CS & IT ENGINEERING

COMPUTER NETWORKS

IPv4 Header & Fragmentation

Lecture No-06

By- Ankit Doyla Sir

Fragmentation in IPv4

Reassembly

Algorithme

Reassemble Algorithm

If each fragment follow a different path and arrives out of order, the final destination host can reassemble the original datagram from the fragment received by using the following strategy:

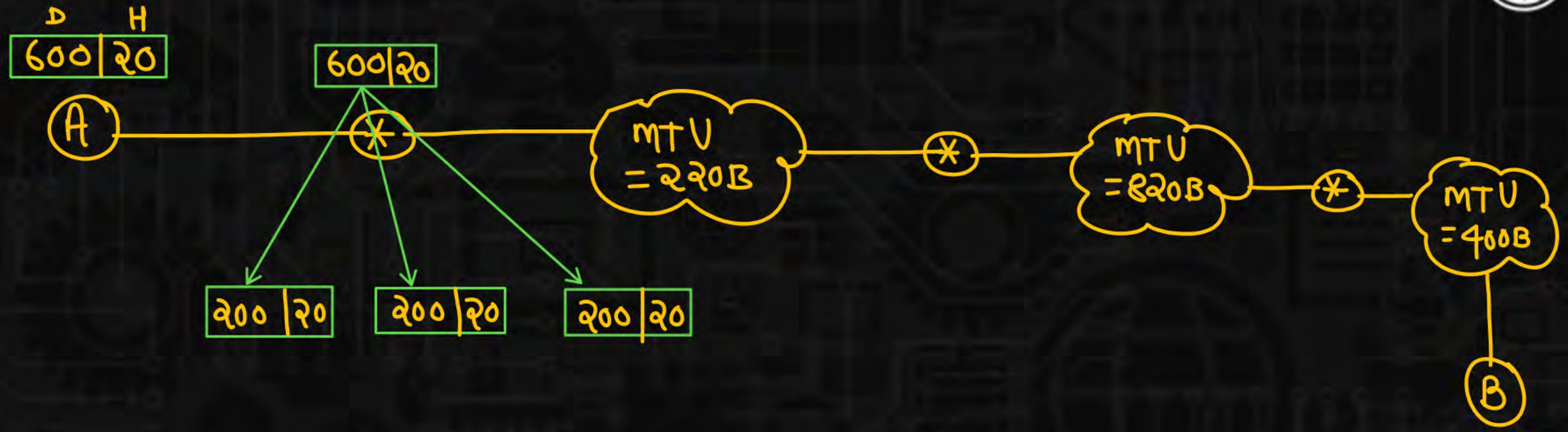
1. Identify the fragment with offset = 0 and it is the first fragment.
2. Identify the fragment with MF = 0 and it is the last fragment.
3. Divide the data length of the first fragment by 8. The second fragment has an offset value equal to that result
4. Divide the data length of the first and second fragment by 8. The third fragment has an offset value equal that result.
5. Repeat this process as many times as possible to cover all the fragment.

