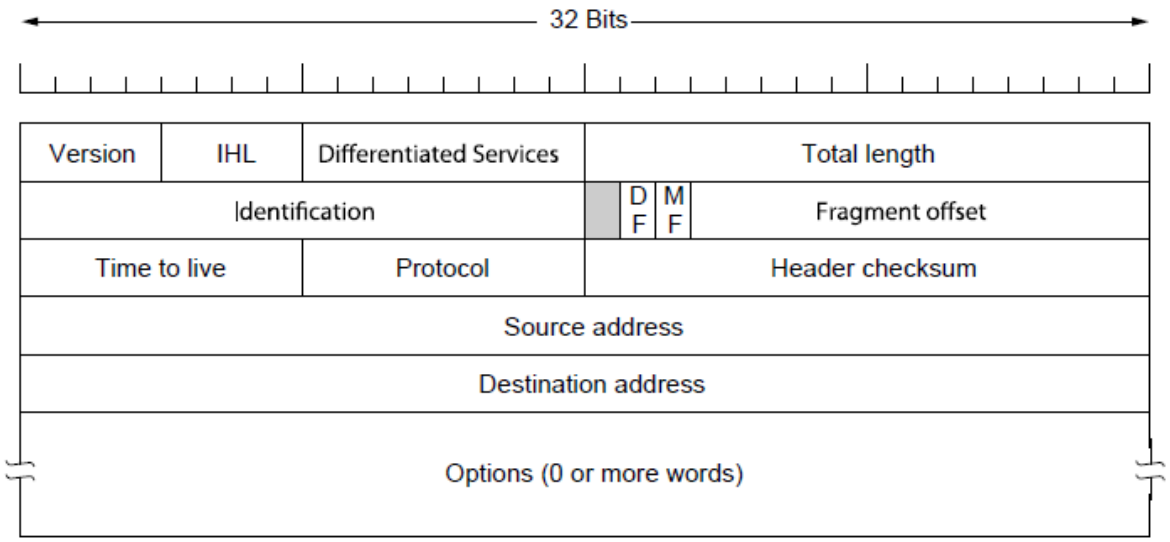
IPV4

- Internet Protocol (IP) is the glue that holds the Internet together.
- Communication in the Internet:
    1. Transport Layer takes a data stream and breaks them up into packets (datagrams).
    2. An IP datagram can be up to 64 KB but in practice they are about 1500 bytes.
    3. Each IP datagram is routed through the Internet, possibly being fragmented into smaller units as it goes.
    4. When all the fragments get to the destination machine they are reassembled by the network layer into the original datagram, which is handed to the transport layer.
- The IP datagram header has a 20 byte fixed part and a variable length optional part.

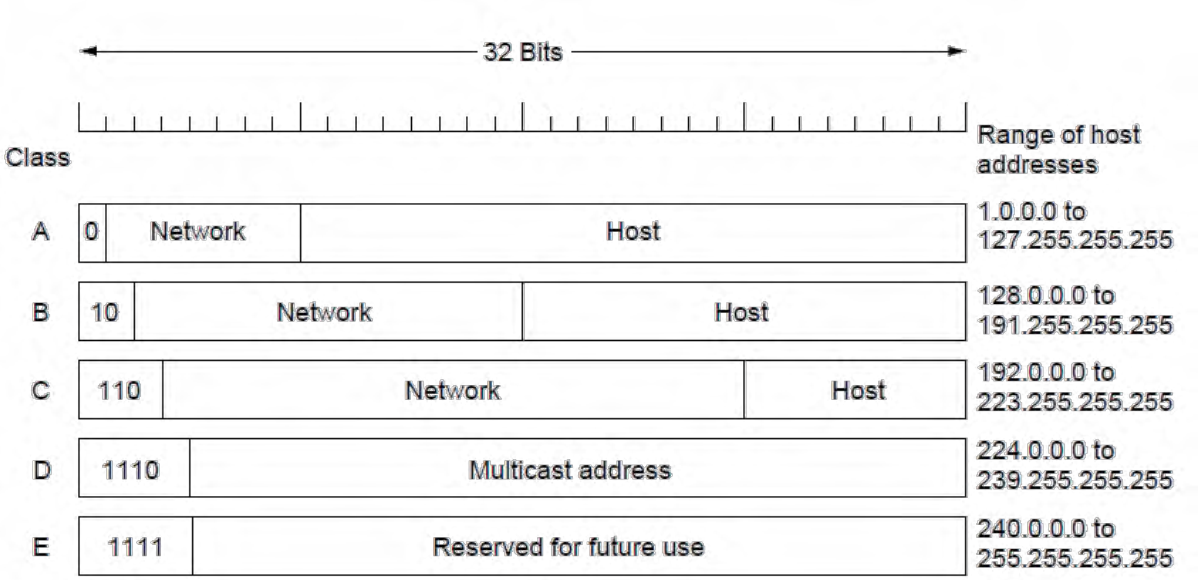


- **Version** (4-bits): indicates version of the protocol the datagram belongs to.

