Example 4

An IP packet has arrived with the first few hexadecimal digits as shown below:

45000028000100000102 . . .

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 (see Table 8.4).

8.2 FRAGMENTATION

The format and size of a frame depend on the protocol used by the physical network. A datagram may have to be fragmented to fit the protocol regulations.

The topics discussed in this section include:

Maximum Transfer Unit (MTU)
Fields Related to Fragmentation

Figure 8.6 *MTU*

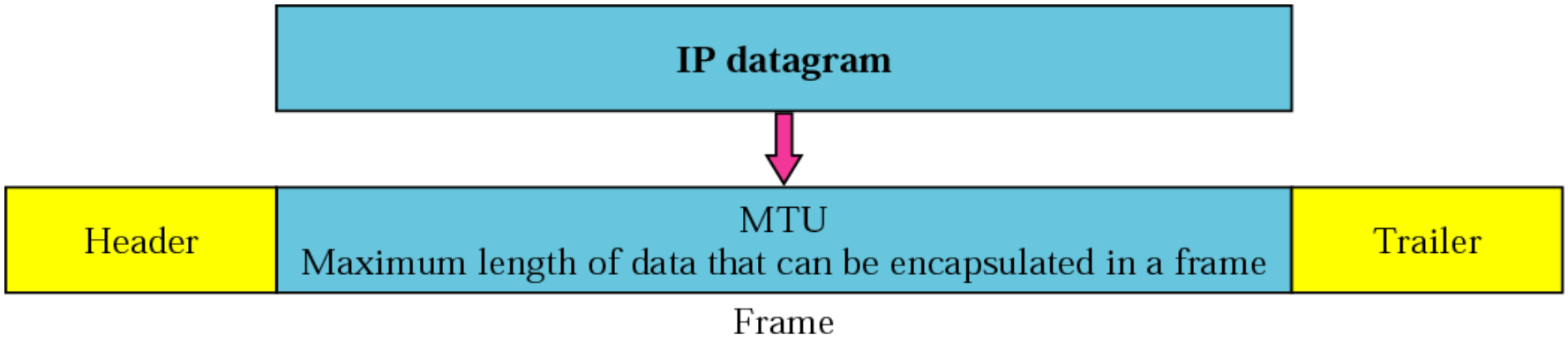


Table 8.5 MTUs for some networks

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

Figure 8.7 *Flags field*

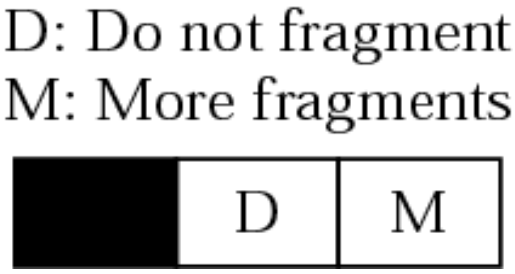


Figure 8.8 *Fragmentation example*

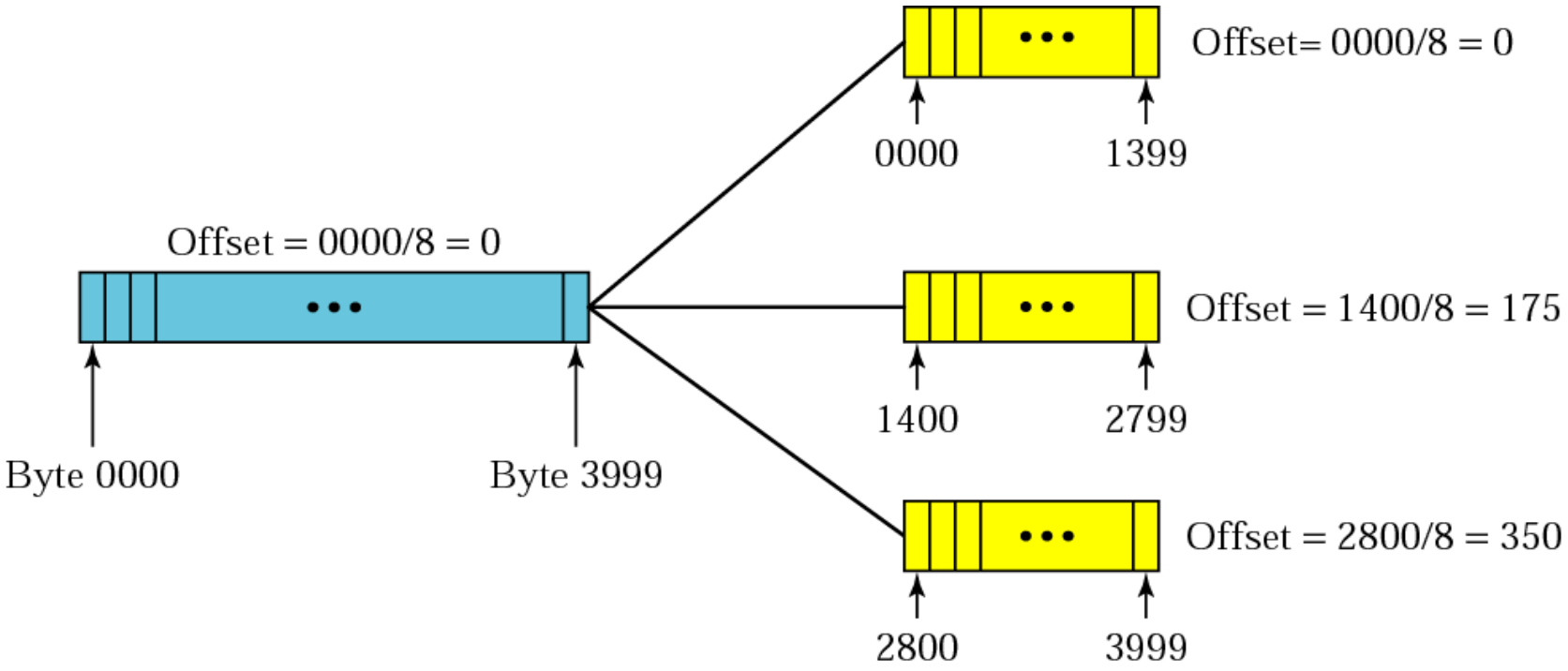
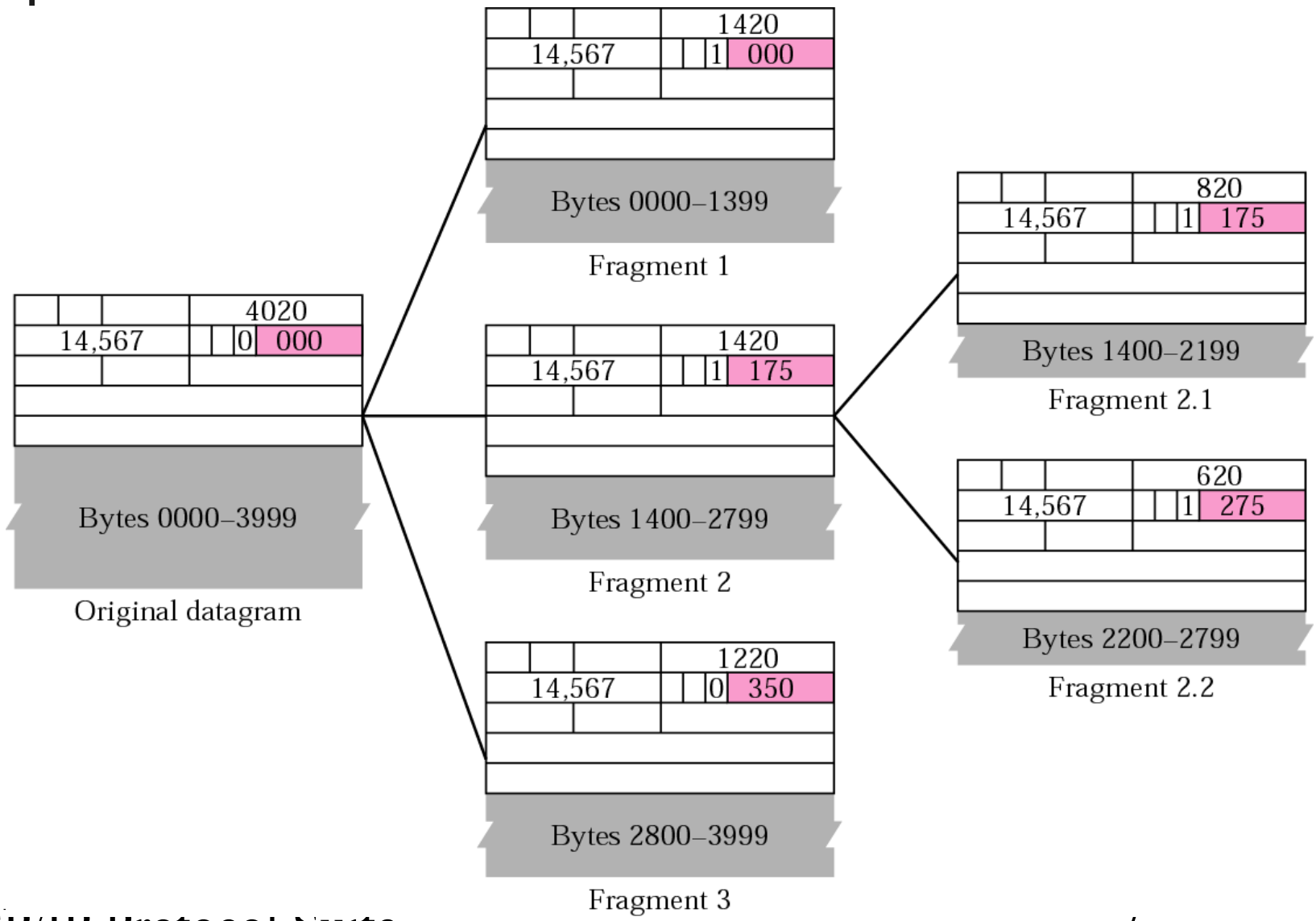


