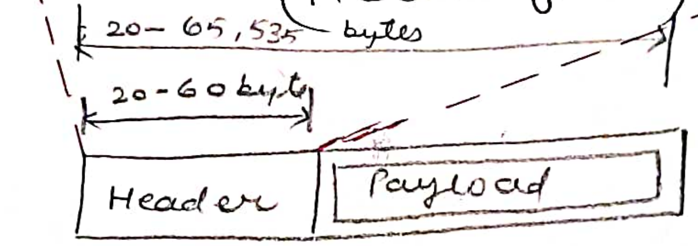
IPv4 Datagram format :- 4

VER (4 bits)	HLEN (4 bits)	Service Type (8 bits)	Total Length (16 bits)
Identification (16 bits)		Flags (3 bits)	Fragment offset (13 bits)
Time-to-line (8bits)	Protocol (8bits)	Header checksum (16 bits)	
Source IP address (32 bits)			
Destination IP address (32 bits)			
options + Padding (0 to 40 bytes)			

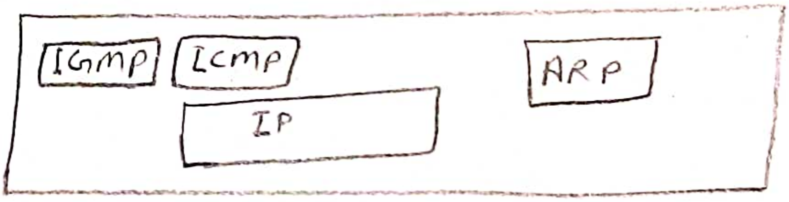
(Header format)

IPv4-header



[IP datagram]

Network layer protocols



32 bit 128 bit

IPv4 Protocol :-

$\boxed{32 \text{ bit} \Rightarrow 2^{32}}$

The glue that holds the whole Internet together is the network layer ~~prol~~ protocol, IP (Internet Protocol). Its job is ~~p~~ to provide a best - effort (i.e., not guaranteed) way to transport datagrams from source to destination, without regard to wheather these machines are on the same n/w or wheather there are other networks in between them.

An IPv4 datagram consists of a header part and a text part. The header has 20-byte fixed part and a varible length optional part.

A Brief desciption of each field :-

a) Version : The version field keeps track of which version of the protocol the datagram belongs to. The current version is 4 i.e. IPv4 with binary value of 0100.

b) HLEN: (Header length) : Since the header length is not constant, a field in the header, HLEN, is provided to tell how long the header is, in 32-bit words. minimum value is 5, which apply when no options are present. The maximum value of this 4-bit ~~feild~~ field is 15, which limits the header to 60 bytes and option field to 40 bytes.

(c) Service Type: The service type field defines how the datagram should be handled. It includes bits that define the priority of the datagram. It also contain bits that specify the type of service the sender desires such as Reliability, Precedence delay, Throughput etc.

eg:- ① For File Transer, error-free transmission is more important than fast Transmission.

② For digitized ~~to~~ voice, fast delivery beats accurate delivery.

→ The 6-bit field contained (from left to right), a three-bit Precedence field and three flags, D, T and R. The Precedence field was a priority, from 0 to 7. The Three flag bits allow the host to specify D → delay, T → Through Put, R → Reliability.

(d) Total length:- The total length includes everything in the datagram - both ~~to~~ header and data. The maximum length is 65,535 bytes.

$2^{16} = 6$

0-651

Data

(e) Identification: This field is needed to allow the destination host to determine which datagram a newly arrived fragment belongs to. All the fragments of a datagram contain the same Identification value.

(f) DF stand for Don't fragment
MF stand for More fragment.
One bit is Reserved and it should be 0.

fragment offset : This is a 13 bit field which shows the relative position of any fragment with respect to the whole datagram (indicates where in the original datagram this fragment belongs measured in 64-bit units).

