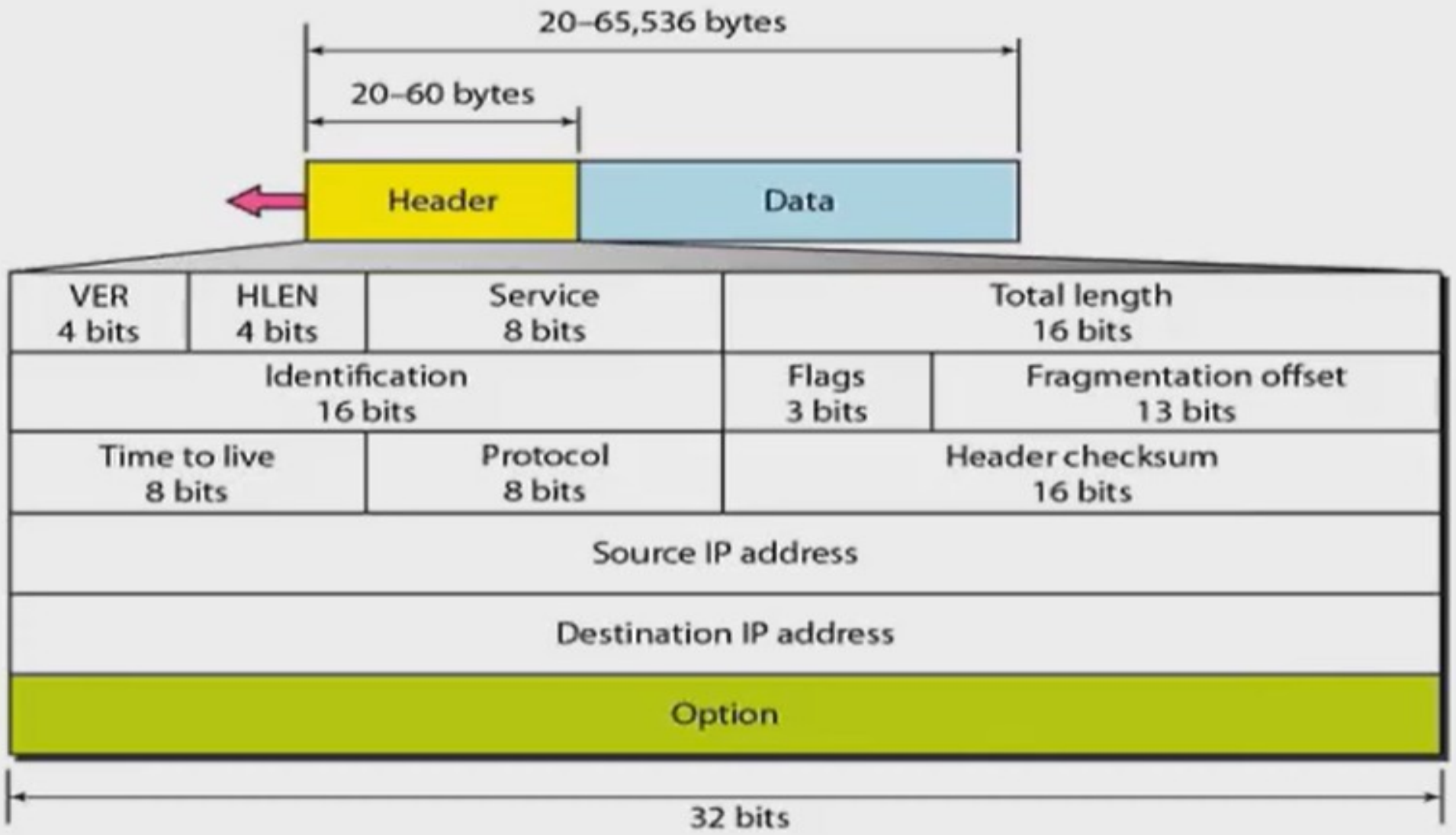
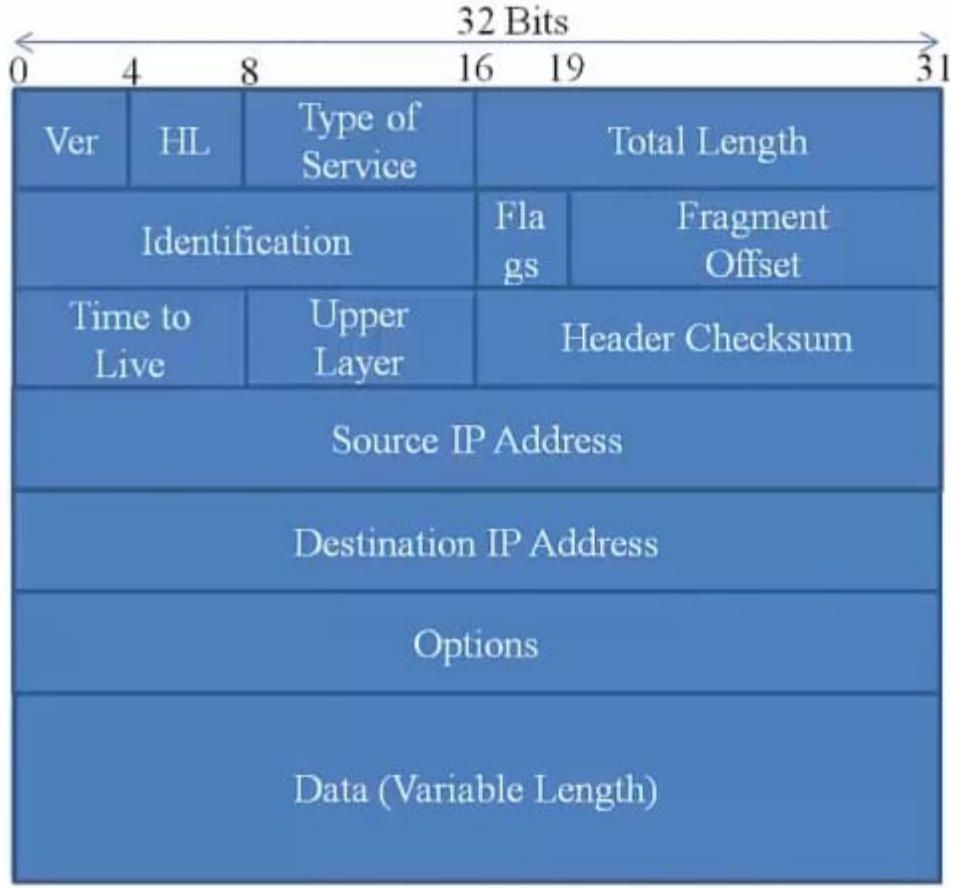
IP HEADER FORMAT