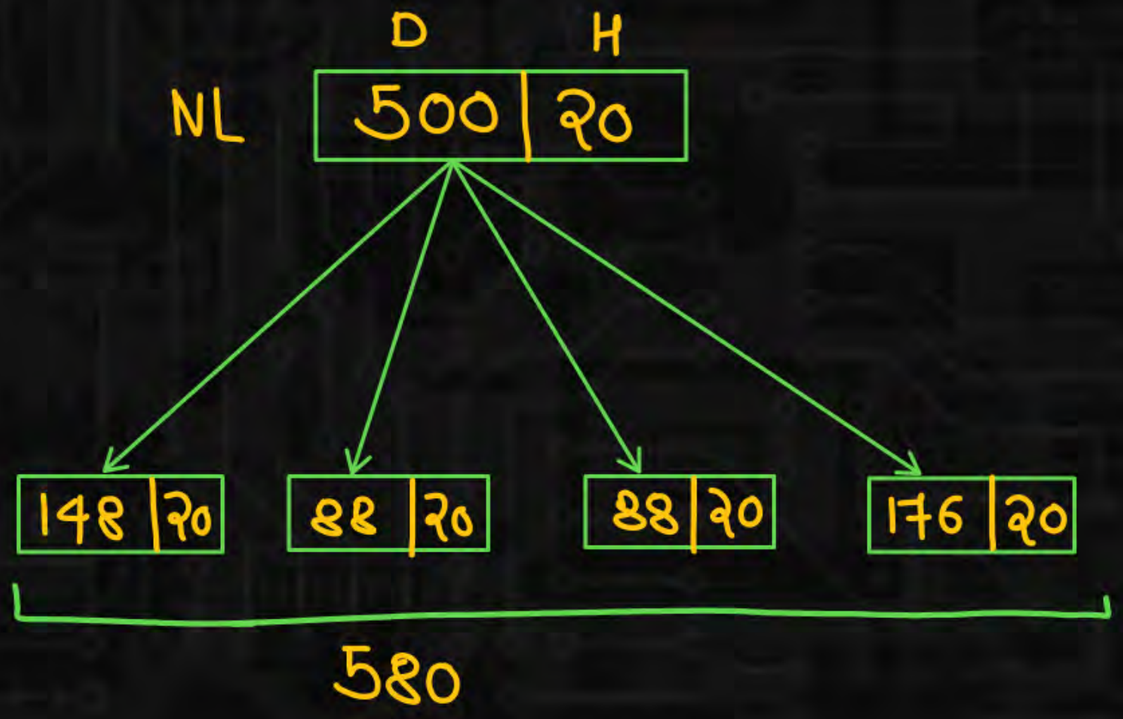
Note:-

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
A
600
20
MTU
=220B
MTU
=820B
MTU
=400B
200
20
200
20
200
20
B



By doing Fragmentation at Router the NL

Overhed = 580 - 520 = 60 B

Fragmentation overhed = (Total No. OF Fragments - 1) * IPv4 Header size

= (4 - 1) * 20 B = 60 Byte

Q: What is NL overhead ?