- **IHL (**4-bits): This field provides the length of the IP header. The length of the header is represented in 32 bit words.
- **Differentiated Services** (8-bits): Corresponds to type of service. The first 3 bits of this field are priority bits and are ignored as of today. The next 3 bits represent type of service and the last 2 bits are unused.
- **Total Length** (16-bits): This represents the total IP datagram length in bytes (header + data). Maximum size = 64 K or 65535 bytes.
- **Identification** (16 bits): Enables the destination host to determine which datagram a newly arrived fragment belongs to. All fragments of a datagram contain the same Identification value.
- **Total Length** (16-bits): This represents the total IP datagram length in bytes (header + data). Maximum size = 64 K or 65535 bytes.
- **Identification** (16 bits): Enables the destination host to determine which datagram a newly arrived fragment belongs to. All fragments of a datagram contain the same Identification value.
- **DF bit** (1-bit): Don't fragment (if destination is incapable of putting a datagram fragments back together).
- **MF** (1-bit): More fragments. All fragments except the last one have this bit set to 1.
- **Fragment Offset** (13-bits): Indicates where in the current datagram this fragment belongs (2^{13} = 8192 fragments per datagram and 8192 * 8 = 65536 bytes. Each fragment is a multiple of 8 bytes)
- **TTL** (8-bits): Used to limit packet lifetime. Maximum lifetime = 255 seconds. In practice, it just counts hops. Default = 64 hops, which is decremented each time the packet is forwarded.
- **Protocol** (8-bits wide): Tells IP which transport protocol to give the datagram to (i.e. TCP or UDP).
- **Header Checksum** (16-bits): Verifies the header.

- **Source and Destination Addresses** (32-bits each): Indicate IP address (network number and host number) of host.
- **Options** (maximum 40-bytes): Presences of options indicated by IHL field. Options include record route, timestamp, and strict source routing.

IP Addressing



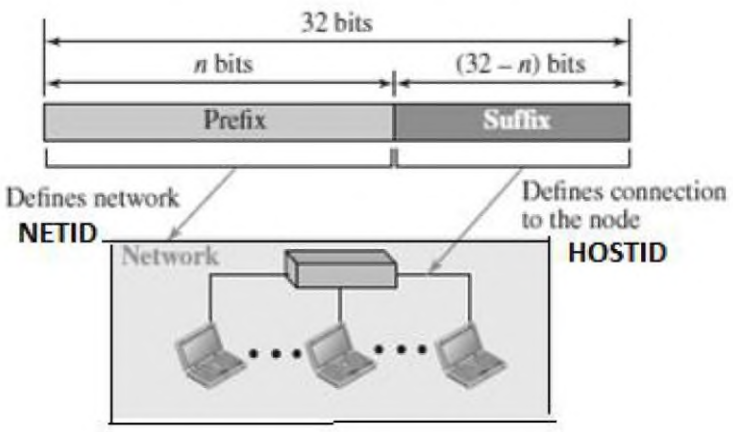
IPV4 ADDRESS SPACE

- IPv4 defines addresses has an address space.
- An address space is the total number of addresses used by the protocol.
- If a protocol uses *b* bits to define an address, the address space is 2^b because each bit can have two different values (0 or 1).
- IPv4 uses 32-bit addresses, which means that the address space is 2^{32} or 4,294,967,296 (more than four billion).
- 4 billion devices could be connected to the Internet.

HIERARCHY IN IPV4 ADDRESSING

- In any communication network that involves delivery, the addressing system is hierarchical.
- A 32-bit IPv4 address is also hierarchical, but divided only into two parts.

- The first part of the address, called the *prefix*, defines the network(Net ID); the second part of the address, called the *suffix*, defines the node (Host ID).
- The prefix length is *n* bits and the suffix length is (32- *n*) bits.



