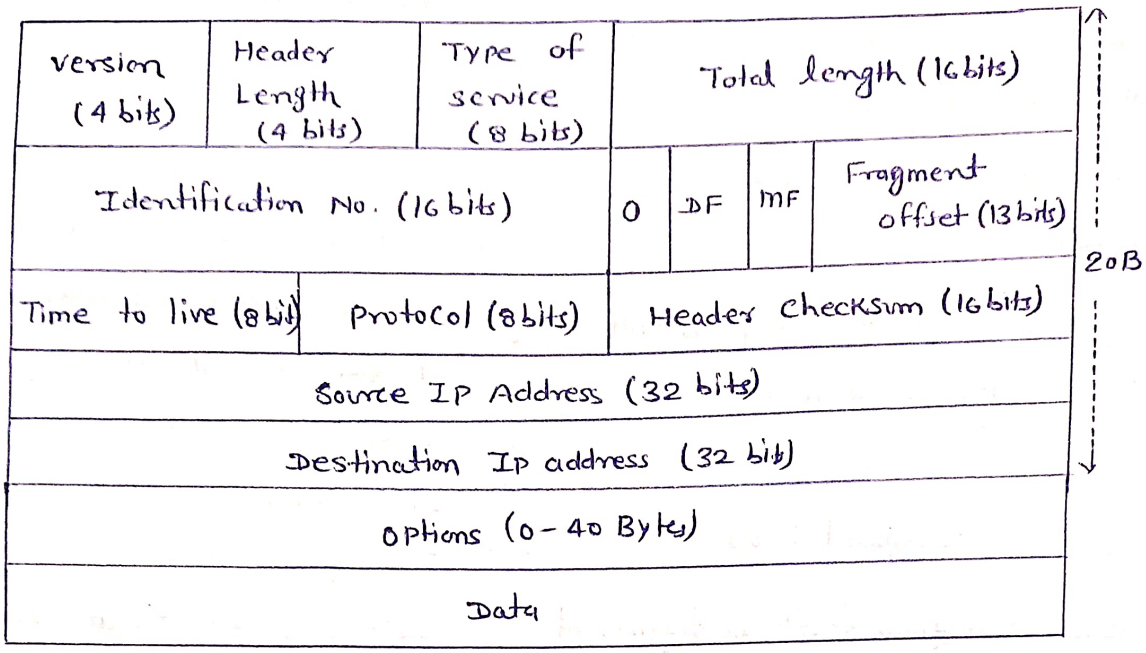
* IPV4 Header:-



→ Minimum Header size = 20B, Maximum Header Size = 20 + 40 = 60 B

- **Header Length :-** 4 bit field that Contains the length of the Ip Header.

  Range = [0, 15]

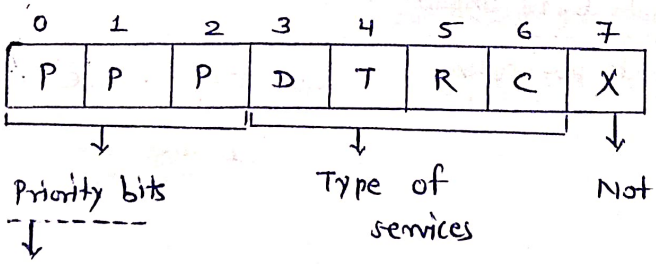
  Header Length = Header Length field Valve x 4 bytes

- **Type of service :-** 1) QOS (Quality of service) 2) Priority etc...

- **Total length :-** total length of datagram

  Total length = Header Length + Payload length

- **Identification No** - used for the identification of the fragments of original Ip datagram.



D : min delay
T : max Throughput
R : High Reliability
C

If the router is Congested need to discard Some datagram, then datagram which have lowest priority is dicarded.

- Identification Number / datagram Number

1) Each datagram is associated with a sequence No. is called as datagram No.
2) Used to identify all the fragment of same datagram.
3) All the fragment of same datagram will have the same identification No.

- DF Bit :- (Do not fragment Bit)

→ DF=1 :- means datagram can't be fragmented
→ DF=0 – datagram can be fragmented.

- MF Bit – (more fragment) :-

→ MF = 1 – It means, This is not the last fragment, there are more fragment after this fragment

→ MF =0 – It means, This is the Last fragment or only fragment.

- fragment offset :-

→ It indicates No. of data byte ahead of this fragment in that particular Packet.

