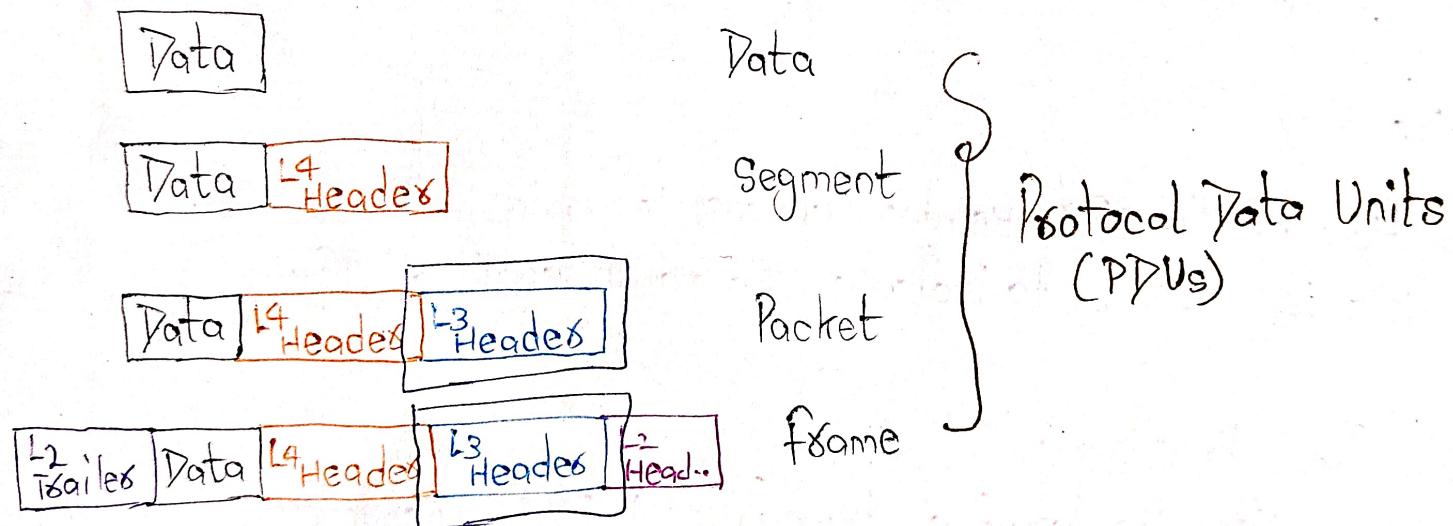


IPv4 Headers

Internet Protocol Version 4 known as IPv4 Headers
This is used at layer 3, to help send data between
devices on separate Network, even on the other
sides of the World over the Internet This is
known as Routing.

We are going to look the IPv4 Header, let's see its position in a complete frame

OSI Models - PDUs



Offsets	Octet	0	1	2	3		
Octet	Bit	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31					
0	0	Version	IHL	DSCP	ECN	Total Length	
4	32	Identification		Flags	Fragment Offset		
8	64	Time To Live	Protocol	Header Checksum			
12	96	Source IP Address					
16	128	Destination IP Address					
20	160						
24	192	Options (if IHL > 5)					
28	224						
32	256						

Length: 4 bits

→ It identifies the version of IP used. Now there are only two versions of IP in use.

- IPv4 = 4 (0100)
- IPv6 = 6 (0110)

What happens to IPv5?

These was an experimental protocol called Internet Stream Protocol which uses an Internet Protocol value of 5, but it was never publicly used, so you could say that's the lost IPvs.

Internet Header Length (IHL)

Length: 4 bits

→ The final field of the IPv4 Headers (options) is variable in length so, this field is necessary to indicate the total length of the headers.

Important Part to remember

This field specifies the length of headers in 4-BYTE Increments

For Example,

If the value of this field is 5 = $5 \times 4 = 20$ bytes, so that means that the length of the headers is 20 bytes

→ The minimum value in this field is 5, which as I just said is equal to 20 bytes. That's the length of the IP packet without any IP options at the end, so an empty options field.

