CS & IT ENGINEERING

COMPUTER NETWORKS

IPv4 Header & Fragmentation

Lecture No-1

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TOPICS TO BE COVERED

- IPv4 Header

Q.9 Consider a 128×10^3 bits/second satellite communication link with one way propagation delay of 150 milliseconds. Selective retransmission (repeat) protocol is used on this link to send data with a frame size of 1 kilobyte. Neglect the transmission time of acknowledgment. The minimum number of bits required for the sequence number field to achieve 100% utilization is _____.

GATE-2016

$B = 128 * 10^3$ bits/sec

$P_d = 150$ msec

Frame size $= 1$ KB
$= 1024$ Byte
$= 8 * 1024$ bits

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$= \frac{8 * 10\cancel{24}^{2^3} \cancel{\text{bits}}}{\cancel{128} * 10^3 \cancel{\text{bits}}/\text{sec}}$$

$$= 64 * 10^{-3} \text{ sec} = 64 \text{ msec}$$

SR Protocol

$$\eta = \frac{\text{useful time}}{\text{total time}}$$

$$\eta = \frac{W_s * T_d(\text{frame})}{T_d(\text{frame}) + 2*P_d + \cancel{Q_d}_{0} + \cancel{P_{rd}}_{0} + T_d(\cancel{Ack})_{0}}$$

$$\frac{1}{1} = \frac{W_s * 64}{64 + 2*150}$$

$$W_s = \frac{364}{64}$$

$$W_s = 5.68$$

$$W_s = \lceil 5.68 \rceil = 6$$

minimum sequence required in SR = 6+6 = 12

$$2^K = 12$$

$$2^K = 2^4$$

$$\boxed{K = 4 \text{ bit}}$$

Q.10 A 3000 km long trunk operating at 1.536 Mbps is used to transmit 64 bytes frames and uses SWP. If the propagation speed is 6 µsec/km, then the number of bits should the sequence numbers be

Sliding window Protocal

(A) 5

(B) 6

(C) 7

(D) 8

$d = 3000\,km$, $B = 1.536 * 10^6$ bits/sec, Frame size = 64 Byte

= $64 * 8$ bits

= 512 bits

Propagation time For 1 Km = 6 µsec

Propagation delay For 3000 Km = $3000 * 6\,\mu sec = 18000\,\mu sec$

$$\eta = \frac{\text{useful time}}{\text{total time}}$$

$$1 = \frac{N * T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d + \cancel{Q_d} + \cancel{P_{rd}} + \cancel{T_d(\text{ACK})}}$$

$$1 = \frac{N * 333.33\ \mu sec}{333.33\ \mu sec + 2 * 18000\ \mu sec}$$

$$N = \frac{36,333.33\ \cancel{\mu sec}}{333.33\ \cancel{\mu sec}}$$

$$N = 109.00108$$

$$N = \lceil 109.00108 \rceil = 110 \text{ (Sender window size)}$$

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$= \frac{512\ \text{bits}}{1.536 * 10^6\ \text{bits/sec}}$$

$$= 333.33 * 10^{-6}\ sec$$

$$= 333.33\ \mu sec$$

minimum seq No required = 110

$$2^K = 110$$

$$2^K = 2^7$$

$$K = 7\ \text{bit}$$

Q.11 Consider selective repeat ARQ is used for flow control, frame size is 4000 bits, data transfer rate of channel is 1 Mbps and one way propagation delay is 18 ms then minimum number of bits required for sequence number field for maximum utilization is ____.