Figure 8.9 *Detailed fragmentation example*



Example 5

A packet has arrived with an M bit value of 0. Is this the first fragment, the last fragment, or a middle fragment? Do we know if the packet was fragmented?

Solution

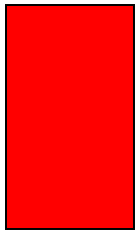
If the M bit is 0, it means that there are no more fragments; the fragment is the last one. However, we cannot say if the original packet was fragmented or not. A nonfragmented packet is considered the last fragment.

Example 6

A packet has arrived with an M bit value of 1. Is this the first fragment, the last fragment, or a middle fragment? Do we know if the packet was fragmented?

Solution

If the M bit is 1, it means that there is at least one more fragment. This fragment can be the first one or a middle one, but not the last one. We don't know if it is the first one or a middle one; we need more information (the value of the fragmentation offset). See also the next example.



Example 7

A packet has arrived with an M bit value of 1 and a fragmentation offset value of zero. Is this the first fragment, the last fragment, or a middle fragment?.

Solution

Because the M bit is 1, it is either the first fragment or a middle one. Because the offset value is 0, it is the first fragment.

Example 8

A packet has arrived in which the offset value is 100. What is the number of the first byte? Do we know the number of the last byte?

Solution

To find the number of the first byte, we multiply the offset value by 8. This means that the first byte number is 800. We cannot determine the number of the last byte unless we know the length of the data.

Example 9

A packet has arrived in which the offset value is 100, the value of HLEN is 5 and the value of the total length field is 100. What is the number of the first byte and the last byte?