IPv4 datagram format



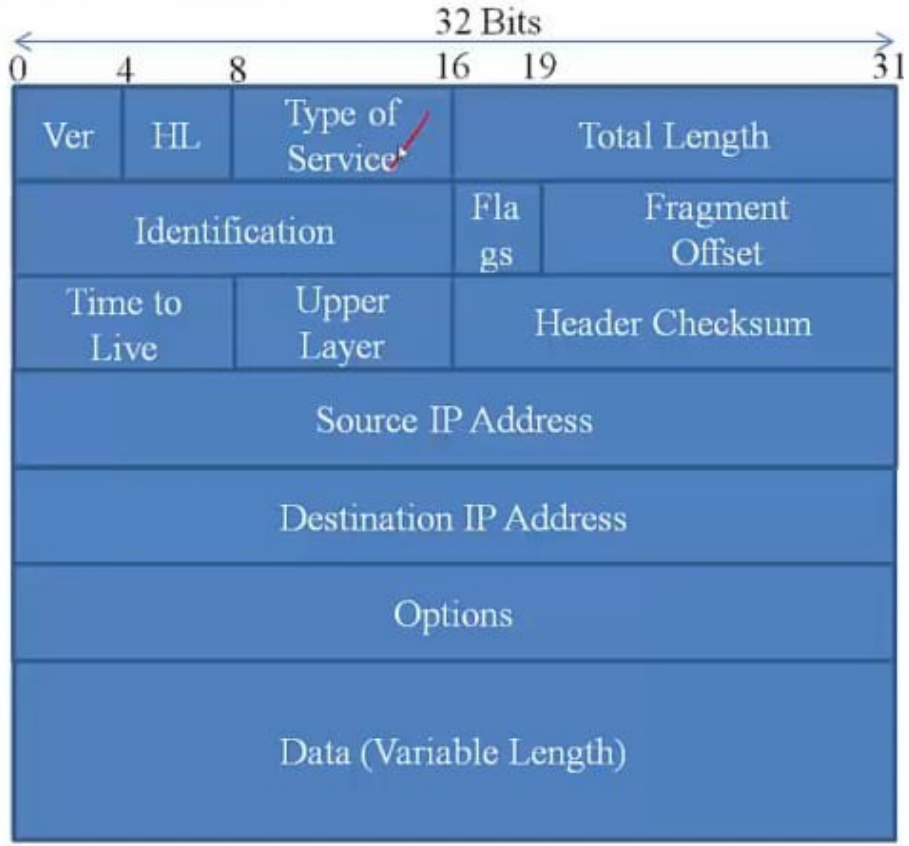
Packet Format

- Version: Specifies the version of the protocol
  - IPv4, IPv6
- Header Length: Specifies the header in 32-bit words
  - 5 words (without options)



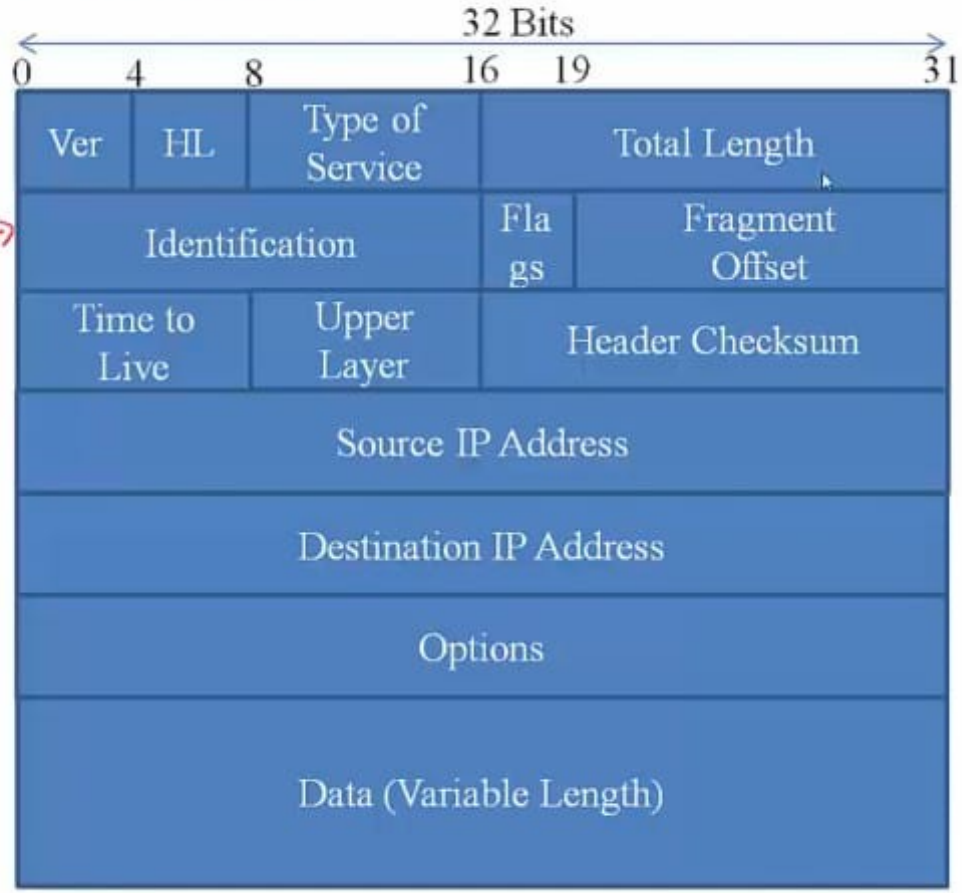
Packet Format

- Type of Service: Permits packets to be treated differently
  - Research Focus
- Total Length: Specifies the length of the datagram (in bytes) including header



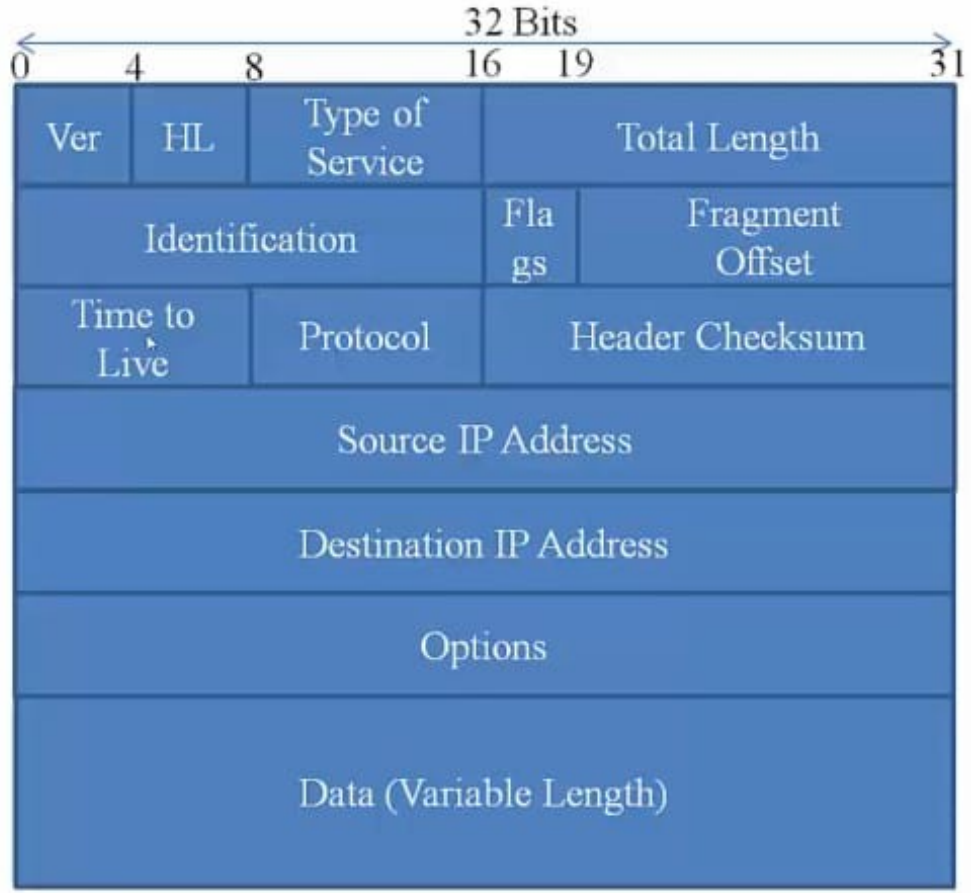
Packet Format

- Identification/Flags/ Fragment Offset:
  - Max size of IP packet is 65535 Bytes
  - Physical Networks may not support large packets
  - Need Fragmentation and reassembly (more on it soon)



