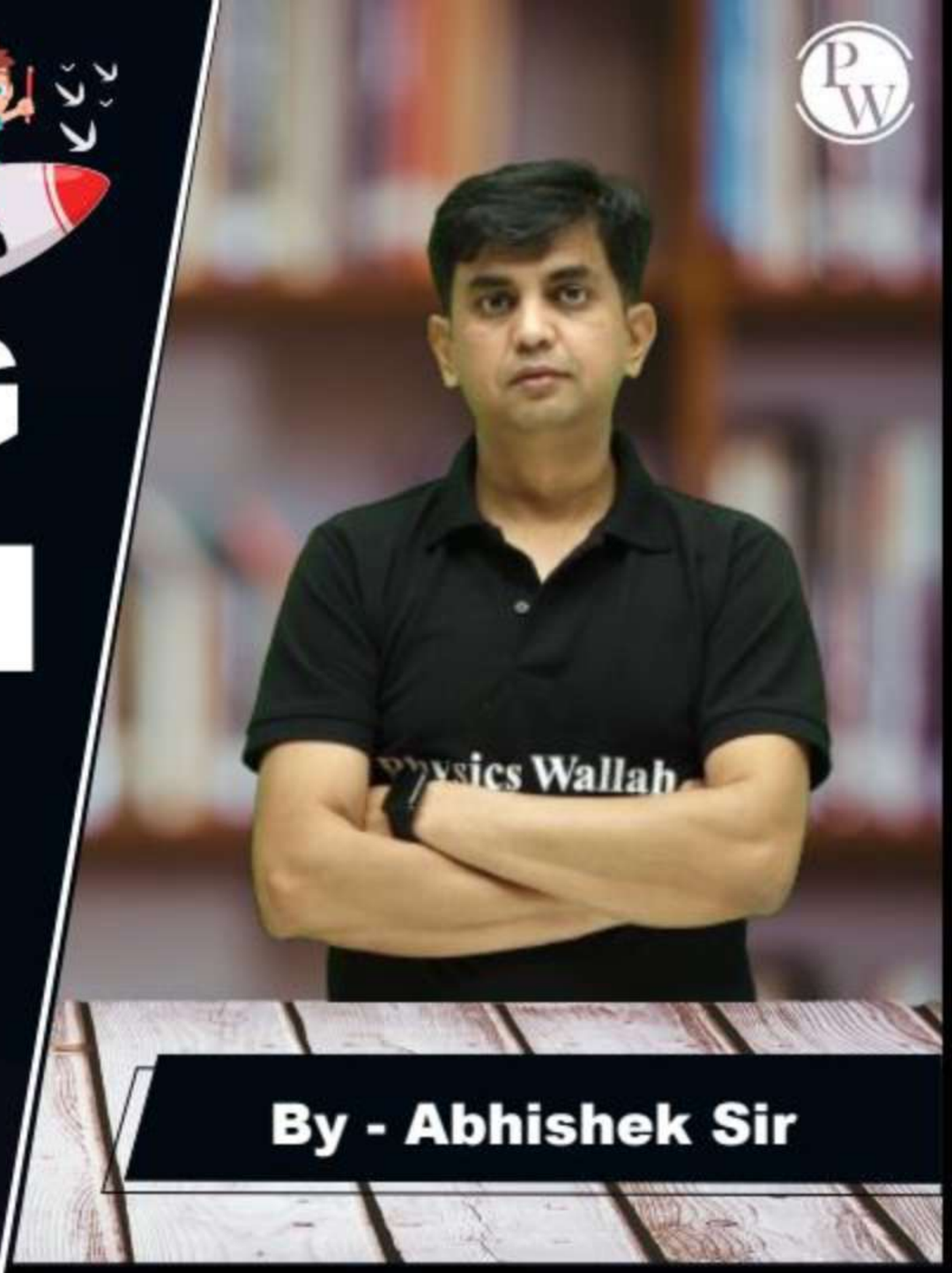
CS & IT ENGINEERING

Computer Network

IPv4 Header

Lecture No. - 03



Recap of Previous Lecture

Topic Identification Number

Topic Fragmentation Offset

Topic MF bit

Topics to be Covered

Topic Fragmentation Offset

Topic Flag bits

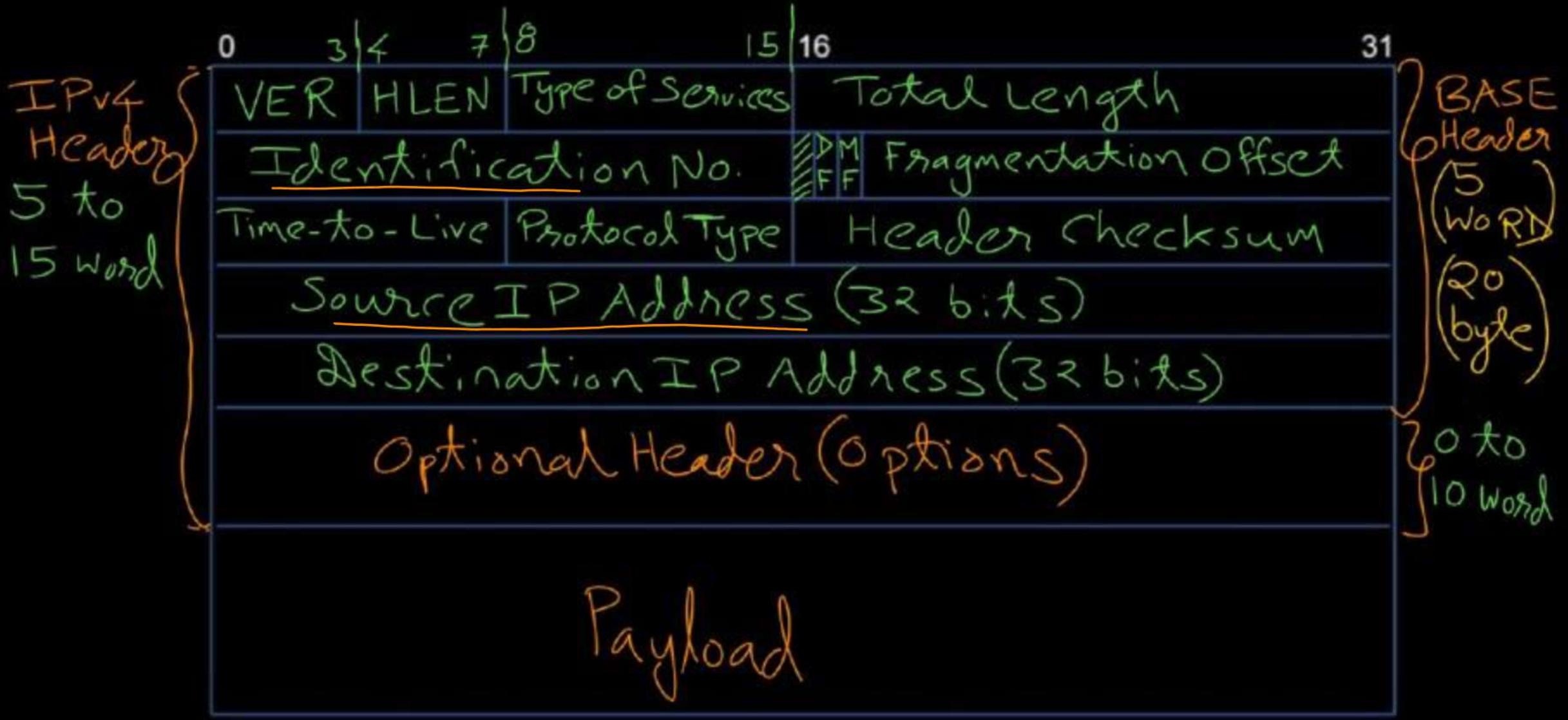
ABOUT ME

Hello, I'm Abhishek

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

Telegram Link : https://t.me/abhisheksirCS_PW

Topic : IPv4 Packet Header



#Q. Every host in an IPv4 network has a 1-second resolution real-time clock with battery backup. Each host needs to generate up to 1000 unique identifiers per second. Assume that each host has a globally unique IPv4 address. Design a 50-bit globally unique ID for this purpose. After what period (in seconds) will the identifiers generated by a host wrap around?