Solution

The first byte number is 100 × 8 = 800. The total length is 100 bytes and the header length is 20 bytes (5 × 4), which means that there are 80 bytes in this datagram. If the first byte number is 800, the last byte number must be 879.

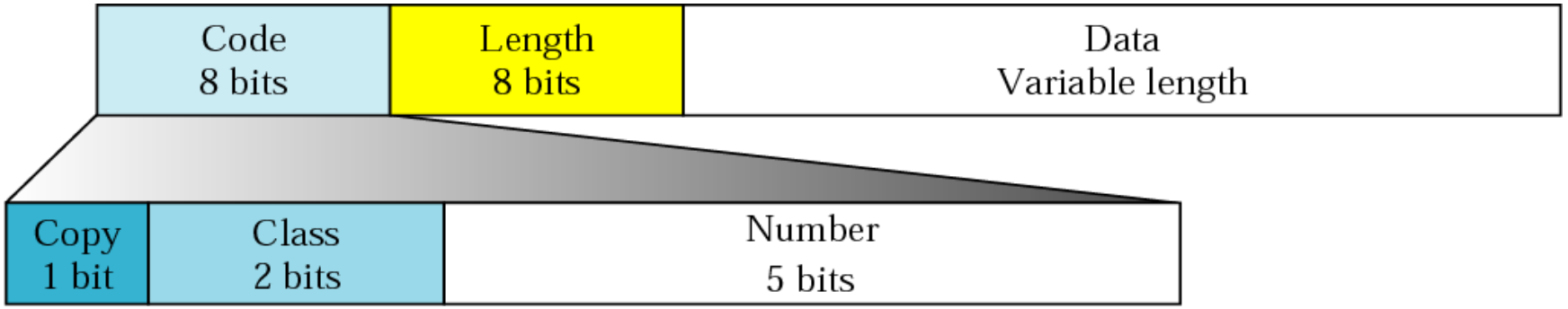
8.3 OPTIONS

The header of the IP datagram is made of two parts: a fixed part and a variable part. The variable part comprises the options that can be a maximum of 40 bytes.

The topics discussed in this section include:

Format
Option Types

Figure 8.10 *Option format*



Copy
0 Copy only in first fragment
1 Copy into all fragments

Class
00 Datagram control
01 Reserved
10 Debugging and management
11 Reserved

Number
00000 End of option
00001 No operation
00011 Loose source route
00100 Timestamp
00111 Record route
01001 Strict source route