Frame size = 4000 bits , $B = 1$ mbps $= 10^6$ bits/sec , $P_d = 18$ msec

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}} = \frac{4000 \cancel{\text{bits}}}{10^6 \cancel{\text{bits}}/\text{sec}} = 4 * 10^{-3}\,\text{sec} = 4\,\text{msec}$$

$$\eta = \frac{\text{useful time}}{\text{total time}}$$

$$1 = \frac{W_s * T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d + \cancel{Q_d}^{0} + \cancel{P_{rd}}^{0} + \cancel{T_d(\text{Ack})}^{0}}$$

$$1 = \frac{W_s * 4\,\text{msec}}{4\,\text{msec} + 2 * 18\,\text{msec}}$$

$$W_s = \frac{\cancel{40\,\text{msec}}}{\cancel{4\,\text{msec}}}$$

$$W_s = 10$$

minimum Sequence Number required in $SR = W_S + W_R$

$$= 10 + 10$$

$$= 20$$

$$2^K = 20$$

$$2^K = 2^5$$

$$\boxed{K = 5\text{ bit}}$$

Q.12 Consider the sliding window flow-control protocol operating between a sender and a receiver over a full-duplex error-free link. Assume the following:

- The time taken for processing the data frame by the receiver is negligible.
- The time taken for processing the acknowledgement frame by the sender is negligible.
- The sender has infinite number of frames available for transmission.
- The size of the data frame is 2,000 bits and the size of the acknowledgement frame is 10 bits.
- The link data rate in each direction is 1 Mbps (= 10^6 bits per second).
- One way propagation delay of the link is 100 milliseconds.
- The minimum value of the sender's window size in terms of the number of frames, (rounded to the nearest integer) needed to achieve a link utilization of 50% is (50-52).

GATE-2021

Frame size = 2000 bits

Ack size = 10 bits

$B = 10^6$ bits/sec

P_d = 100 msec

$\eta = 50\% = \frac{1}{2}$

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$= \frac{2\cancel{000}\ \cancel{\text{bits}}}{10^{\cancel{6}}\ \cancel{\text{bits}}/\text{sec}}$$

$$= 2 * 10^{-3}\ \text{sec}$$

$$= 2\ \text{msec}$$

$$T_d(\text{Ack}) = \frac{\text{Ack size}}{\text{Bandwidth}}$$

$$= \frac{1\cancel{0}\ \cancel{\text{bits}}}{10^6\ \cancel{\text{bits}}/\text{sec}}$$

$$= 10^{-5}\ \text{sec}$$

$$= 10^{-5} * 10^3\ \text{msec}$$

$$= 10^{-2}\ \text{msec}$$

$$= \frac{1}{100}\ \text{msec}$$

$$= 0.01\ \text{msec}$$

$$\eta = \frac{W_s * T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d + \underbrace{\cancel{Q_d}}_{0} + \underbrace{\cancel{P_{rd}}}_{0} + T_d(\text{Ack})}$$

$$\frac{1}{2} = \frac{W_s * 2}{2 + 2 * 100 + 0.01}$$

$$4 * W_s = 202.01$$

$$W_s = \frac{202.01}{4}$$

$$W_s = 50.50$$

$$W_s = \lceil 50.50 \rceil$$

$$W_s = 51$$

Q.13 Station A uses 32 bytes packets to transmit messages to Station B using a sliding window protocol. The round trip delay between A and B is 80 milliseconds and the bottleneck bandwidth on the path between A and B is 128 kbps. What is the optimal window size that A should use?

(A) 20

(B) 40

$\boxed{\text{GATE-2005}}$ (2m)

(C) 160

(D) 41

Packet size or Frame size = 32 Byte
= 32*8 bits
= 256 bits

RTT = 80 msec

B = 128*10^3 bits/sec

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$= \frac{\cancel{256}\ \text{bi}\cancel{\text{ts}}}{1\cancel{28} * 10^3\ \text{b}\cancel{\text{its}}/\text{sec}}$$