→ The maximum value is 15, which is maximum value of 4 bits
The value of the 4 bits are 1, 2, 4 & 8 adding them up
result is 15, so 15×4 bytes are equal to 60 bytes

$$\boxed{\begin{array}{cccc} 1 & 1 & 1 & 1 \\ 8 + 4 + 2 + 1 = 15 \end{array}}$$

that means the maximum length of the IP options field is 40 bytes so, an IPv4 header with no option field is 20 bytes in length and that's the minimum length of an IPv4 header. And an IPv4 with a maximum length options field, 40 bytes, has a length of 60 bytes, and the maximum length of an IPv4 header

- Minimum IPv4 Header Length = 20 bytes
- Maximum IPv4 Header Length = 60 bytes

Differentiated Services Code Point (DSCP field)

length: 6 bits

- This field is used for QoS (Quality of Service)
- It is used to prioritize delay-sensitive data (streaming voice, video etc.)
- This field is used to identify which traffic should receive priority treatment

'Explicit Congestion Notification'

Length: 2 bits

- Provides end to end notification of network congestion without dropping packets.
- Normally in a network, if the network is super busy, if there is congestion, this is signalled by dropping packets. The ECN field provides a way to signal a congested network without dropping packets.
- This is optional field that requires both endpoints as well as the underlying network infrastructure to support it.

Total Length Field

Length: 16 bits

- Indicates the total length of the packet (L3 header + L4 Segment) this is different than the (IHL) field which indicates only the length of the IPv4 header itself.
- Measured in bytes (not 4-byte increments like IHL)
- Minimum value of 20 bytes (= IPv4 header with no encapsulated data)
- Maximum value of 65,535 bytes [maximum of 16 bit value]
[all set to '1']

Identification Field

Length: 16 bits

- If a packet is fragmented due to being too large, this field is used to identify which ~~which~~ ^{original} packet the fragment belongs to.
- All fragments of the same packet will have their own IPv4 header with the same value in this field, so they can be reassembled later.
- Packets are fragmented if larger than the MTU (Maximum Transmission Unit)
- The MTU is usually 1500 bytes. Remember the maximum size of Ethernet frames? The maximum payload size of the Ethernet is 1500 bytes so these are related.
- Fragments are reassembled by the receiving host.

Flags field

Length: 3 bits

- Used to control & identify fragments

These are 3 bits, and they function like this.

Bit0: Reserved, always set to 0.

Bit1: Don't fragment (DF bit), if it is set to 1, it means that the packet should not be fragmented.

Bit 2: More fragments (MF bit), set to 1 if there are more fragments in the packet, set to 0 for the last fragment

Fragment offset field

Length: 13 bits

- Used to indicate the position of the fragment within the original, unfragmented IP packet

This allows fragmented packets to be reassembled even if the fragments arrive out of order. since this field lets the receiver know the original order of the fragments.

Time to Live Field

Length: 8 bits

- A router will drop a packet with TTL of '0'
- This field is used to prevent infinite loops
- This field originally designed to indicate the packet's maximum lifetime in second
- In practice, indicates a 'hop count': each time the packet arrives at a router on the way to its destination, the router decreases the TTL by 1, until the packet reaches its destination or the TTL reaches 0 and the packet is dropped.

"The current recommended default TTL is 64"

Protocol Field

Length: 8 bits

→ Indicates the protocol of the encapsulated L4 PDU.

Typically, this will be one of the following:

↳ Value of 6: TCP

↳ Value of 17: UDP

↳ Value of 1: ICMP

↳ Value of 88: OSPF (dynamic routing protocol)

Header Checksum Field

Length: 16 bits

→ A calculated checksum used to check for errors in the IPv4 header.

→ When a router receives a packet, it calculates the checksum of the header and compares it to the one in this field of the header.

→ If they do not match, the router drops the packet.

→ Note that this is only used to check for errors in the IPv4 header, not in encapsulated data.

→ IP relies on the encapsulated protocol to detect errors in the encapsulated data.

→ Both TCP and UDP have their own checksum fields to detect errors in the encapsulated data.

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Source/Destination IP Address Field

Length: 32 bit (each)

"Covered in detail already."

Options field

Length: 0-320 bit (40 bytes)

→ This field is rarely used, however if the IHL field is greater than 5 it means options are present