Figure 8.11 *Categories of options*

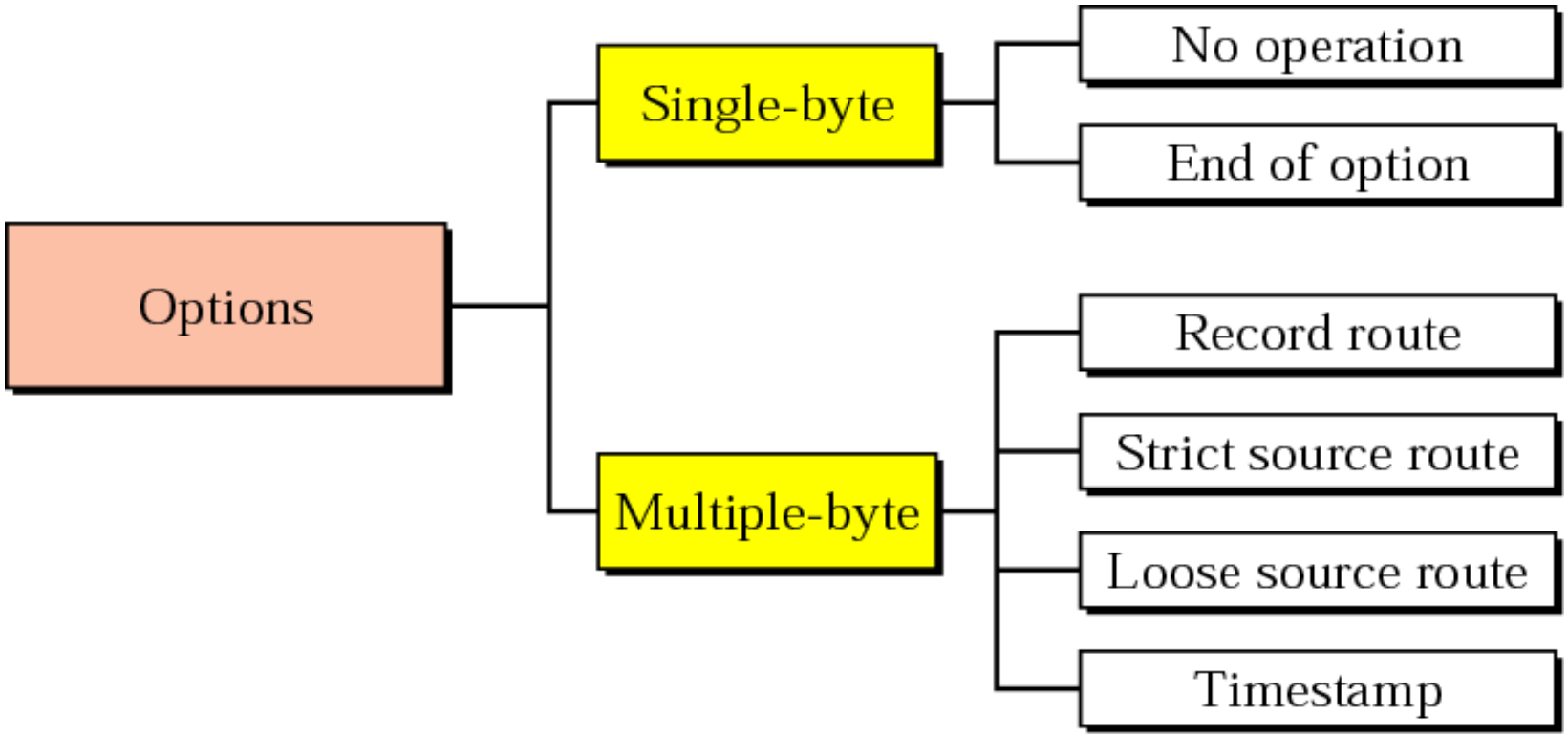


Figure 8.14 *Record route option*