Packet Format

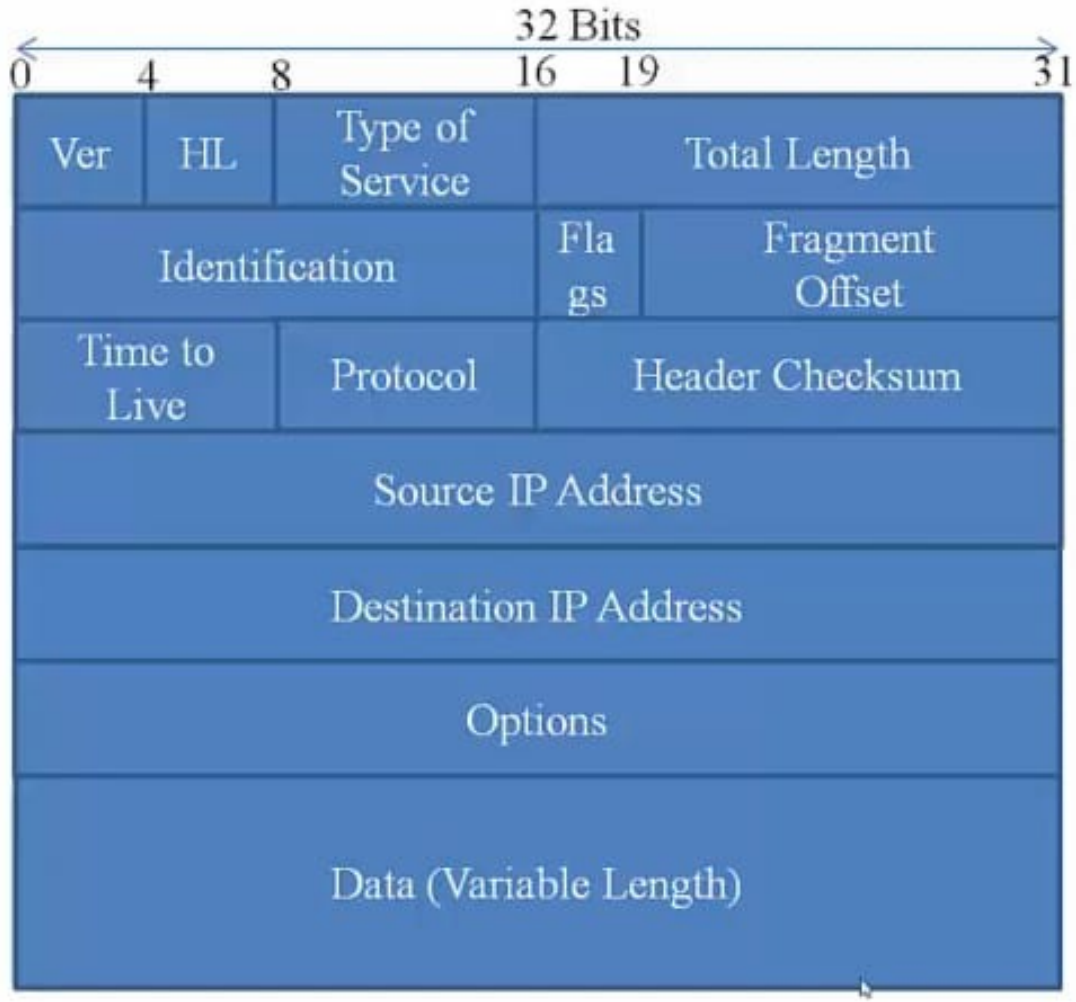
- Protocol: Demux key that identifies higher layer protocol
  - TCP: 6, UDP: 17
- Checksum (Internet): Detects errors in header



Packet Format

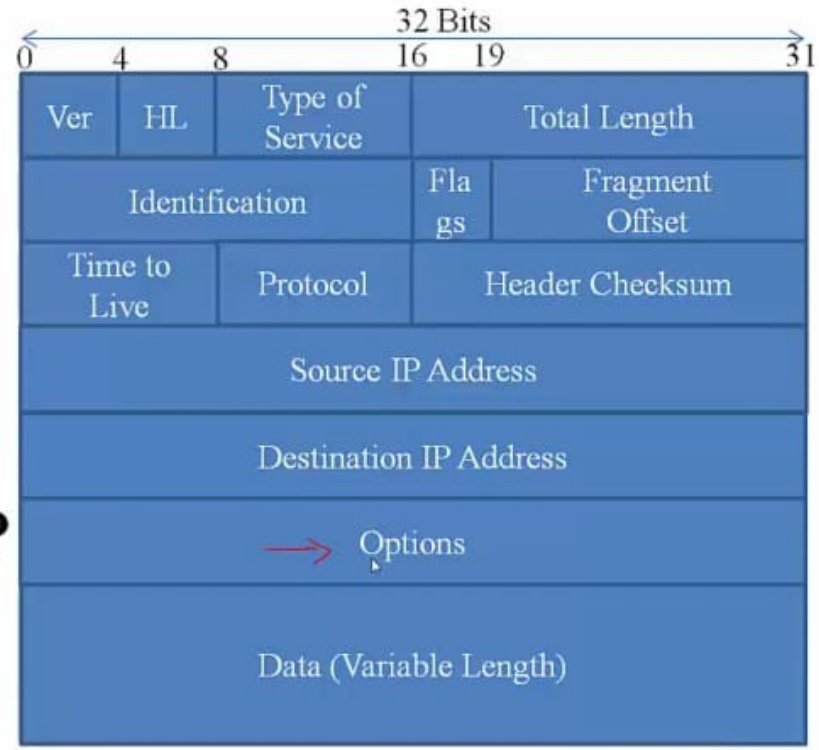
Source/Destination IP address: 32-bit

- Destination key to forwarding
- Source for replying back
- Global address space, independent of physical network address (MAC)



Packet Format

- Options: Rarely used
  - Record Time stamp
  - Record route taken
  - Specify source route
- Data/Payload: Higher Layer Data (TCP or UDP segment)



Fragmentation and Reassembly

- Goal: Interconnect heterogeneous networks
- Problem: Each technology has different Maximum Transmission Unit (MTU) size
  - MTU: Largest IP datagram that can be carried in a frame
  - E.g. Ethernet: 1500, FDDI: 4352, PPP: 296 (Negotiable), WiFi: 7981

- At host: Select MTU of link it is connected to
- At intermediate router: Forward datagram on a network with smaller MTU
  - Need to fragment the datagram
- Where to reassemble?
  - Next hop router? Increases overhead and datagram may again be fragmented
  - Destination is the best place

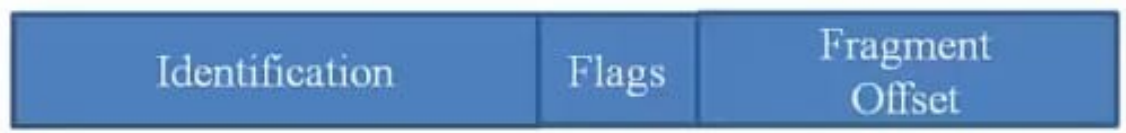
Fragmentation Fields

- Identification: Helps identify a datagram
  - All fragments carry same identification
- Flags: 3 bits

