CS & IT ENGINEERING

COMPUTER NETWORKS

IPv4 Header & Fragmentation

Lecture No-07

By- Ankit Doyla Sir

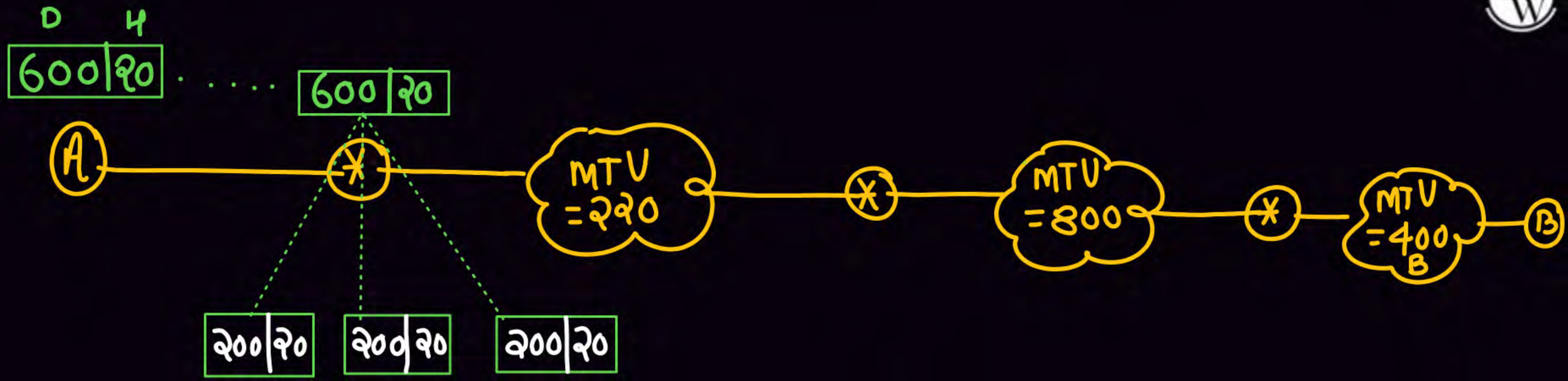
Fragmentation in IPv4

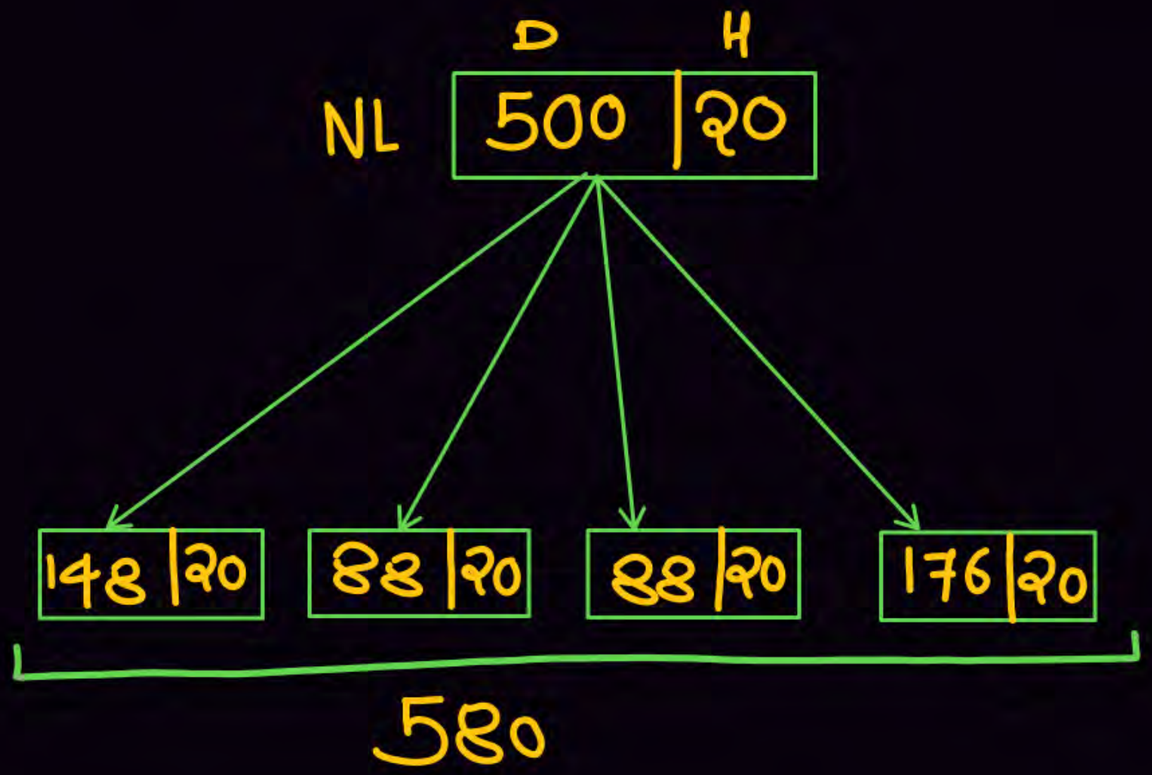
Note:-

1. Fragmentation is done by Intermediary devices such as Router.
2. The reassembly of fragmented datagrams is done only after reaching the destination

Q. Why Reassembly is not done at the router?

1. All the fragment may not meet at a router
2. Fragmented datagram may reach the destination through Independent path.
3. Fragmented packet may be fragmented further.