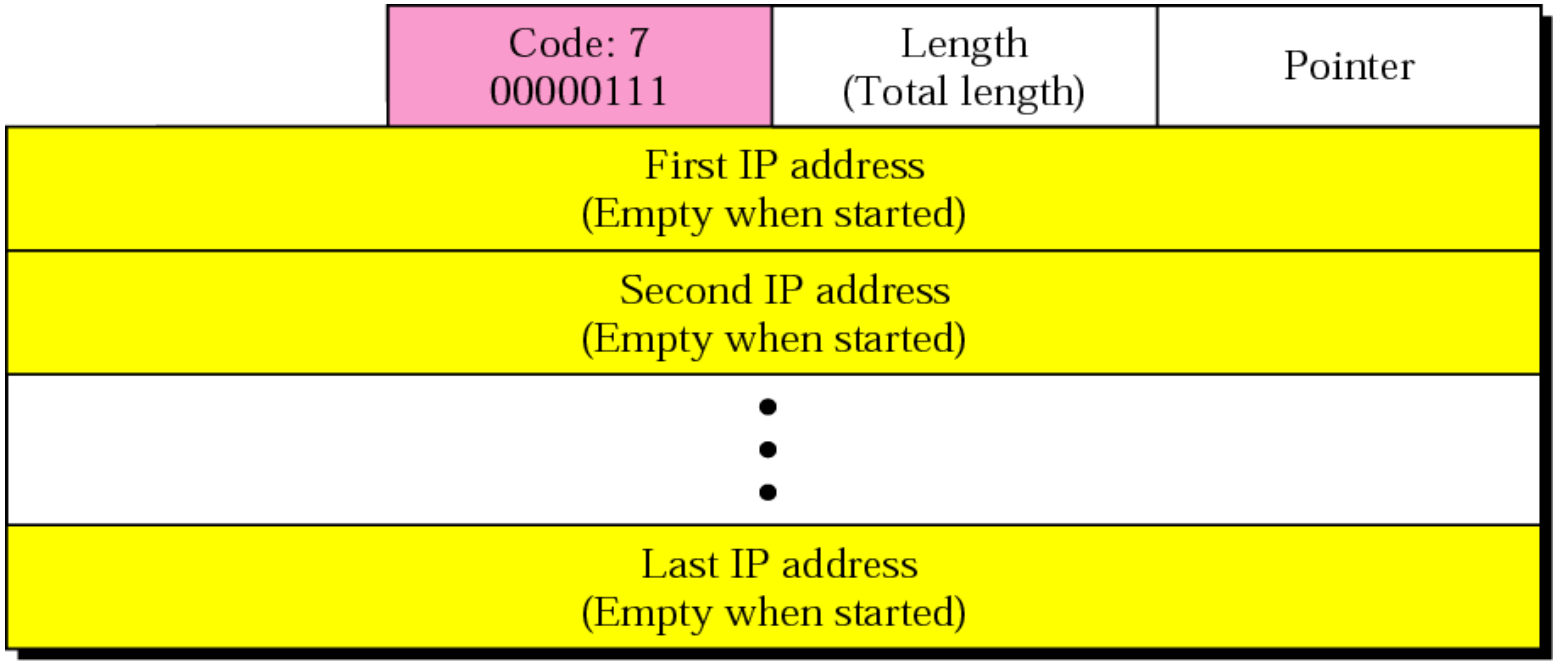


Figure 8.15 *Record route concept*

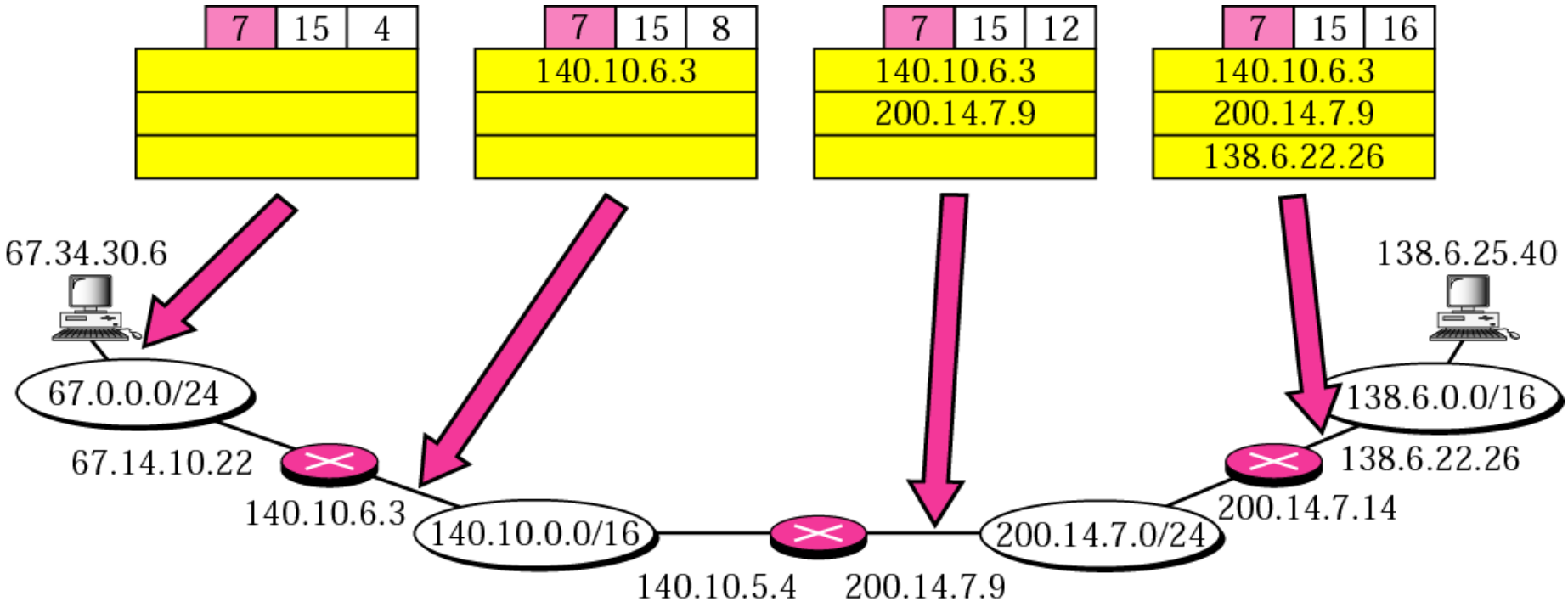


