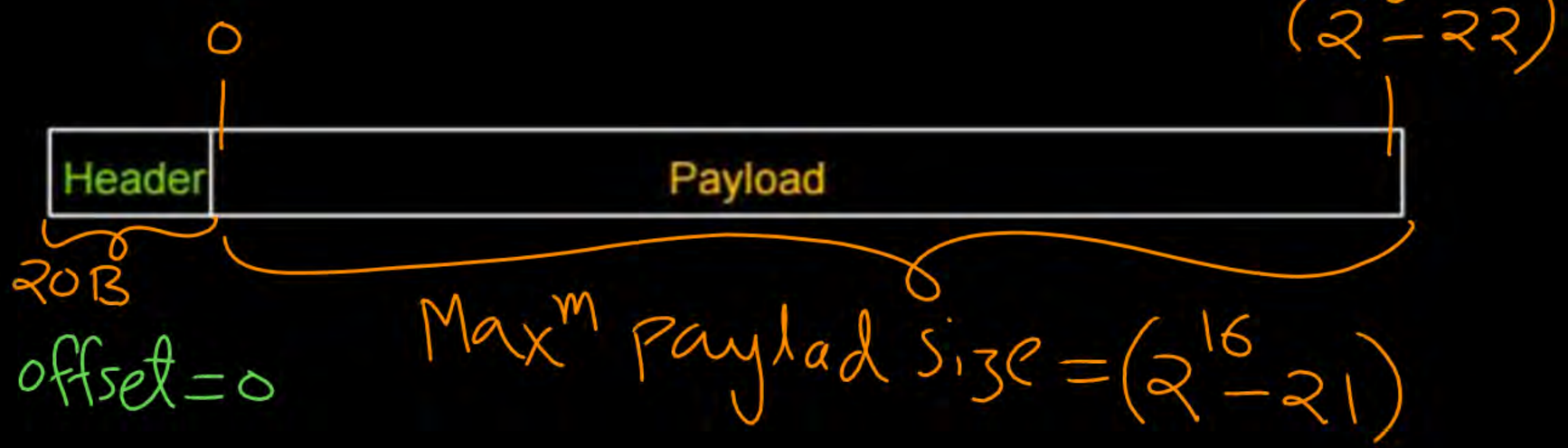
C. If the second fragment is lost, P is required to resend the whole TCP segment.

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

Topic : Fragmentation Offset

→ Total Length field size = 16 bits

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



Topic : Fragmentation Offset

→ Fragmentation Offet field size = (13-bits)

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

→ Fragmentation may be needed at any intermediate router

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

2 mins Summary

Topic Fragmentation and Reassembly

THANK - YOU