[GATE 2014, Set-3, 2-Mark]

IIT KGP

1000 identifier $\longrightarrow$ 1 sec

2^{18} identifier $\longrightarrow \left(\frac{2^{18}}{1000}\right)$ sec

Ans = 262.14 sec ✓

IIT KGP $\Rightarrow$ **256**

IPv4 Add. $\Rightarrow$ 32 bit

Globally unique ID $\Rightarrow$ 50 bit

Id no. $\Rightarrow$ 18 bit

Topic : Fragmentation at Source Host

IPv4 Datagram Size ≤ Source Network MTU

Payload Size = [MTU – (HLEN * 4)] bytes

Number of fragments at source host (N) = $\lceil$ [SDU Size / Payload Size] $\rceil$

Offset value of last fragment = [(N – 1) * Payload Size / 8]

Total length of last fragment = (HLEN * 4) + [SDU Size – (N – 1) * Payload Size]

#Q. 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

Ans: C

300*8
= 2400

(2400+360-1)
= 2759

360 byte

M=0

HLEN=10

TL=400

offset=300

Payload size
= [TL - (HLEN*4)] byte
= [400 - (10*4)] byte
= 360 byte

#Q. 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 may 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

Ans: C

UDP Packet Payload Size = 8880 byte
UDP Packet Header Size = 8 byte

UDP Packet Size = (Header Size + Payload Size)
(SDU for N/w layer) = (8 + 8880) bytes
= 8888 bytes

MTU Size = 1500 byte

Header Size = 20 byte

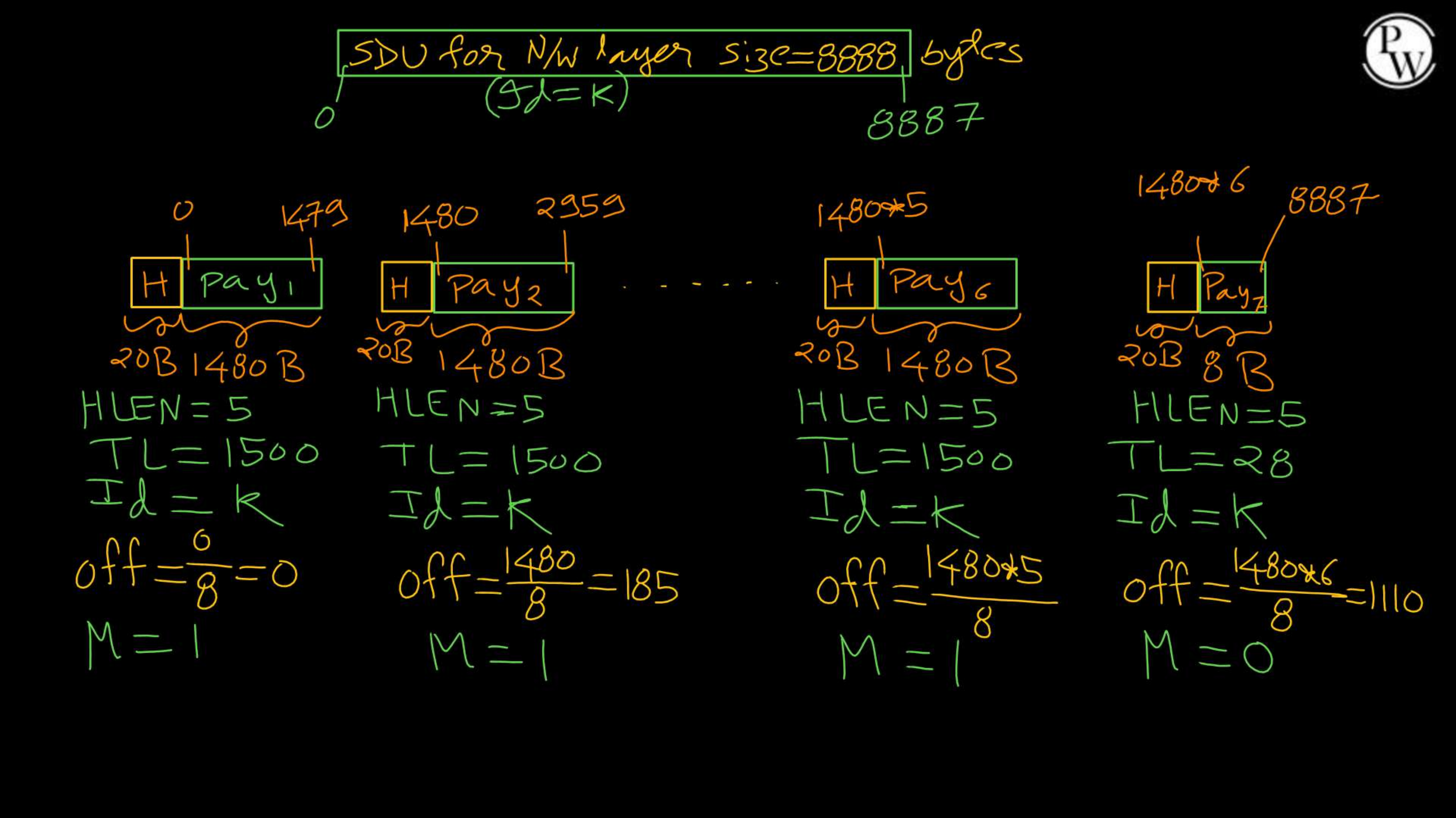
Payload size = [MTU size − Header size] bytes
= [1500 bytes − 20 bytes]
= 1480 bytes