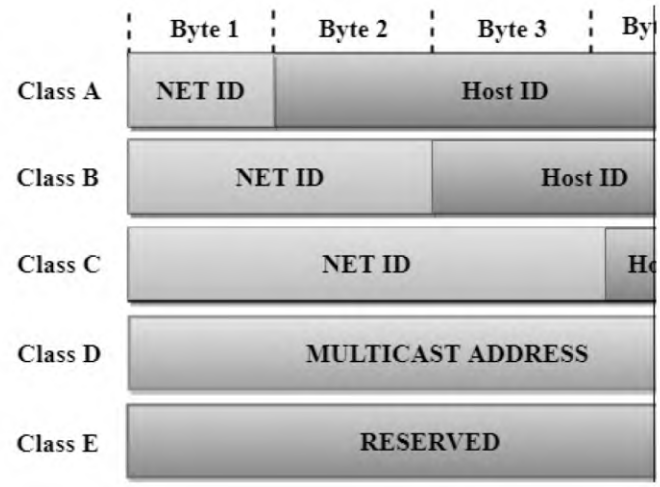
- A prefix can be fixed length or variable length.
- The network identifier in the IPv4 was first designed as a fixed-length prefix.
- This scheme is referred to as classful addressing.
- The new scheme, which is referred to as classless addressing, uses a variable-length network prefix.

CATEGORIES OF IPV4 ADDRESSING

- There are two broad categories of IPv4 Addressing techniques.
- They are
    1. Classful Addressing
    2. Classless Addressing

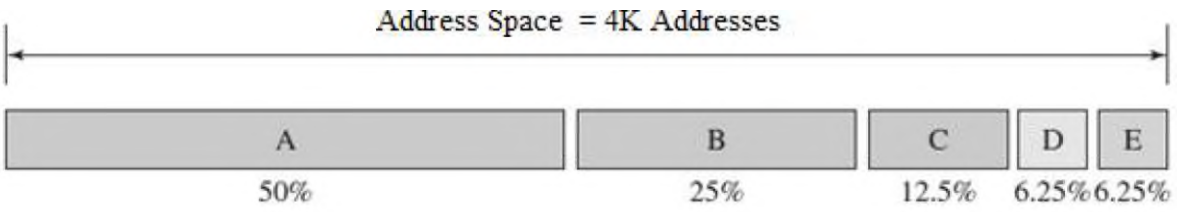
CLASSFUL ADDRESSING

- An IPv4 address is 32-bit long(4 bytes).
- An IPv4 address is divided into sub-classes



Class	Prefixes	First byte
A	*n* = 8 bits	0 to 127
B	*n* = 16 bits	128 to 191
C	*n* = 24 bits	192 to 223
D	Not applicable	224 to 239
E	Not applicable	240 to 255

Classful Network Architecture



Class A

- In Class A, an IP address is assigned to those networks that contain a large number of hosts.
- The network ID is 8 bits long.
- The host ID is 24 bits long.
- In Class A, the first bit in higher order bits of the first octet is always set to 0 and the remaining 7 bits determine the network ID.
- The 24 bits determine the host ID in any network.
- The total number of networks in Class A = 2^7 = 128 network address
- The total number of hosts in Class A = 2^{24} - 2 = 16,777,214 host address

Class B

- In Class B, an IP address is assigned to those networks that range from small-sized to large-sized networks.
- The Network ID is 16 bits long.
- The Host ID is 16 bits long.
- In Class B, the higher order bits of the first octet is always set to 10, and the remaining14 bits determine the network ID.
- The other 16 bits determine the Host ID.
- The total number of networks in Class B = 2^{14} = 16384 network address
- The total number of hosts in Class B = 2^{16} - 2 = 65534 host address

Class C

- In Class C, an IP address is assigned to only small-sized networks.
- The Network ID is 24 bits long.
- The host ID is 8 bits long.
- In Class C, the higher order bits of the first octet is always set to 110, and the remaining 21 bits determine the network ID.
- The 8 bits of the host ID determine the host in a network.
- The total number of networks = 2^{21} = 2097152 network address
- The total number of hosts = 2^{8} - 2 = 254 host address

Class D

- In Class D, an IP address is reserved for multicast addresses.
- It does not possess subnetting.
- The higher order bits of the first octet is always set to 1110, and the remaining bits determines the host ID in any network.

Class E

- In Class E, an IP address is used for the future use or for the research and development purposes.
- It does not possess any subnetting.
- The higher order bits of the first octet is always set to 1111, and the remaining bits determines the host ID in any network.