D
H
600 20
600 20
A
MTU
=220
MTU
=800
MTU
=400
B
B
200 20
200 20
200 20



By doing Fragmentation at Router the NL

overhed = 580 - 520

= 60 Byte

Fragmentation overhed = (Total No. of Fragment - 1) * IPv4 Header size

= (4-1) * 20 = 60 Byte

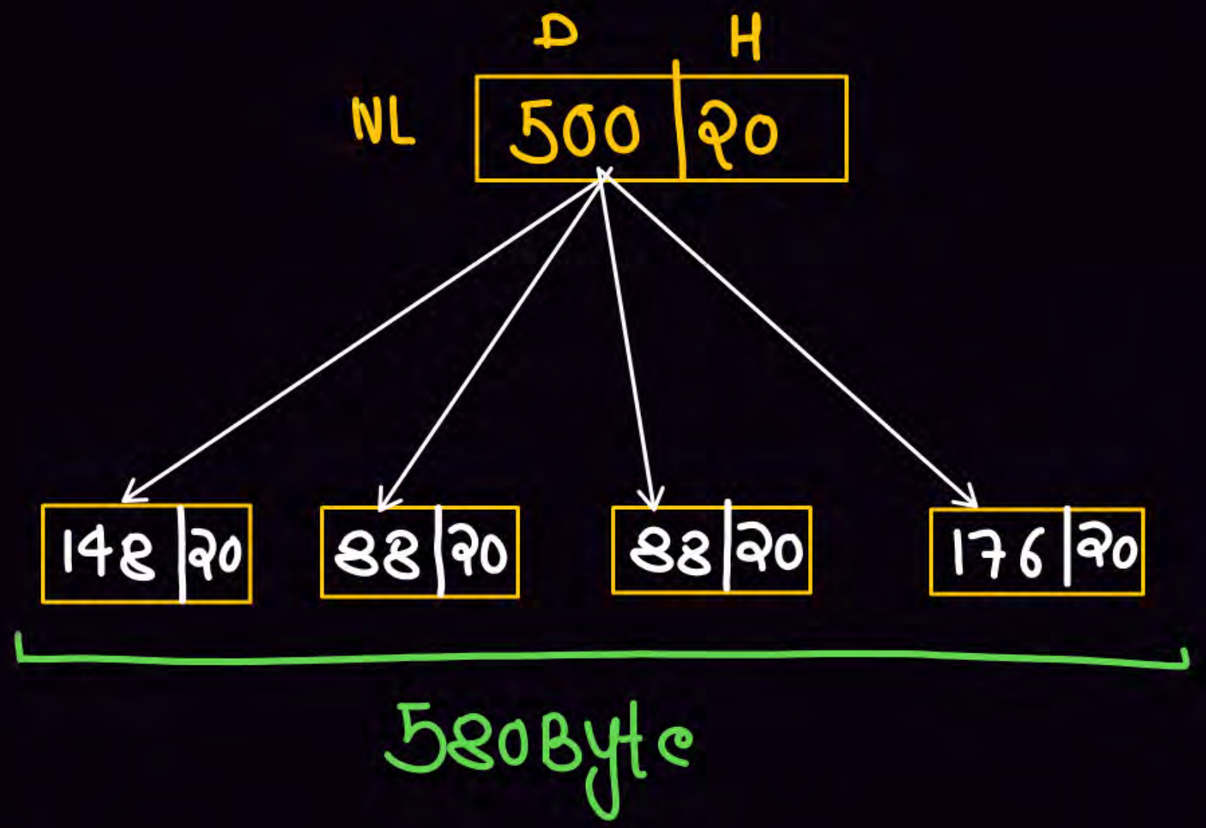
Q: what is Network Layer overhed

Ans: 580 - 500 = 80 Byte

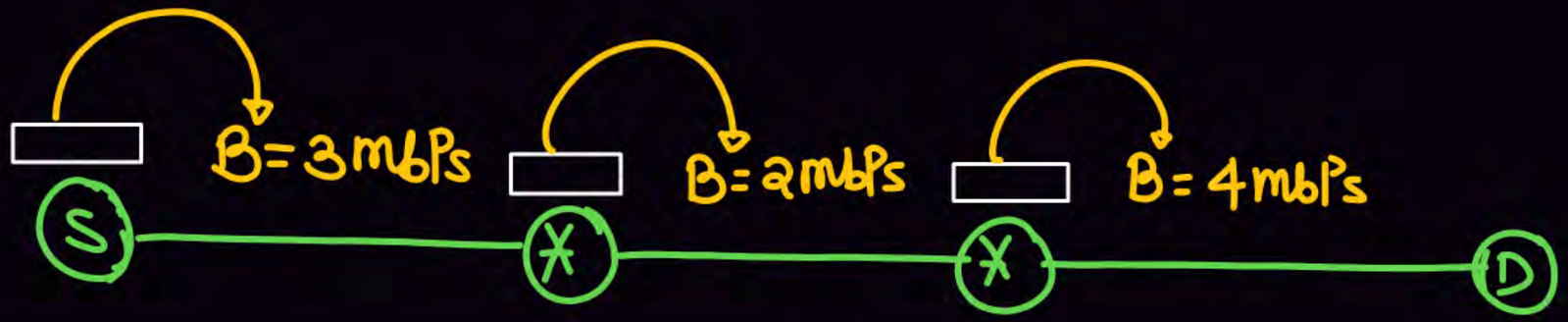
Fragmentation Overhead

1. Fragmentation of datagram Increase the overhead
2. This is because after fragmentation, IP header hast to be attached with each Fragment.