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

$N = \left\lceil \frac{8888 \text{ bytes}}{1480 \text{ bytes}} \right\rceil = \lceil 6.005 \rceil = 7$

Offset field value of last fragment

$= \frac{(N-1) * \text{Payload size}}{8} = \frac{(7-1) * 1480 \text{ byte}}{8} = 1110 \text{ word}$


SDU for N/W layer size=8888 bytes
(Id=K)
0
8887
0
1479
1480
2959
1480*5
1480*6
8887
H
Pay1
H
Pay2
H
Pay6
H
Payz
20B 1480B
20B 1480B
20B 1480B
20B 8B
HLEN=5
TL=1500
Id=K
off=0/8=0
M=1
HLEN=5
TL=1500
Id=K
off=1480/8=185
M=1
HLEN=5
TL=1500
Id=K
off=1480*5/8
M=1
HLEN=5
TL=28
Id=K
off=1480*6/8=1110
M=0

Topic : DF Flag

DF : Do not fragment

→ Source host can restrict further fragmentation (division) of datagram at any intermediate router

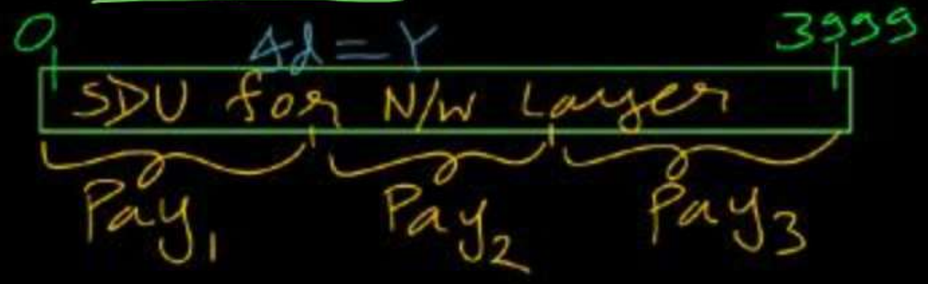
→ In such cases, source host set DF bit [DF = 1]