  - bit 0: Reserved, set to zero
  - bit 1: Don't Fragment (DF); Useful for path MTU discovery
  - bit 2: More Fragments (MF); Set to one to indicate more fragments to follow

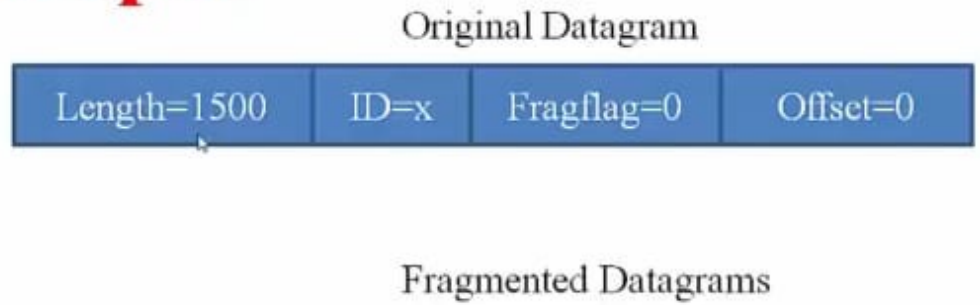
Fields

- Fragmentation Offset: 13 bits long
  - Measures data/payload in units of eight-byte blocks
  - For a particular fragment, offset specifies start of data relative to the beginning of the original un-fragmented IP datagram.
    - E.g first fragment would have an offset of zero

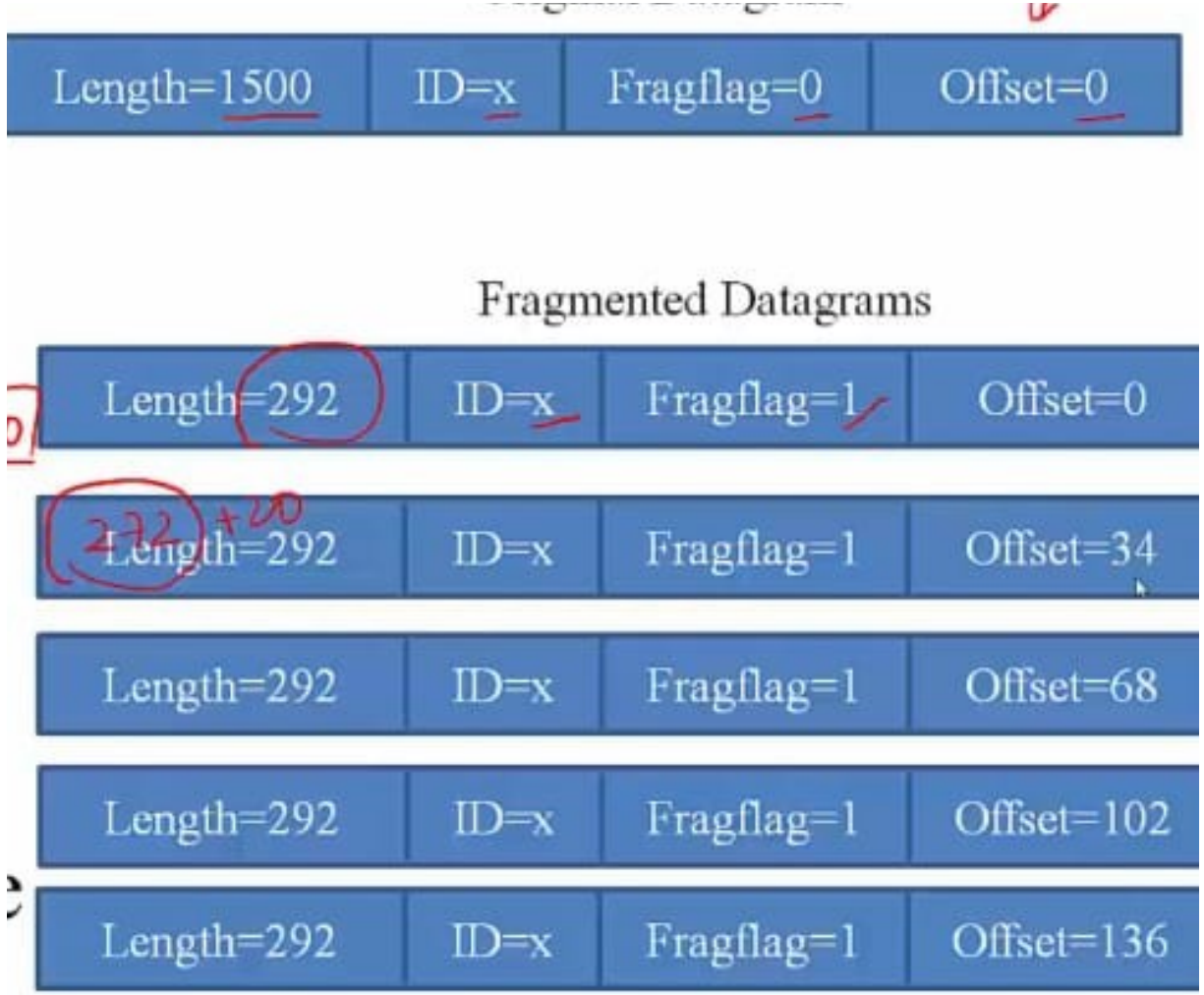


Example

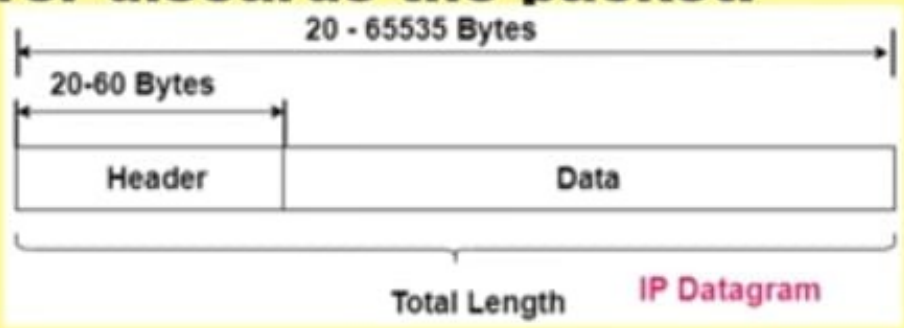
- Original datagram: 1500B
  - Data within is 1480B
- MTU: 296B



- Original datagram: 1500B
  - Data within is 1480B
- MTU: 296B



Q. **An IP Packet has arrived with the first 8 bits as shown 01000010. The receiver discards the packet. Why?**



Solution:

Given 8 bits are:

0100 0010

Ver HLEN

HLEN=0010

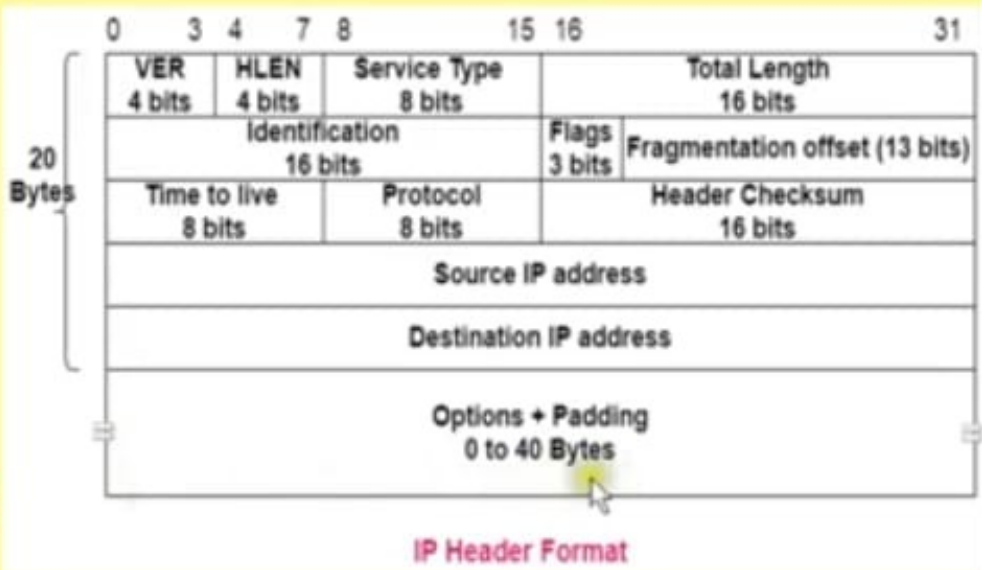
= 2 Hex

= 2 Dec.

Header length (size) = HLEN x 4 bytes

Therefore header length in bytes = 2 x 4 bytes = 8 bytes (Invalid)

Minimum size of IP header should be 20 bytes



Q.2 In an IP packet the value of HLEN is 1000 in binary. How many bytes of options are being carried by this packet?

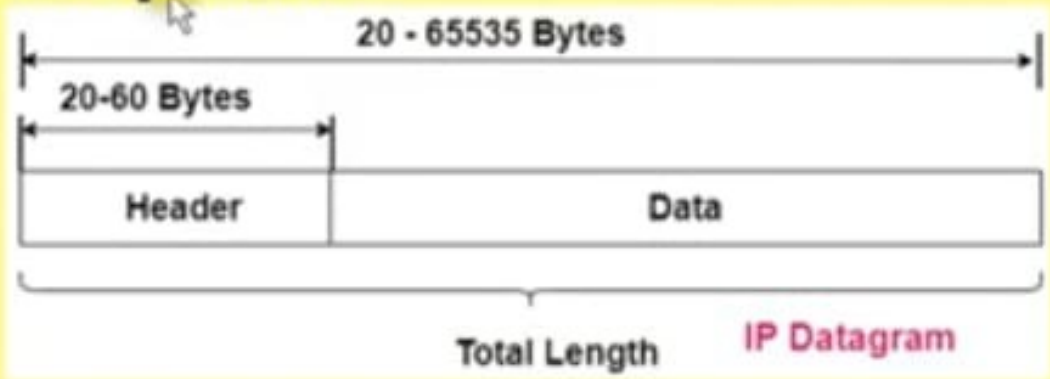
Solution:

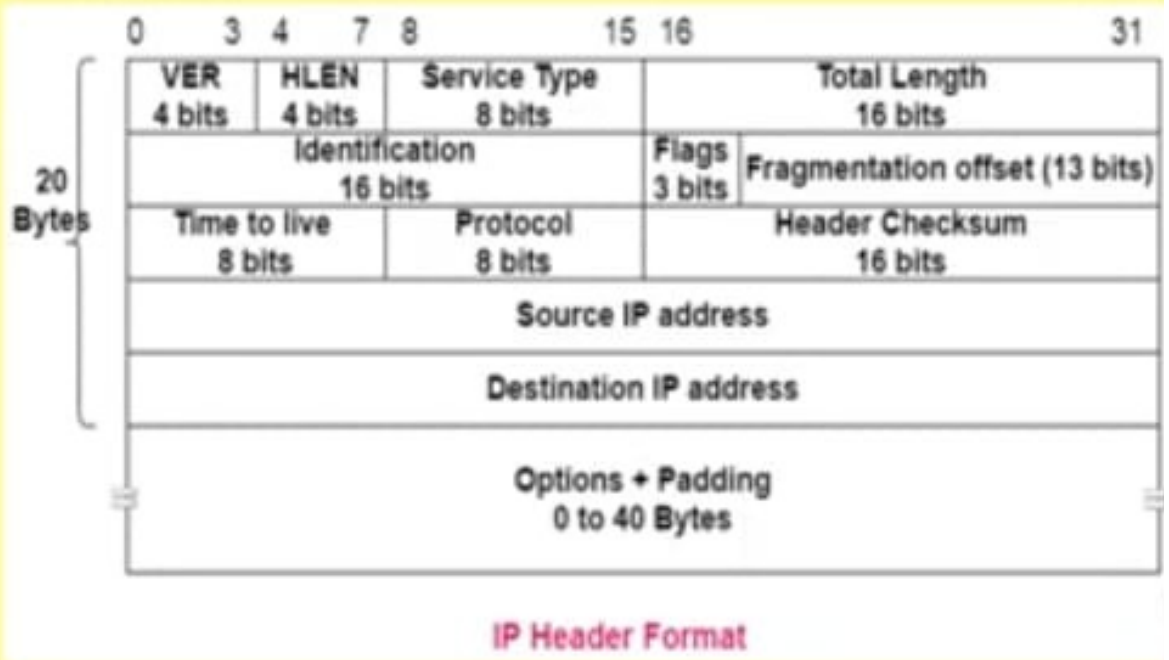
Header length (size) = HLEN x 4 bytes

Options= actual header size – fixed header size

= 32 bytes – 20 bytes = **12 bytes**

HLEN in binary	HLEN in Hex.	HLEN in Dec.	Header length (size) in bytes	Number of bytes in options
1000	8	8	8 x 4 bytes = 32 bytes	32 bytes – 20 bytes (fixed header) =12 bytes of options.





Q. An IP packet has arrived with the first few hex digits as : 45000028000100000102..... How many hops can this packet travel before being dropped? The data belongs to which upper layer protocol?

Solution:

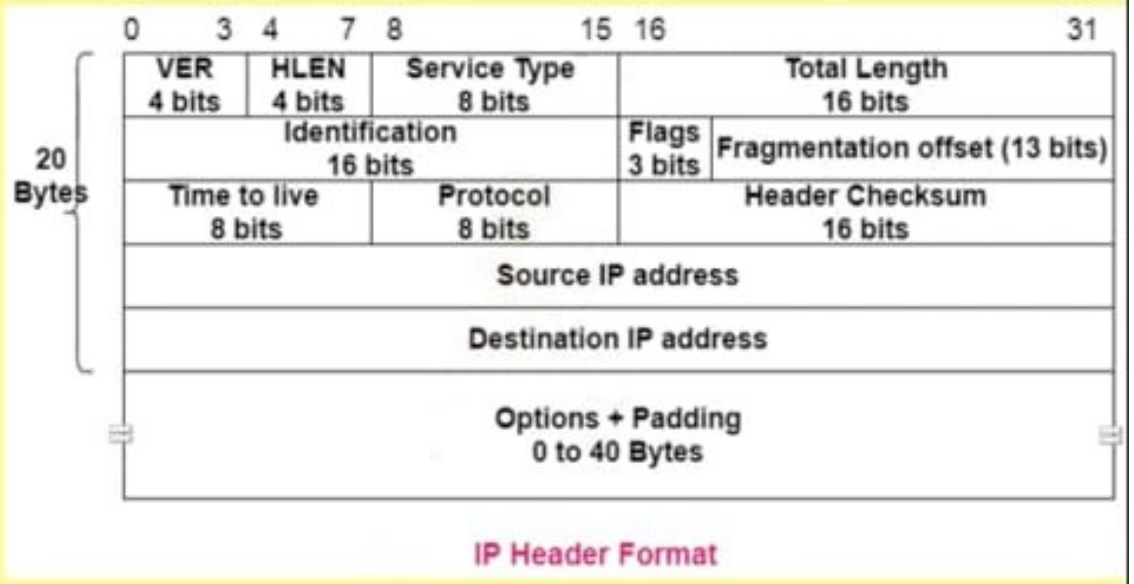
4 5 00 0028 0001 0000 01 02 .....