Total overhead = (Total No. of Fragment datagram−1) * size of IP Header



$$\text{Efficiency} = \frac{\text{useful Byte}}{\text{Total Byte}} = \frac{500}{580} = 0.8620 = 86.2\ \%$$



Throughput = $\eta * B$

ThroughPut = η * minimum Bandwidth

Throughput = 0.86 * 2mbps

Throughput = 1.72mbps

Ex-1

1500
1008
492

	492 | 20	504 | 20	504 505 | 20
Offset	$\frac{2\times504}{8}=126$	$\frac{504}{8}=63$	$\frac{0}{8}=0$
MF	0	1	1
TL	512	524	524

EX-2

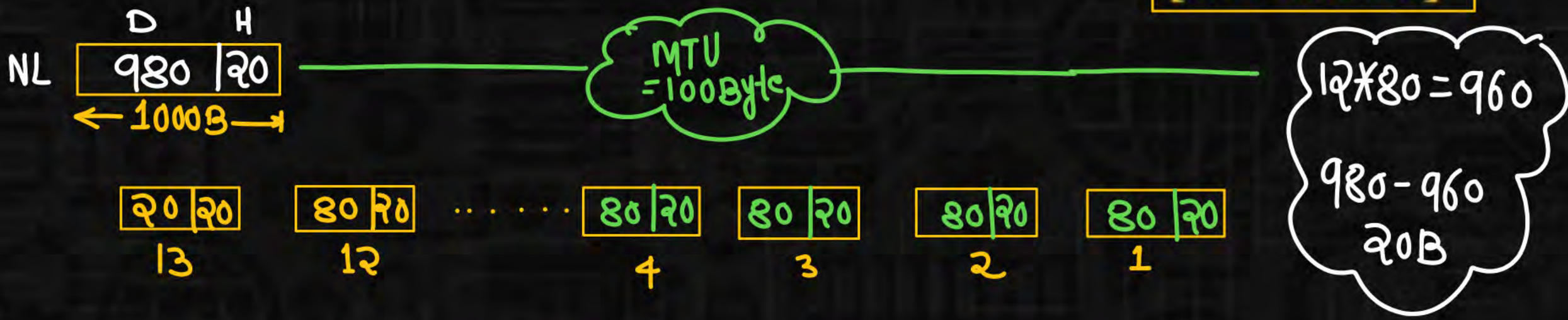
4000
2800
1200

1200 | 20	1400 | 20	1400 | 20	
$\frac{2*1400}{8}=350$	$\frac{1400}{8}=175$	$\frac{0}{8}=0$	OFFset
0	1	1	MF
1220	1420	1420	TL

Problem Solving on Fragmentation

Q.1 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 13 .

[GATE 2016]

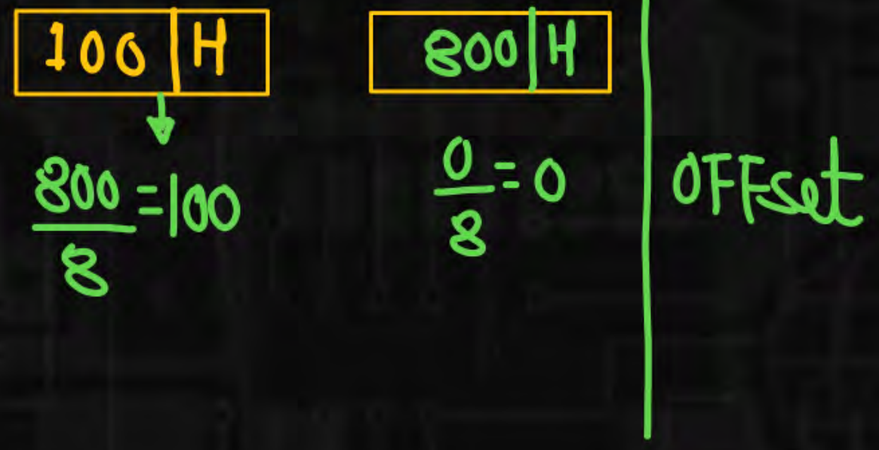


No. of Fragmen = $\frac{980}{80}$ = $\lceil 12.25 \rceil$ = 13 Fragment

Q.2 If the value available in "fragment offset" field of IP header is 100, then the number of bytes ahead of this fragment is _____ .

Fragment OFFset = 100

No. OF data Byte ahead OF this Fragment = 8 * 100
= 800



Q.3 In IPv4 datagram, offset value is non zero and in M (more fragment) bit is one, then what is the position of datagram?

can't be First Fragment

M = 1 ⇓ can't be Last Fragment

A. First Fragment

B. Last Fragment

C. Neither First Fragment nor Last Fragment — It is middle Fragment

D. Can't Determine

Q.4 An IP router with a Maximum Transmission Unit (MTU) of 1500 bytes has received an IP packet of size 4404 bytes with an IP header of length 20 bytes. The values of the relevant fields in the header of the third IP fragment generated by the router for this packet are

[GATE 2014]

A. MF bit: 0, Datagram Length: 1444; Offset: 370

B. MF bit: 1, Datagram Length: 1424; Offset: 185

C. MF bit: 1, Datagram Length: 1500; Offset: 370

D. MF bit: 0, Datagram Length: 1424; Offset: 2960

4384
2960
1424

1424 | 20	1480 | 20	1480 | 20	
$\frac{2*1480}{8} = 370$	$\frac{1480}{8} = 185$	$\frac{0}{8} = 0$	OFFset
0	1	1	MF
1444	1500	1500	Datagram length (TL)

Q.5 Host A sends a UDP datagram containing 8880 bytes of user data to host B over an Ethernet LAN. Ethernet frames may carry data up to 1500 bytes (i.e. MTU = 1500 bytes). Size of UDP header is 8 bytes and size of IP header is 20 bytes. There is no option field in IP header. How many total number of IP fragments will be transmitted and what will be the contents of offset field in the last fragment?