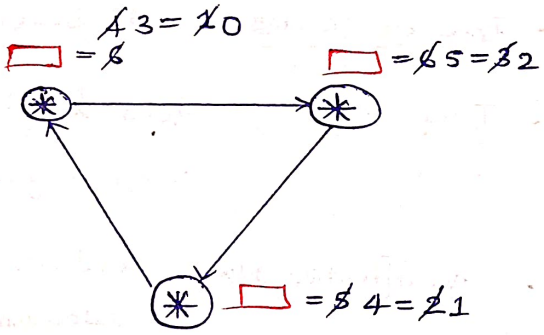
Note :-

1) IP is a packet stream protocol i.e. every packet is associated with an sequence Number.
2) Tcp is a Byte stream protocol i.e. every byte is associated with an sequence Number.

→ fragment offset used to ordering the packets.

- Time to Live –

→ 8 bit field. [0 to 255]
→ Used to avoid Infinite Looping.
→ Used to Control the maximum No. of hops visited by datagram.
→ When a source host send a datagram, It stores a Number in this field. Each router that process the datagram decrements this number by one. If TTL field reaches Zero before the datagram at its destination, then the datagram is discarded and an Icmp message sends back to sender



→ TTL Value will always be in b/w 1 and 255.

- Protocol :-

→ This tells us which protocol is encapsulated in the Ip packet.
→ At the time of traffic, some packets must be discarded, In this Case It will be advantageous to know which protocol data it Contains.

→ The order in which Router eliminate the datagram from buffer is-

ICMP > IGMP > UDP > TCP
(1) (02) (17) (06)

OSPF (89)

- Header checksum :-

→ Calculated only for Header not data.

→ It is Calculated at each and every Router because IP Header might be change When packet is moving from one to another Router.

→ modified fields-

1) TTL,
2) options
3) Fragment offset
4) Total Length

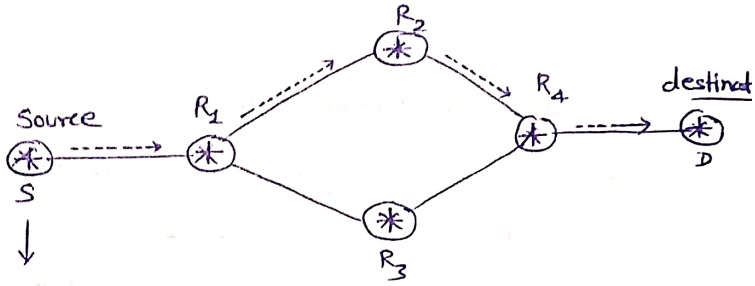
- options-

There are 5 options-

1) strict source Routing
2) Loose source Routing
3) Record Routing
4) Time stamp
5) Padding

1) Strict source Routing :-

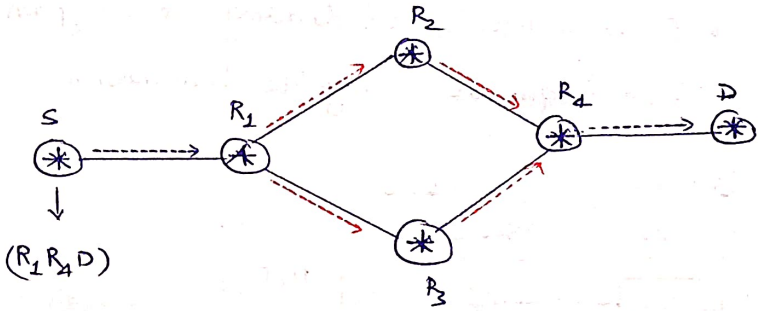
→ This is used by the source to predetermine the Route for datagram as it travel through the ~~internet~~ internet.



$SR_1R_2R_4D$

2) Loose source Routing :-

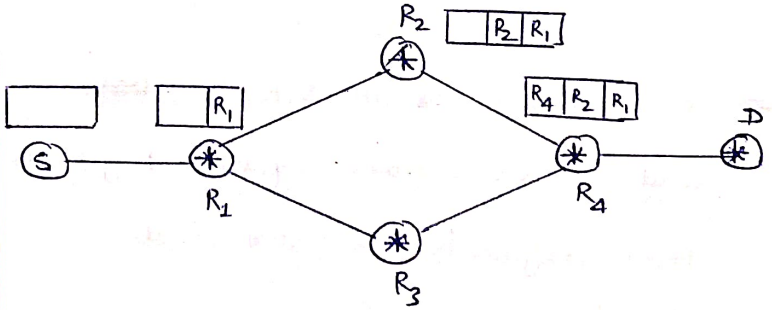
→ Similar to strict source Routing, but it is less rigid, Each Router in the list must visited, but the datagram Can visit other outer as well



3) Record Routing :-

→ Used to record the internet routers that handle the datagram. It Can list upto 9 router Address.