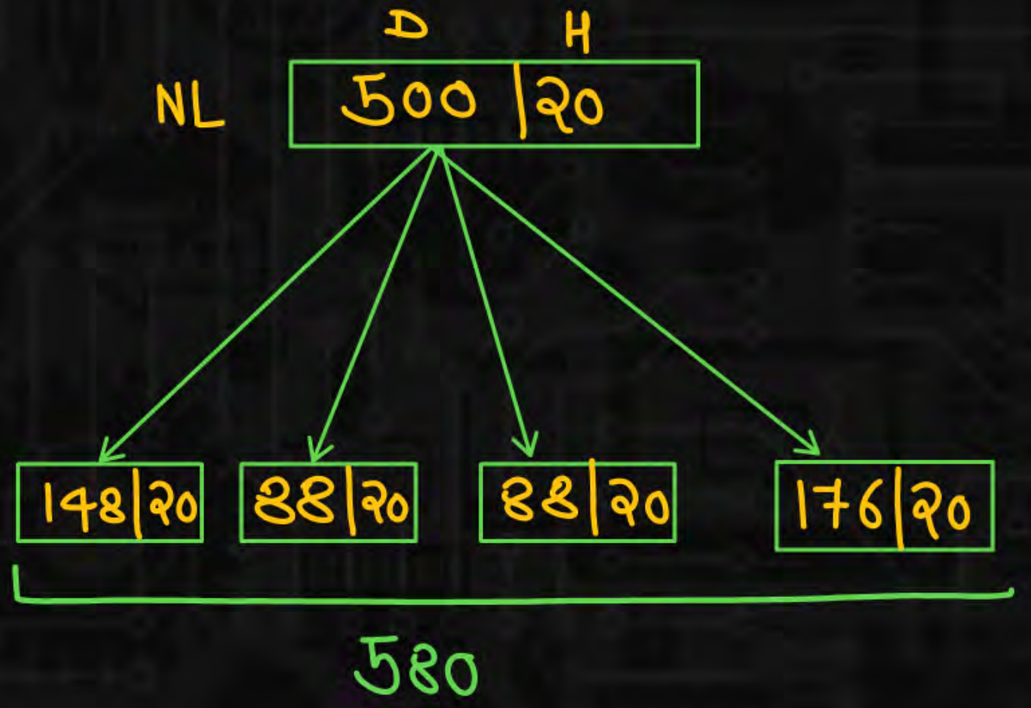
Ans: 580 - 500 = 80 Byte

Fragmentation Overhead

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

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

= (4-1) * 20B = 60Byte

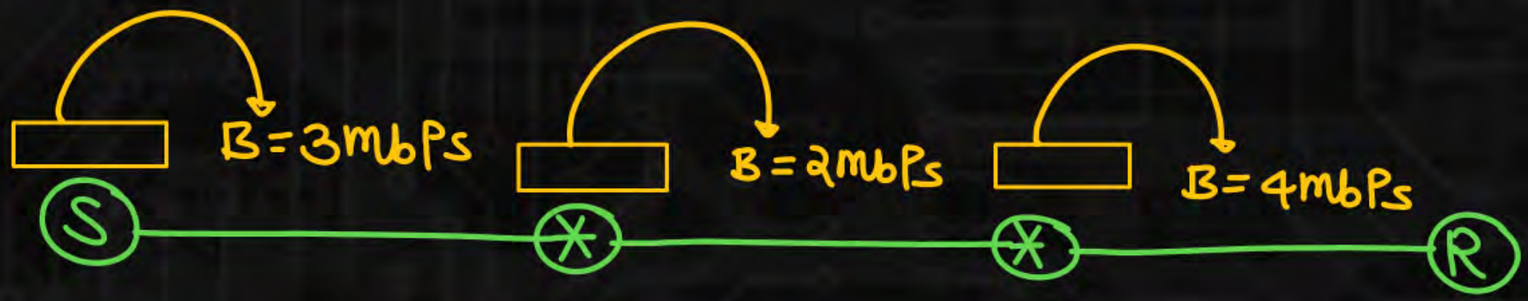


$$\text{efficiency} = \frac{\text{useful Byte}}{\text{Total Byte}}$$

$$= \frac{500}{580}$$

$$= 0.862$$

$$\text{efficiency} = 86.2\ \%$$



Throughput = η * B

Throughput = η * minimum Bandwidth

= 0.86 * 2mbPs

Throughput = 1.72 mbPs

EX-1

1500
1008
492

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

Ex-2

4000
- 2800
1200

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

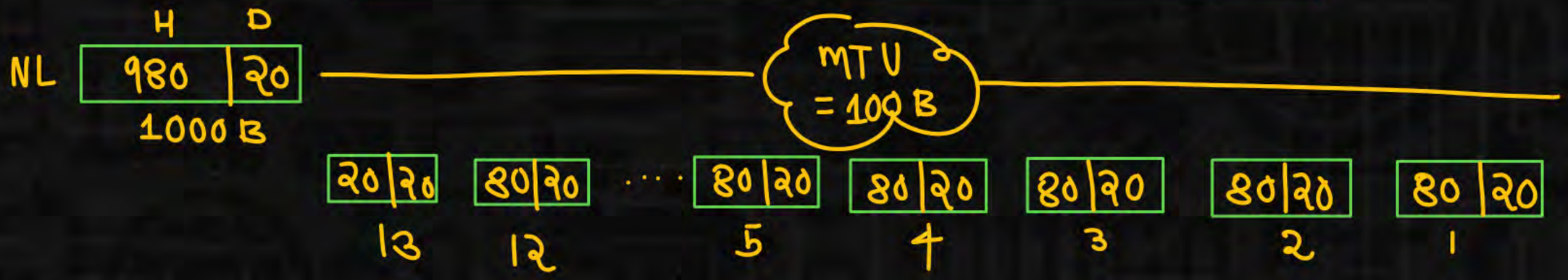
Problem Solving on Fragmentation

980-960=20B

12*80=960Byte

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 .