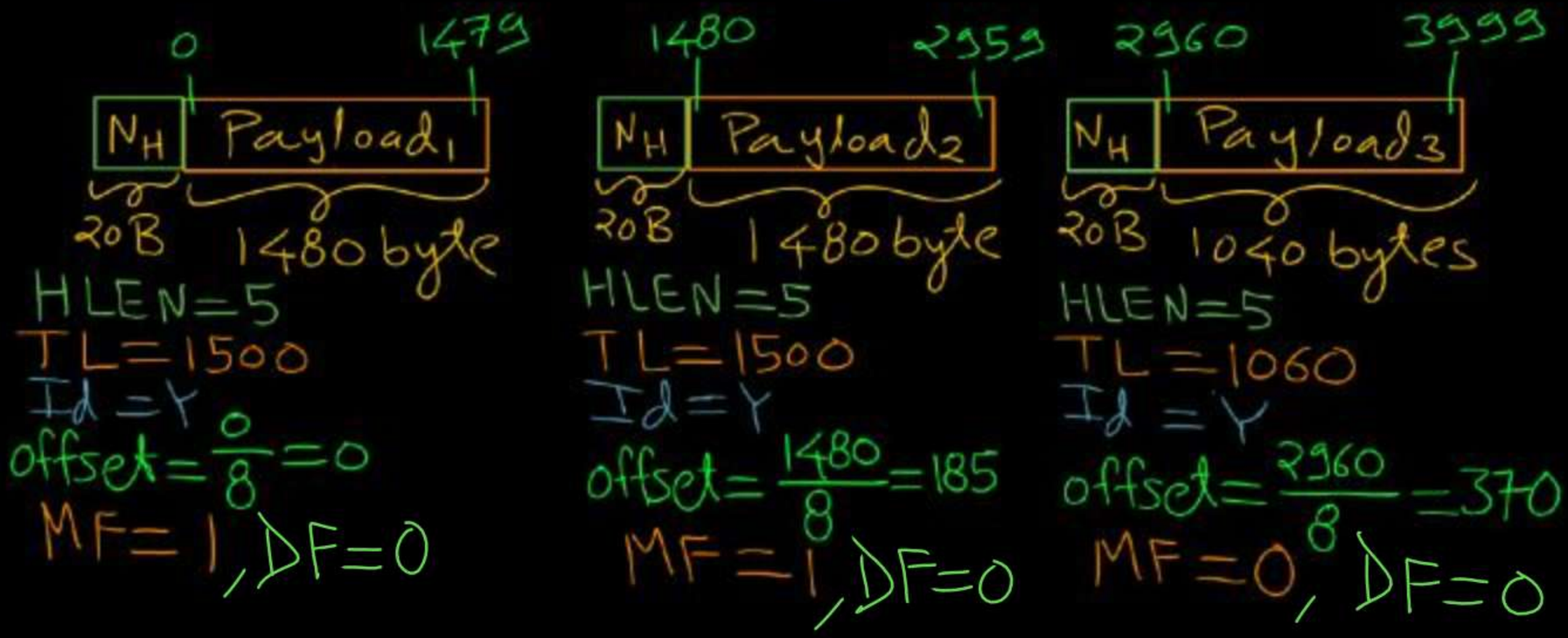
→ e.g "Remote Booting"

→ Default value of DF flag is "Zero"

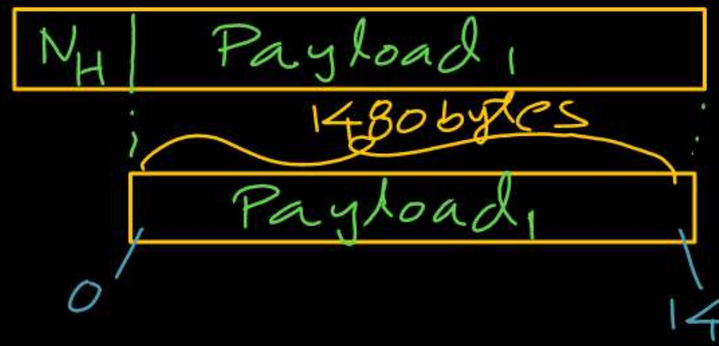
→ Set / reset by source host only.