→ All the Router are supposed to record their IP Add on their IP packet



4) Time stamp :-

→ Used to find out delays at each Router. Every Router should record Incoming and outgoing time.

4) Padding :-

→ Addition of dummy data

→ When header length is not a multiple of 4, Extra Zeroes are added in the option field. to become multiple of 4.

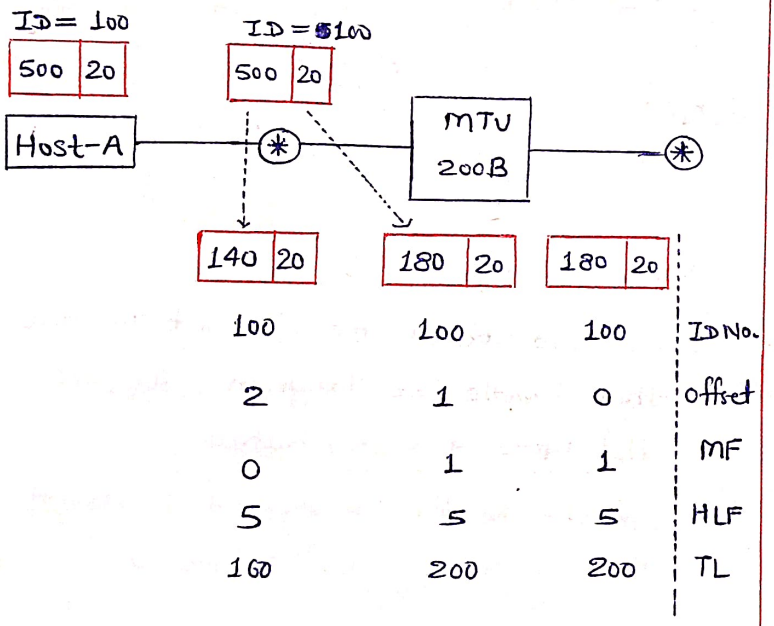
→ If header length = 30 B

2 B are padded in option.

⇒ make header length = 32 B

* Ip Fragmentation :-

→ It is a process of dividing the datagram into fragments during its Transmission.



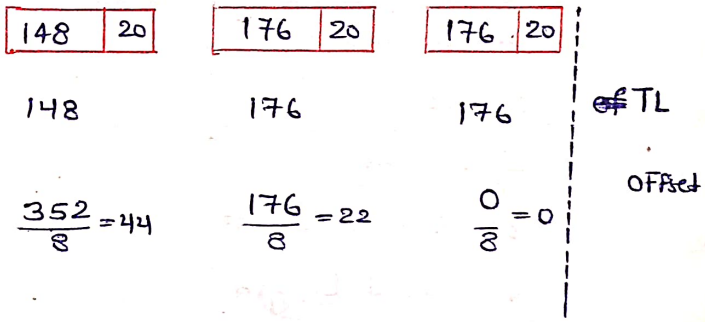
⇒ If Any Packet has MF value 1, then and if It divides again in fragments then fragments MF value of all is set to 1.

360 180 0 offset

To get offset We divide it by '8' because total length is 16 bit field While fragment offset is 13 bit field.

$\frac{360}{8} = 45$ $\frac{180}{8} = 22.5$ $\frac{0}{8} = 0$ offset

There is a floating point value, that is not represented in fixed bit field. So We take data multiple of 8 except Last.



* 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 first segment by 8. The second segment has an offset value equal to that result.

4) Divide the data length of first and second segment by 8 = Third fragment offset

5) Repeat this process

Eg – if packet Receive in order –

{22, 44, 0}

Last ↑ first

176	20

$\frac{176}{8} = 22$ = second fragment offset

Note :-

1.) IPV4 fragmentation can occur at both the source and the router.

2) The Reassembly of fragmented datagram is done only after reaching the destination.

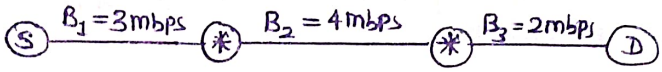
* fragment overhead = (Total No. of fragment − 1) * IPV4 Header size

NL overhead = Total No. of fragment * IPV4 Header size

Efficiency = Useful Byte / Total Byte

Throughput = η * BW

Throughput = η * (Min BW)



Throughput = η * 2