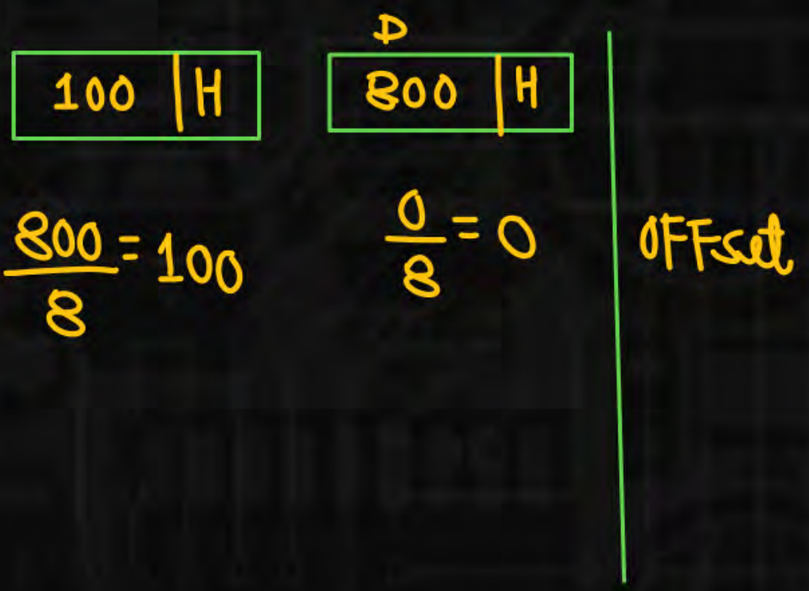
X No. of Fragments = $\frac{980}{80}$ = $\lceil 12.25 \rceil$ = 13 Fragment **[GATE 2016]**