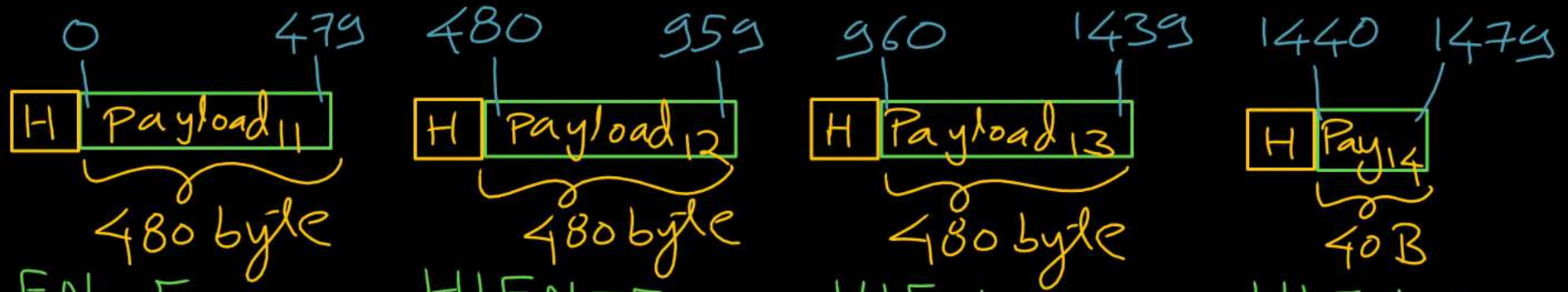
#Q. Suppose IPv4 datagrams created in previous question are arrived at intermediate IPv4 router where next network MTU is 500 bytes, then calculate total number of fragments?





HLEN = 5
TL = 1500
Id = Y
off = 0
M = 1
D = 0





HLEN = 5
TL = 500
Id = Y
off = $\frac{0}{8}$ = 0
M = 1
D = 0

HLEN = 5
TL = 500
Id = Y
off = $\frac{480}{8}$ = 60
M = 1
D = 0

HLEN = 5
TL = 500
Id = Y
off = $\frac{960}{8}$ = 120
M = 1
D = 0

HLEN = 5
TL = 60
Id = Y
off = $\frac{1440}{8}$ = 180
M = 1
D = 0

AT Router :-

MTU size = 500 bytes

Old payload size

$= [TL - (HLEN * 4)]$ byte

$= [1500 - (5 * 4)]$ bytes

$= 1480$ bytes

New Payload size

$= [MTU - (HLEN * 4)]$ bytes

$= [500 - (5 * 4)]$ bytes

$= 480$ bytes

No. of IP fragments (N)

$= \left\lceil \frac{\text{Old payload size}}{\text{New Payload size}} \right\rceil$

$N = \left\lceil \frac{1480 \text{ byte}}{480 \text{ byte}} \right\rceil = \lceil 3.083 \rceil = 4$

Total length of last fragment

$= (HLEN * 4) +$

$[\text{old payload size} - (N-1) * \text{New Payload size}]$

$= (5 * 4)$ bytes $+$

$[1480 \text{ byte} - (4-1) * 480 \text{ bytes}]$

$= 60$ bytes

offset value of last fragment

$$= (\text{old offset value}) + \left\lceil \frac{(N-1) * \text{New Payload size}}{8} \right\rceil$$

$$= 0 + \left(\frac{(4-1) * 480 \text{ byte}}{8} \right)$$

$$= 0 \text{ word} + 180 \text{ word}$$

$$= 180 \text{ word}$$

Topic : Fragmentation at Intermediate Router

IPv4 Datagram Size ≤ Intermediate Network MTU

Old Payload Size = [TL – (HLEN * 4)] bytes

New Payload Size = [MTU – (HLEN * 4)] bytes

Number of fragments at intermediate router (N)
= ⌈[Old Payload Size / New Payload Size]⌉

Offset value of last fragment = Original Offset + [(N – 1) * New Payload Size / 8]

Total length of last fragment
= (HLEN * 4) + [Old Payload Size – (N – 1) * New Payload Size]

#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 _____ .

[GATE 2016]

1-1. W.

#Q. 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]

H.W.

(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: 37

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

#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?

[GATE 2004]

H.W.

A) 40 bytes

B) 80 bytes

C) 120 bytes

D) 160 bytes

#Q. Consider three IP networks A, B and C. Host H_A in network A sends messages each containing 180 bytes of application data to a host H_C in network C. The TCP layer prefixes a 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 :

A : 1000 bytes B : 100 bytes C : 1000 bytes

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

Consider only data packets.

[GATE 2004]

A) 200 B) 220 C) 240 D) 260

H.W.

2 mins Summary

Topic Fragmentation Offset

Topic Flag bits

THANK - YOU