Computer Network

Lecture-31

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Internet Protocol

Internet Protocol

Internet as a Datagram Network

- The Internet has chosen the datagram approach to switching in the network layer.
- It uses the universal addresses defined in the network layer to route packets from the source to the destination.

Internet Protocol

Internet as a Connectionless Network

- Delivery of a packet can be accomplished by using either a connection-oriented or a connectionless network service.
- In a **connection-oriented service**, the source first makes a connection with the destination before sending a packet. When the connection is established, a sequence of packets from the same source to the same destination can be sent one after another. In this case, there is a relationship between packets. They are sent on the same path in sequential order. A packet is logically connected to the packet traveling before it and to the packet traveling after it. When all packets of a message have been delivered, the connection is terminated.
- This type of service is used in a virtual-circuit approach. to packet switching such as in Frame Relay and ATM.

Internet Protocol

In **connectionless service**, the network layer protocol treats each packet independently, with each packet having no relationship to any other packet. The packets in a message mayor may not travel the same path to their destination.

This type of service is used in the datagram approach to packet switching. The **Internet** has chosen this type of service at the network layer.

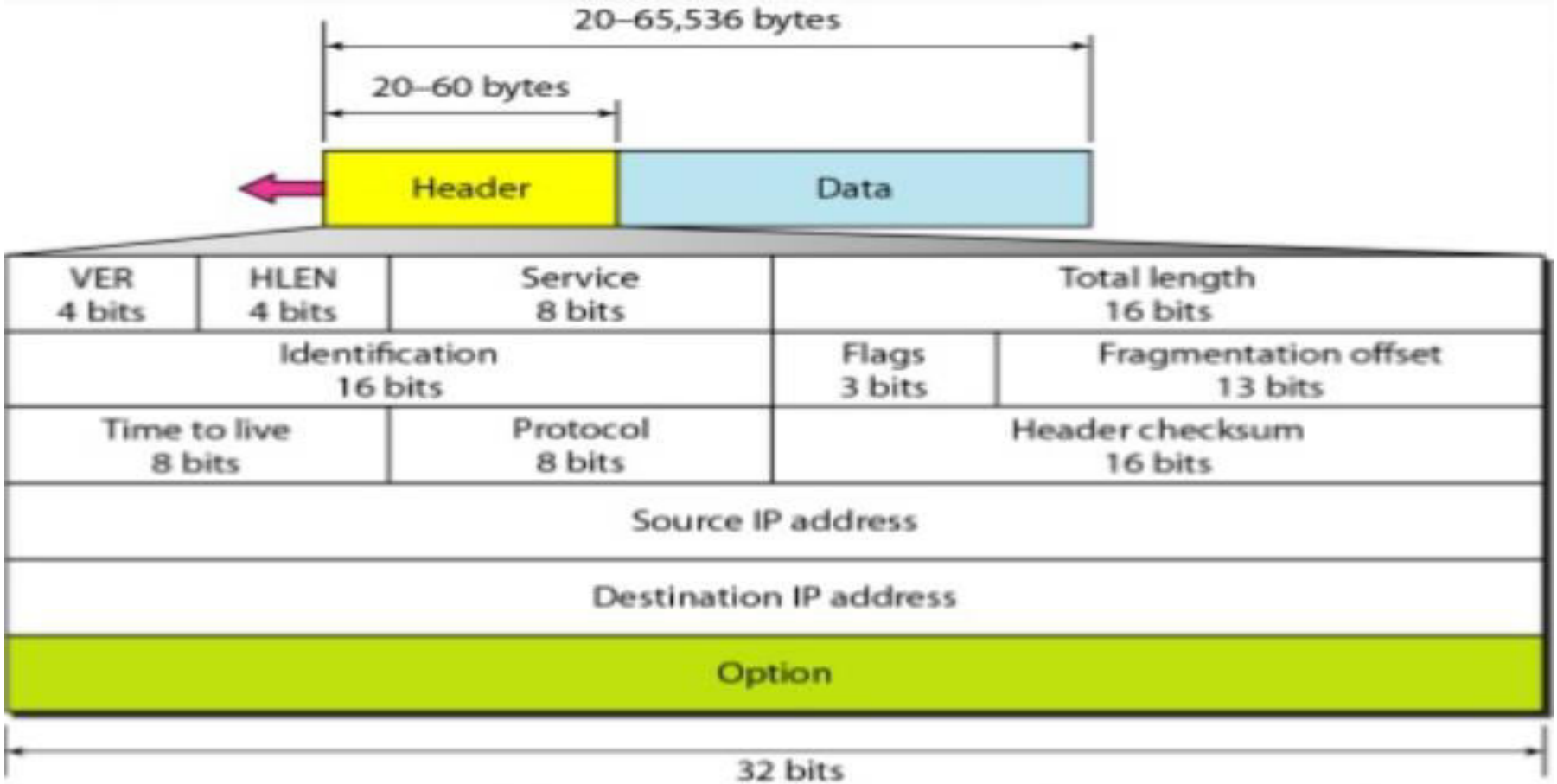
IPv4

- The Internet Protocol version 4 (IPv4) is the delivery mechanism used by the TCP/IP protocols.
- IPv4 is an unreliable and connectionless datagram protocol-a best-effort delivery service.
- The term best-effort means that IPv4 provides no error control or flow control (except for error detection on the header).
- If reliability is important, IPv4 must be paired with a reliable protocol such as TCP.

IPv4

Datagram

Packets in the IPv4 layer are called datagrams. Following figure shows the IPv4 datagram format.