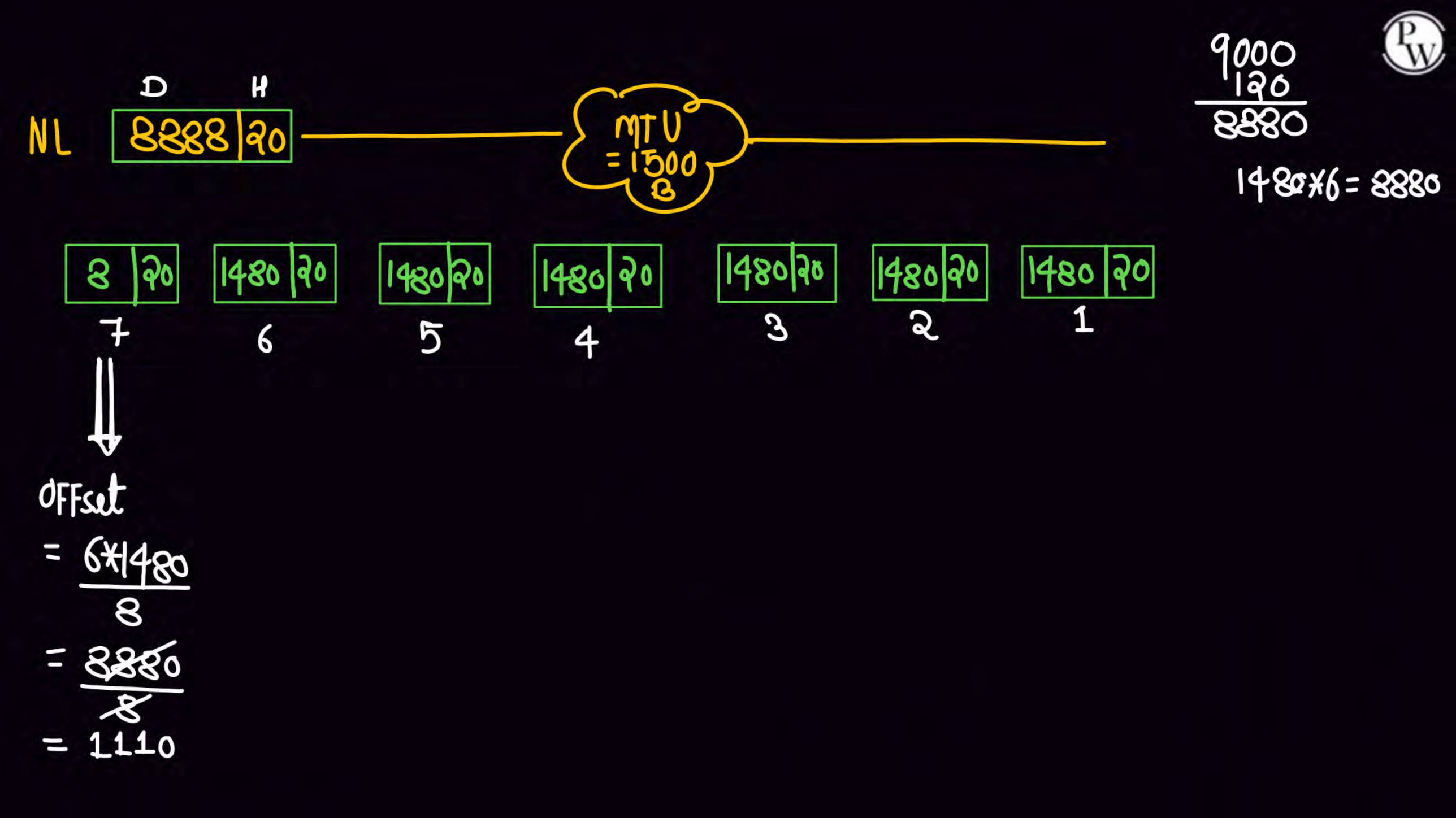
[GATE 2015]

A. 6 and 925

B. 6 and 7400

C. 7 and 1110 ✓

D. 7 and 8880


D
H
NL
8888
20
MTU
=1500
B
8
20
1480
20
1480
20
1480
20
1480
20
1480
20
1480
20
7
6
5
4
3
2
1
OFFset
= 6*1480
8
= 8880
8
= 1110
9000
120
8880
1480*6 = 8880

Q.6

In an IPv4 datagram, the M bit is 0, the value of HLEN is 10, the value of total length is 400 B and the fragment offset value is 300. The position of the datagram, the sequence numbers of the first and the last bytes of the payload, respectively are

[GATE 2013]

A. Last fragment, 2400 and 2789

B. First fragment, 2400 and 2759

C. Last fragment, 2400 and 2759

D. Middle fragment, 300 and 689

Last Fragment

(data)

(390)

(360)

