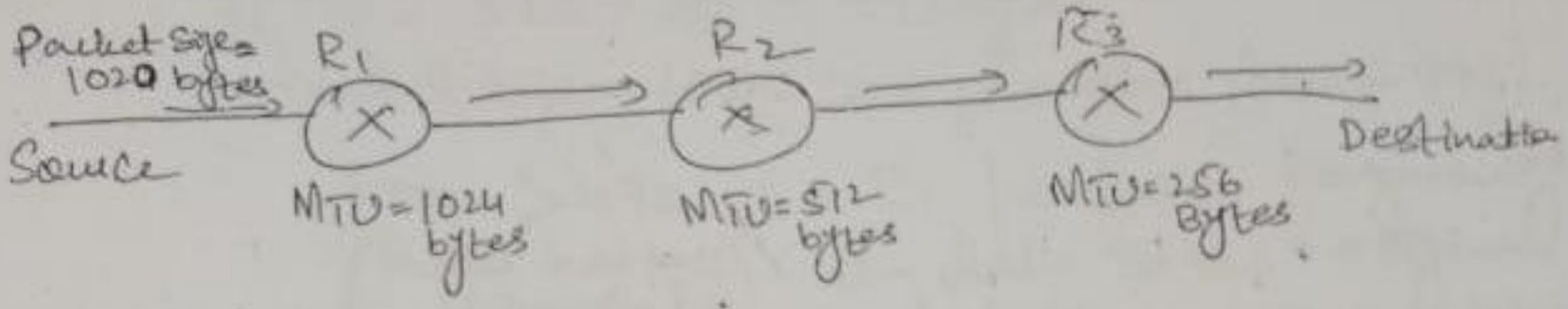
Fragmentation Example.

IP datagram size = 1020 bytes



At R1

MTU of R1 is = 1024 bytes
original packet size is = 1020 bytes
∴ 1020 < 1024

So packet can easily pass through R1. No need for Fragmentation by source

ID = 1
OFFset = 0
DF = 0
MF = 1

MTU without header
1024 − 20 = 1004 bytes

Packet size without header
1020 − 20 = 1000 bytes

Note:-
The value of offset is only for data in the original datagram so fragmentation is only applied on data by header offset 0 20 bytes

At R2

IP datagram size is = 1020 bytes (0000 — 1019)

With header.
MTU of R2 is = 512 bytes
Packet size is = 1020 bytes
∴ 1020 > 512 bytes

So packet cannot pass through R_2

So R1 perform fragmentation

Without header

MTU = 512 − 20 = 492 bytes

Packet size = 1020 − 20 = 1000 bytes (0000 − 999)

∴ 1000 > 492 so R_1 perform fragmentation on data in the original datagram i.e 1000 bytes
(Packet not pass through R_2)

∴ 492 + 20 can only pass through R_2

but 492 is not divisible by 8:

But 488 is divisible by 8

so the 1000+20 bytes have three fragments

- 488 + 20 bytes → f_1 = 508 bytes < 512 bytes
- 488 + 20 " → f_2 = 508 bytes < 512 bytes
- 24 + 20 " → f_3 = 508 bytes < 512 bytes.

1000 + 20 bytes = 1020 bytes

f1 → 488 + 20 bytes (0000 − 487) → 508 bytes
ID = 1, OFFset = 0, DF = 0, MF = 1

offset = 0

f2 → 488 + 20 bytes (488 − 975) → 508 bytes
ID = 1, OFFset = 61, DF = 0, MF = 1

offset = 61

f3 → 24 + 20 bytes (976 − 999) → 44 bytes
ID = 1, OFFset = 122, DF = 0, MF = 0

OR offset = 61+61 = 122

$8 \overline{)8}$ = 1 → f1

$8 \overline{)488}$ = 61 → f2

$8 \overline{)976}$ = 122

$8 \overline{)24}$ = 3

OR 488 + 488 = 976

At R_3

After three fragmentations at R_2, the datagram is in 3 fragments.

f_1 = 508 bytes (0000 – 507 bytes)
f_2 = 508 bytes (0000 – 507 bytes)
f_3 = 44 bytes (0000 – 43 bytes)

With header.

MTU of R_2 is = 256 bytes
f_1 size is = 508 bytes
f_2 size is = 508 bytes
f_3 size is = 44 bytes

∴ 508 > 256, 44 < 256

So f_1 & f_2 cannot pass through R_3
but f_3 can easily pass through R_3
So R_2 perform further fragmentation on f_1 & f_2

Without Header.

MTU = 256 – 20 = 236 bytes
f_1 & f_2 = 508 – 20 = 488 bytes (0000 – 487 bytes)

∴ 488 > 236 so R_2 perform fragmentation (f1 & f2 not pass through R_3) on fragmented data f_1 & f_2 i.e 488 bytes

236 + 20 can only pass through R_3
but 236 is not divisible by 8
But 232 is divisible by 8

So the 488+20 bytes have three fragments
So f_1 & f_2 together have 6 fragments

For f_1

~~488+20~~
232 + 20 bytes → f_{11} = 252 < 256
232 + 20 bytes → f_{12} = 252 < 256
+ 24 + 20 bytes → f_{13} = 44 < 256
488 + 20 bytes = 508 bytes

For f_2

232 + 20 bytes → f_{21} = 252 < 256
232 + 20 bytes → f_{22} = 252 < 256
24 + 20 bytes → f_{23} = 44 < 256
488 + 20 bytes = 508 bytes.

For f_1 = 488+20 bytes

f_{11} → 232 + 20 bytes (0000 – 231) → 252 bytes
ID=1, Offset=0, DF=0, MF=1

f_{12} → 232+20 bytes (232 – 463) → 252 bytes
ID=1, Offset=29, DF=0, MF=1

f_{13} → 24+20 bytes (464 – 487) → 44 bytes
ID=1, Offset=58, DF=0, MF=0

~~OR offset~~ is same as f_1

offset = 29

OR offset = 29+29 = 58

For f_2 = 488 + 20 bytes

f_{21} → 232 + 20 bytes (488 – 719) → 252 bytes
ID=1, Offset=61, DF=0, MF=1

f_{22} → 232 + 20 bytes (720 – 951) → 252 bytes
ID=1, Offset = 90, DF=0, MF=1

f_{23} → 24+20 bytes (952 — 975) → 44 bytes
ID=1, offset = 119, DF=0, MF=0

OR offset is same as f_2 OR at f_{13} – $\frac{24}{8}$ = 3 so 3 is added in ~~the offset~~ of f_{13} → 3+58 = 61

OR offset 61+29 = 90

OR offset 90+29 = 119

$0 \div 8 = 0$ → f_{11}

$232 \div 8 = 29$ → f_{12}

$464 \div 8 = 58$

$24 \div 8 = 3$

$488 \div 8 = 61$

$720 \div 8 = 90$

$952 \div 8 = 119$

Verification

$f_3 + f_{11} + f_{12} + f_{13} + f_{21} + f_{22} + f_{23} + 20 = \text{Original packet size}$

$f_3 \rightarrow 24 + 20$
$f_{11} \rightarrow 232 + 20$
$f_{12} \rightarrow 232 + 20$
$f_{13} \rightarrow 24 + 20$
$f_{21} \rightarrow 232 + 20$
$f_{22} \rightarrow 232 + 20$
$f_{23} \rightarrow 24 + 20$

$1000 + 20 = 1020$ bytes

Verified

Home Work

IP datagram size = 1500 bytes