Ver = 4, HLEN = 5, ST = 00,

TL =0028, Identi.= 0001,

Flags and frag. Offset = 0000

TTL = 01, Protocol = 02



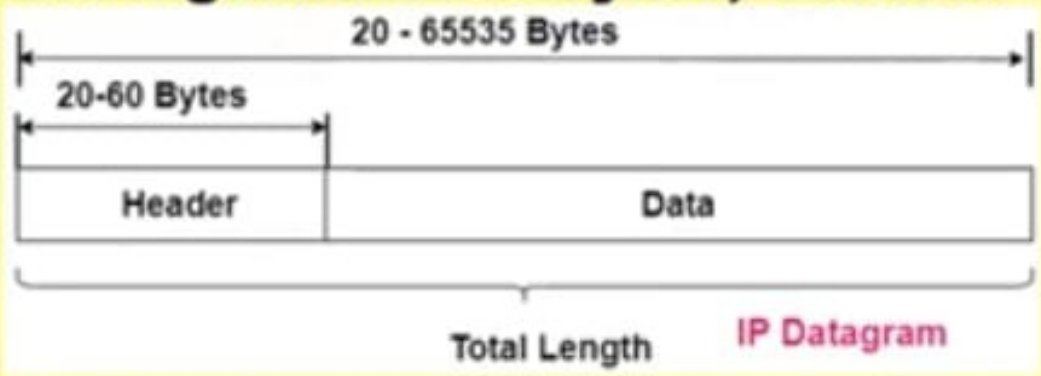
IP Header Format

The packet can travel to one router At the max because TTL field will become zero at this router. So, the packet will not be Forwarded further.

The data belongs to IGMP protocol.

Value	Protocol
1	ICMP
2	IGMP
6	TCP
17	UDP
89	OSPF

Q. Calculate the HLEN value if the total length is 1200 bytes, 1176 of which is data from upper layer.



Solution:

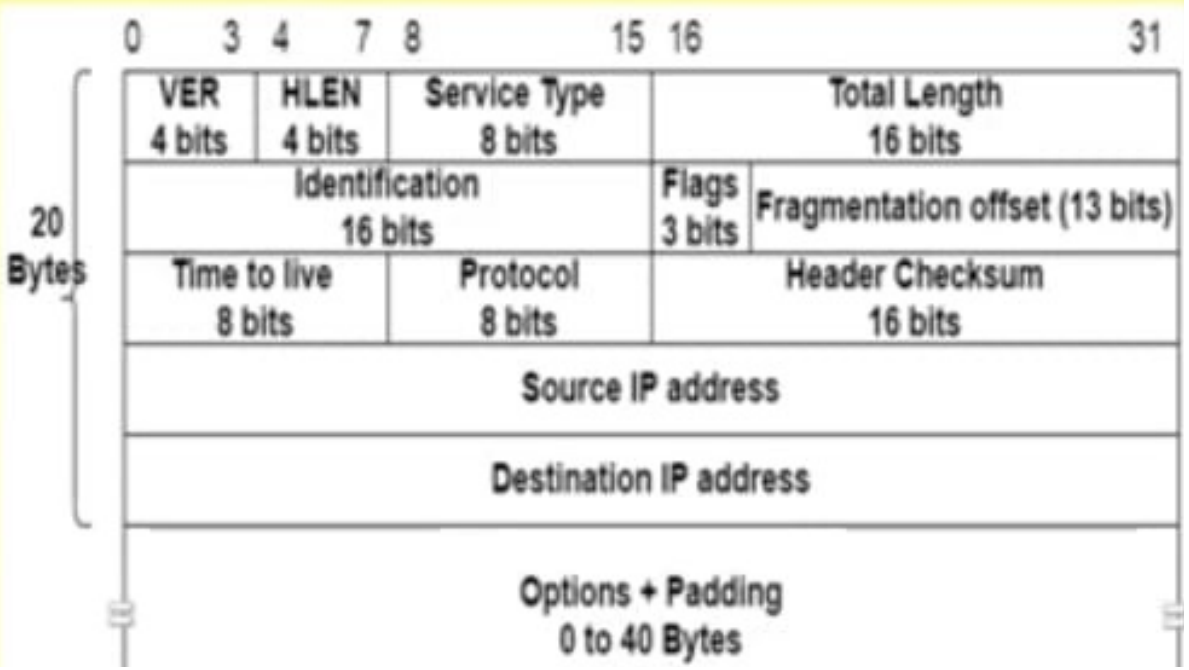
Total length = header length + data length

Therefore, header length = total length - data length
= 1200 bytes - 1176 bytes
= 24 bytes

Now, Header length = HLEN x 4 bytes
Therefore, HLEN = header length/ 4bytes
= 24 bytes/ 4 bytes
=6 D

Therefore HLEN = 0110 in binary

Fixed header size = 20 bytes
Therefore options = 4 bytes



Q. The value of HLEN in an IP datagram is 7. How many option bytes are present?

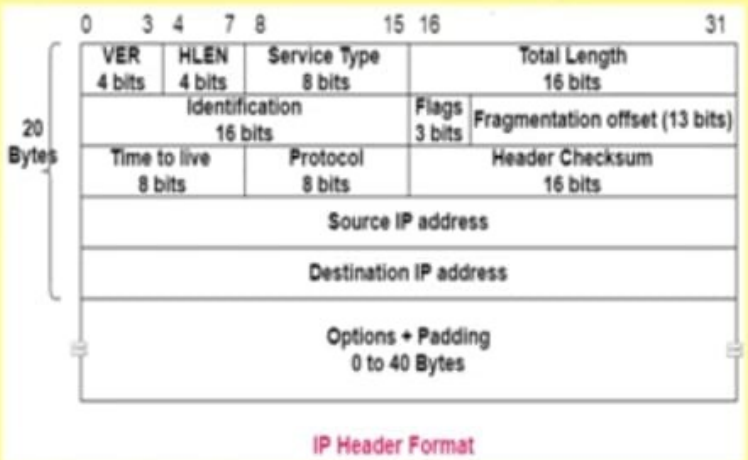
Solution:

HLEN = 7
Therefore,
Header length (size) = 7 x 4 bytes = 28 bytes

Fixed IPv4 header size is 20 bytes

Therefore,
Options = header length – fixed header size
= 28 bytes – 20 bytes
= 8 bytes