HLEN = 10

Header size = 10*4 = 40B

Total length = 400

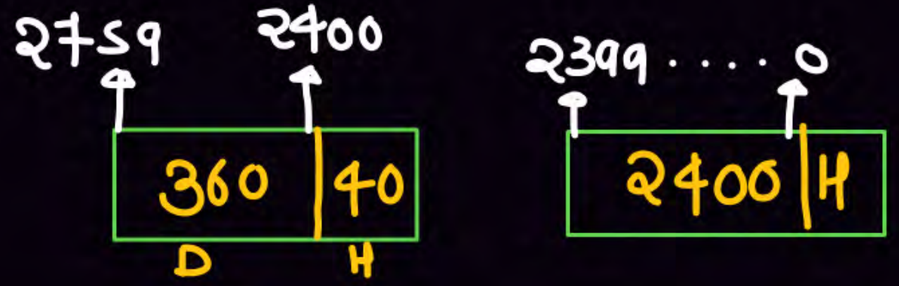
TL = D + H

D = TL - H

= 400 - 40 = 360 Byte

Fragment offset = 300

No. of data Byte ahead = 8 × 300 = 2400



Q.7 A 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 frame and the second network can carry a maximum payload of 400 bytes per frame, excluding network overhead. Assume that IP overhead per packet is 20 bytes.

What is the total IP overhead if the second network is considered for transmission of 2100 Bytes?

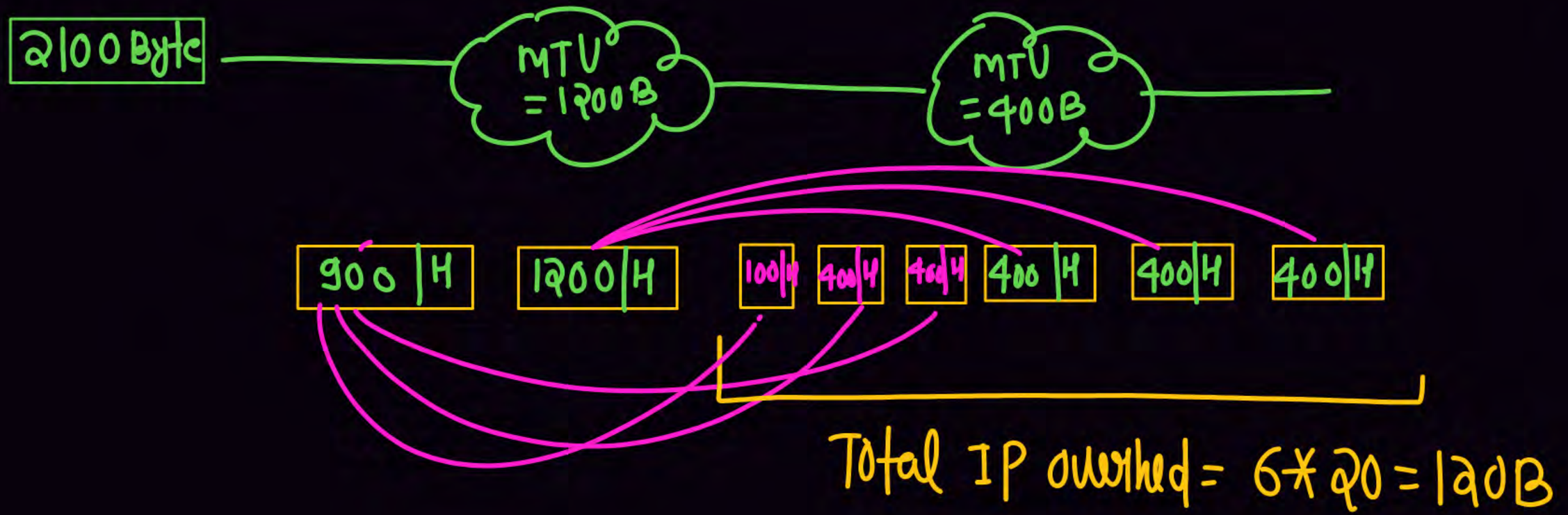
[GATE 2004]