Figure 8.16 *Strict source route option*

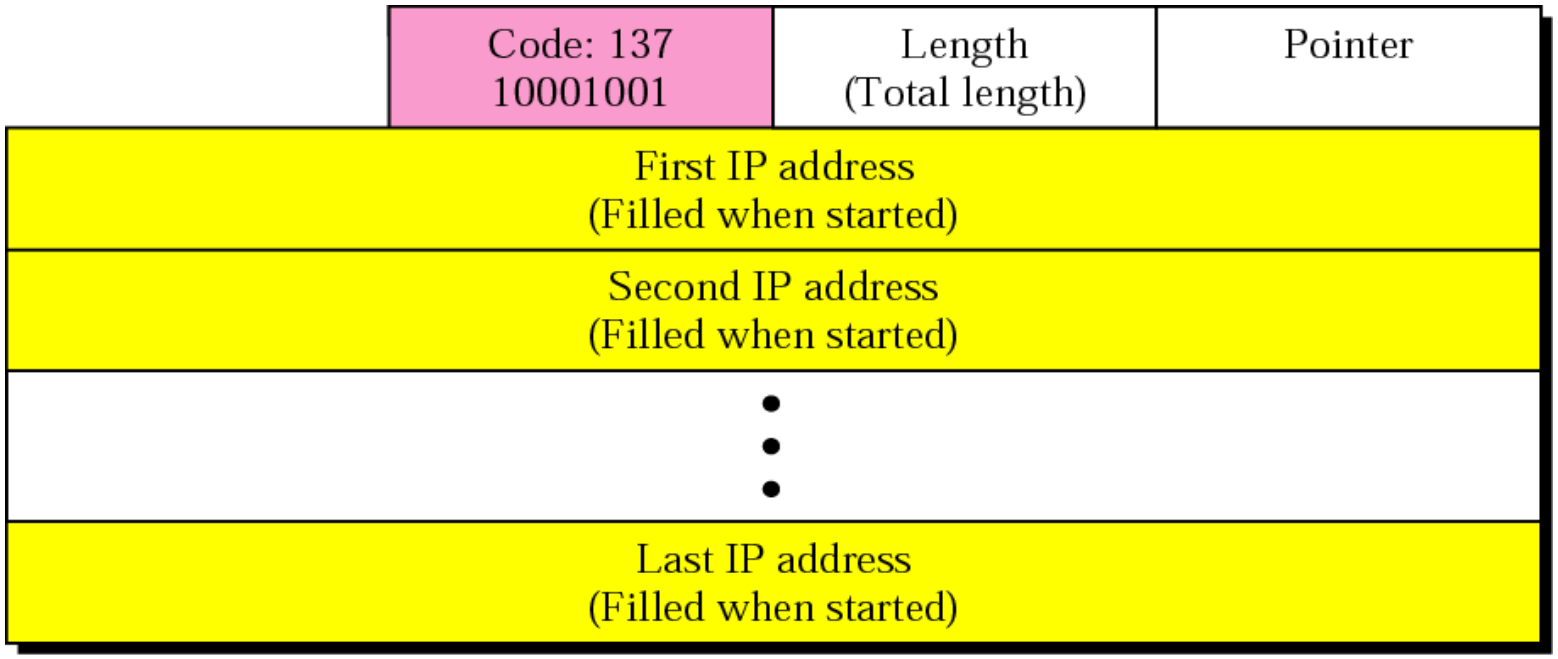