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 Value = 100

No. OF data Byte ahead = 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

MF = 1

Can't be Last Fragment

It is middle Fragment

A. First Fragment

B. Last Fragment

C. Neither First Fragment nor Last 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

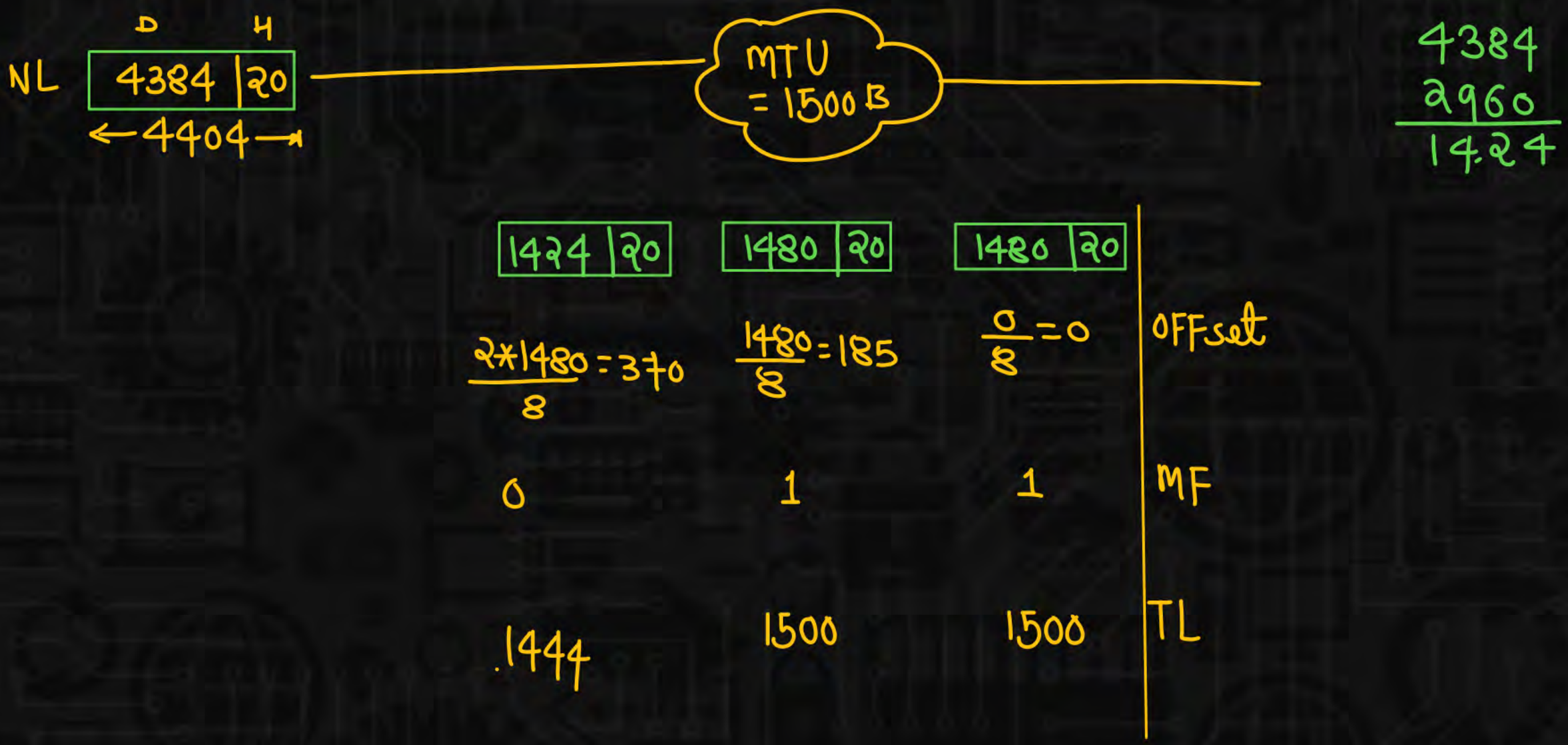
[GATE 2014] (2M)

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


D
H
NL
4384
20
4404
MTU
= 1500 B
4384
2960
1424
1424
20
1480
20
1480
20
2*1480/8 = 370
1480/8 = 185
0/8 = 0
OFFset
0
1
1
MF
1444
1500
1500
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?

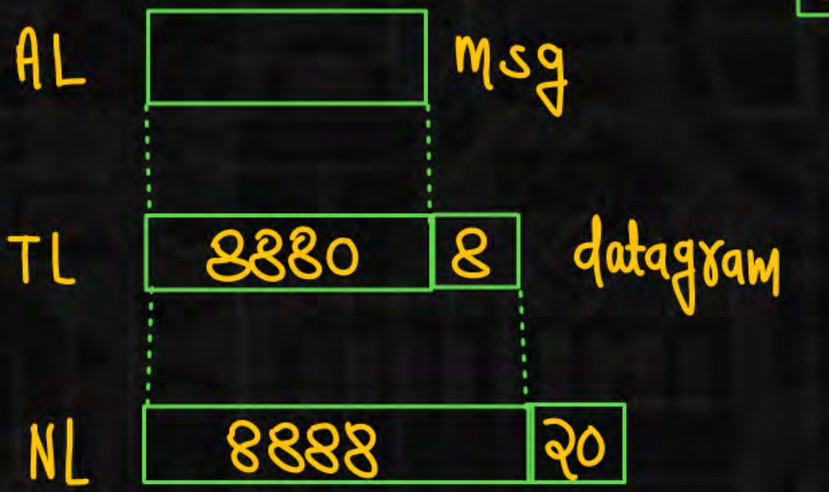
[GATE 2015]