A. 40 bytes

B. 80 bytes

C. 120 bytes ✓

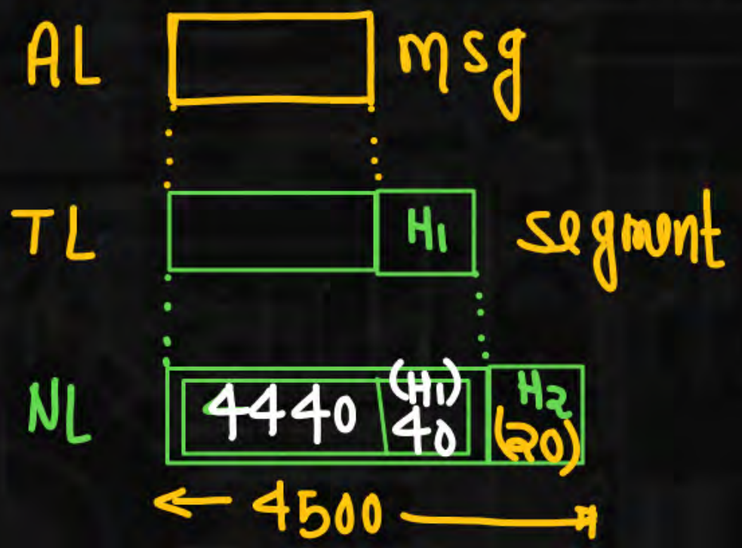
D. 160 bytes

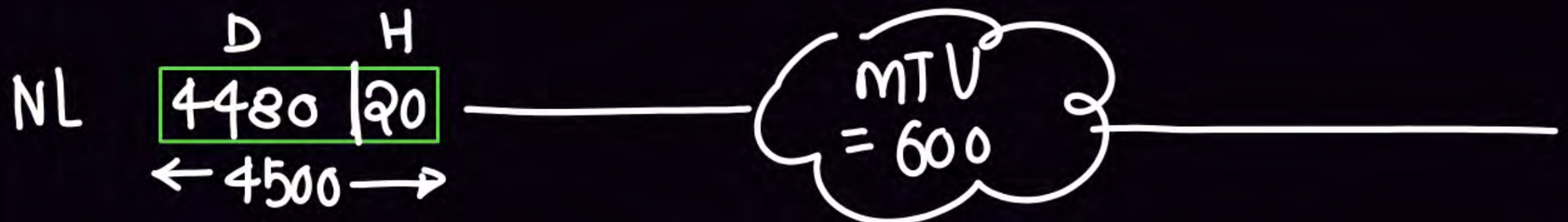

2100 Byte
MTU = 1200 B
MTU = 400 B
900 H
1200 H
100 H
400 H
400 H
400 H
400 H
400 H
Total IP overhead = 6 * 20 = 120 B

Q.8 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 144 .

[GATE 2018]





576	20

3

576	20

2

576

580	20

1

$$\text{OFFset} = \frac{2 \times 576}{8} = \frac{2 \times 72}{}$$

OFFset = 144

Q.9 A packet has arrived in which the offset value is 100, the value of HLEN is 5, and the value of the total length field is 100. What are the number of the first byte and the last byte of Payload (800-879)

Offset Value = 100

No. of data Byte ahead = 8 * 100 = 800

HLEN = 5

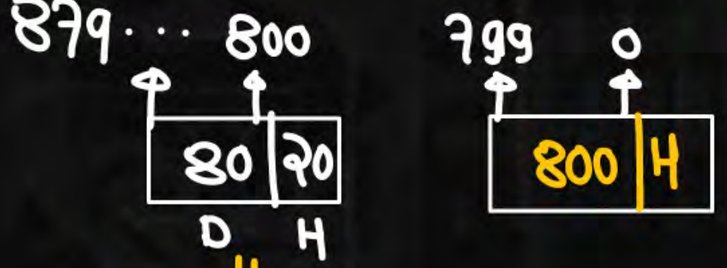
Header size = 5 * 4 = 20 Byte,

Total length = 100

TL = D + H

D = TL - H

D = 100 - 20 = 80



Offset = 800/8 = 100

Q.10 In IPv4 datagram HLEN is 5 and total length is 200, then what is the position of datagram?

A. First Fragment

B. Intermediate Fragment

C. Last Fragment ✓

D. Can't Determine

HLEN = 5

Header size = 5*4 = 20Byte

Total length = 200

TL = Data + H

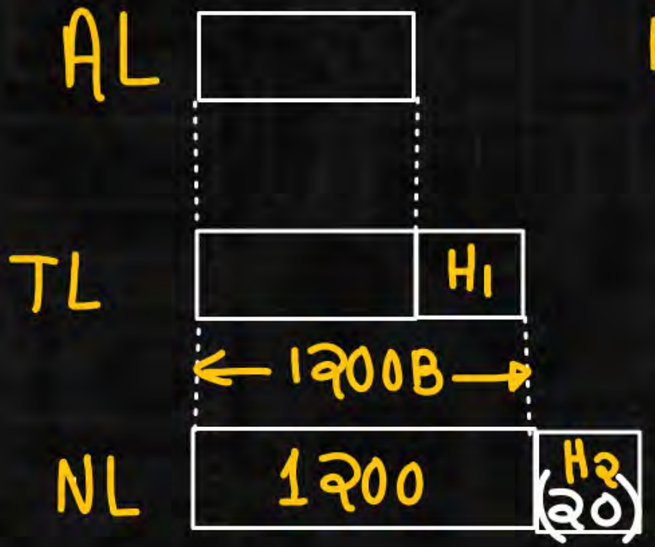
Data = TL - H

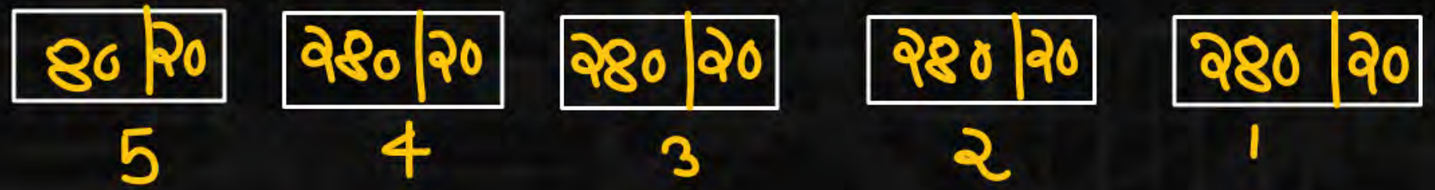
= 200 - 20

= 180

Data size is not div by 8 → It is Last Fragment

Q.11 Consider transport layer packet (PDU) size is 1200 Bytes, IP(V4) Header size is 20 Bytes and MTU is 300 Bytes then number of IP fragments is 5 .





280 × 4 = 1120

1200 − 1120 = 80

No. of Fragments = 5

Q.12

H·W

An IP router with MTU of 1200 byte has received an IP packet of size 4408 byte with an IP Header of 20 byte. What is the total length value of the Last Fragment _____

Q.13

H.W

If a router receives an IP packet containing 300 data byte and has to forward the packet to the network with maximum transmission unit of 80 byte. Assume that IP header is 10 byte long. Find the total fragment, more Fragment, and offset values.

