Data Communications and Networking Fourth Edition Forouzan

Chapter 20

Network Layer: Internet Protocol

20-1 INTERNETWORKING

In this section, we discuss internetworking, connecting networks together to make an internetwork or an internet.

Topics discussed in this section:

Need for Network Layer
Internet as a Datagram Network
Internet as a Connectionless Network

Figure 20.1 *Links between two hosts*

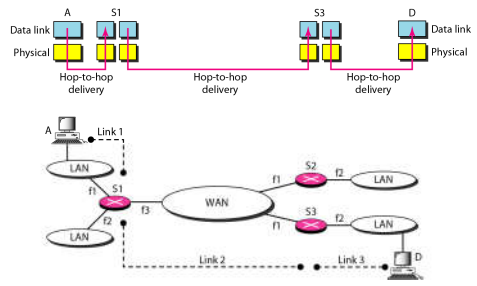

Figure 20.2 *Network layer in an internetwork*

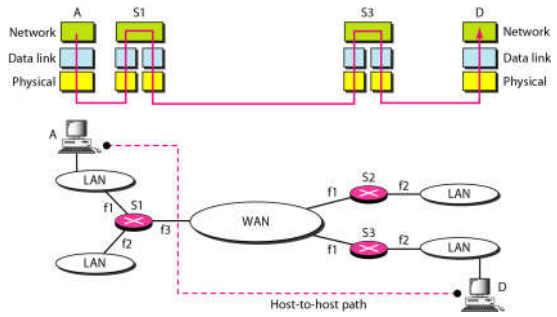

Figure 20.3 *Network layer at the source, router, and destination*

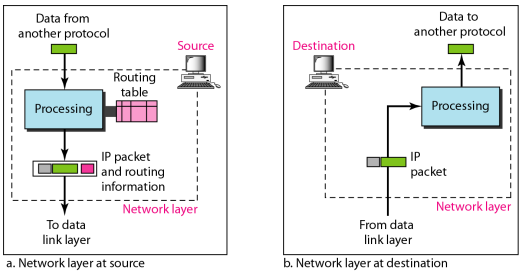

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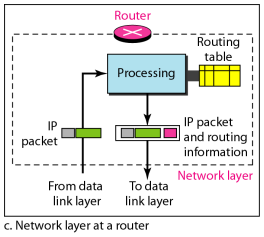
Figure 20.3 *Network layer at the source, router, and destination (continued)*



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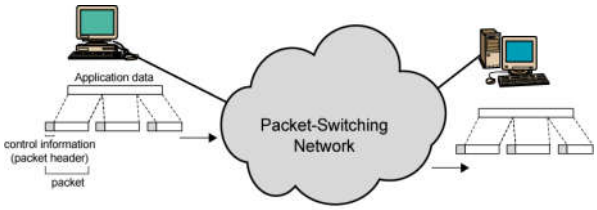
Packet Switching

- Data transmitted in small packets
  - Typically less than 1500 bytes (why?)
  - Longer messages split into series of packets
  - Each packet contains a portion of user data plus some control info
- Control info
  - Routing (addressing) info
- Packets are received, stored briefly (buffered) and past on to the next node
  - Store and forward

Use of Packets



Switching Technique

- Station breaks long message into packets
- Packets sent one at a time to the network
- Packets handled in two ways
  - Datagram:Each packet treated independently
  - Virtual circuit: Preplanned route established before any packets sent

William Stallings.. Data and Computer Communications, 7/E, Prentice Hall, 2004.

Note

Switching at the network layer in the Internet uses the datagram approach to packet switching.

Communication at the network layer in the Internet is connectionless.

20.10

20-2 IPv4

The Internet Protocol version 4 (IPv4) is the delivery mechanism used by the TCP/IP protocols.

Topics discussed in this section:

Datagram

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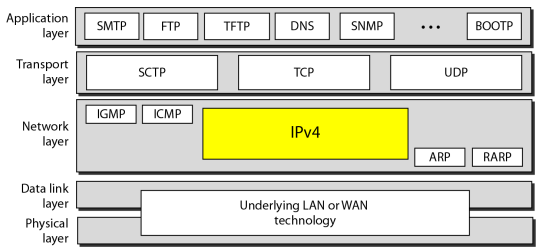
Figure 20.4 *Position of IPv4 in TCP/IP protocol suite*



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Note

IPv4 is an unreliable and connectionless datagram protocol – a best effort delivery

Best effort means that IPv4 provides no error control (except for error detection on the header) or flow control

IPv4 does its best to get a transmission through to its destination, but with no guarantees

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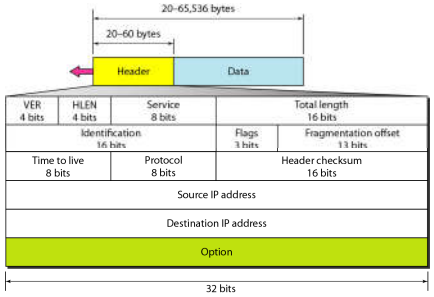
Figure 20.5 *IPv4 datagram format*



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IPv4 Datagram Format

- Version (VER): version of the IP protocol. Currently, the version is 4.
- Header length (HLEN): the total length of the datagram header in 4-byte words.
- Services: service type or differentiated services (not used now).
- Total length: total length (header plus data) of the datagram in bytes.
  - Total length of data = total length – header length

20.15

IPv4 Datagram Format

- Identification: used in fragmentation
- Flags: used in fragmentation.
- Fragmentation offset: used in fragmentation
- Time to live: it is used to control the maximum number hops visited by the datagram.
- Protocol: defines the higher-level protocol that uses the services of the IPV4 layer.