A. 6 and 925

B. 6 and 7400

C. 7 and 1110

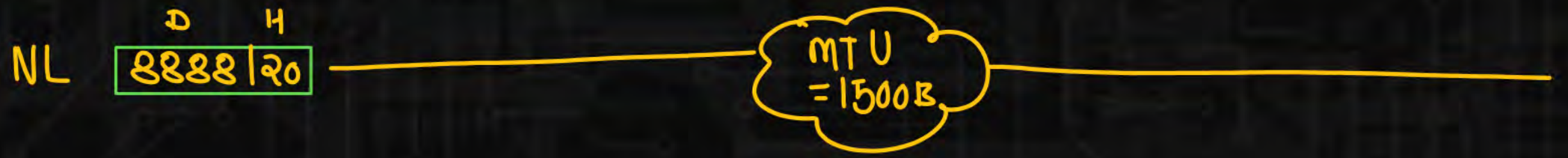
D. 7 and 8880



1500*6=9000

9000-120

8880



8 | 20	1480 | 20	1480 | 20	1480 | 20	1480 | 20	1480 | 20	1480 | 20
7	6	5	4	3	2	1	

$$OFFset = \frac{6*1480}{8}$$

$$= \frac{8880}{8}$$

$$= 1110$$

Q.6 In an IPv4 datagram, the M bit is 0, the value of HLEN is 10, the value of total length is 400 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

MF = 0 [Last Fragment]

HLEN = 10

Header size = 10 * 4 = 40B

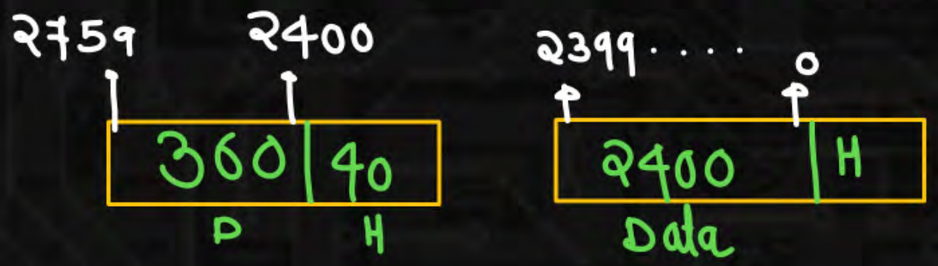
Total length = 400

D + H = 400

D = 400 - 40 = 360

Fragment OFFset = 300

No. OF data Byte ahead OF this Fragment = 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.

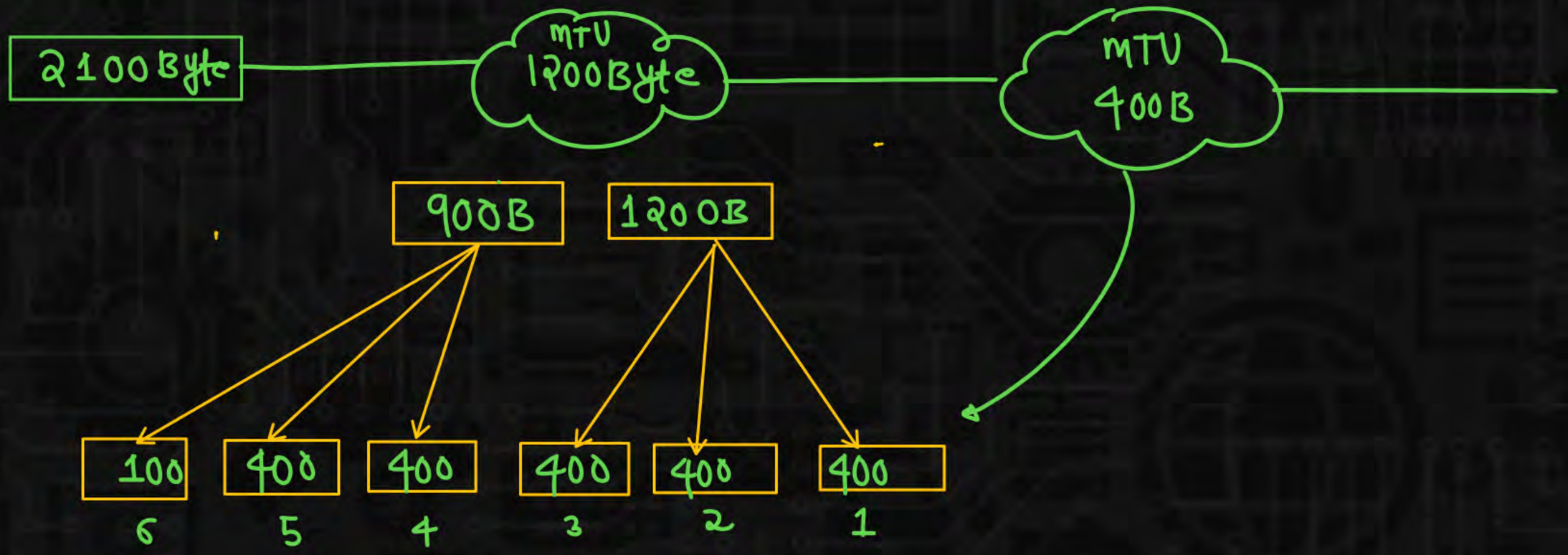
What is the total IP overhead if the second network is considered for transmission of 2100 Bytes? **[GATE 2004]**