Figure 8.17 *Strict source route concept*

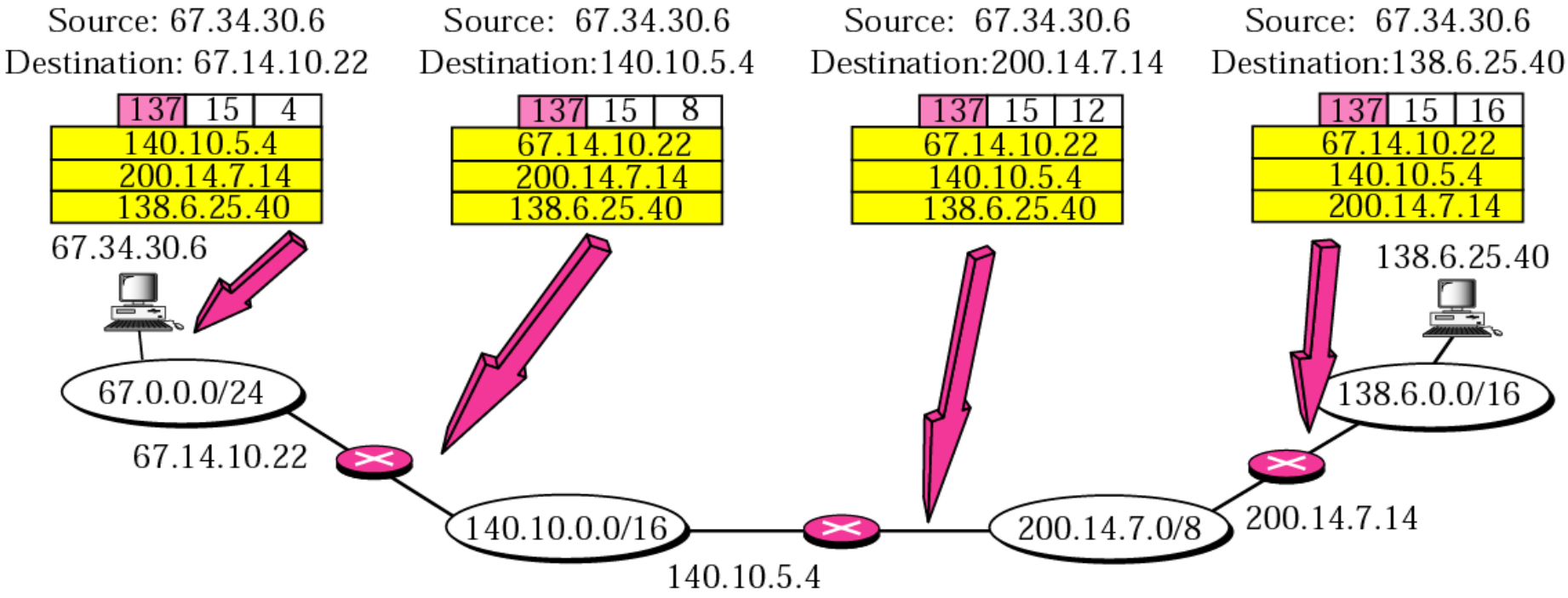


Figure 8.18 *Loose source route option*