Answer:
Options = 8 bytes



IP Header Format

Q. The size of the option field of an IP datagram is 20 bytes. What is the value of HLEN? What is the value in binary?

Solution:
Options = 20 bytes
Fixed IP header size = 20 bytes

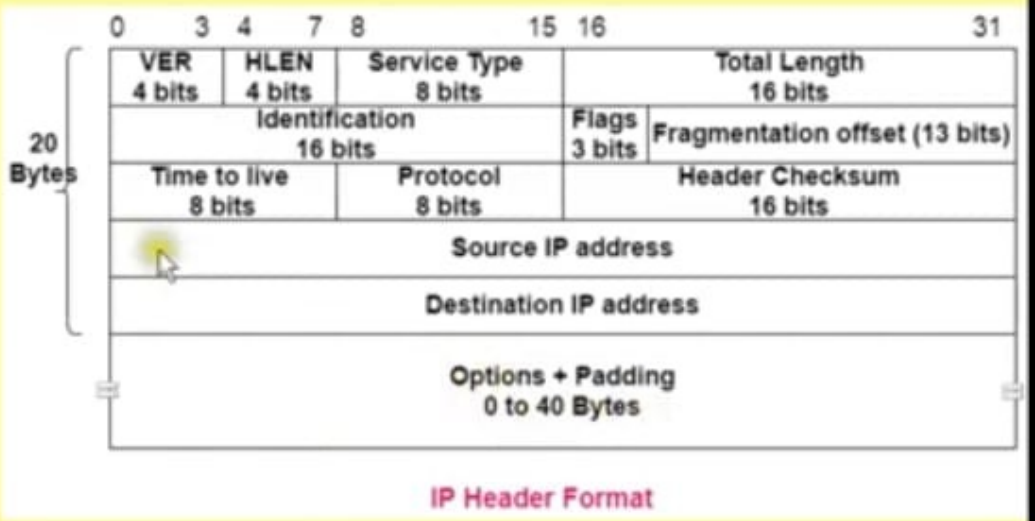
With options, the IP header
Size will be 20 bytes + 20 bytes = 40 bytes

Therefore,

HLEN = header size/ 4 bytes
= 40 bytes/ 4 bytes
= 10 D

HLEN in binary = 1010

Answer:
HLEN = 10 D



IP Header Format

Q. The value of the total length field in an IP datagram is 36 and the value of the header length field is 5. How many bytes of data is the packet carrying ?

Solution:

Total length = 36 bytes

HLEN = 5

Therefore,

header size = HLEN X 4 bytes

= 5 x 4 bytes

= 20 bytes

Therefore,

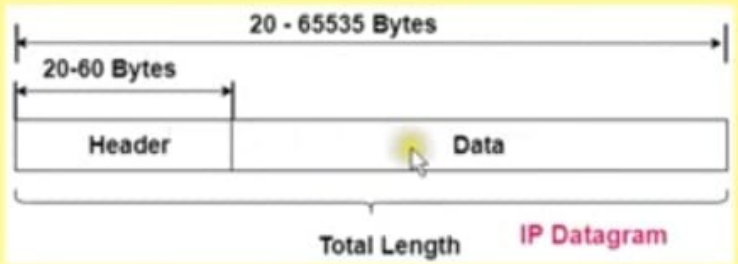
Length of data

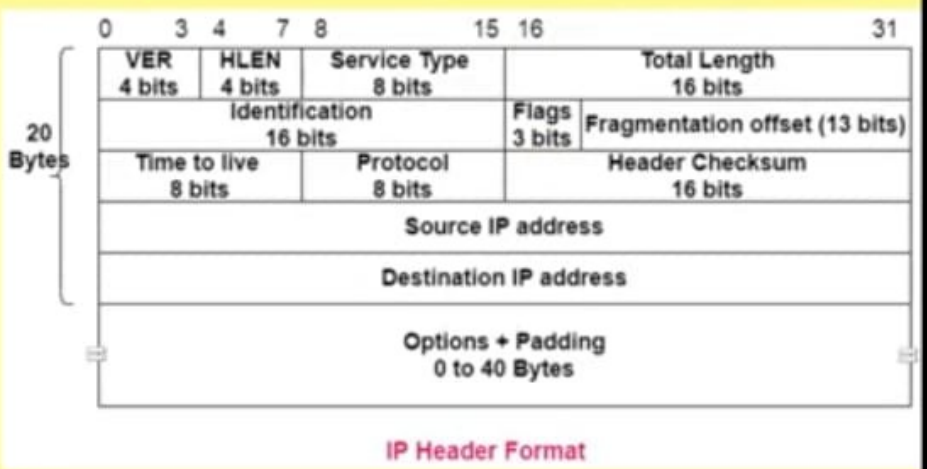
= total length – header size

= 36 – 20

= 16 bytes

Answer:
Data = 16 bytes





Q. The value of the total length field in an IP datagram is 36 and the value of the header length field is 5. How many bytes of data is the packet carrying ?

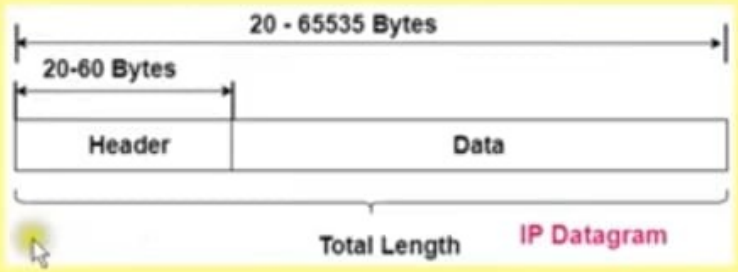
Solution:

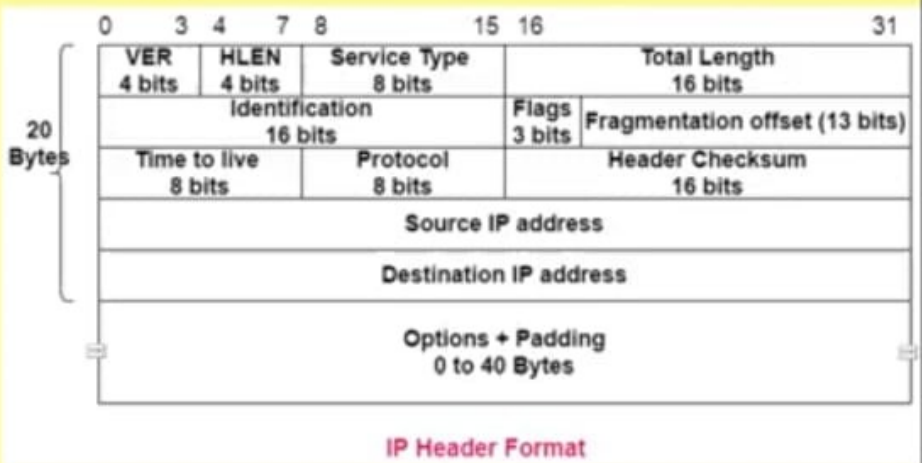
Total length = 36 bytes
HLEN = 5

Therefore,
header size = HLEN X 4 bytes
= 5 x 4 bytes
= 20 bytes

Therefore,
Length of data
= total length – header size
= 36 – 20
= 16 bytes

Answer:
Data = 16 bytes





Q. A datagram is carrying 1024 bytes of data. If there is no option information, what is the value of the header length field? What is the value of the total length field?