A. 40 bytes

B. 80 bytes

C. 120 bytes

D. 160 bytes



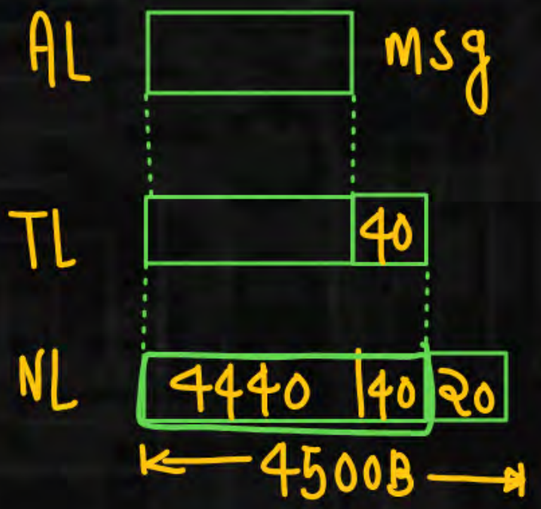
Total Fragments = 6

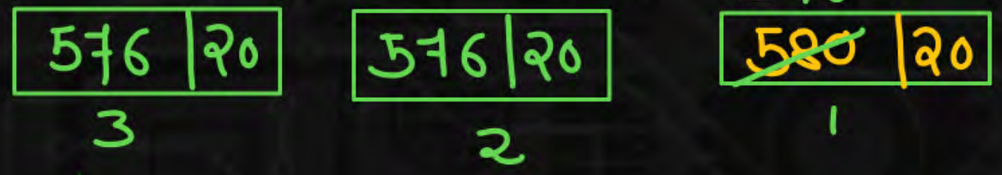
Total overhead = 6 * 20 = 120 Byte

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]





$$\text{Offset} = \frac{2 * 576}{8} = 144$$

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 ?

OFFset = 100

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

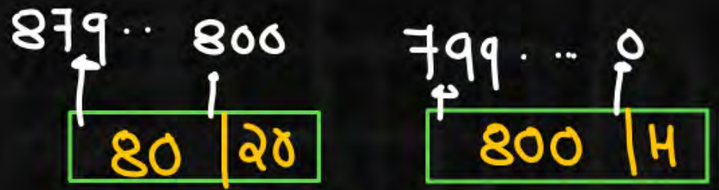
HLEN = 5

Header size = 5*4 = 20Byte

TL = 100

D+H = 100

D = 100-20 = 80Byte



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 = 20 Byte

Total length = 200

D + H = 200

Data = 200 - 20

Data = 180 → Not div by 8 so gt 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 _____ .

H.W

Q.12

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 _____

H·W


THANK YOU
GW
SOLDIERS !