$$= 2 * 10^{-3}\ \text{sec}$$

$$= 2\ \text{msec}$$

$$\eta = \frac{\text{Useful time}}{\text{total time}}$$

$$1 = \frac{W_s * T_d(\text{frame})}{RTT}$$

$$1 = \frac{W_s * 2\ \text{msec}}{80\ \text{msec}}$$

$$W_s = \frac{80\ \text{m}\cancel{\text{sec}}}{2\ \text{m}\cancel{\text{sec}}}$$

$$\boxed{W_s = 40}$$

AD steps to solve SWP Problem

1. Calculate RTT $= 80 * 10^{-3}$ sec
2. Based on the given Bandwidth and RTT calculate No. of bits we are able to transfer with in RTT and Equate it as window in terms of bits $\boxed{(W_{bits}) = B * RTT}$ $= 128 * 10^3$ bits/~~sec~~ $* 80 * \cancel{10^{-3}}$ ~~sec~~ $= 128 * 80$ bits
3. W_{pkt} or $W_p = \dfrac{W_{bits}}{\text{(Packet size) bits}} = \dfrac{1\cancel{28} * \cancel{80} \text{ bits}}{2\cancel{56} \text{ bits}} = 40$ Pkt
4. Minimum sequence No. required $= W_p = 40$
5. $2^K = W_P$, $2^K = 40$, $2^K = 2^6$, ($K = 6$ bits)

   Where K = No. of bits required in the sequence number field

Q.14 Consider two node A and B round trip delay between these is 80 ms and bottle neck bandwidth of link between A and B is 512 KBps, the optimal window size (in packets) if the packet size is 64 Byte _____.

$RTT = 80\,msec = 80 \times 10^{-3}\,sec$, $B = 512\,KBPS = 512 \times 10^{3} \times 8$ bits/sec

Packet size = 64 Byte = 64×8 bits

AD Rule

(1) $RTT = 80 \times 10^{-3}\,sec$

(2) $W_{bits} = B \times RTT = 512 \times \cancel{10^{3}} \times 8\ bits/\cancel{sec} \times 80 \times \cancel{10^{-3}}\ \cancel{sec} = 512 \times 8 \times 80$ (bits)

(3) $W_{pkt} = \dfrac{W_{bits}}{(\text{Packet size})_{bits}} = \dfrac{\overset{2^3}{\cancel{512}} \times \cancel{8} \times 80}{\cancel{64} \times \cancel{8}} = 640$ Pkts

$$\eta = \frac{\text{useful time}}{\text{total time}}$$

$$\frac{1}{1} = \frac{W_s * T_d(\text{frame})}{RTT}$$

$$W_s = \frac{RTT}{T_d(\text{frame})}$$

$$W_s = \frac{80\,m\cancel{sec}}{\frac{1}{8}\,m\cancel{sec}}$$

$$W_s = 80 * 8 = 640 \text{ Packets}$$

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$= \frac{\cancel{64} * \cancel{8} \text{ bi}\cancel{ts}}{\cancel{512} * 10^3 * 8 \text{ bits/sec}}$$

$$= \frac{1}{8} * 10^{-3} \text{ sec}$$

$$= \frac{1}{8} \text{ msec}$$

Digital
A, B, C, D
⇓
Live → 5^{th} June

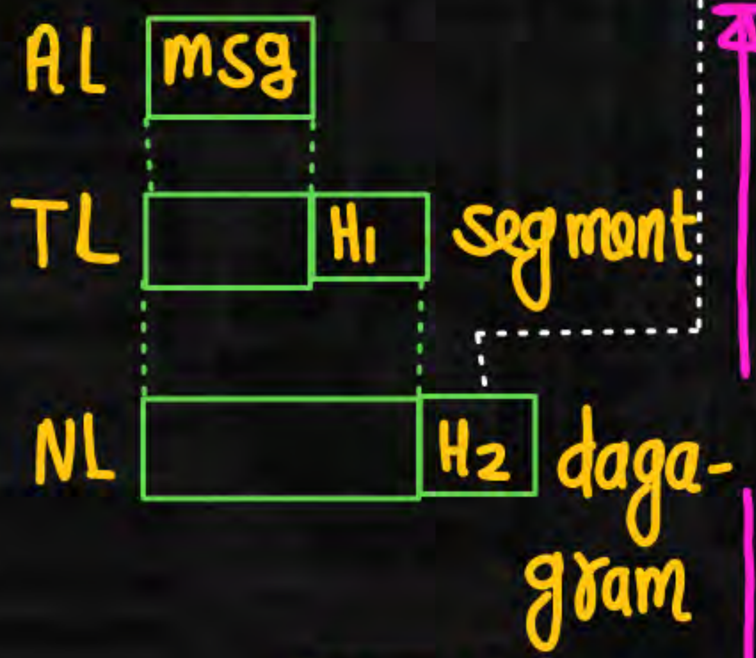
Live Recorded
Batch → A → TOC, Digital → Mon to Fri
7 to 9 pm 9:30 to 11:30 pm