(h) Time to Line :- The time to line field defines the number of hops a datagram can travel before it is discarded. The source host, when it creates the datagram, set this field to an initial value. Then, as the datagram travel through the Internet, ~~ro~~ router by router, each router decreaments this value by 1. $\boxed{2^8 = 256 \downarrow 255}$
~~If the value become 0 before the~~

(i) Protocol :- The protocol field tells it which transport process to give it to. TCP is one possibility, but so are UDP and some others.

(j) Header checksum :- The Header checksum verifies the header only. Since an error detecting code is applied to the header only. Because some header fields may change during transit (eg. time to line etc), this is reverified and recomputed at each router. The checksum is formed by taking the ones compliment of the 16 bit ones complement.

(k) Source IP address :- The source address field is a four byte (32-bit) Internet address. It identifies the original source of the datagram.

(l) destination IP address :- It identifies the final destination of the datagram.

(m) options :- The options are variable length. Each begin with a 1-byte code identifying the option. Some options are followed by a 1-byte options length field and then one or more data bytes. The options field is padded out to a multiple of four bytes.

Fine options are defined :-

Option	Description
Security	Specify how secret the datagram is
Strict source routing	Give the complete path to be followed
Loose source routing	Gives a list of routers not to be missed
Record route	Makes each router append its IP address
Timestamp	Makes each router append its address and timestamp

Pv 6 :- 128 bit ⇒ 2^{128} address

Its major goals :-

1. Support billion of host, even with inefficient address space allocation.
2. Reduce the size of the routing tables.
3. Simplify the protocol, to allow routers to process packets faster.
4. Provide better security (authentication and privacy) than current IP.
5. Pay more attention to type of service, Particularly for real-time data.
6. Aid multicasting by allowing scopes to be specify.
7. Make it possible for a host to roam without changing its address.
8. Allow the protocol to evolve in the future.
9. Permit the old and new protocols to coexist for years.

<table>
<tr><td>Version
(4 bit)</td><td>Traffic class
(4 bit)</td><td colspan="2">Flow label (3 byte)</td></tr>
<tr><td colspan="2">Payload length
(2 byte)</td><td>Next header
(8 bit)</td><td>HOP limit
(8 bit)</td></tr>
<tr><td colspan="4">Source address
(16 bytes)</td></tr>
<tr><td colspan="4">Destination address
(16 bytes)</td></tr>
</table>

(IPv6 fixed header)

<u>Version</u> : Version field is always 6 for IPv6.

<u>Traffic class</u> : It is used to distinguish between packets with different real-time delivery requirements.

<u>Flow label</u> : This field is designed for providing special handling for particular flow of data.

<u>Payload length</u> : This field is used to define the total length of the datagram excluding the base header.

<u>Next header</u> : it defines the header which follows the base header in the datagram.

Hop Limit : This is used for Time to live.

Source address : it defines the original source datagram.

Destination address : it defines the final destination of the datagram.

⇒ Extension Headers :

IPv6 has introduced the concept of an (optional) extension header. This gives more functionality to the IP datagram. Each extension header has a length equal to a multiple of 8 octet (64 bits). Each one is optional, but if more than one is present, they must appear directly fter the fixed header and ~~for~~ preferably in the order listed.

Some of the headers have a fixed format; thers contain a variable number of variable-ngth fields.

ension header	Description
-by-Hop options	Miscellaneous information for routers
tination options	Additional information for the destination
ting	Loose list of routers to visit
mentation	Management of datagram fragments
entication	Verification of the sender's identity
pted security ayload	Information about the encrypted contents

Next header	Header length extension	Routing type	Segments left
Type specific data			

The extension header for routing

Segment keeps track of how many of the addresses in The list have not yet been visited.

IPv6 main header (40 bytes)	IPv6 Extension header 1	IPv6 extension header 2	..	Layer 4 header (any payload)

IPv 6 header Next header = TCP	TCP header + data

IPv6 header Next Header = Routing	Routing header Next Header = TCP	TCP Header + data