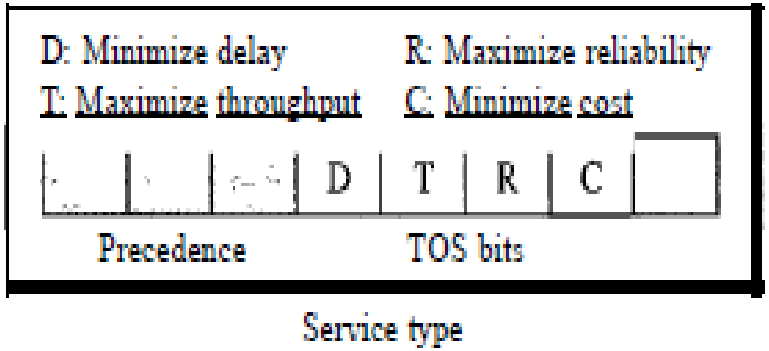
IPv4

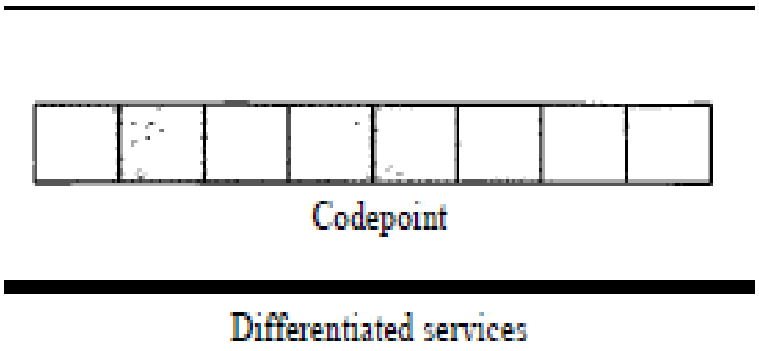
- A datagram is a variable-length packet consisting of two parts: header and data.
- The header is 20 to 60 bytes in length and contains information essential to routing and delivery.

Version (VER): This 4-bit field defines the version of the IPv4 protocol.

Header length (HLEN): This 4-bit field defines the total length of the datagram header in 4-byte words.

Services: This field, previously called service type, is now called differentiated services.





IPv4

Service Type

In this interpretation, the first 3 bits are called precedence bits. The next 4 bits are called type of service (TOS) bits, and the last bit is not used.

a. Precedence is a 3-bit subfield ranging from 0 (000 in binary) to 7 (111 in binary). The precedence defines the priority of the datagram in issues such as congestion. If a router is congested and needs to discard some datagrams, those datagrams with lowest precedence are discarded first.

b. TOS bits is a 4-bit subfield with each bit having a special meaning. Although a bit can be either 0 or 1, one and only one of the bits can have the value of 1 in each datagram.

IPv4

Total length:

- This is a 16-bit field that defines the total length (header plus data) of the IPv4 datagram in bytes.
- To find the length of the data coming from the upper layer, subtract the header length from the total length.
- The header length can be found by multiplying the value in the HLEN field by 4.

Length of data = total length - header length

Identification: This field is used in fragmentation.

Flags: This field is used in fragmentation

Fragmentation offset: This field is used in fragmentation

IPv4

Time to live: A datagram has a limited lifetime in its travel through an internet.

- This field was originally designed to hold a timestamp, which was decremented by each visited router. The datagram was discarded when the value became zero.

- Today, this field is used mostly to control the maximum number of hops (routers) visited by the datagram. When a source host sends the datagram, it stores a number in this field. This value is approximately 2 times the maximum number of routes between any two hosts. Each router that processes the datagram decrements this number by 1. If this value, after being decremented, is zero, the router discards the datagram.

IPv4

Protocol: This 8-bit field defines the higher-level protocol that uses the services of the IPv4 layer. An IPv4 datagram can encapsulate data from several higher-level protocols such as TCP, UDP, ICMP, and IGMP. This field specifies the final destination protocol to which the IPv4 datagram is delivered.

The value of this field for each higher-level protocol is shown in the following table:-

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

IPv4

Checksum: This field is used to detect error.

Source address: This 32-bit field defines the IPv4 address of the source. This field must remain unchanged during the time the IPv4 datagram travels from the source host to the destination host.

Destination address: This 32-bit field defines the IPv4 address of the destination. This field must remain unchanged during the time the IPv4 datagram travels from the source host to the destination host.

IPv4

Example

In an IPv4 packet, the value of HLEN is 1000 in binary. How many bytes of options are being carried by this packet?

Solution

The HLEN value is 8, which means the total number of bytes in the header is 8 x 4, or 32 bytes. The first 20 bytes are the base header, the next 12 bytes are the options.

Example

In an IPv4 packet, the value of HLEN is 5, and the value of the total length field is Ox0028. How many bytes of data are being carried by this packet?

Solution

The HLEN value is 5, which means the total number of bytes in the header is 5 x 4, or 20 bytes (no options). The total length is 40 bytes, which means the packet is carrying 20 bytes of data (40- 20).

IPv4

Example

An IPv4 packet has arrived with the first few hexadecimal digits as shown.

Ox450000280001000000102 ...

How many hops can this packet travel before being dropped? The data belong to what upper-layer protocol?

Solution

To find the time-to-live field, we skip 8 bytes (16 hexadecimal digits). The time-to-live field is the ninth byte, which is 01. This means the packet can travel only one hop. The protocol field is the next byte (02), which means that the upper-layer protocol is IGMP.