Batch → B, C, D → TOC, C → Mon to Fri
Live Live
7 to 9 pm 9:30 to 11:30 pm

Batch A, B, C, D → CN → Sat, Sun
Live

(10:00 to 12:00 pm
12:30 pm to 2:30 pm) (Sat | Sun)

IPv4 Header



VER (4bit)	HL (4bit)	Services (8bits)	Total Length (16bit)	→ 32bit → 4B
Identification No. (16bits)		Flags (3 bits)	Fragment offset (13 bits)	→ 32bit → 4B
Time to Live (8bit)		Protocol (8bit)	Header checksum (16 bits)	→ 32bit → 4B
Source IP Address (32bits)				→ 32bit → 4B
Destination IP Address (32bits)				→ 32bit → 4B
(5bit) Padding 10000		Option (0 - 40 Byte)		

20Byte Fixed

40Byte Variable ⇒

= 5*4B

= 20Byte

Minimum Header size = 20B + 0B = 20 Byte

Maximum Header size = 20B + 40B = 60 Byte

Header Length (HL) = 4 bit

max No → 1111 → 15

Maximum Header size = 60 Byte

$$(S.F) \rightarrow \frac{60}{x} = 15$$

$$(S.F) \rightarrow \frac{60}{4} = 15$$

Header size	HLF
$\frac{20B}{4} = 5$	0101
$\frac{40B}{4} = 10$	1010
$\frac{32B}{4} = 8$	1000
$\frac{60B}{4} = 15$	1111

Header size	HLF
$\frac{30B}{4} = 7.5$ X	
$30B + 2B = \frac{32B}{4} = 8$	1000

$2B \Rightarrow$ Dummy Byte $\Rightarrow$ Option $\Rightarrow$ Padding = 2Byte

HLF	Header size
1010 → 10	10*4 = 40Byte
1100 → 12	12*4 = 48 Byte
1000 → 8	8*4 = 32 Byte
1111 → 15	15*4 = 60 Byte

HLF	Header size
(5 - 15)	(20B - 60B)

Services :

In this Interpretation the first 3 bit are called precedence bit (Priority bit) and Next 4 bit are called types of services bits and last bit is Not used.

Priority :

It is a 3 bit subfield ranging from 0 to 7 (000 to 111 in binary). Priority field is needed if a router is congested need to discard some datagram , those datagram which have the lowest priority are discarded first

Types of Services :

It is a 4 bit subfield . Each bit having a special meaning .although a bit can be 0 or 1 . One and only one of the bits can have the value 1 in each datagram.

Identification Number :

1. Each datagram is associated with a sequence no. is called as datagram no. or identification no.
2. It is used to identify all the fragment of same datagram.
3. All the fragment of same datagram will have the same identification no.