20.16

IPv4 Datagram Format

- Checksum: 1's compliment checksum
- Source address: is the IPv4 address of the source.
- Destination address: is the IPv4 address of the source.

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Figure 20.8 *Protocol field and encapsulated data*

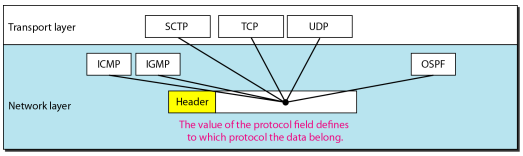

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Table 20.4 *Protocol values*

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

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Example 20.1

An IPv4 packet has arrived with the first 8 bits as shown:

01000010

The receiver discards the packet. Why?

Solution

There is an error in this packet. The 4 leftmost bits (0100) show the version, which is correct. The next 4 bits (0010) show an invalid header length ($2 \times 4 = 8$). The minimum number of bytes in the header must be 20. The packet has been corrupted in transmission.

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Example 20.2

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 × 4, or 32 bytes. The first 20 bytes are the base header, the next 12 bytes are the options.

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Figure 20.9 *Maximum transfer unit (MTU)*

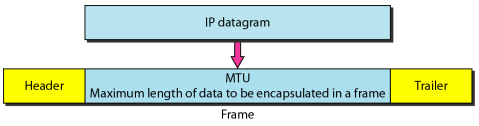

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Table 20.5 *MTUs for some networks*

Protocol	*MTU*
Hyperchannel	65,535
Token Ring (16 Mbps)	17,914
Token Ring (4 Mbps)	4,464
FDDI	4,352
Ethernet	1,500
X.25	576
PPP	296

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20-3 IPv6

The network layer protocol in the TCP/IP protocol suite is currently IPv4. Although IPv4 is well designed, data communication has evolved since the inception of IPv4 in the 1970s. IPv4 has some deficiencies that make it unsuitable for the fast-growing Internet.

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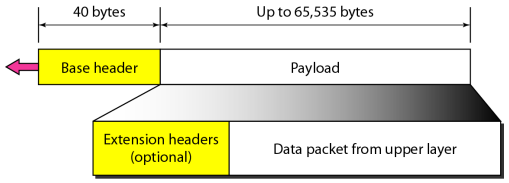
IPv6: Advantages

- Larger address space.
- Better header format.
- New options.
- Allowance for extensions.
- Support for more security.

Figure 20.15 *IPv6 datagram header and payload*



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20-4 TRANSITION FROM IPv4 TO IPv6

Because of the huge number of systems on the Internet, the transition from IPv4 to IPv6 cannot happen suddenly. It takes a considerable amount of time before every system in the Internet can move from IPv4 to IPv6. The transition must be smooth to prevent any problems between IPv4 and IPv6 systems.

Topics discussed in this section:

Dual Stack
Tunneling
Header Translation

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Figure 20.18 *Three transition strategies*

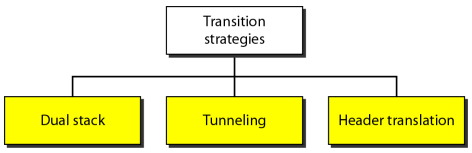

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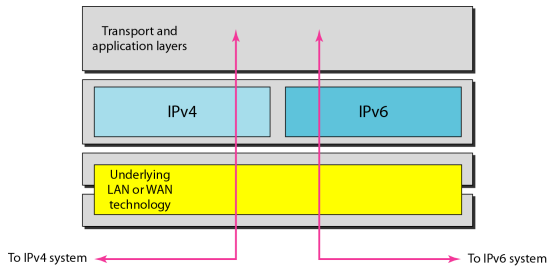
Figure 20.19 *Dual stack*



Host uses DNS query result to determine which IP to use

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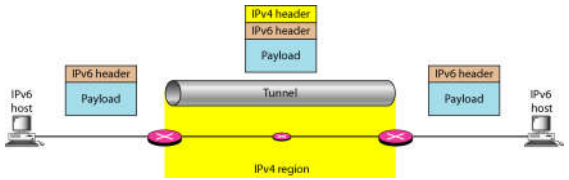
Figure 20.20 *Tunneling strategy*



Popular used right now in many countries

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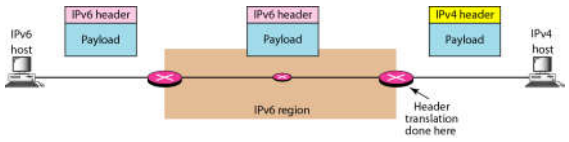
Figure 20.21 *Header translation strategy*



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