Solution:

Data length = 1024 bytes
Options = 0
Therefore, Header size = 20 bytes (fixed)

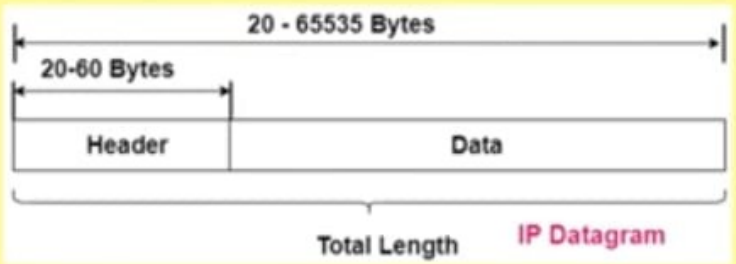
And HLEN = header size / 4bytes
= 20 bytes / 4 bytes
= 5 D

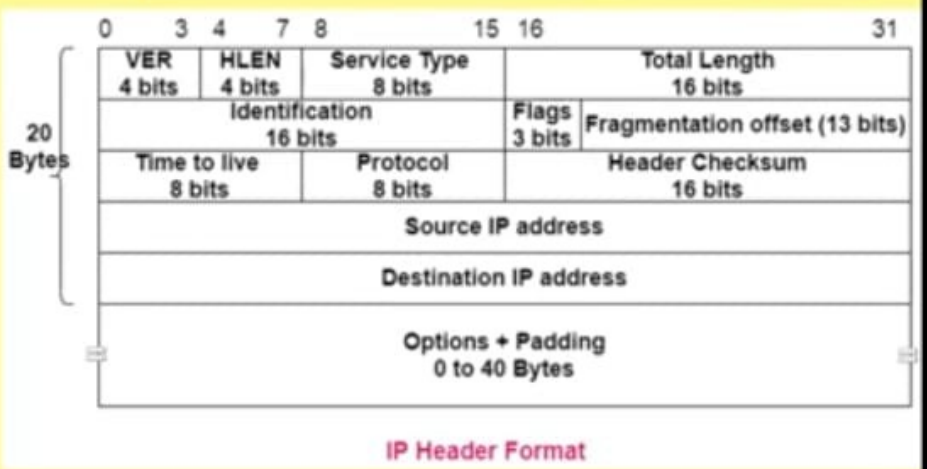
Total length = header size + Data
= 20 bytes + 1024 bytes
= 1044 bytes

Answer:

HLEN = 5 D = 0101 binary

Total length = 1044 bytes

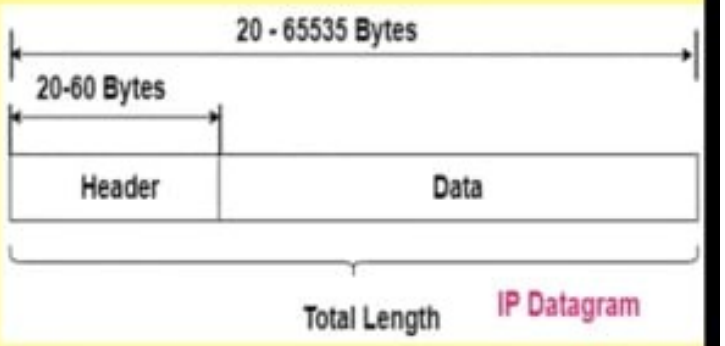




Q. An IP datagram has arrived with the following information in the header (in hexadecimal)
45 00 00 54 00 03 00 00 20 06 00 00 7C4E 0302 B40E 0F02
Are there any options?
Is the packet corrupted ? Why?
Is the packet fragmented?
What is the size of the data?
How many more routers can the packet travel to?
What is the identification number?
What is the type of service?

Unused	DF	MF
Flags		

Value	Protocol
1	ICMP
2	IGMP
6	TCP
17	UDP
89	OSPF



Solution:

4 5 00 0054 0003 0000 20 06 0000 7C4E0302 B40E0F02

VER = 4

HLEN = 5 Header size = HLEN x 4 bytes = 20 bytes --> options = 0 **(No options)**

ST = 00 → normal service

TL = 0054 = 84 D = 84 bytes, therefore data = TL – header size = 84 – 20 = **64 bytes**

IDENTIFICATION = **0003**

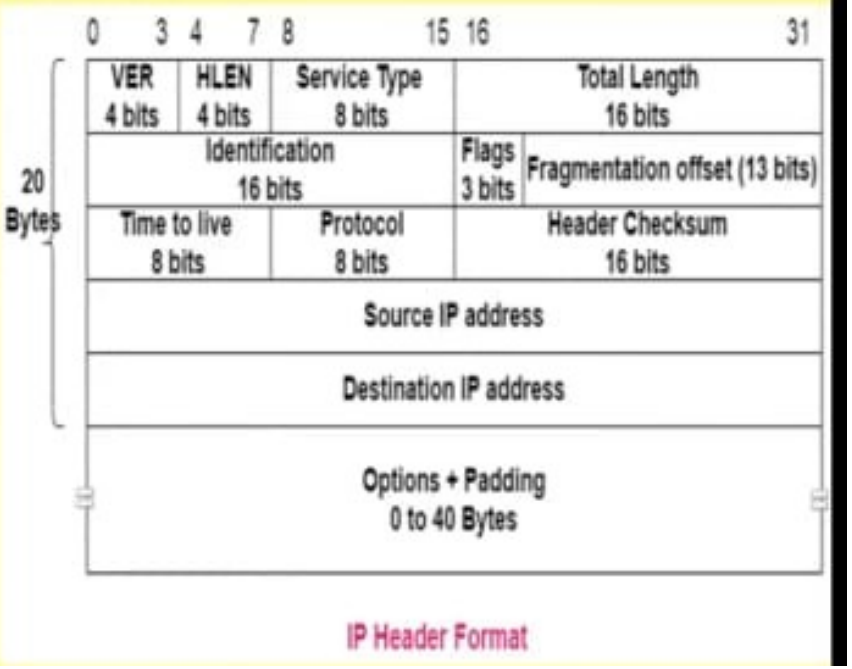
FLASGS/FRAG. OFFSET = 0000 → DF = 0 MF = 0 → **fragmentation not done**

TTL = 20 → 32 D → packet can travel to **32 routers**

PROTOCOL = 06 → TCP data

CHECKSUM = 0000 → ?

SOURCE IP =7C4E0302 = 124.76.3.2 DESTINATION IP = B40E0F02 = 180.14.15.2



IPv4 has a 32-bit address length	IPv6 has a 128-bit address length
It Supports Manual and DHCP address configuration	It supports Auto and renumbering address configuration
In IPv4 end to end, connection integrity is Unachievable	In IPv6 end-to-end, connection integrity is Achievable
It can generate 4.29×10^9 address space	The address space of IPv6 is quite large it can produce 3.4×10^{38} address space
The Security feature is dependent on the application	IPSEC is an inbuilt security feature in the IPv6 protocol
Address representation of IPv4 is in decimal	Address Representation of IPv6 is in hexadecimal
Fragmentation performed by Sender and forwarding routers	In IPv6 fragmentation is performed only by the sender
In IPv4 Packet flow identification is not available	In IPv6 packet flow identification are Available and uses the flow label field in the header
In IPv4 checksum field is available	In IPv6 checksum field is not available
It has a broadcast Message Transmission Scheme	In IPv6 multicast and anycast message transmission scheme is available
In IPv4 Encryption and Authentication facility not provided	In IPv6 Encryption and Authentication are provided
IPv4 has a header of 20-60 bytes.	IPv6 has a header of 40 bytes fixed
IPv4 can be converted to IPv6	Not all IPv6 can be converted to IPv4
IPv4 consists of 4 fields which are separated by addresses dot (.)	IPv6 consists of 8 fields, which are separated by a colon (:)
IPv4's IP addresses are divided into five different classes. Class A , Class B, Class C, Class Da , Class E.	IPv6 does not have any classes of the IP address.
IPv4 supports VLSM(Variable Length subnet mask).	IPv6 does not support VLSM.