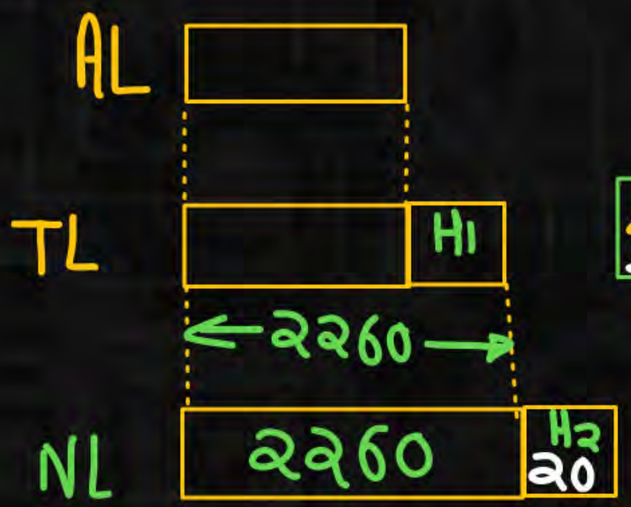
A. 4, 1110 (0, 10, 20, 30)

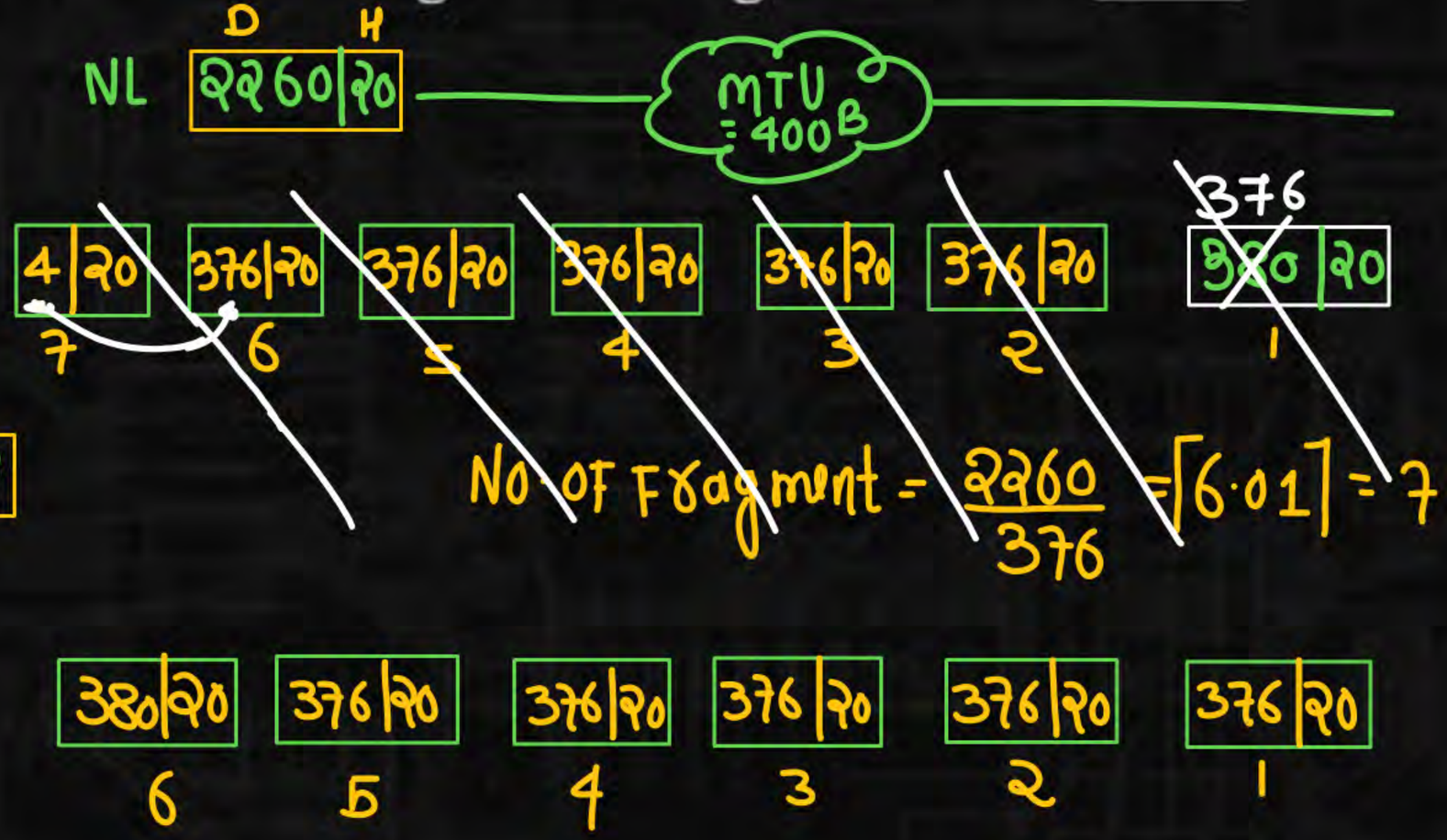
B. 5, 11110 (0, 8, 17, 26, 35)

C. 6, 111110 (0, 7.5, 15, 22.5, 30)

D. 5, 11110 (0, 8, 16, 24, 32)

Q.14 Consider PDU size of transport layer packet is 2260 Bytes at source host. MTU for the network is 400 Bytes and IP(V4) header size is 20 Bytes the number of Fragments for given PDU is 6.