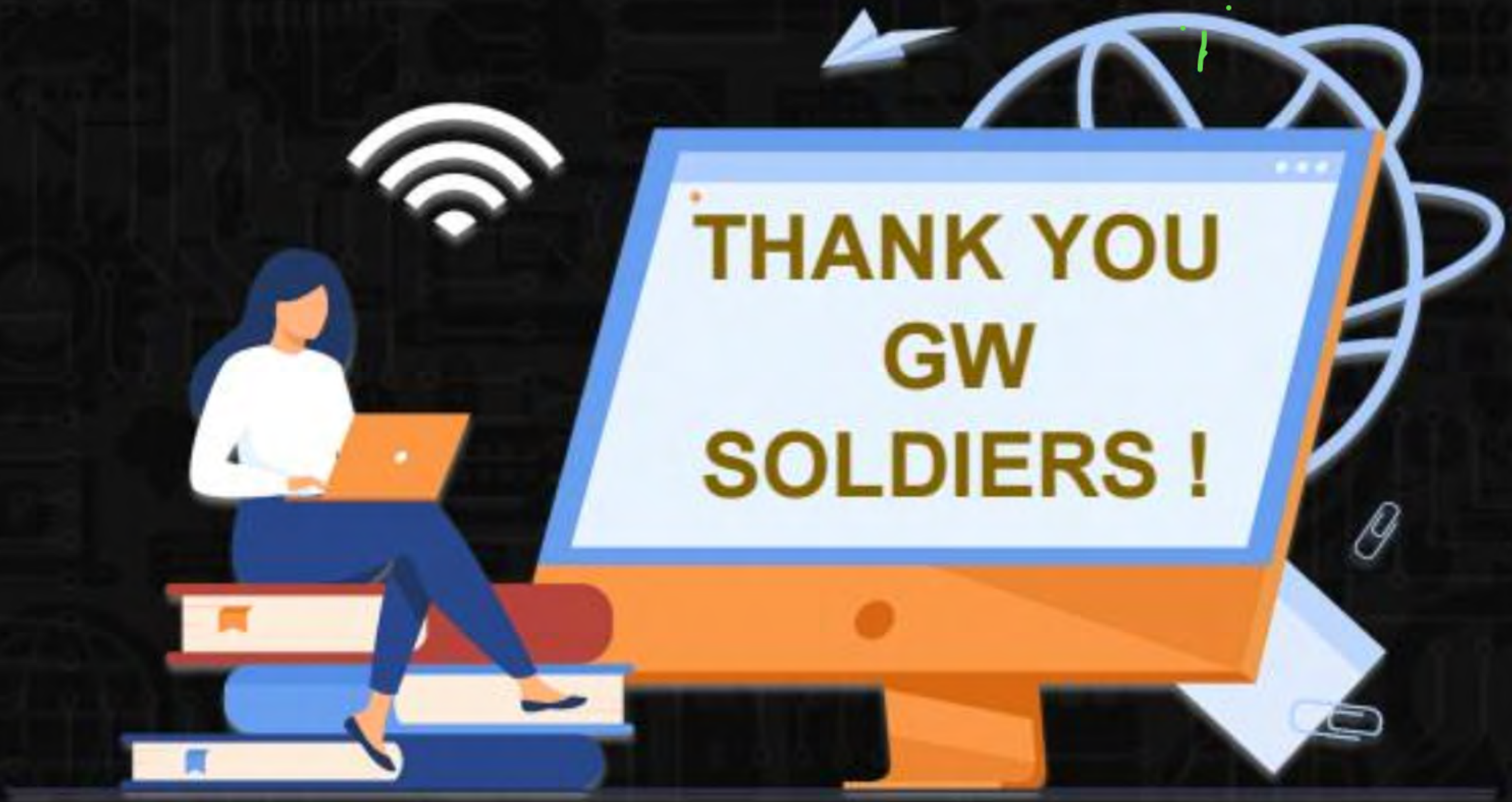
Flags :

It is the 3 bit Field or shown in the figure.

X	DF	MF

Fragment offset :

Fragment offset indicate no of data byte ahead of this fragment in that particular packet.


THANK YOU
GW
SOLDIERS !