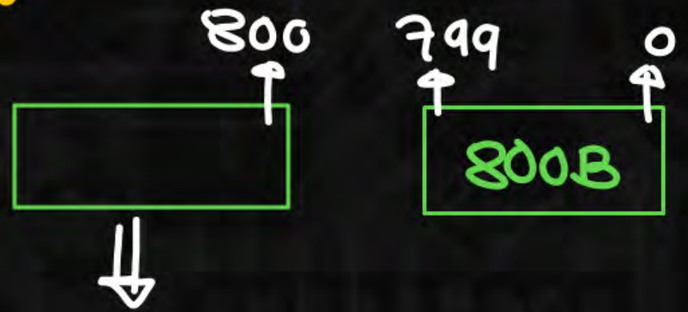




Q.15 A packet has arrived in which the offset value is 100. what is the number of first byte 800

OFFset = 100

Number of Data Byte ahead = 8 * 100 = 800



OFFset = 100

Q.16

Consider the following fields in IP header and choose correct combination :

P.	MF	1.	Zero for first fragment
Q.	DF	2.	It must be available in all fragments
R.	Offset	3.	If it is '1', then fragmentation is not allowed
S.	Strict source routing	4.	zero for last fragment

A. P-3, Q-1, R-4, S-2

B. P-2, Q-3, R-1, S-4

C. P-4, Q-3, R-1, S-2

D. P-4, Q-3, R-2, 3-1

Q.17

Why do you think IPv4 has fragment reassembly done at the end point, rather than at the next hop router ?

MCQ

A. Fragment may follow the same route

B. Fragments may follow the different routes

C. Different networks will have the same MTU size

D. Intermediate routers do not know the reassemble algorithm

Q.18 In an IPv4 datagram, M bit is zero and fragment offset value is zero, then the fragment is ____.

MCQ

A. First Fragment

B. Last Fragment

C. Middle Fragment

D. No Fragmentation

M = 0 ⇒ Last Fragment or only Fragment

Offset = 0 → 1st Fragment

300	20

MF = 0

Offset = 0

Q.19 In an IPv4 datagram, M bit is one. then the fragment is ____.

M = 1 → can't be Last Fragment

It can be First Fragment or Middle Fragment

A. First Fragment

B. Last Fragment

C. Middle Fragment

D. Both A and C ✓

Q.20

A packet has arrived in which the offset value is 100 ,the value of HLEN is 5 and the value of total length is 100. what is the number of last byte _____

H·W

Q.21

Find number of fragments while packet traverse through a network with below details in incoming packet header and network characteristics. Maximum transport unit (MTU) size as 300 bytes, network header as 20 bytes, don't fragment (DF) bit as 1 and incoming datagram data size as 1000 bytes.

H.W

A. 3 fragment

B. 2 fragments

C. 4 fragments

D. None of the above

Q.22 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]

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

B. If the second fragment is lost, R will resend the fragment with the IP identification value 0x1234.

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

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

MSQ

Q.23

Consider the following statements about the functionality of an IP based router.

I. A router does not modify the IP packets during forwarding.

II. It is not necessary for a router to implement any routing protocol.

III. A router should reassemble IP fragments if the MTU of the outgoing link is larger than the size of the incoming IP packet.

Which of the above statements is/are TRUE ? **[GATE 2020]**

H·W

A. I and II only

B. I only

C. II and III only

D. II only

Q.24

An IPV_4 datagram is received by an IPv4 Router, Header length (HLEN) field contains value 10 and total length field contains value 2060, MTU of the link is 100 bytes. Calculate total number of IP fragments after fragmentation_____.

H·W

Q.25

An IPv4 datagram has arrived in which the offset value is 800, the HLEN is 8, and the value of total length field is 500 and M bit is 0.

What are the numbers of the 1st Byte and the last Byte and the position of the datagram?

H.W

A. 6400, 6887 and Last Fragment

B. 6400, 6867 and First Fragment

C. 6400, 6867 and Last Fragment

D. 801, 1268 and First Fragment

Q.26

An IP router with MTU of 1200 Bytes has received an IP packet of size 4408 byte with an IP header of 20 byte. The value of the MF, offset, and total length of the 4th fragment

H·W

A. MF = 1, Offset = 404, Total length = 880

B. MF = 0, Offset = 294, Total length = 1196

C. MF = 0, Offset = 441, Total length = 880

D. MF = 0, Offset = 404, Total length = 1196

Q.27

Consider three IP Address A,B and C. Host HA in network each containing 180 bytes of application data to a hos HC in network C. The TCP layer prefixes 20 bytes header to the message.

This passes through an intermediate network B. The maximum packet size, including 20 bytes IP header, in each network is:

H.W

A: 1000 bytes

B: 100 bytes

C: 1000 bytes

The network A and B arc connected through a 1 Mbps link, while B and C arc connected by a 512 Kbps link (bps = bits per second).

Assuming that the packets are correctly delivered, how many bytes, including headers, are delivered to the ZP layer at the destination for one application message, in the best case? Consider only data packets.

A. 200

B. 220

C. 240

D. 260

Q.28

Consider three IP networks A, B and C. Host HA in network A sends messages each containing 180 bytes of application data to a host HC in network C. The TCP layer prefixes 20 byte header to the message. This passes through an intermediate network B. The maximum packet size, including 20 byte IP header, in each network, is:

H.W

A : 1000 bytes

B : 100 bytes

C: 1000 bytes

The network A and B are connected through a 1 Mbps link, while B and C are connected by a 512 Kbps link (bps = bits per

What is the rate at which application data is transferred to host HC? Ignore errors, acknowledgments, and other overheads.

A. 325.5 Kbps

B. 354.5 Kbps

C. 409.6 Kbps

D. 512.0 Kbps


THANK YOU
GW
SOLDIERS !